Project Lead

Clean Power Research®

Project Partners

University at Albany, State University of New York

UCSD

EPRI

SEPA

Primary Funders

GO solar CALIFORNIA

Itron

pier

Power Industry

SMUD™

California ISO
Your Link to Power

PG&E

INTEGRATING PV INTO UTILITY PLANNING AND OPERATION TOOLS

SunShot U.S. Department of Energy

GO solar CALIFORNIA

High Penetration Solar Forum 2013
Feb 13-14, San Diego, CA

Project Focuses

- CSI Project
  - > Address cost-effective strategies and solutions for integrating large amounts of PV into distribution systems by integrating PV modeling into utility planning and operation tools

- Complimentary CEC project
  - > Validate ability of satellite-derived solar data to forecast PV fleet output in partnership with the CAISO, and to integrate the methodologies into the CAISO planning process.

Tasks

- Produce, Validate, and Extend SolarAnywhere Data
- Validate SolarAnywhere FleetView Methodology
- Integrate SolarAnywhere FleetView into Utility Software Tools

Produce, Validate, and Extend SolarAnywhere Data

- Extend SA Enhanced Resolution (1 km, ½ hour)
- Produce SA High Resolution (1 km, 1 minute)
- Validate SA Enhanced Resolution (CSI and SMUD PV output data)
- Validate SA High Resolution (California ISO and SMUD irradiance data)

SolarAnywhere

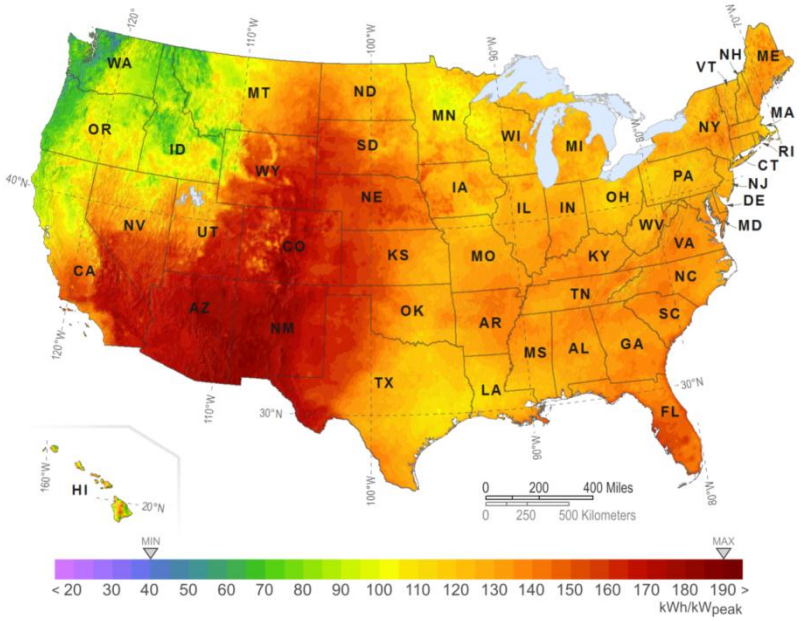
Web-accessible solar irradiance data & analytical tools

Irradiance data

- Satellite-derived time-series data
- Historical values from 1998 through latest hour
- Forecasts up to 7-days in advance

Analytical tools

- PV system modeling (FleetView)
- Benchmark to site data (DataCheck)
- PV fleet variability



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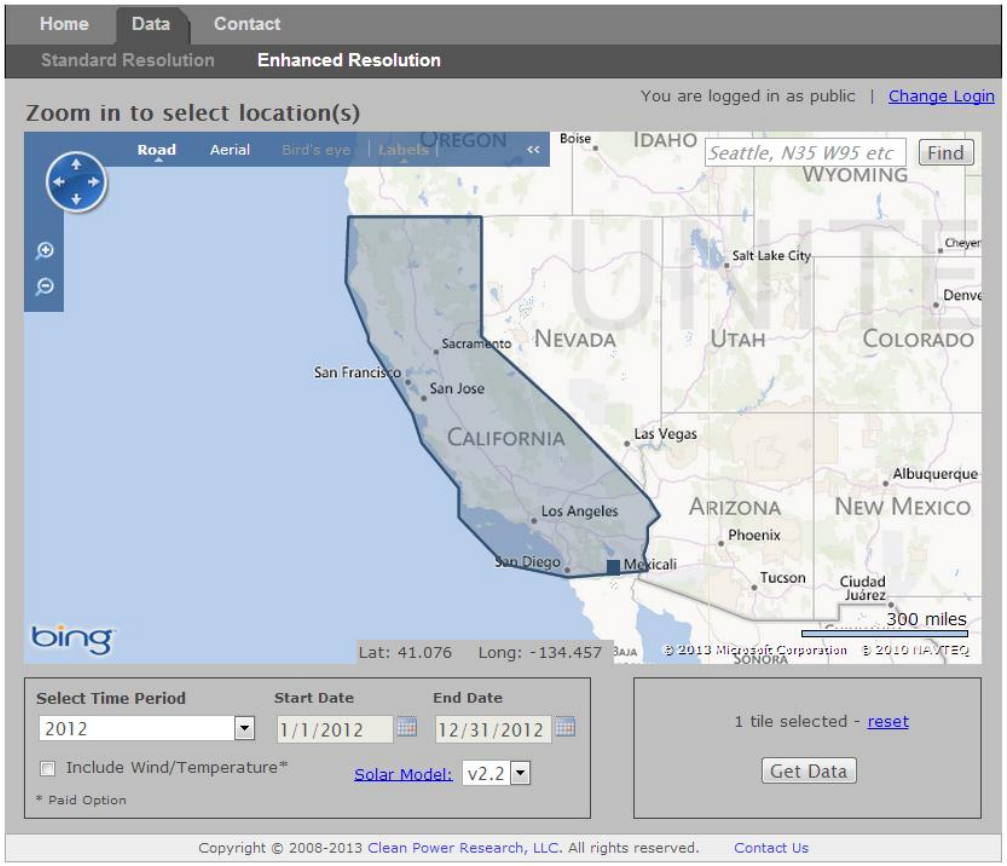
Publicly Accessible Solar Data (SolarAnywhere.com)

SOLARanywhere® ENHANCED RESOLUTION



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Three SolarAnywhere Resolutions

