

Renewables Integration in the Operations of the California ISO Market

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Shaping the industry

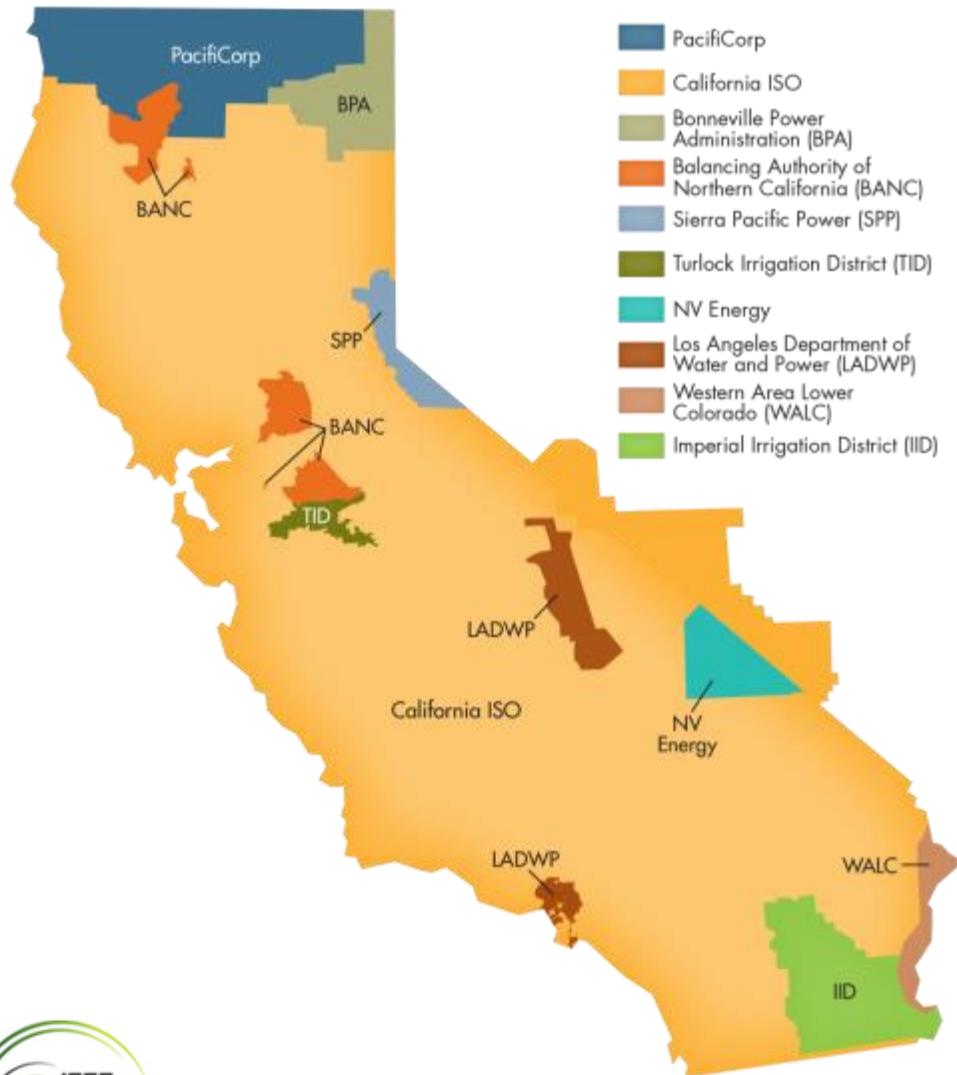
The ISO, a nonprofit public benefit corporation, maintains the constant and reliable flow of electricity for the health, safety and welfare of consumers

How?

- Delivering **286 million megawatt-hours** of electricity annually
- Facilitating **fair and transparent** wholesale electricity market
- Performing comprehensive **transmission planning**
- Clearing the way for **clean, green resources** to access the grid



