

Behind-the-Meter PV Fleet Forecasting: Results for 130,000 PV Systems in California

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Overview

- Background
 - Integrate PV modeling into utility planning and operation tools (CSI project)
 - Validate satellite-derived PV fleet forecast for CAISO (CEC project)
- Describe fleet forecasting method and applications
- Present fleet forecasts and validation of results



Predicting PV Fleet Output

SOLAR *anywhere*

Historical

Forecast

PV Specifications From *power*CLERK® and Other Sources

FleetView Simulation Methods

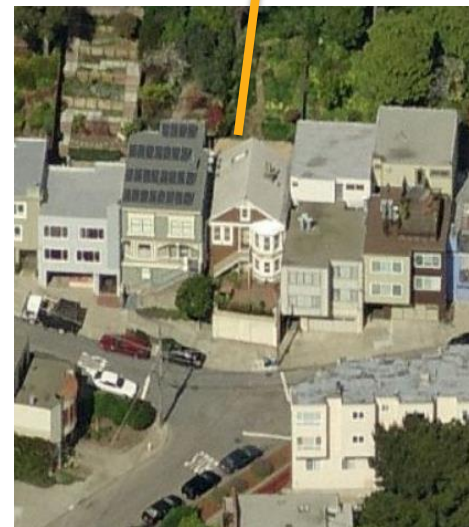
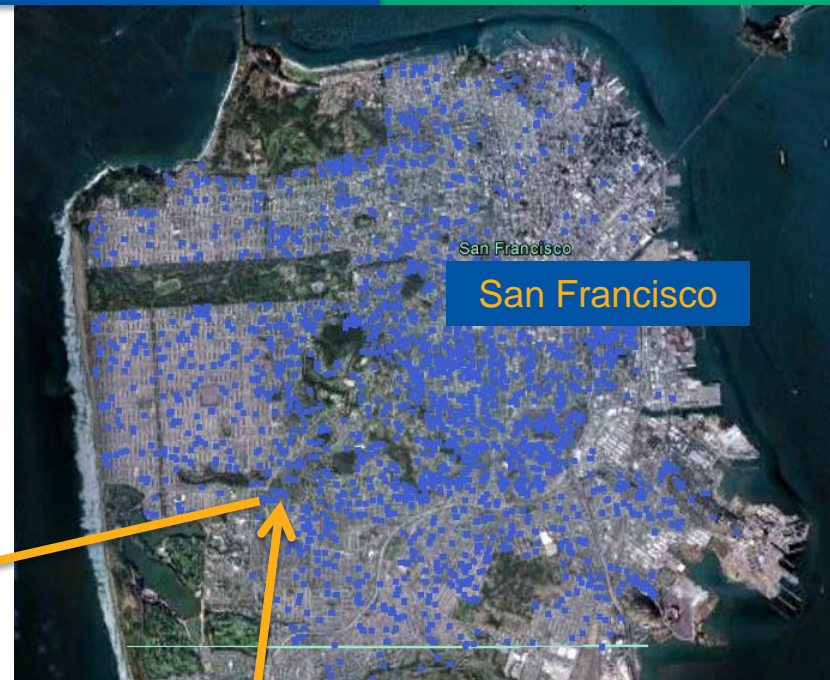
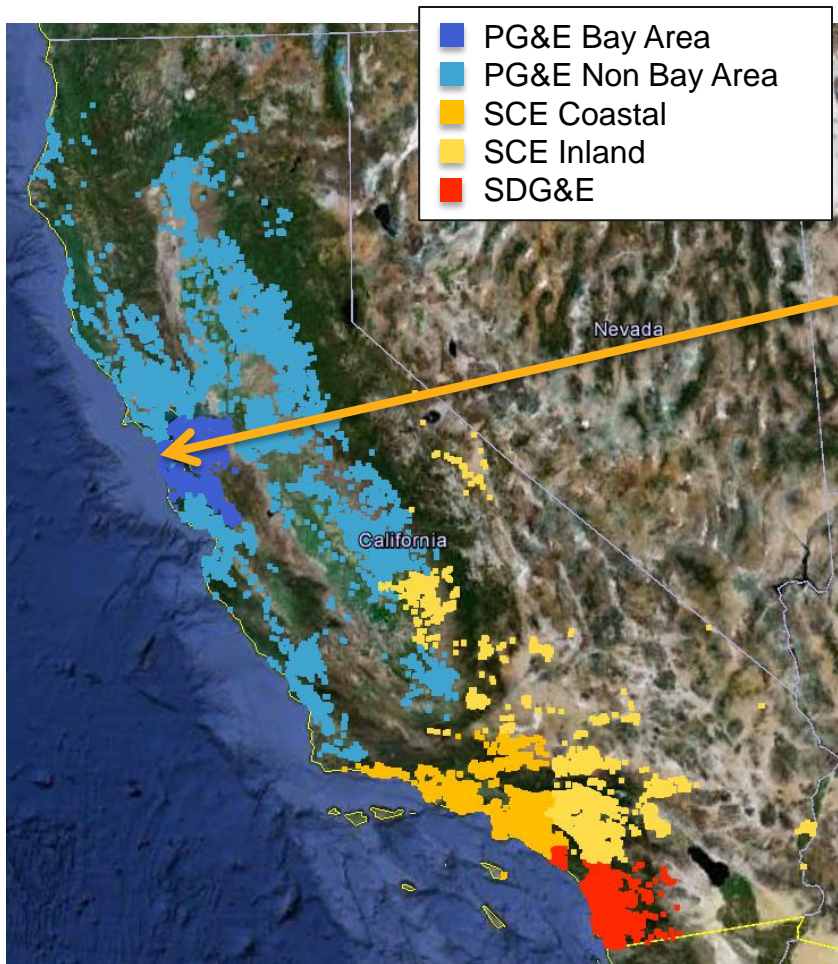
Fleet Planning