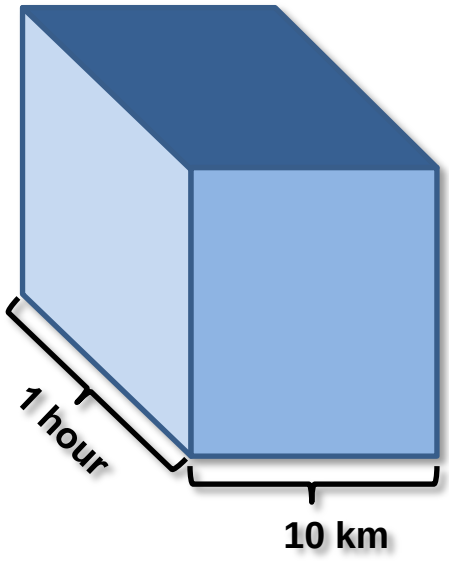
Standard Resolution
10 km, 1 hour

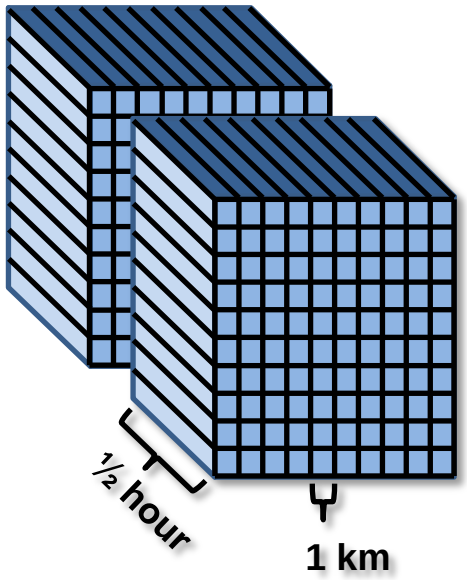
→

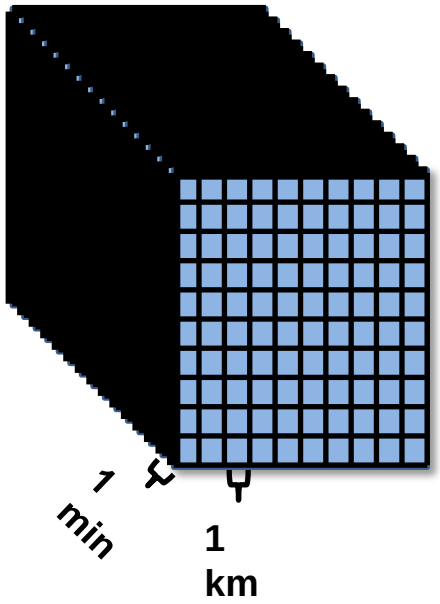
Enhanced Resolution
1 km, ½ hour

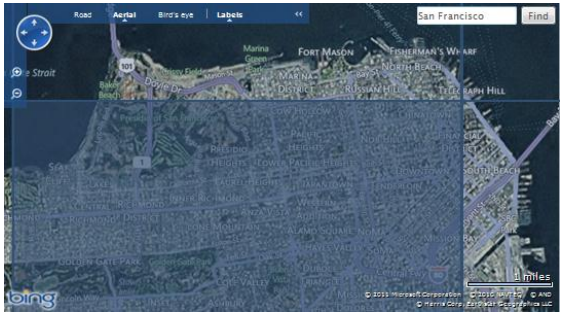
→

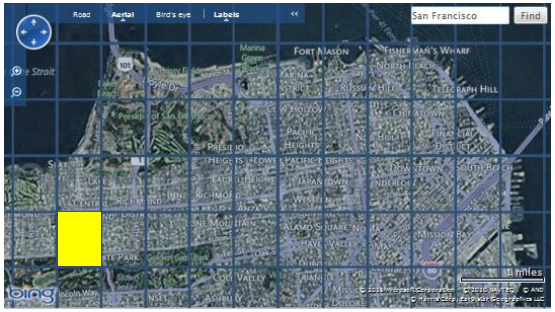
High Resolution
1 km, 1 minute











Example: San Francisco, CA

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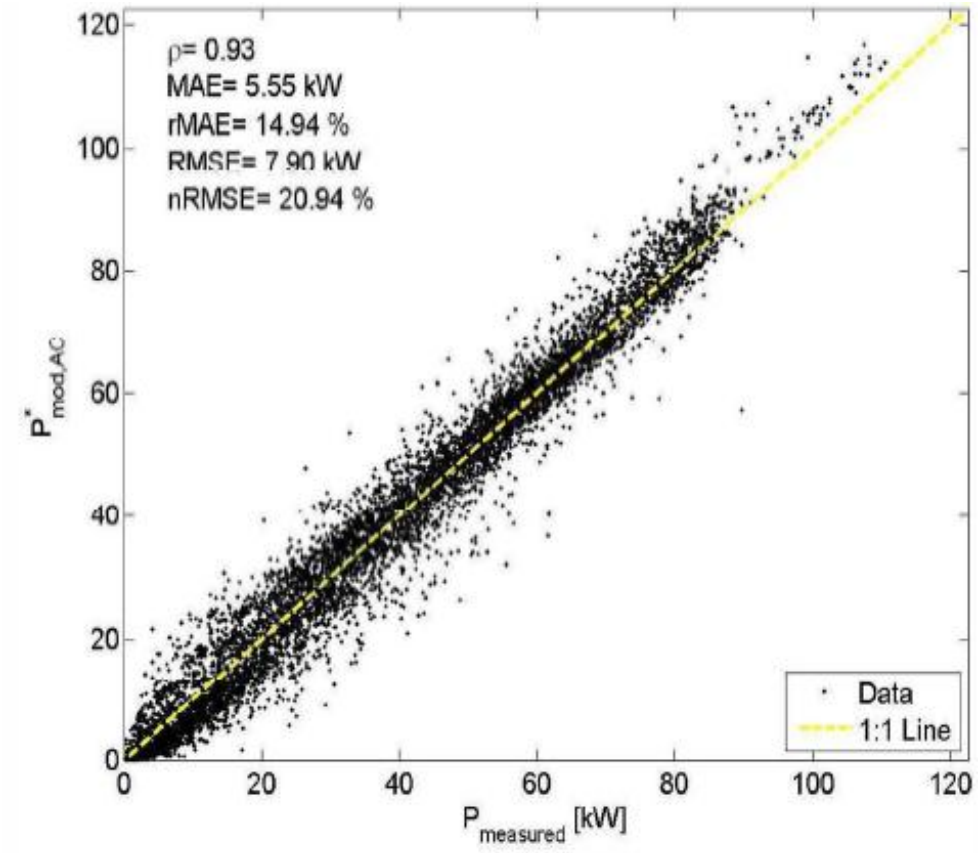
UCSD Validation of SolarAnywhere Enhanced Resolution Data