California ISO by the numbers

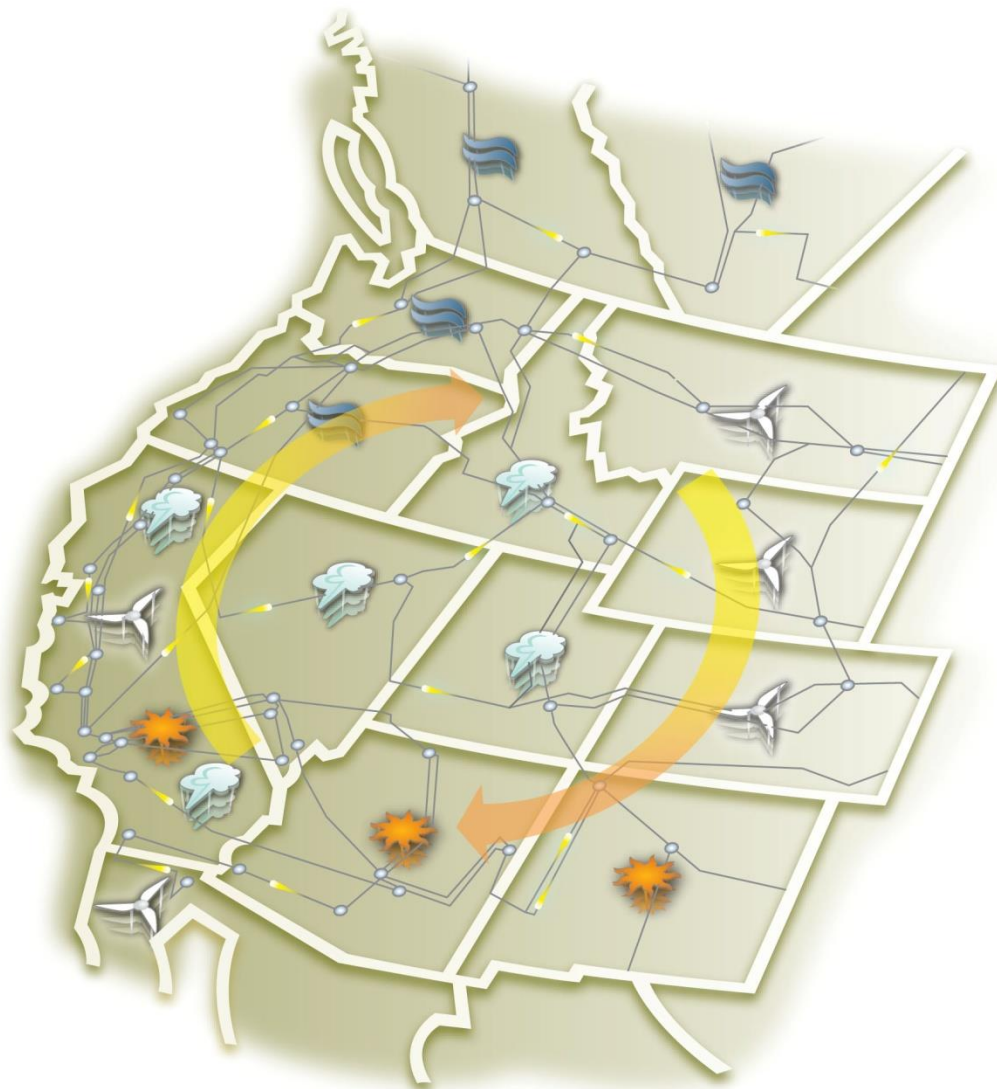


- **60,703** MW of power plant capacity
 - Wind 5,890 MW
 - Solar PV 4,173 MW
 - Solar Thermal 1,058 MW
- **50,270** MW record peak demand (July 24, 2006)
- **27,589** market transactions per day
- **26,024** circuit-miles of transmission lines
- **30 million** people served
- **246 million** megawatt-hours of electricity delivered annually

Resource reciprocity

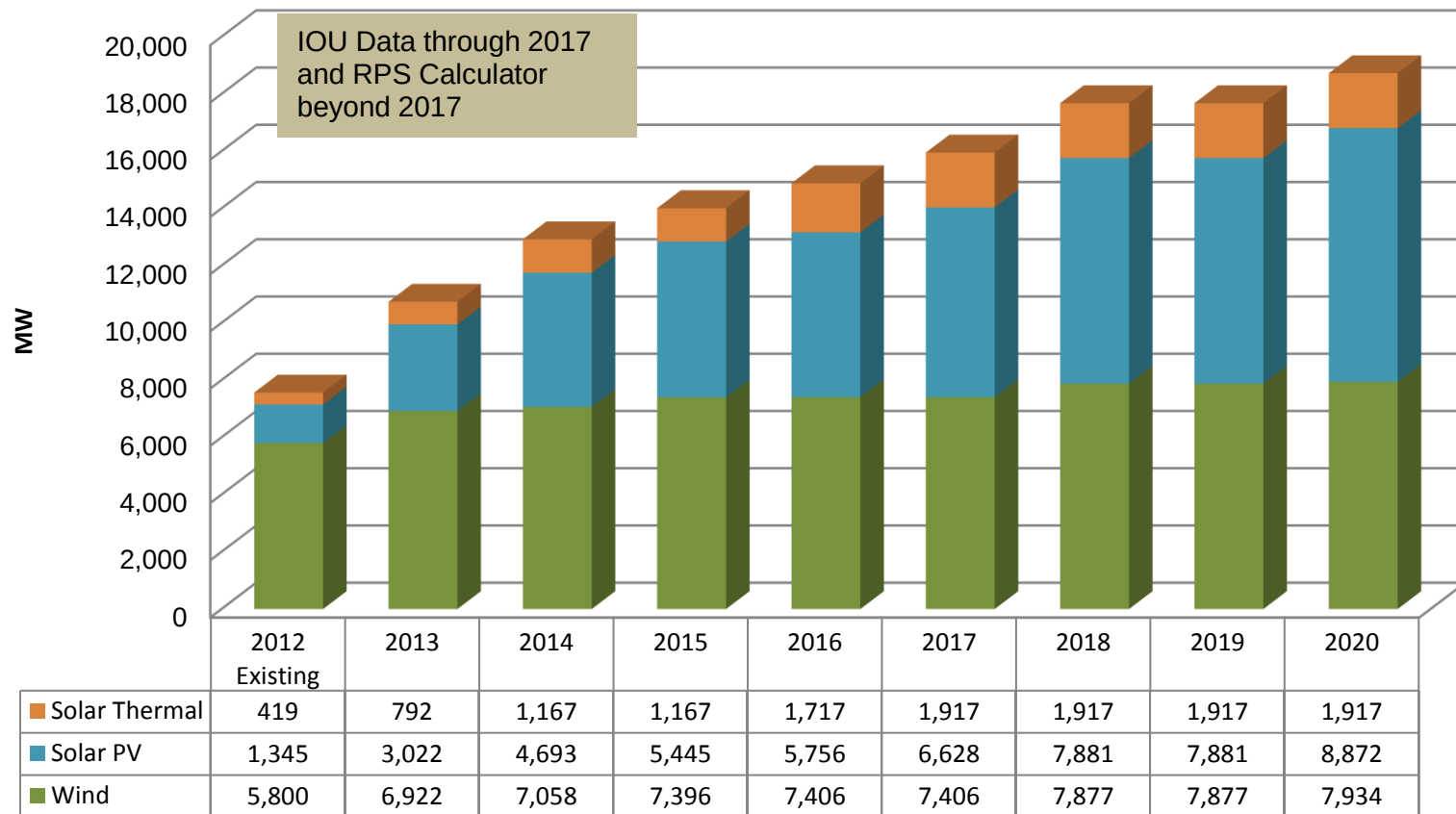
Welcome to the Western Grid

- CA is one of 14 states within **Western Electricity Coordinating Council**
- Resource sharing enhances reliability, helps achieve renewable targets and manages cost
- A quarter of all the electricity that keeps the lights on during the summer comes from other parts of the west including parts of Canada and Mexico