Fleet Operations



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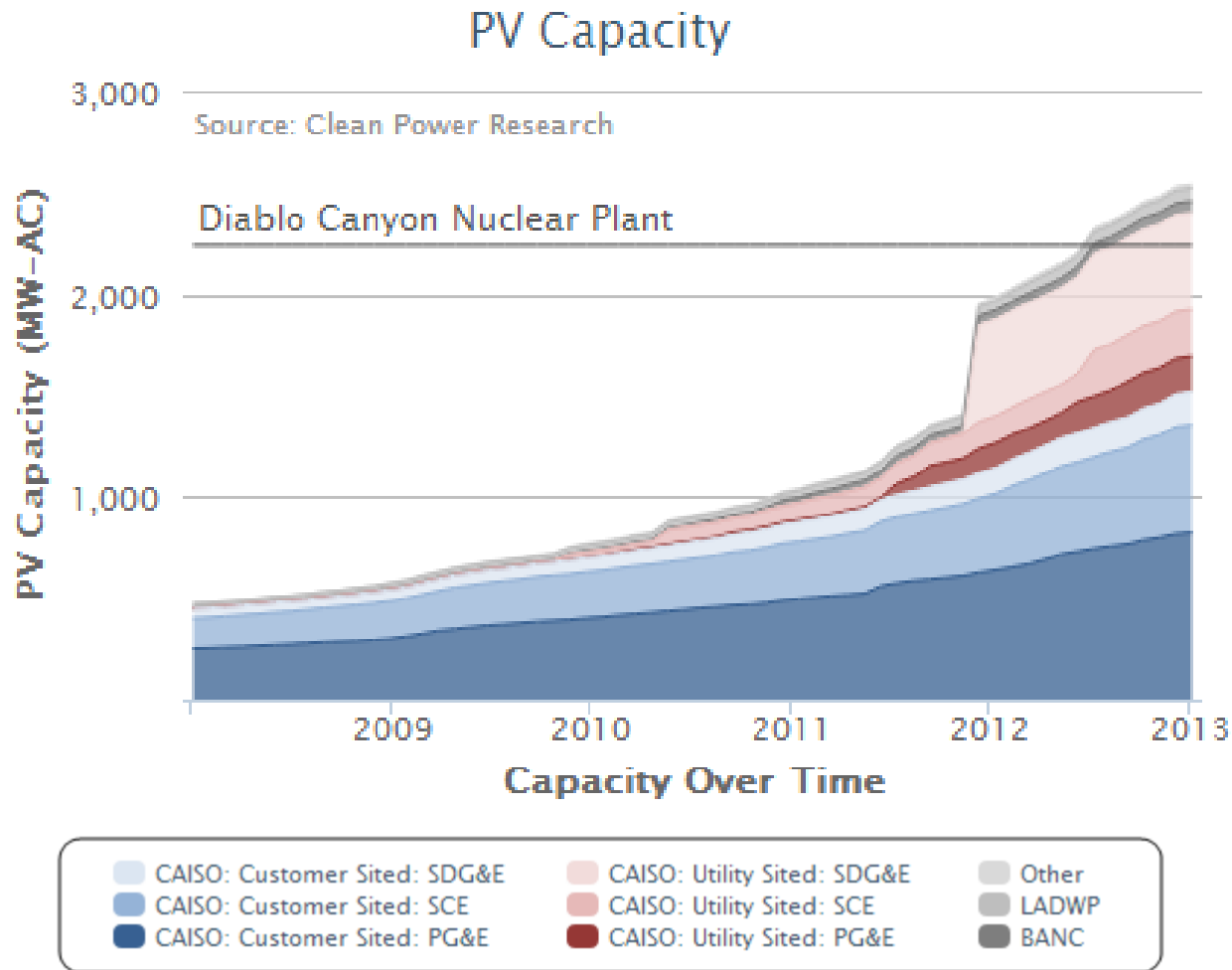
CAISO Customer-Owned Mapping