Calibrated SolarAnywhere performance, with 30-min time step, versus CSI measured output (averaged over two 15-min time steps), for 86 PV sites in 2009 in San Diego, CA

Source: Jan Kleissl, UCSD

Produce, Validate, and Extend SolarAnywhere Data

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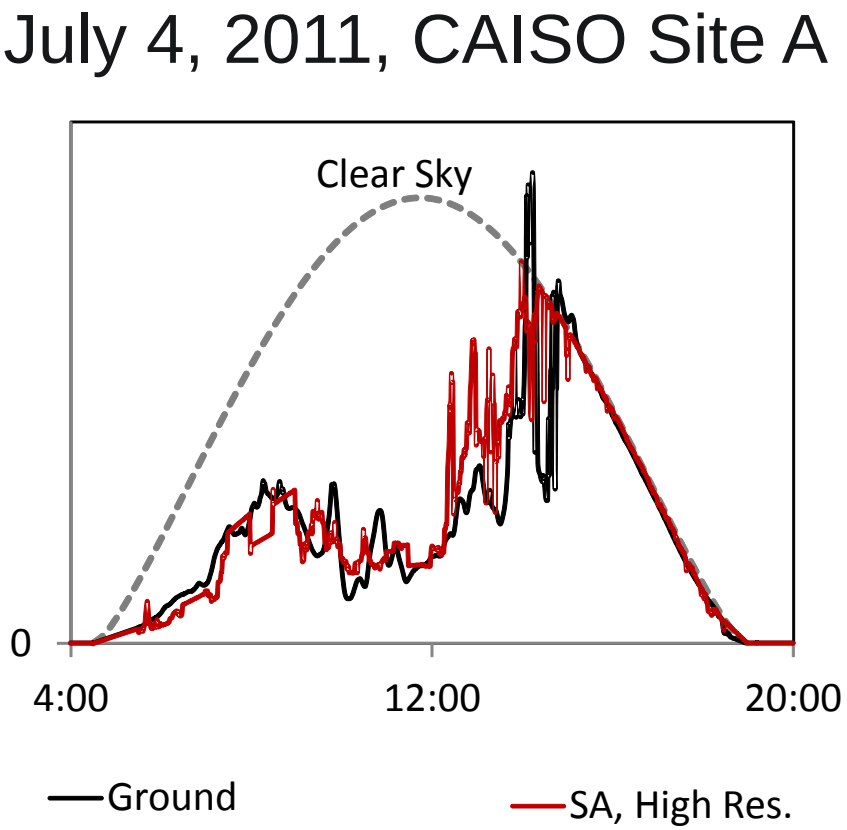
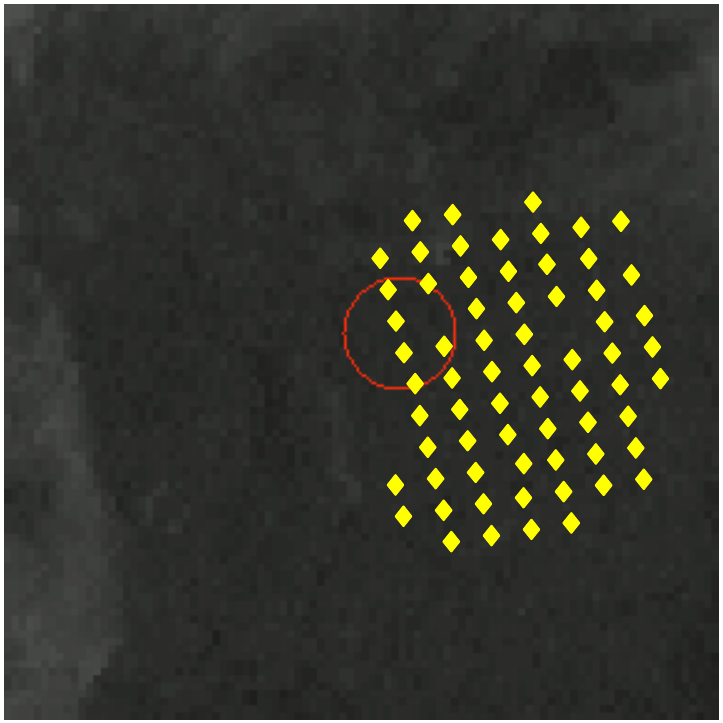
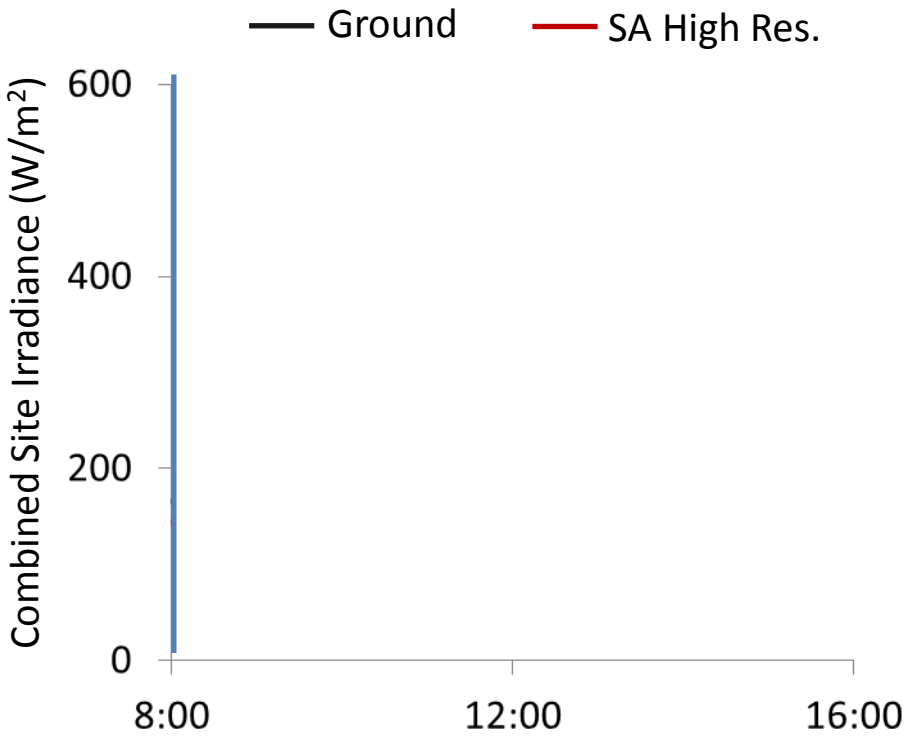
- **Validate SA High Resolution (California ISO and SMUD irradiance data)**