33% Renewable Portfolio Standard build-out through 2020

33% RPS --- Variable Resources Expected Build-out Through 2020



California's new gold rush!



Renewable Integration

Integrating renewables reliably

The ISO is focused on the reliable integration of zero-emission resources such as solar and wind power in support of the state's renewables portfolio standard. [Read more](#)

[Monitor renewable power in real-time](#)

[Track yesterday's green output](#)

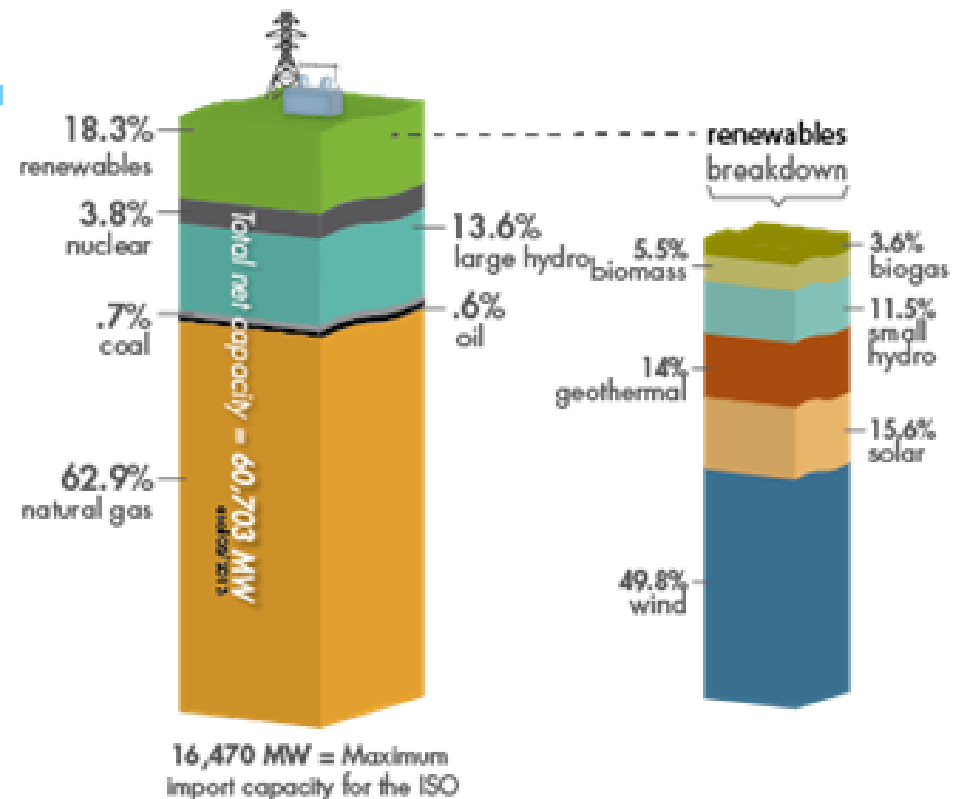
[Learn how flexible resources help renewable integration](#)

