

ISO Integration of Utility-Scale Solar

Trimark Associates

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Utility-Scale Solar in the News

- “To finally spark the creation of a clean energy economy, we will double the production of alternative energy in the next three years.”
- Barack Obama 1/8/09
- “This is a time of transition for the company. We are moving rapidly into the utility power plant market.”
- Tom Werner, SunPower CEO, 1/29/09

Trimark Overview

- Established in April 2000
- California Solar Initiative (CSI) Performance Data Provider (PDP) and Perf. Monitoring & Reporting Service (PMRS)
- Expertise in electricity metering, SCADA, AMI
- Responsible for metering, telemetry, and meter data management on nearly **20,000 MW** of power generation
 - 40% of electricity generated in California
 - By comparison: the entire \$2B CSI program covers 350MW
- Extensive utility-scale wind measurement experience
- Trimark was **responsible for ISO integration of SCE's 2MW utility-scale solar** facility in Fontana, CA

SCE's Solar Rooftop Project



- First site: Fontana, CA
- 600,000 sqft roof facility
- 2MW (33,700 thin-film panels)
- **Real-time data integration to CAISO**
- Total Project: 150 rooftops, 2 sq miles, 250MW

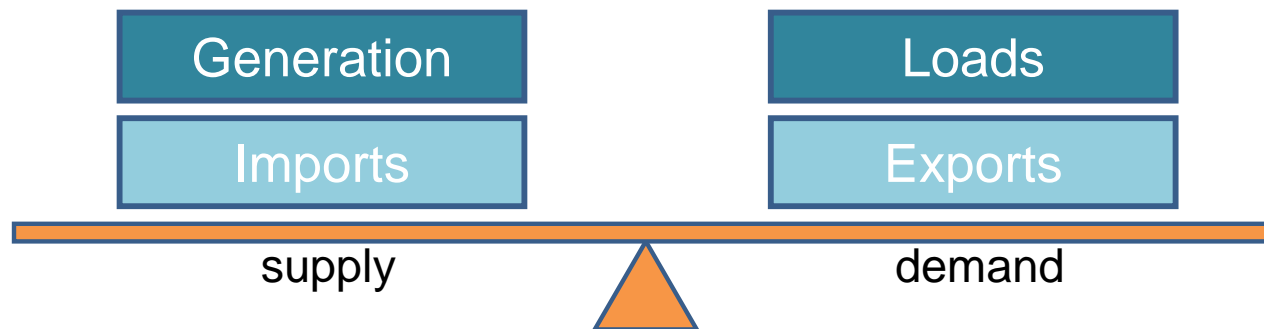


ISOs and RTOs (North America)

- Independent System Operator (ISO)
 - Under authority of the Federal Energy Regulatory Commission (FERC), an ISO oversees the electrical power system **within a single state**
 - Alberta Electric System Operator (AESO)
 - California ISO (CAISO)
 - Electric Reliability Council of Texas (ERCOT)
 - Florida Reliability Controlling Council (FRCC)
 - Independent Electricity System Operator (IESO – Ontario, Canada)
 - New York ISO (NYISO)
- Regional Transmission Operator (RTO)
 - Controls the power transmission system **across multiple states**
 - Midwest Independent Transmission System Operator (MISO)
 - ISO New England (ISO-NE)
 - PJM Interconnection (PJM)
 - Southwest Power Pool (SPP)

Energy Markets and Scheduling Generation

- Electricity on the grid cannot be stored
 - Supply must equal Demand
 - Demand varies continuously, making it difficult to forecast and schedule generation (Supply)
 - Wholesale energy market exists to trade electricity



- Timing: **Day-ahead** and **Hour-ahead** scheduling
 - Producers incur imbalance (deviation) charges whenever delivered energy differs from the scheduled amount

Scheduling Complexities of Wind and Solar

- CAISO: Hour-ahead schedules must be submitted 2hr 45min before the start of each hour
 - Wind, clouds, and dust storms can shift unpredictably in the course of 2.75 hours
- Imbalance charges are calculated for every ten-minute interval
 - 4,320 ten-minute intervals each month
 - 4,320 opportunities to incur deviation charges **caused by uncontrollable factors**

CAISO PIRP

- Participating Intermittent Resource Program
 - Launched in 2004 to encourage market participation from renewable resources
 - Allows intermittent producers >1MW to bid into California forward market without exposure to hourly or daily imbalance charges
 - Imbalance charges are based upon **monthly net deviations**
 - Increases the revenue certainty for producers

4,320 → 1

- To date, wind generators are the sole PIRs
- Solar has been under consideration for inclusion into PIRP since mid-2007
 - Anticipated approval in **mid-2009**

How Does PIRP Work?

