



4<sup>th</sup> International Conference

on

Renewable and Distributed Energy Resources

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# Impacts of Solar Variability from a Utility Perspective

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California ISO

# California Independent System Operator Corporation

A nonprofit public benefit corporation created by the state:

- Manages flow of electricity, ensuring reliable operation of the grid
- Facilitates market for day-ahead, real-time energy & ancillary services
- Provides open and non-discriminatory access to grid supported by comprehensive planning process
- Board appointed by governor and confirmed by state senate
- Regulated by Federal Energy Regulatory Commission (FERC)
- Main control center in Folsom; second control room in Southern CA



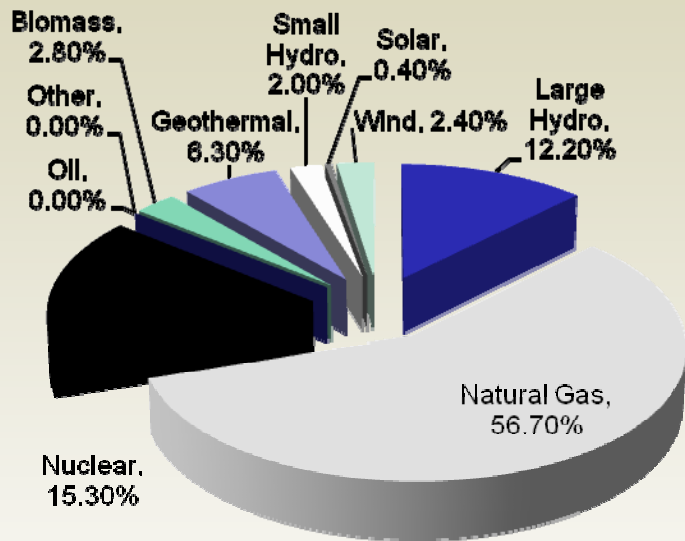
# California ISO by the Numbers



Approximately 80% of California's electricity load is managed by the ISO

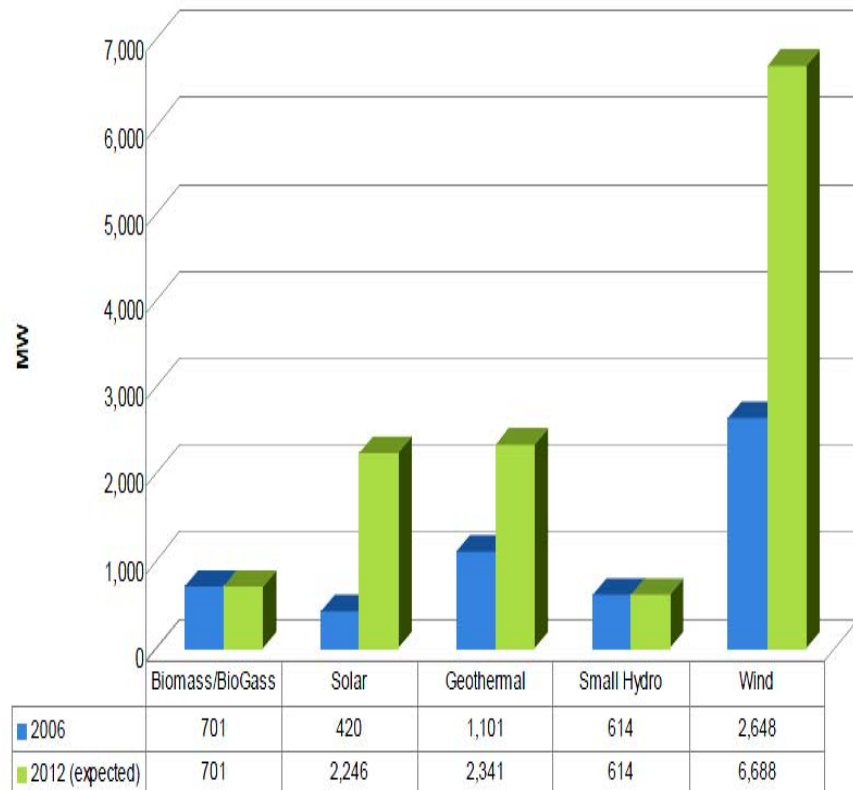
- **55,027** MW of power plant capacity
- **10,000** MW import capacity
- **50,270** MW record peak demand (July 24, 2006)
- **25,526** circuit-miles of transmission lines
- **30 million** people served
- **230 billion** annual kilowatt-hours of electricity delivered annually