Advancing technologies for a smarter grid

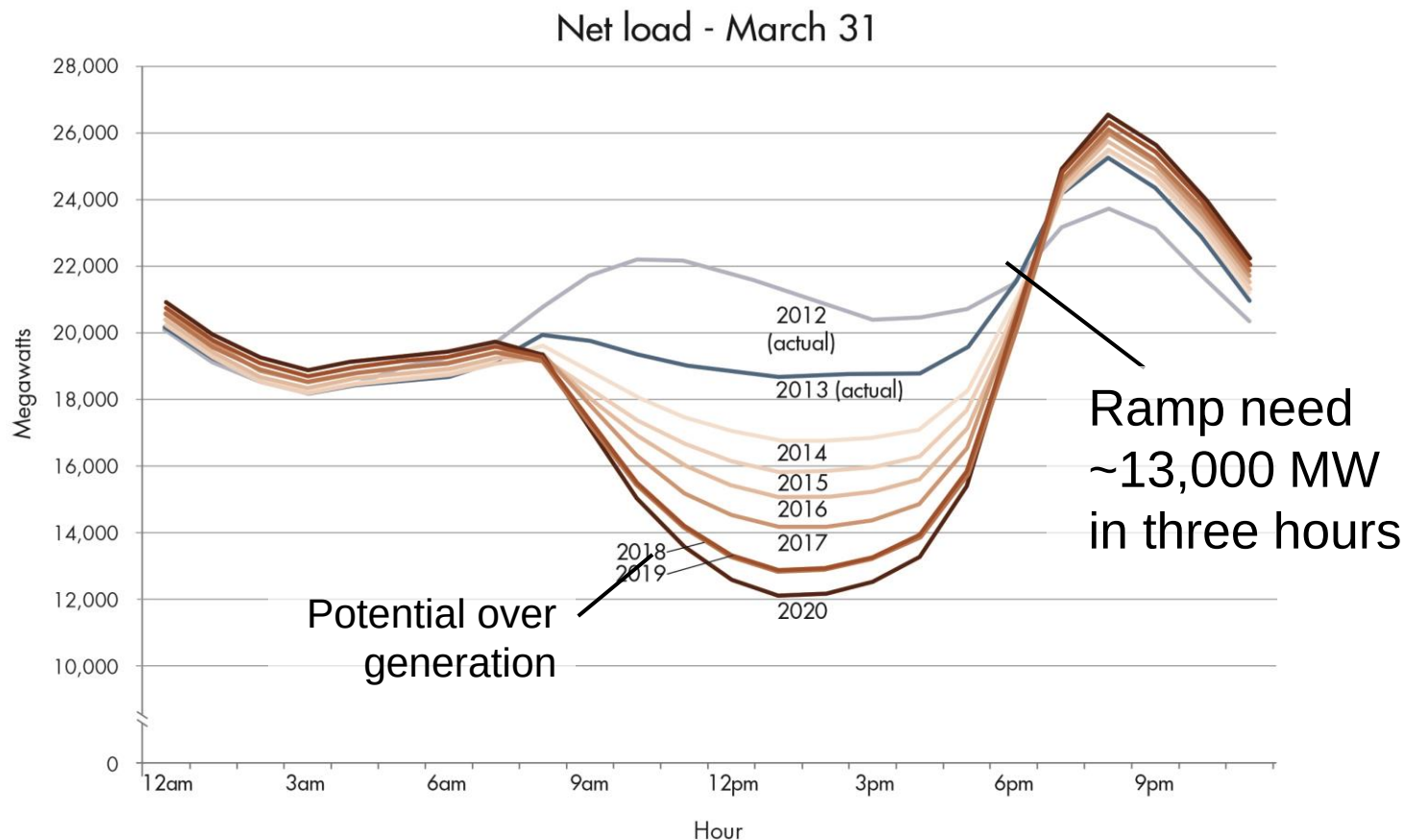
We actively engage in activities that identify and prove next generation smart technologies. The exciting advances will forever change how electricity is produced and consumed. [Read more](#)

[View our smart grid roadmap](#)