- Scheduling is driven by **The Forecast**
- CAISO has a contract with a forecasting service provider
 - Wind Forecasting Service Provider = AWS Truewind
 - Solar Forecasting Service Provider = TBD
- Forecasting methodology
 - Combining regional atmospheric models with **statistical data** from each site
 - Production data
 - Meteorological data
- The PIR's Scheduling Coordinator (SC) sets their schedules based upon the forecast provided by CAISO's forecasting service provider

CAISO PIRP Solar Telemetry Requirements

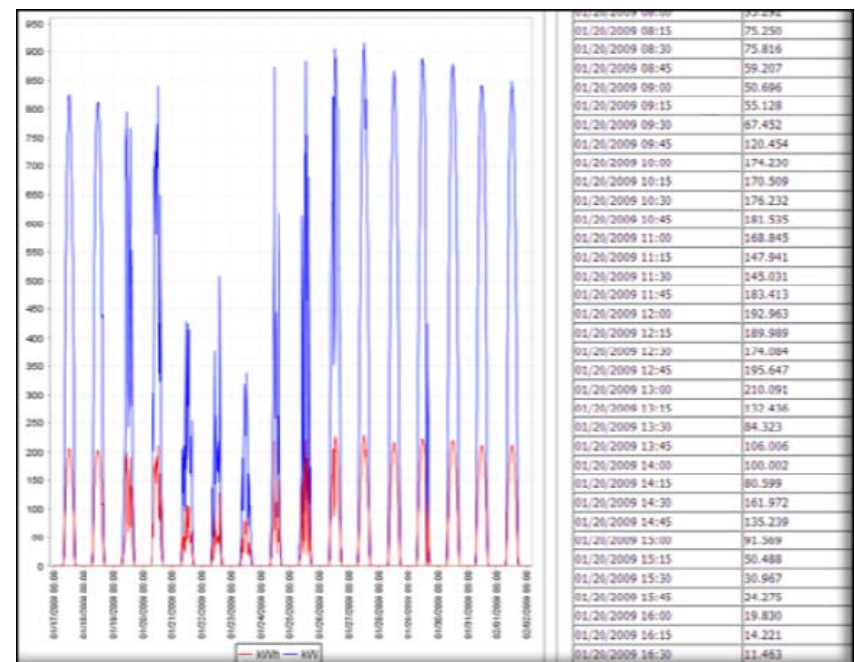
- Minimum of **2 MET Stations** per Site
- Meteorological Sensors (Photovoltaic System)
 - **Thermopile** Pyranometer (Direct & Indirect Irradiance)
 - Ambient Temperature
 - Backpanel Temperature
 - Anemometer and Wind Vane (Wind Speed and Direction)
- **CAISO-approved** Revenue Meter
- Data Processing Gateway (**DPG**)
- Production and meteorological data must be collected for a minimum of 60 days before PIRP eligibility
 - This data is used to train the power production forecast models for each site

Data Processing Gateway (DPG)

- Server-based SCADA system with PKI data security
 - Secure connection to CAISO's private network
- Centralized database of all site data points
- Flexible I/O
 - Ethernet, Serial, Discrete I/O, Multiple outputs for various users
- Provides data to meet all CAISO requirements
 - Plus interfaces to owner, operator, and local utility
- Supports all standard communications protocols
 - DNP 3.0, Modbus, OPC, PI System
- Email alerts and alarms
- Historian capabilities
- HMI Graphical user interface

Revenue Meter Data

- Must use CAISO-approved revenue meter
 - Landis+Gyr MAXsys 2510
 - Schlumberger Q1000
 - TransData Mark V
 - Power Measurement ION8600, ION8500, ION8400, ION8300
 - Scientific Columbus JEMSTAR
 - Nexus 1262, Nexus 1272
- Interval Data Recording (IDR)
- MV90-readable

