# *Generation Interconnection System Impact Study Report*

# *For*

# *PJM Generation Interconnection Request Queue Position AB2-129*

# *Doubs 230 kV*

***March 2017***

# 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.

# General

Potomac Solar, LLC has proposed a solar generating facility located between Route 351 and Pleasant View Road, Adamstown, Frederick County, MD. AB2-129 requested 80.0 MW Energy (MFO) and 30.4 MW Capacity Interconnection Rights (CIR). The proposed in-service date for this project 6-1-2019. **This study does not imply a Potomac Edison ("Transmission Owner") commitment to this in-service date.**

# Point of Interconnection

AB2-129 will interconnect with the Potomac Edison distribution system by direct injection into Doubs 230 kV substation as illustrated in the one-line diagram in Appendix 2. The primary direct connection of this project will be accomplished by removing the existing East Alco 230 kV line and line trap from the Doubs 230 kV substation and connecting Potomac Solar, LLC to the connection point previously occupied by the East Alco 230 kV line approximately 1 span outside of Doubs 230 kV substation.

## Costs Summary and Transmission Owner Scope of Work

Potomac Edison facilities and network upgrades required to support AB2-129 project are:

(a) Attachment Facilities: $ 0.0

(b) Direct Connection Network Upgrades:

(b1) Reconfigure and re-energize the last span into Doubs Substation on the Doubs-East Alco (205) 230 kV line for the customer interconnect. At Doubs-East Alco (205) 230kV Termination at Doubs; Network Upgrade Number: tbd at facilities study stage; estimated cost: **$ 638,500**.

(b2) Project Management, Commissioning, Metering & SCADA; estimated cost: **$ 115,000**.

(b3) Remove East Alco 230 kV line exit to allow for AB2-129 to be connected. Remove wave trap and line tuner on East Alco exit (205). Replace line relaying for 205 line at Doubs Substation; Network Upgrade Number: tbd at facilities study stage; estimated cost: **$ 248,200**.

(c) Non-Direct Connection Network Upgrades:

(c1) Approximately 0.5 miles of ADSS fiber from Doubs Substation line exit #205 to Potomac Solar, LLC. to support fiber relaying scheme. Assumed ADSS fiber tail extensions to bring fiber into the substation control house. Assumed existing communications transport (MPLS) at Doubs substation is sufficient for additional SCADA telemetry.; estimated cost: **$ 134,800.**

(d) Direct Connection Local Upgrades: $ 0.0

(e) Non-Direct Connection Local Upgrades: $ 0.0

(f) Option to Build Upgrades: $ 0.0

***Estimated Total Costs (a) to (f): ..... $ 1,136,500***

NOTE: Above net amounts are in 2017 Dollars. Contribution in Aid of Construction (CIAC) Federal Income Tax Gross Up charge will be added to above amounts if this project does not meet the eligibility requirements of IRS Notice 88-129.

## Interconnection Customer Requirements

In addition to the Potomac Edison facilities, Interconnection Customer will also be responsible for meeting all criteria as specified in the applicable sections of the FirstEnergy "Requirements for Transmission Connected Facilities" document, effective 10-3-2016, which can be found under this link: http://www.pjm.com/~/media/planning/plan-standards/private-fe/fcr-facilities-connection-requirements.ashx, including:

1. The purchase and installation of a fully rated 230 kV circuit breaker on the high side of the AB2-129 step-up transformer.
2. The purchase and installation of the minimum required FirstEnergy 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 FirstEnergy Transmission System Control Center.
4. The establishment of dedicated communication circuits for SCADA report to the FirstEnergy Transmission System Control Center.
5. A compliance with the FirstEnergy and PJM generator power factor and voltage control requirements.
6. The execution of a back-up retail service agreement to serve the customer load supplied from the (AB2-129) generation project interconnection point when the units are out-of-service.
7. Compliance Issues: Any proposed interconnection facilities by Interconnection Customer must be designed in accordance with the "FirstEnergy Requirements for Transmission Connected Facilities" document; link is provided above. Potomac Solar, LLC must also meet all PJM, ReliabilityFirst and NERC reliability criteria and operating procedures required for standards compliance. For example, the Interconnection Customer 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 FirstEnergy system.
8. Reactive Power Requirements: AB2-129 project shall be designed to have a range of dynamic reactive capability that supports its operation from a 0.95 leading to 0.95 lagging power factor at the generator's terminals. Solar projects can cause voltage swings as their output oscillates with moving clouds without continuous regulation, and system voltages can exceed the established limits. Should Interconnection Customer fail to provide dynamic reactive capability from the AB2-129 generation project for any reason once interconnected, FirstEnergy and/or PJM dispatchers may need to take action to curtail both the energy and capacity portions of its output to prevent non-compliance with voltage criteria.