The power mix

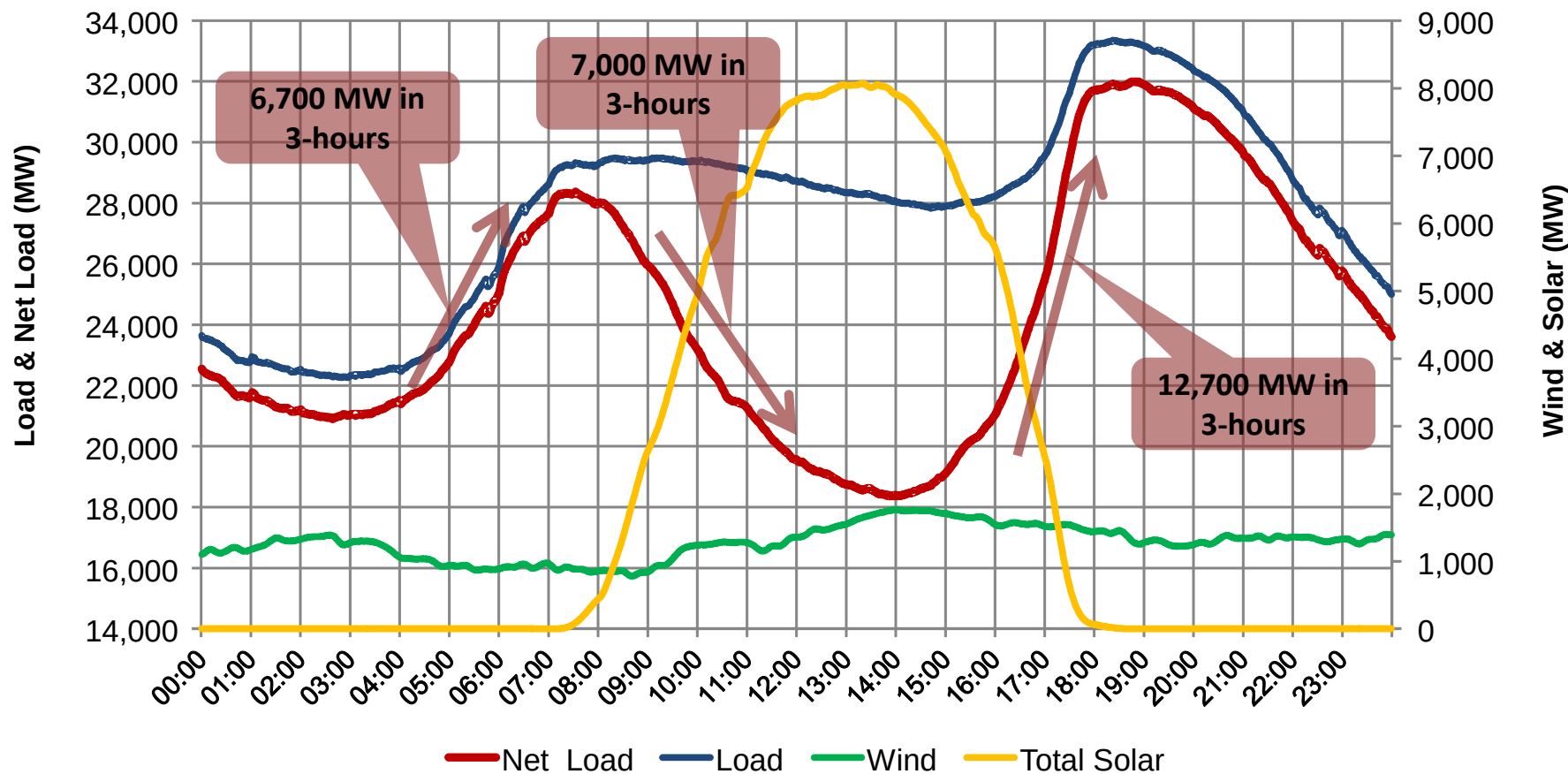


Non-summer months — Net load pattern changes significantly



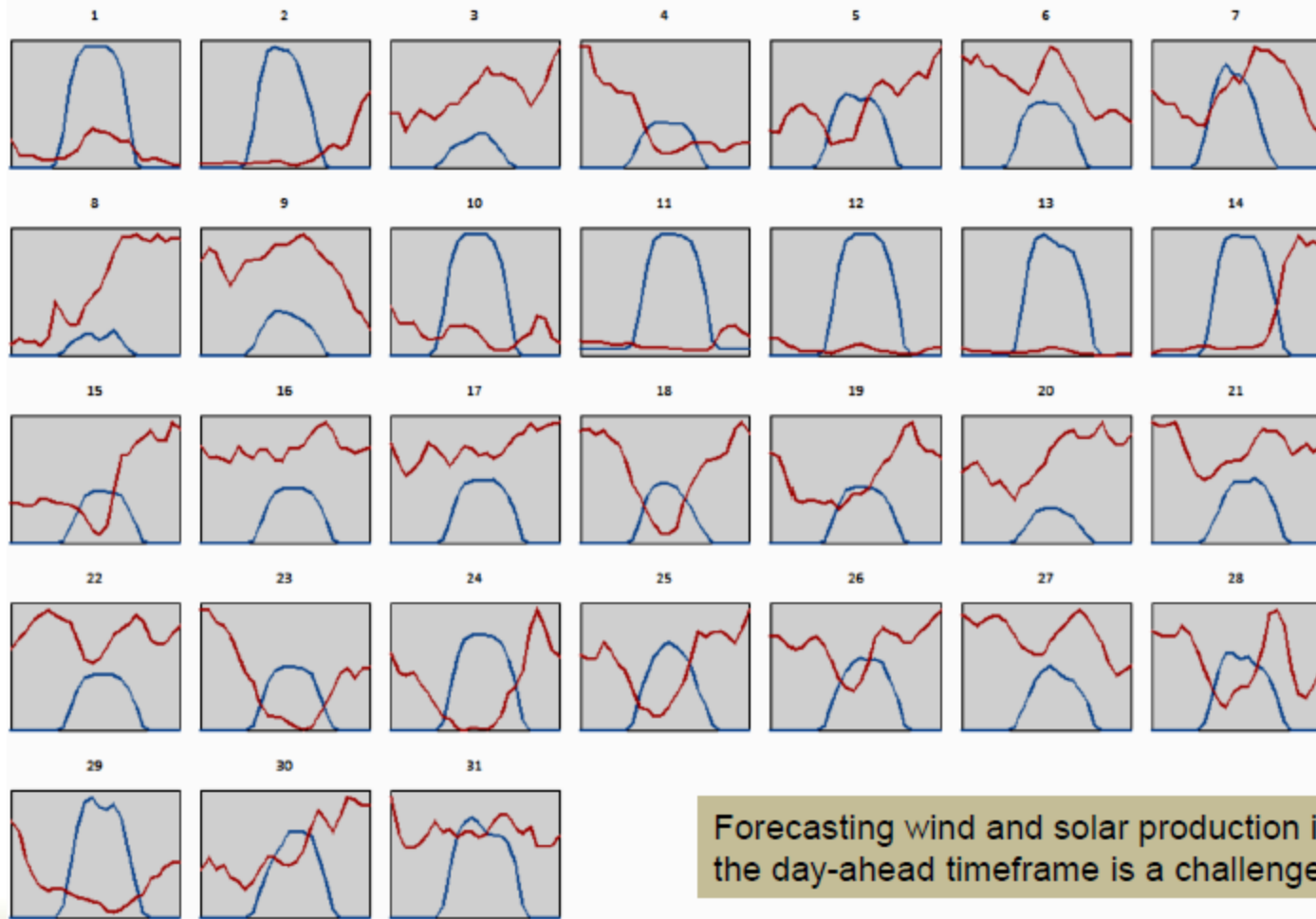
Flexible resources would be dispatched to the net (red) load demand curve