2.4. Validate 1 km, 1 Minute Irradiance Data



Example Using SMUD's Solar Data Network on Highly Variable Day (Nov. 18, 2011)





Validate SolarAnywhere FleetView Methodology

- Validate Correlation Models (66 irradiance sensor network from SMUD)
- Validate High Speed PV Fleet Simulation (10 PV systems from CAISO)
- Validate Forecasted PV Fleet Simulation (100 PV systems from PG&E)

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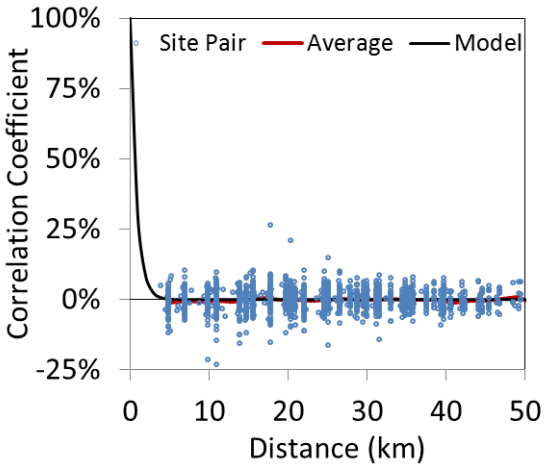
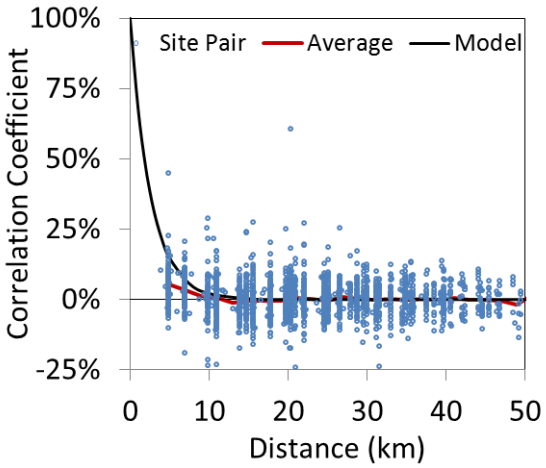
Variability Results: SMUD's 66 Sensor Network

Time Interval

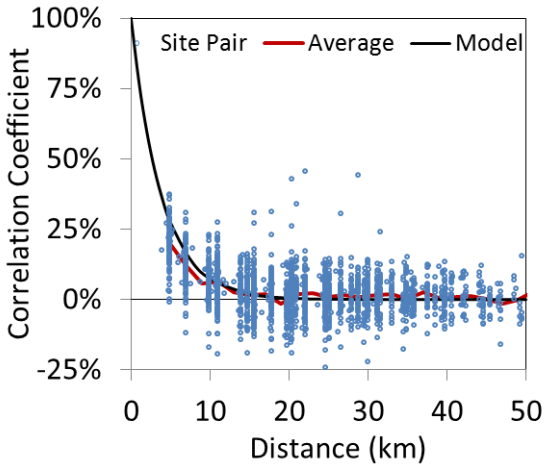
1 Minute



5 Minutes



10 Minutes



Results based on most variable days in SMUD's network from July 1, 2011 to December 31, 2011

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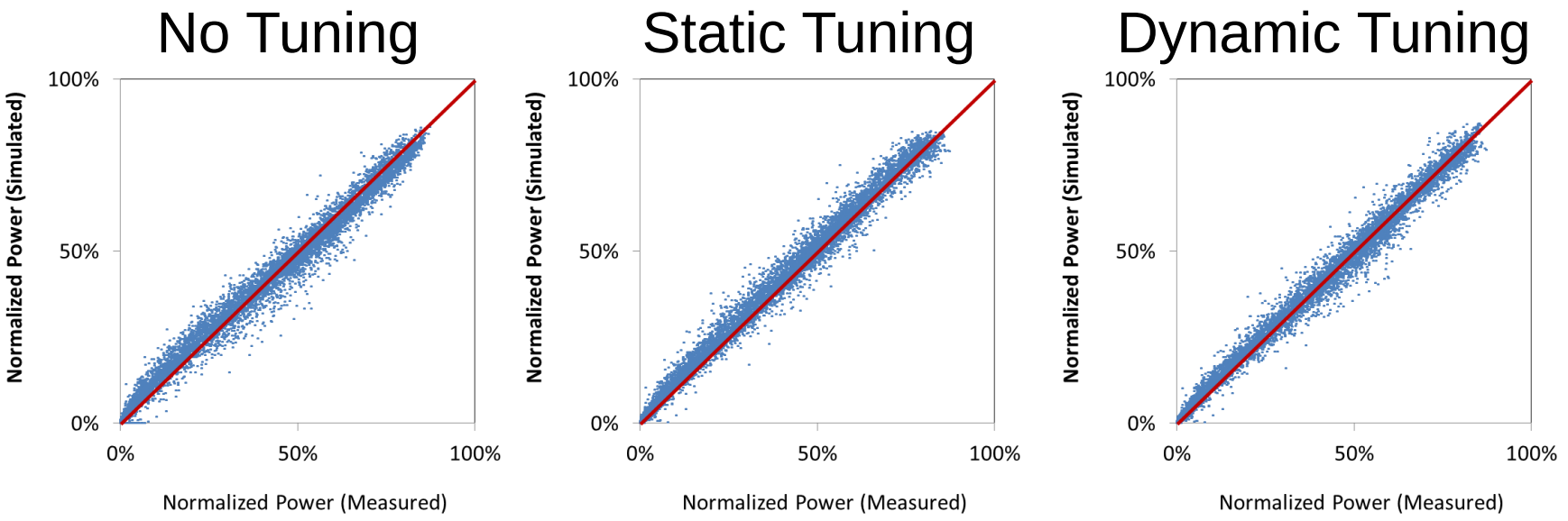
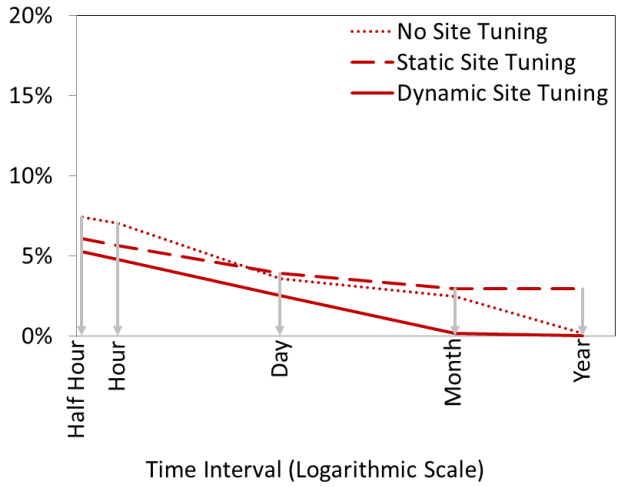
CAISO Fleet Results