The above requirements are in addition to any metering required by PJM.

# Revenue Metering and SCADA Requirements

**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 Interconnection Customers's generating Resource. See PJM Manuals M-01 and M-14D, and PJM Tariff Sections 24.1 and 24.2.

**FirstEnergy Requirements**

The Interconnection Customer will be required to comply with all FirstEnergy Revenue Metering Requirements for Generation Interconnection Customers. The Revenue Metering Requirements may be found within the "FirstEnergy Requirements for Transmission Connected Facilities" document located at the following links:

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

# System Protection Analysis

An analysis was conducted to assess the impact of the AB2-129 generation project on the system protection requirements in the area. The results of this review have identified that the following current relaying and protection needs installed at the Doubs 230 kV substation connection point:

- New SEL-411L and SEL-311L relays for primary and backup protection are needed on the East Alco line terminal panel to replace existing SEL-321 and SEL-311A relays
- Fiber needs installed from the Doubs 230 kV substation East Alco line terminal to Potomac Solar, LLC's interconnection station.

Potomac Solar will still be responsible for meeting the generator interconnection requirements in FirstEnergy's "Requirements for Transmission Connected Facilities" document.

# Schedule

Based on the scope of the attachment facilities, direct and non-direct system upgrades, it is expected to take fifteen (15) months from the date of a fully executed Interconnection Construction Service Agreement to complete the installation. This includes a full payment for the work that is related to this interconnection project. It also assumes that the Interconnection Customer will provide the property for the Project direct connection facilities and all right-of-way, permits, easements, etc. that will be needed. A further assumption is 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 facilities and that transmission system outages will be possible when requested.

# Network Impacts

The Queue Project AB2-129 was evaluated as a 80.0 MW (Capacity 30.4 MW) injection into the Doubs 230 kV substation in the APS area. Project AB2-129 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AB2-129 was studied with a commercial probability of 100%. Potential network impacts were as follows:

**Summer Peak Analysis - 2020**

**Generator Deliverability**

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

None.

**Multiple Facility Contingency**

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

None.

**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):*

None.

**Steady-State Voltage Requirements:**

None.

**Short Circuit**:

None.

The fault currents at the POI, approximately one span outside of Doubs 230 kV Substation are listed below.

| | |
|---|---|
| Three phase fault current: | 40,720 Amps |
| Single line to ground fault current: | 35,730 Amps |
| Positive Sequence Thevenin (ohms): | 0.1785 + j3.2570 |
| Zero Sequence Thevenin (ohms): | 0.5740 + j4.6020 |

These values are for the current system configuration. Any system changes in the area could have a significant impact on these values. It will be the responsibility of the Interconnection Customer to make any protection upgrades required should this occur. The proposed interconnection facilities must be designed in accordance with the "FirstEnergy Requirements for Transmission Connected Facilities" document.

## Affected System Analysis & Mitigation

### NYISO Impacts:

None.

**Delivery of Energy Portion of Interconnection Request**
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.
Only the most severely overloaded conditions are listed. 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 will study all overload conditions associated with the overloaded element(s) identified.

None.

### Light Load Analysis – 2020:

None.

# System Reinforcements

### Short Circuit:

None.

### Stability and Reactive Power Requirement:

None.

### Summer Peak Load Flow Analysis Reinforcements:

**New System Reinforcements:**
*(Upgrades required to mitigate reliability criteria violations, i.e. Network Impacts, initially caused by the addition of this project generation):*

None.

**Contribution to Previously Identified System Reinforcements:**
*(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have a % allocation cost responsibility which will be calculated and reported for the Impact Study):*

None.

## Light Load Load Flow Analysis Reinforcements:

### New System Reinforcements:

*(Upgrades required for mitigating reliability criteria violations, i.e. Network Impacts, initially caused by the addition of this project generation):*

None.

### Contribution to Previously Identified System Reinforcements:

*(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have a % allocation cost responsibility which will be calculated and reported for the Impact Study):*

None.

# Appendix 1

## Facility Location
## PJM Queue Position: AB2-129

# Appendix 2

## Interconnection One-Line Diagram
## PJM Queue Position: AB2-129