Load, Wind & Solar Profiles --- Base Scenario January 2020

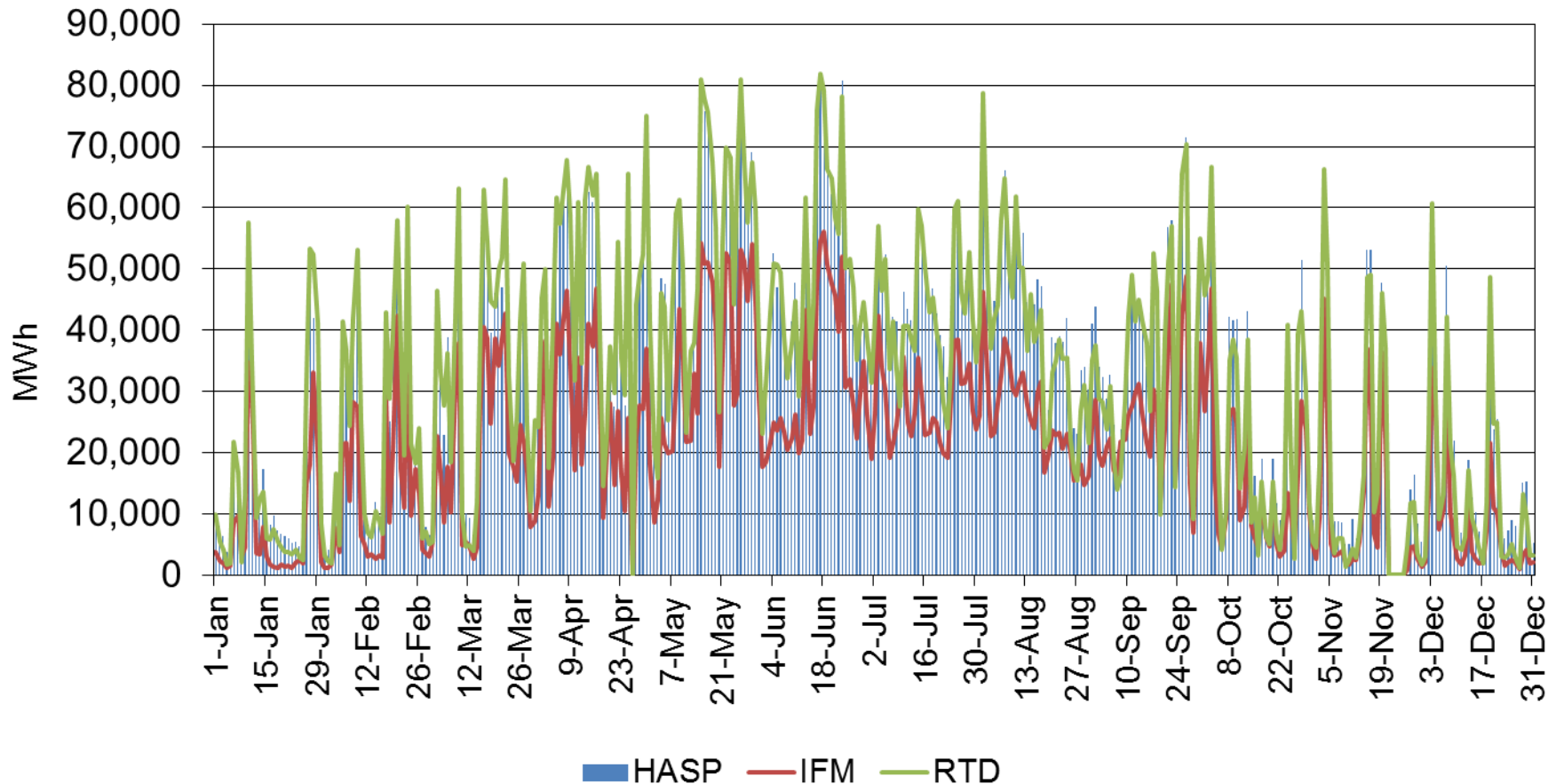


$$\text{Net Load} = \text{Load} - \text{Wind} - \text{Solar}$$

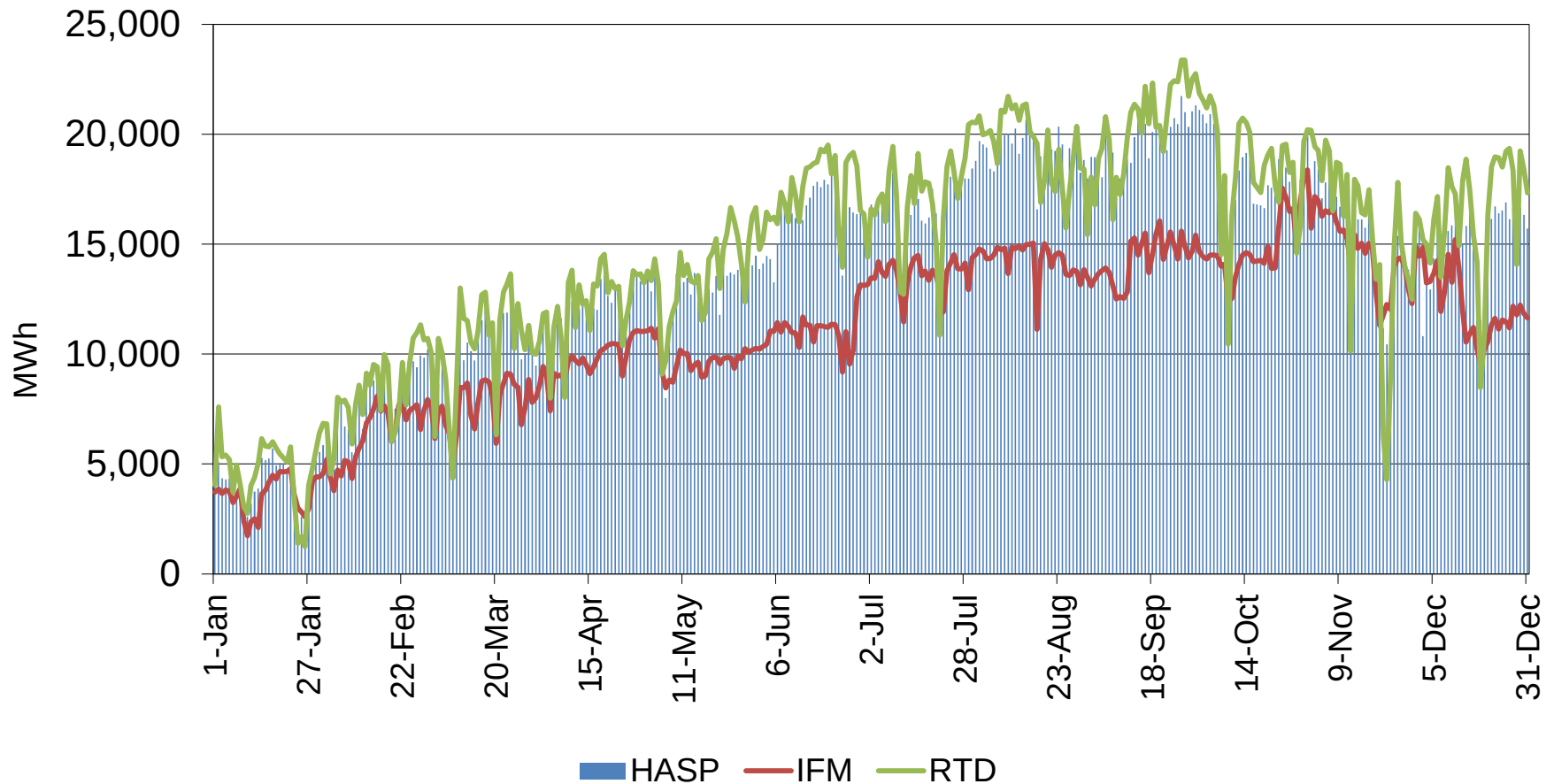
Wind and Solar production can vary significantly between days