# Capacity Today and Tomorrow



2009 Installed Capacity

Solar ~ 420 MWs  
Wind ~ 2900 MWs



# Variability and Uncertainty Challenge

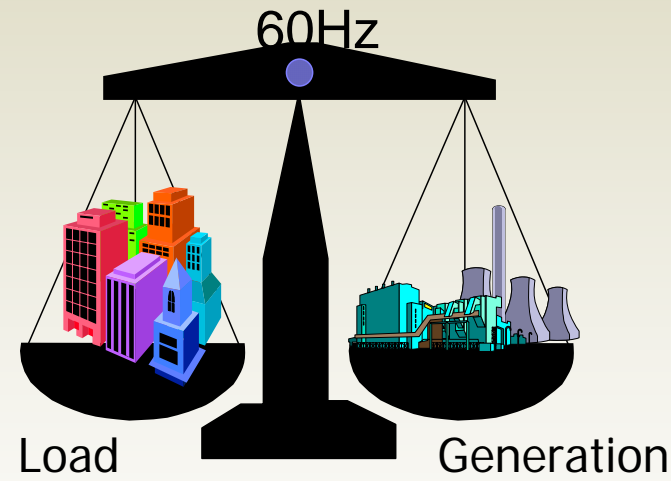
Forecasting errors could lead to:

- Less efficient unit commitment
- Unanticipated system ramps
  - upward and downward
- Increased load/renewable resource following requirements
- Increased regulation requirements
- Increased frequency and magnitude of minimum generation or over-generation events.