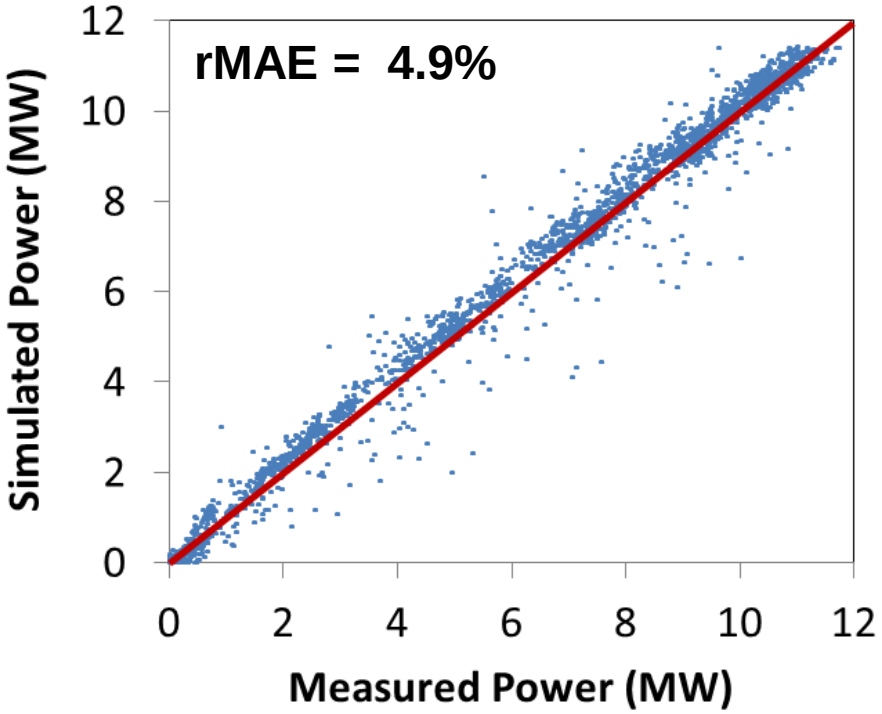
Measured Data

- 18 PV systems
- Sept. 2011 to Aug. 2012
- Half-hour data
- Capacity normalized to eliminate effect of PV size
- Presented on scale of 0 to 100%



SMUD Fleet Results

Results are preliminary and may change as a full year of data is included



Measured Data

- 1,048 PV systems
- April – October 2013 (6 months)
- Hourly data

Screening

- 13 systems removed for data issues
- +/- 1 hour time shift issues identified for 30% of systems
- Required measured power > 1% of max
- Scaled annual simulated to match annual measured

Integrate SolarAnywhere FleetView into Utility Software Tools

- Distribution planning (SMUD)
- Smart grid operation (SMUD)
- Utility load scheduling (PG&E)
- Balancing area planning and operation (California ISO and SMUD)

Integrate SolarAnywhere FleetView into Utility Software Tools

- Distribution planning (SMUD)
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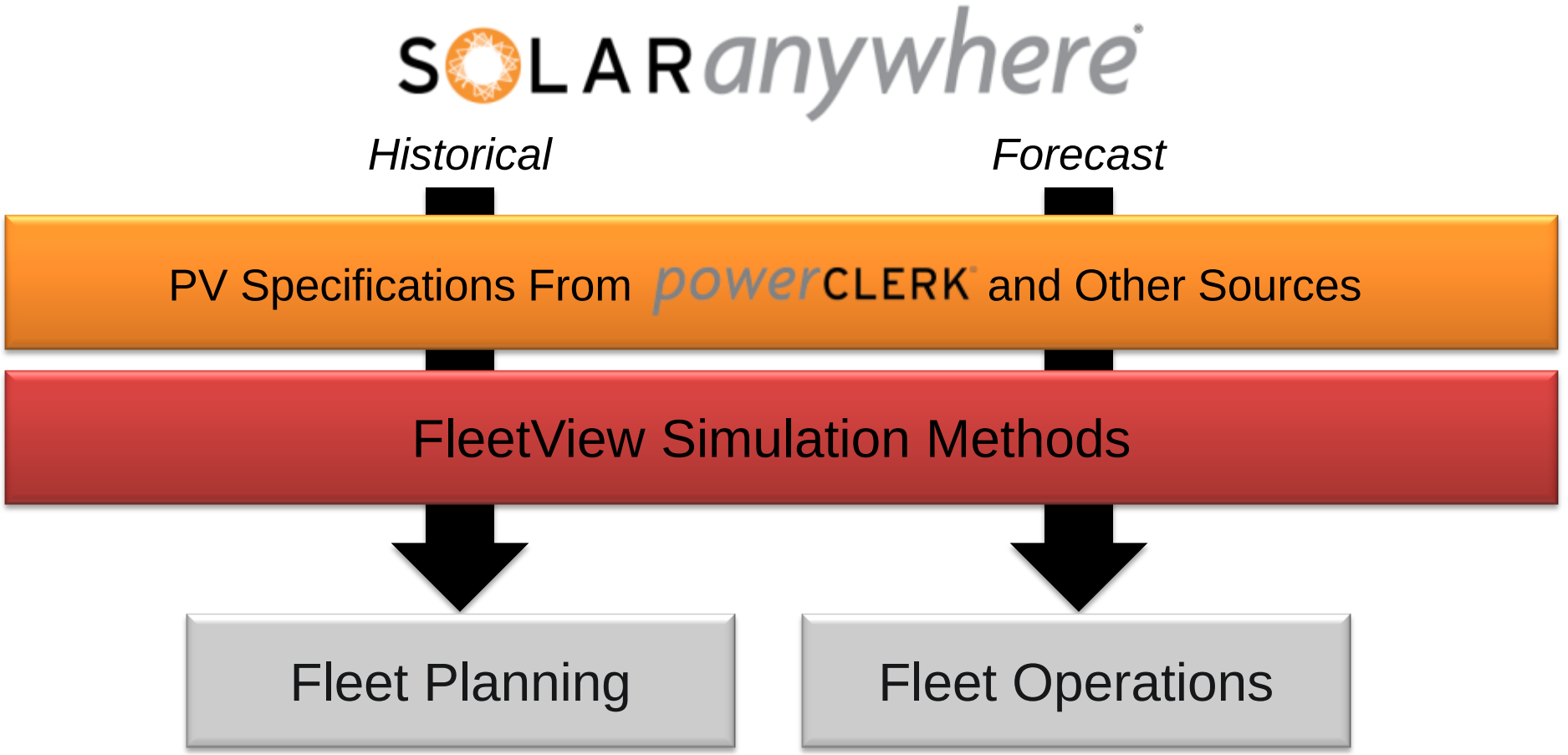
- **Balancing area planning and operation (California ISO and SMUD)**