Wind schedules



Solar Schedules



March 8, 2014

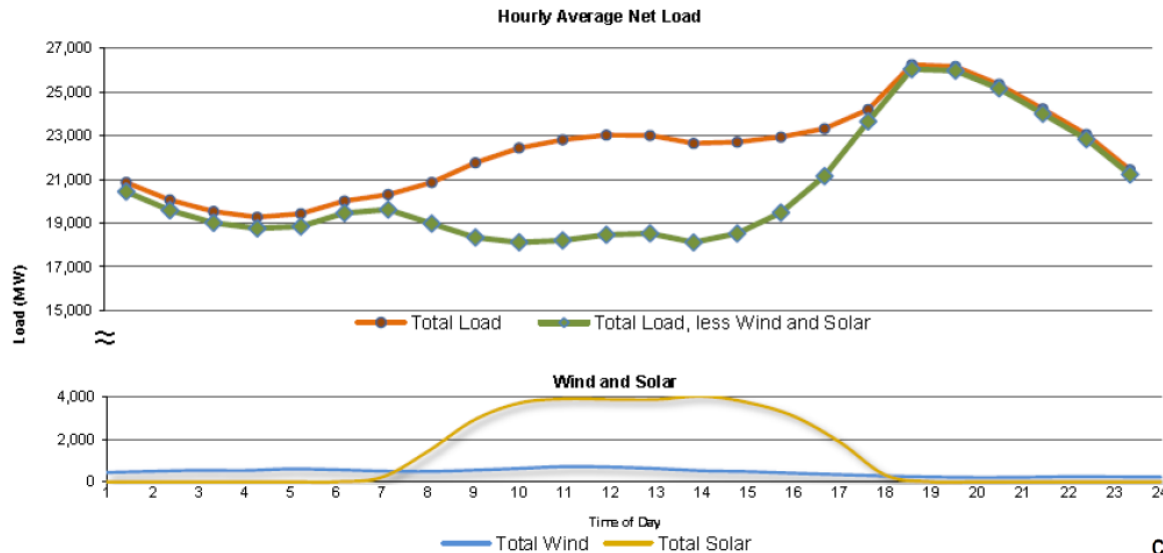
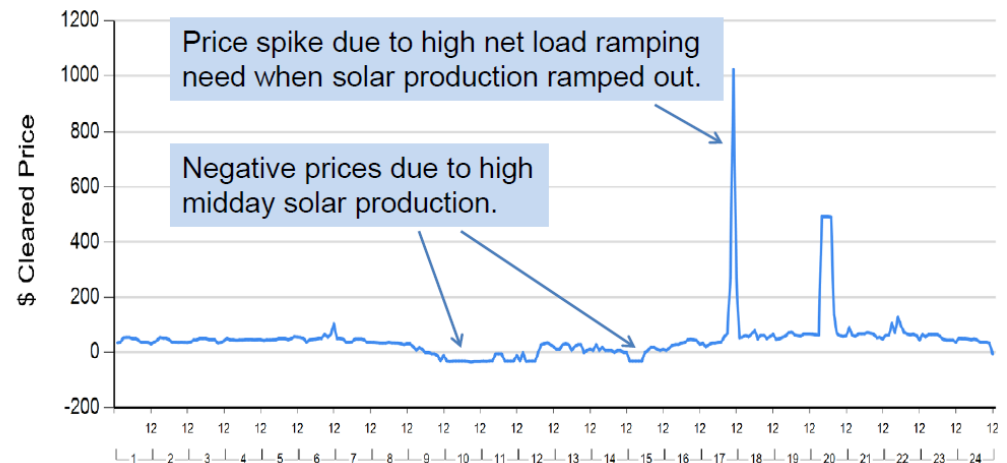
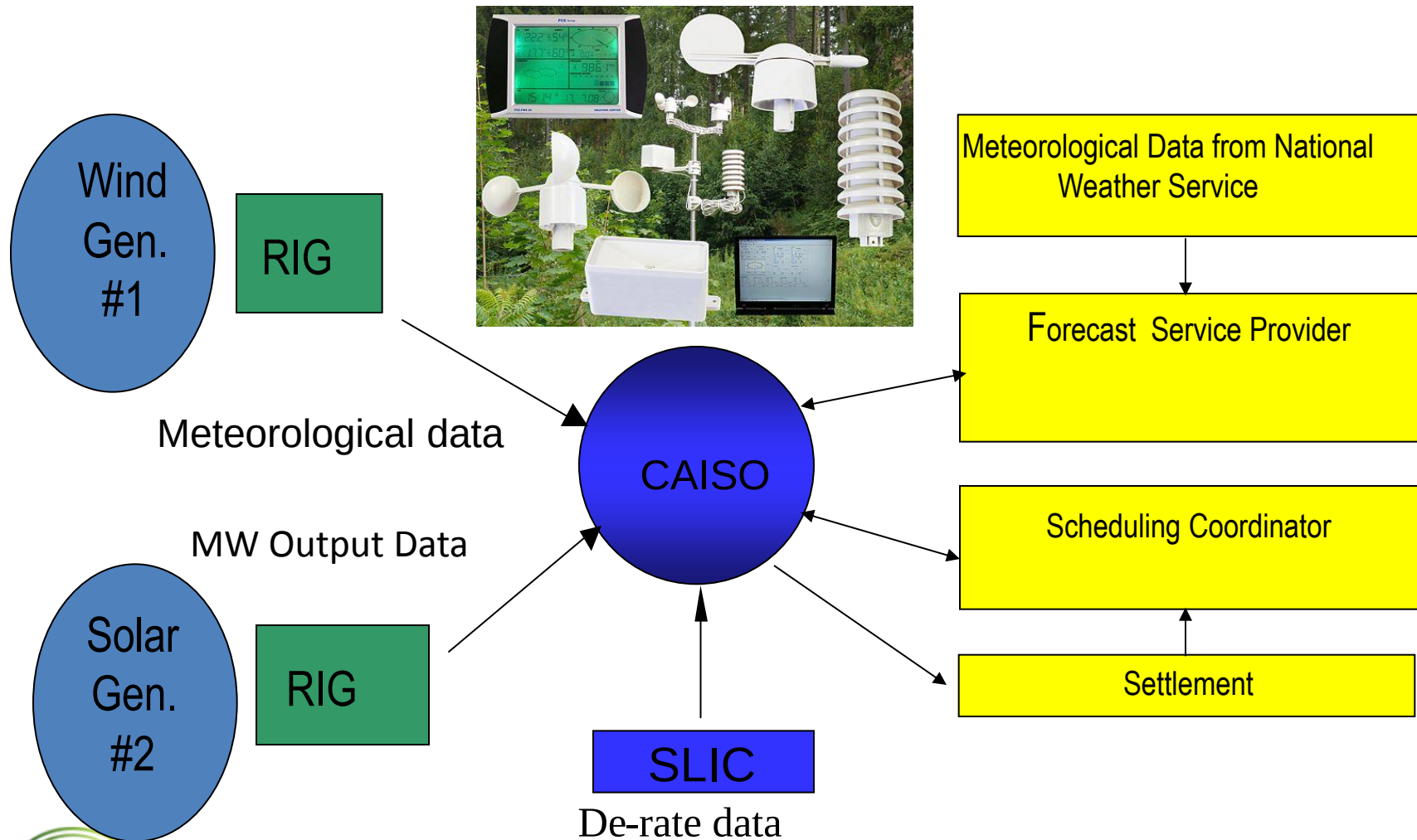