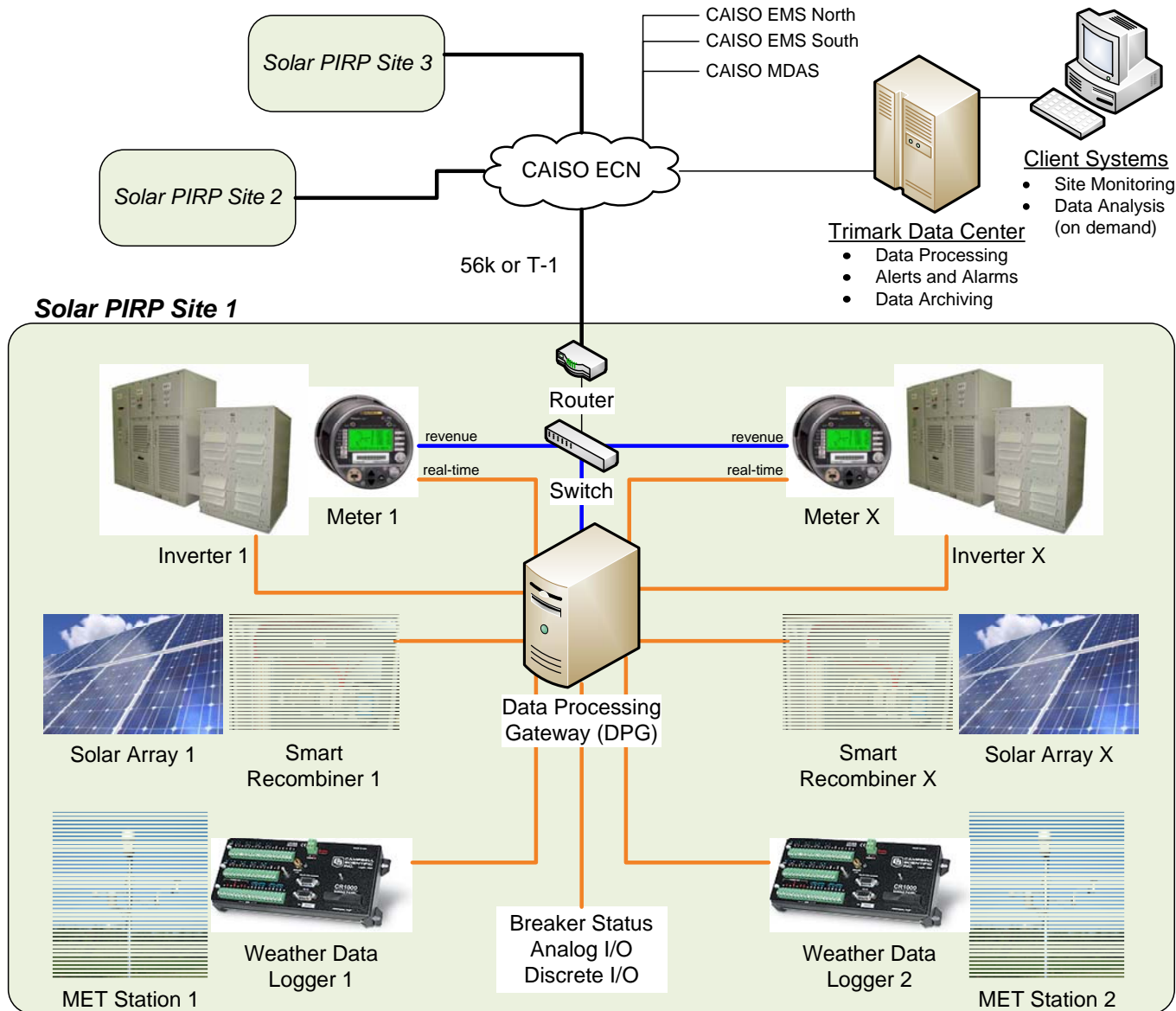


CSI versus PIRP

- Your current revenue meter and meteorological sensor specifications may not be PIRP-compliant

| | CSI | PIRP |
|------------------|-------------------|-------------------|
| System Size | $\leq 1\text{MW}$ | $\geq 1\text{MW}$ |
| Meter Accuracy | 2.0% | 0.25% |
| Approved Meters | >250 | 10 |
| Weather Stations | not required | 2 per site |
| DPG | not required | 1 per site |

ISO Integration of Site Data



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