



## Phasor Measurement Unit (PMU) Placement Plan in RTEP Planning Process

### Problem / Opportunity Statement

Recognizing the history and lessons learned from the Department of Energy’s 2009 Smart Grid Investment Grant (SGIG) PMU deployment project, a formalized process is needed to expand deployment beyond the existing research-grade PMU devices on the PJM transmission system. This placement process is needed to:

1. Ensure that PJM’s real-time, post-event, and planning applications have the proper quantity and quality of PMU measurements required by these applications.
2. Expand the coverage of high-speed Synchrophasor devices in the PJM footprint to meet the dynamic monitoring needs of the future grid.

This plan would establish a minimum standard of PMU placement and would target the backbone transmission system in PJM.

### Benefits of Synchrophasor Devices

PJM has long recognized and explored the use of these devices, including: Oscillation detection, post-event analysis, and dynamic model validation.

### History of Synchrophasors in PJM

The bulk of PMU’s installed in the PJM footprint originated from the DOE SGIG grant from 2009 to 2013. The following table summarizes the current distribution of PMUs as of April 2020:

Type	Quantity
SGIG - Active	372
SGIG – Retired	23
ISA Requirement	35
TO Sponsored Installation	62
External RTO	398

A growth-cycle is needed to ensure to consistent replacements and new installations as the grid evolves.

### Generator Requirement

In 2014, PJM filed a Tariff ISA requirement requiring interconnecting generators larger than 100 MVA with an ISA executed after October 1, 2012 to install a PMU. This (typically) requires PMU voltage and current measurements on the low-side of the generator step-up transformer.

### Voluntary PMU Placement Plan for Transmission System

In 2016, PJM published a voluntary [PMU Placement Strategy](#) to guide placement of new (transmission level) PMUs in the PJM footprint.



## Problem/Opportunity Statement

Placement drivers include:

- **Area of Known Stability Concern (STABILITY or S)**
  - Any station with impact to the PJM RTO and/or neighboring systems within the Eastern Interconnection, which has been identified as having conditional stability concerns / limitations / restrictions.
- **IROL Measurement (IROL or I)**
  - Any station which is utilized in the derivation of a PJM Transfer Interface which is also classified as an Interconnection Reliability Operating Limit [IROL]. NOTE: Focus would be on direct phasor measurements for pieces of equipment explicitly identified within an Interface Definition, but for the ease of assembling the list contained herein, only the substation has been identified.
- **Expanded Observability (OBSERVABILITY or O)**
  - Stations within the PJM system that further expand / add to redundancy/ complete PJM's observability with respect to the Extra High-Voltage [EHV] network or Oscillatory behavior. In addition to oscillatory situational awareness, the expansion of the EHV observability would be utilized by PJM to derive a full view of the PJM EHV system within the synchrophasor-driven PJM Linear State Estimator [LSE].
- **System, Generator, or Load Model Validation (MODEL or M)**
  - Whether utilized as part of system, generator or load model validation, this is data is utilized in order to confirm or refine the PJM Planning and Operations models with respect to dynamic reactive power resources, large industrial loads, large block loads, HVDC resources, automatic control resources, and/or Remedial Action Schemes (aka Special Protection Schemes).

### Summary

- PJM has identified the [reliability and resilience benefits](#) of PMU data observability across the PJM footprint. To achieve and maintain these benefits, a minimum coverage of Synchrophasor devices are needed.
- A PMU placement provision is needed in the RTEP planning process to 'opportunistically' install Synchrophasor devices at minimal cost. Targeted (retrofit) PMU placement projects may be needed to ensure near-term PMU coverage needed by key Synchrophasor applications.
- PJM sees an opportunity to incorporate PMU Placement as a prospective requirement in the RTEP planning process to establish a growth-cycle of new and replacement PMU devices. Adding such a requirement for an identified category of RTEP projects will be a low-cost, high-benefit implementation.
- Such a requirement would require a long-lead notice for newly approved projects to include PMU devices in project costs and design documents.