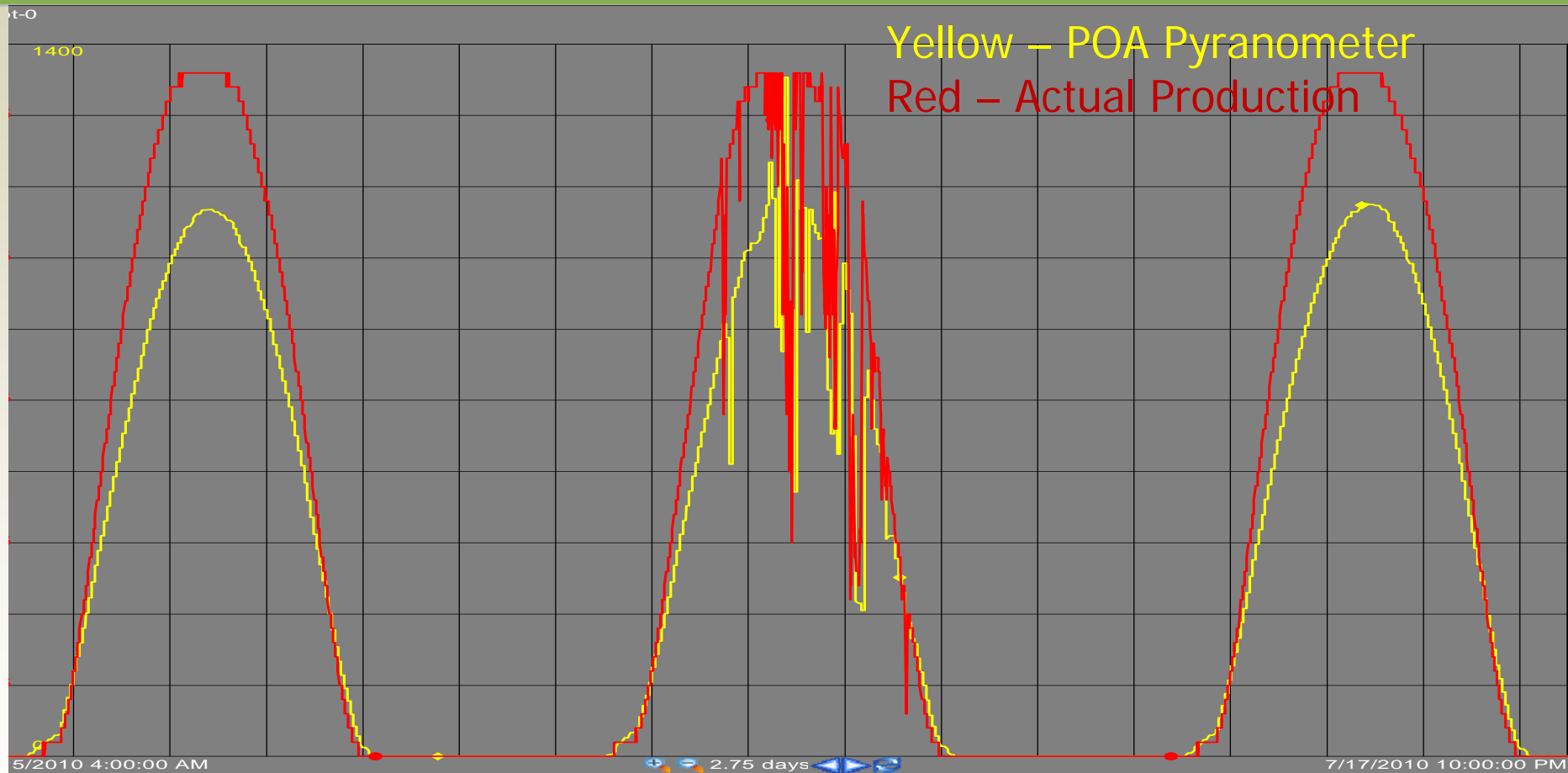


# Reliability Concerns

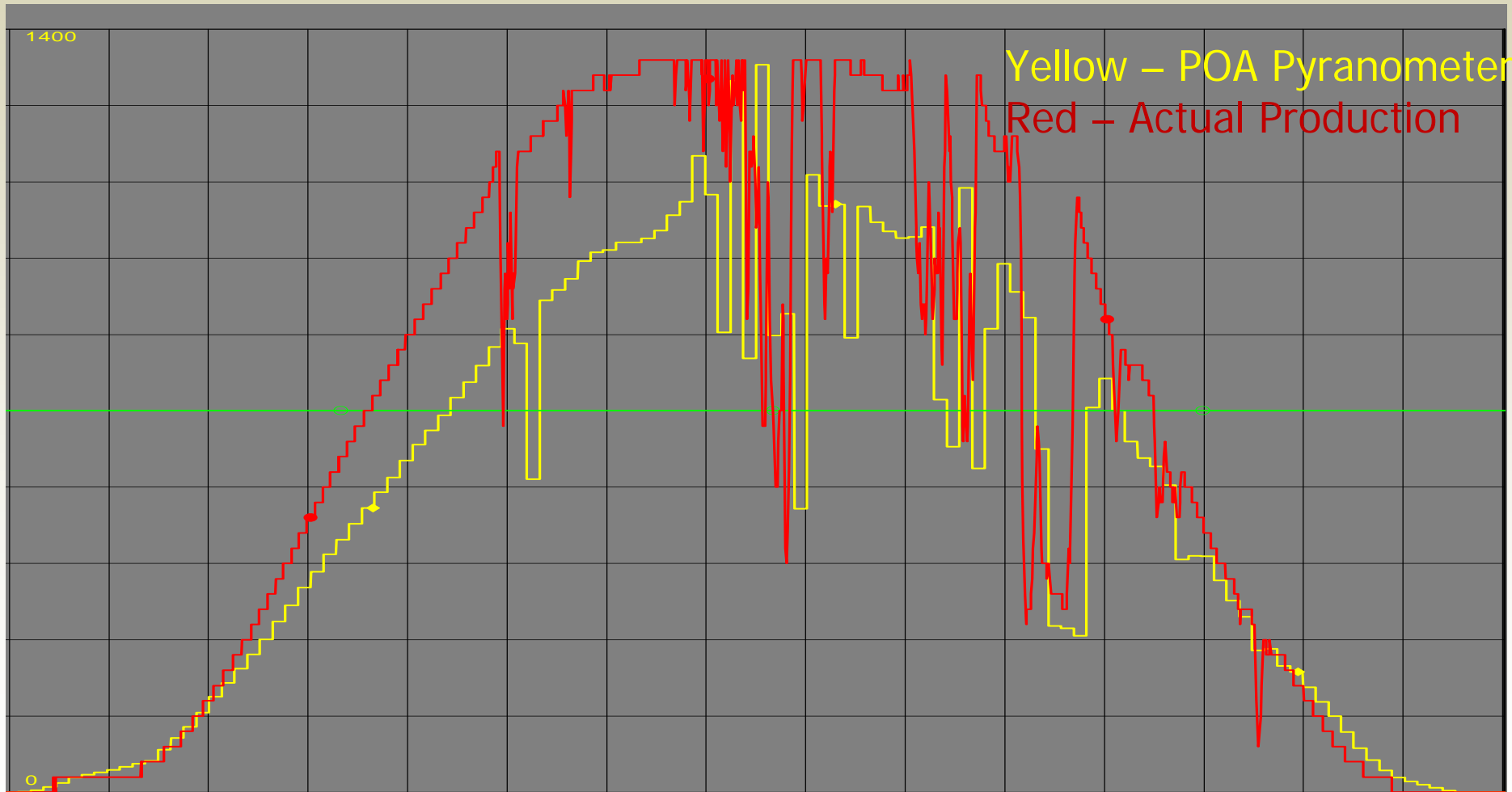
- Renewable Forecast Under Estimation
  - Over generation
  - Acceleration In System Frequency
  - Violation of NERC CPS rules
  - Inadvertent Energy Flows
- Renewable Forecast Over Estimation
  - Insufficient Load Following Capacity
  - Reduced Contingency Reserves
  - Inability to Serve Load