Approach

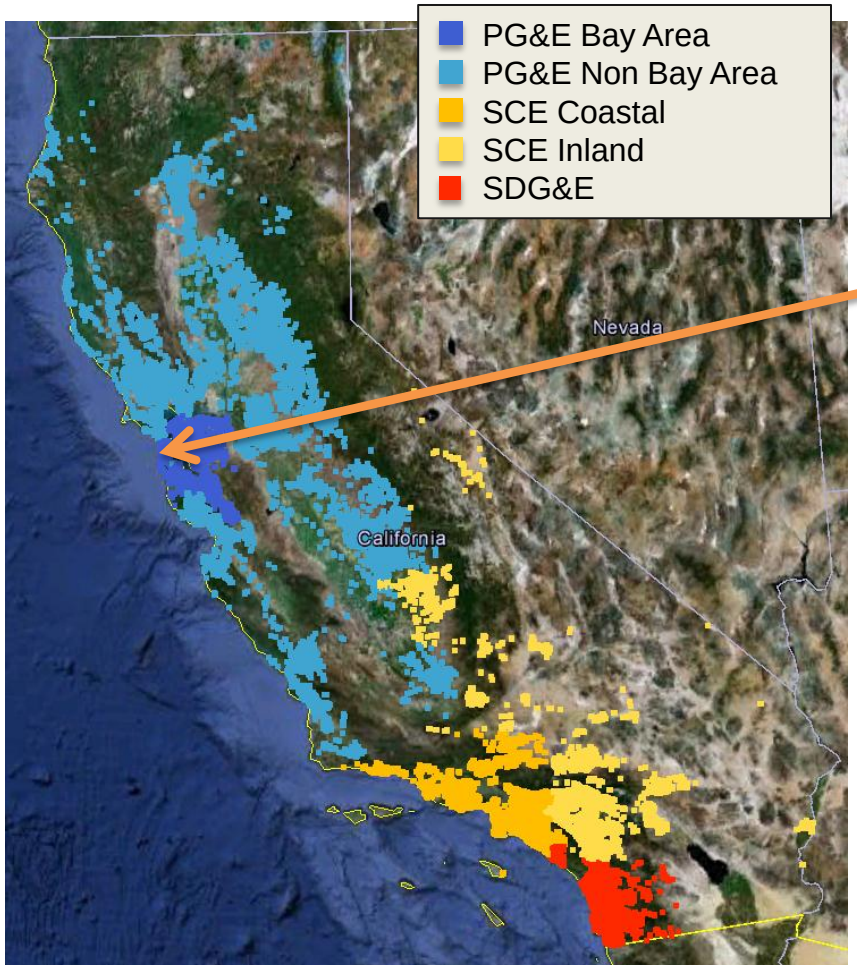
- ✓ Obtain PV system specs (~150,000 PV systems in CA)
- ✓ Map each system to correct balancing area
- ✓ Implement forecasting system (forecast ½ hour output for every system and sum results by region)