Chart 6.Interval Energy MCP in RTD



Information Exchange is the Heart of the System



Load Forecasting Improvements

- Model improvements
 - Backcast evaluation
 - Trending evaluation
 - Economic adjustments
 - Temperature Min/Max
 - Re-estimation by area
 - Cloud cover/marine layer
 - Irradiance
 - Wind Speed
- Forecaster Evaluation
 - Temperature Study
 - Trending evaluation
 - Weather provider allocation Temp weighting /load area
 - Generating new forecasters

Forecasting Timelines

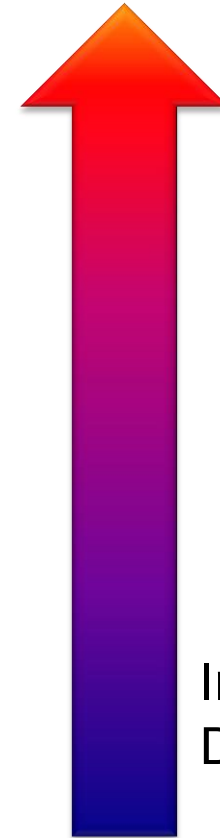
- 8 – Day Ahead
- 3 – Day Ahead
- 1 – Day Ahead
- 18-42 hours ahead
- Event Prediction
 - Large changes in short periods
- Hour Ahead
 - 105 Minutes
- Intra hour forecasts
 - 15 minute time line - out 2 hours

Climatological

Vendor
Provided

Internally
Developed

Persistence



Solar: Behind-the-Meter Rooftop Generation

- 1961 MW of installed capacity with potential of 12000 MW
 - Installed capacity provided by CPUC (California Public Utility Commission) and other sources
- No visibility of generation
- Affects load forecast
- How do you forecast with no historical data?
 - Map capacity to weather regions
 - Model each weather region using
 - Position/angle of the sun throughout
 - Capacity of installed panels
 - Efficiency of panel generation
 - Adjust for cloud cover forecast
 - Spatial diversity



<http://www.californiasolarstatistics.org/>

Thanks