# Solar Event July 16, 2010

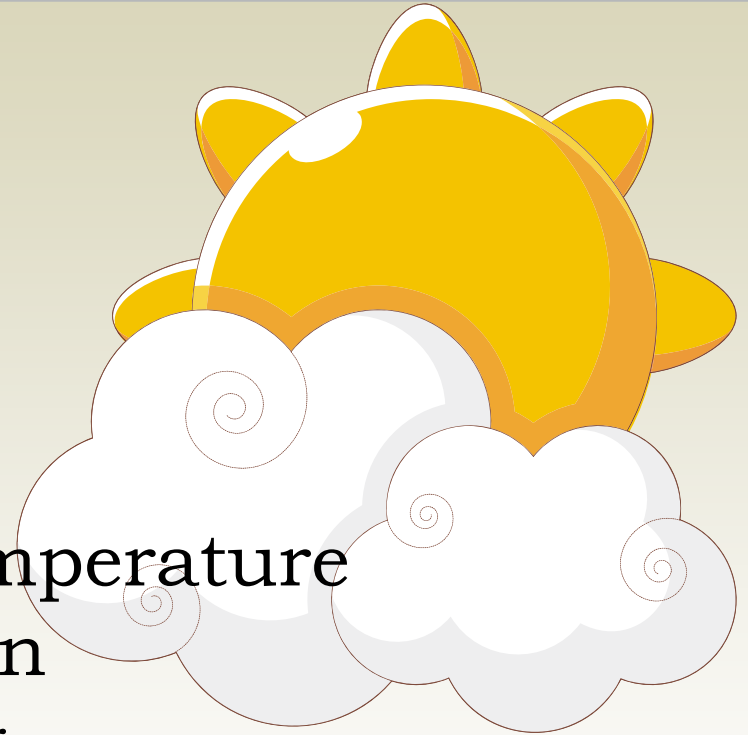


# Solar Event July 16, 2010



# Data Requirements

- Diffused Irradiance
- Direct Irradiance
- Wind Speed/Direction
- Barometric Pressure
- Back Plane/Ambient Temperature
- Real Time MW Production
- MW Production Metering
- Outage Reporting
- Minimum 2 Met towers



# Increased Data Quality

- Unreported Outages
- Communication Failures
- Equipment Failures
- Sensor Quantities
- Sensor Locations



# Areas of Solar Forecast Investigation

## ■ University Collaboration

### ■ Sky Tracker Project - Solar

- CAISO, NREL, UCSD & Sempra collaboration
- Clouds are photographed every 5 mins
- Images are digitized and plotted.
- Using dual Sky tracker technology to triangulate cloud size and movement

### ■ Satellite, Sky & Land Monitoring Techniques



# Areas of Forecast Improvement Investigation

- Forecast Service Providers
  - Large Ramp Alert System
    - Defines Large Ramp Event
    - Estimates the Probability of Large Ramp event
    - Time of occurrence, duration and max magnitude of ramp
    - Rapid Update Cycle of NWS forecast
- Internal Forecast Development
  - Based on NWS
  - Tuned using actual wind park data
  - Proving techniques to use on solar parks.
- New Technologies
  - SoDAR
  - LiDAR
  - High Tower Wind Monitoring

# Thank You

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