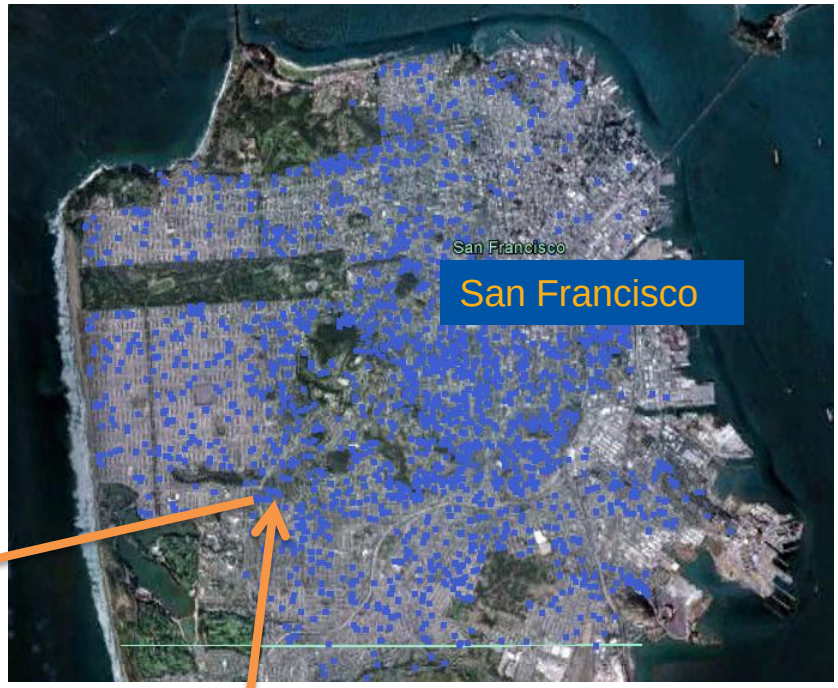
- Validate accuracy

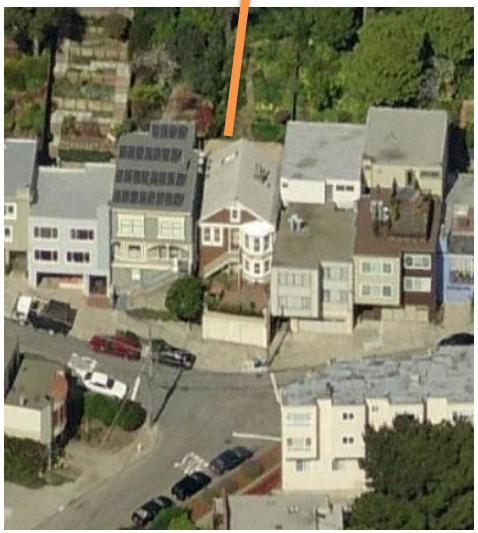
Simulate Fleet Output Using SolarAnywhere FleetView™



CAISO Customer Owned Mapping







- 4.49 kW-AC
- SunPower Inverter (SPR-5000X, 240V)
- 27 Modules (SunPower 210 W, SPR-210-WHT)
- 37.76281º N, 122.44313º W
- Commissioned April 2008

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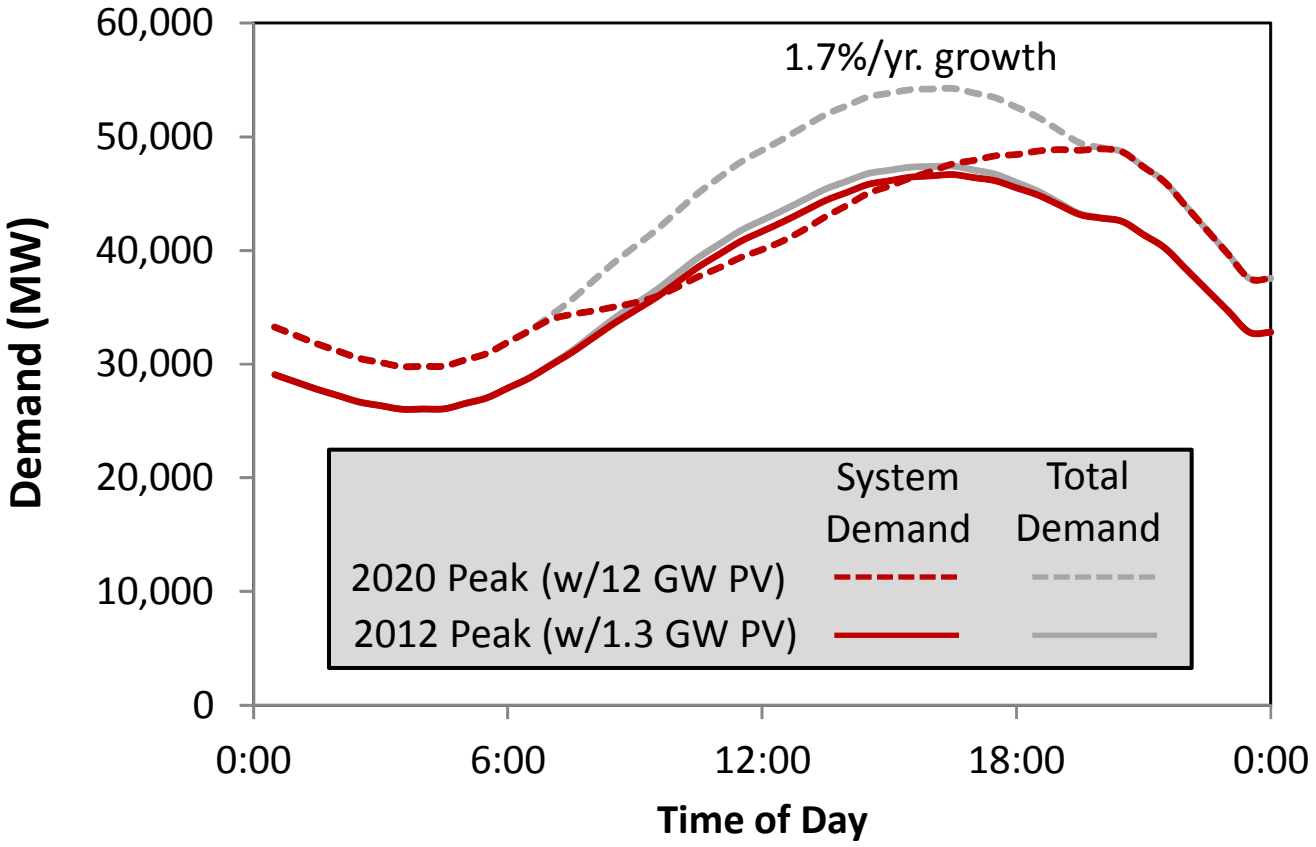
Using FleetView for Capacity Planning



Peak Day: August 13, 2012

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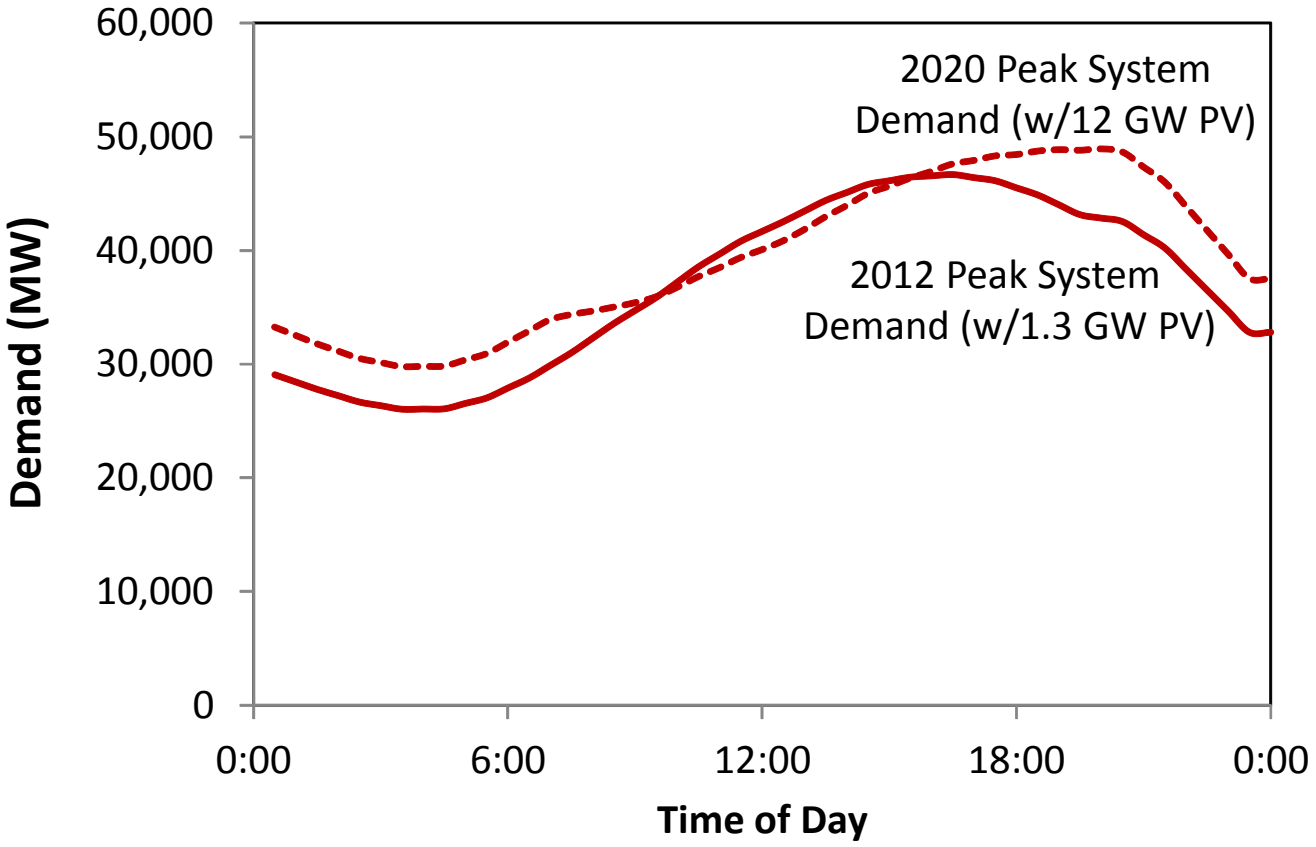
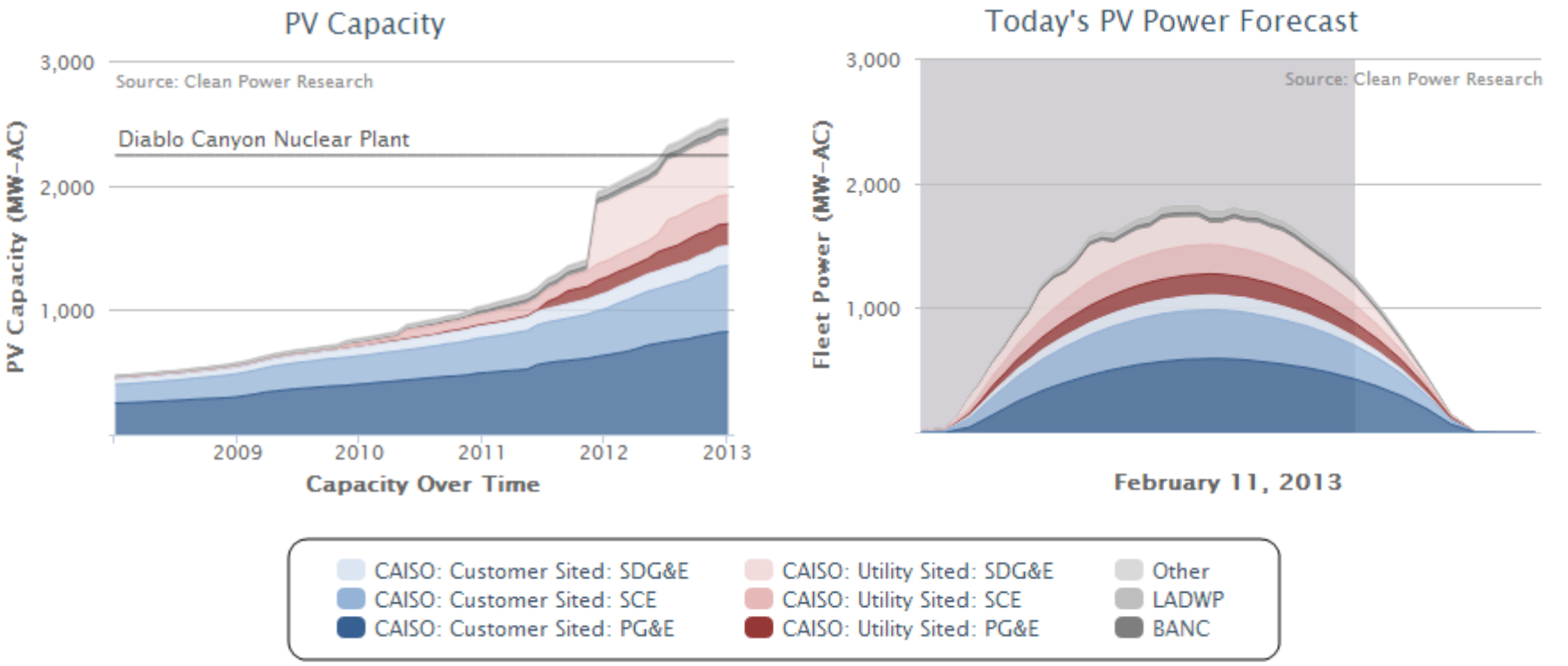


Peak Day: August 13, 2012

Using FleetView for Forecasting

California Solar Resource Portfolio



Note: Utility Sited systems include intertie systems in NV and AZ

Conclusion

- SolarAnywhere Enhanced Resolution (1 km, ½ hour) data is publicly available at www.solaranywhere.com
- SolarAnywhere High Resolution (1 km, 1 min) data can be produced throughout CA
- Initial validation efforts are promising
- Satellite-derived PV simulation holds good promise for a low-cost method for addressing grid-integration issues through PV planning and forecasting

Next Steps

- Continue balancing area integration efforts for both planning and operational needs

- Continue model validation

- Extend tools to:
  - > Utility load scheduling
  - > Distribution planning
  - > Smart grid operation

Please feel free to contact us for any details or clarification related to presentations

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THANK YOU