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



California PV Capacity by ISO Areas



Note: Utility-sited systems include intertie systems in NV and AZ



SolarAnywhere

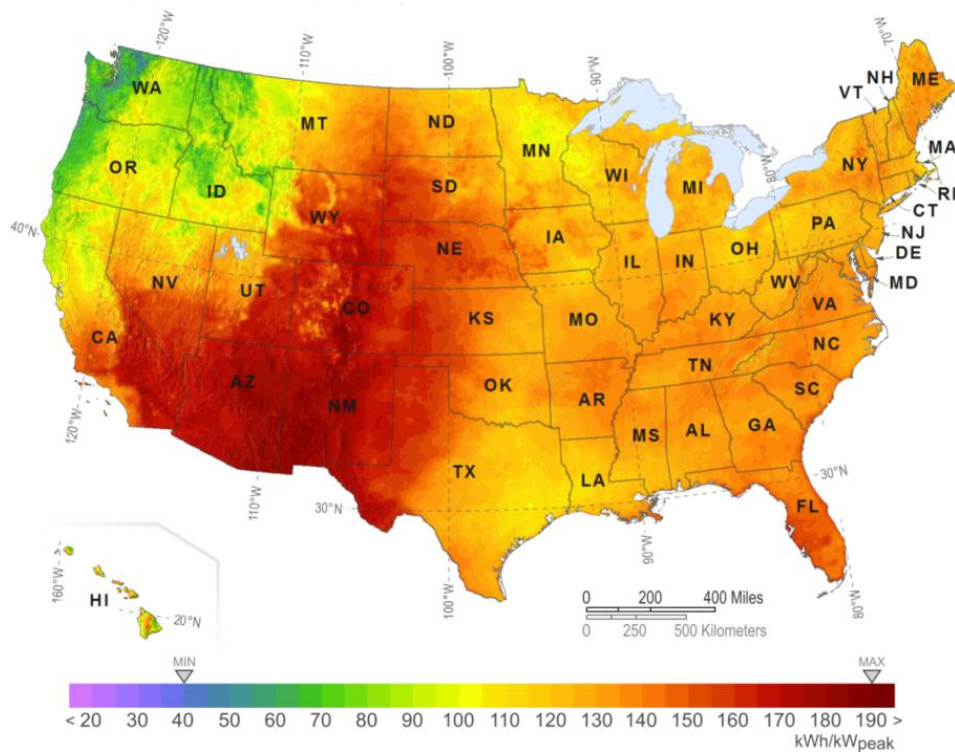
Web-accessible solar irradiance data & analytical tools

Irradiance data

- Historical satellite-derived time-series data from 1998 through latest hour
- Forecasts up to 7-days in advance by combining cloud motion vector and NWP approaches

Analytical tools

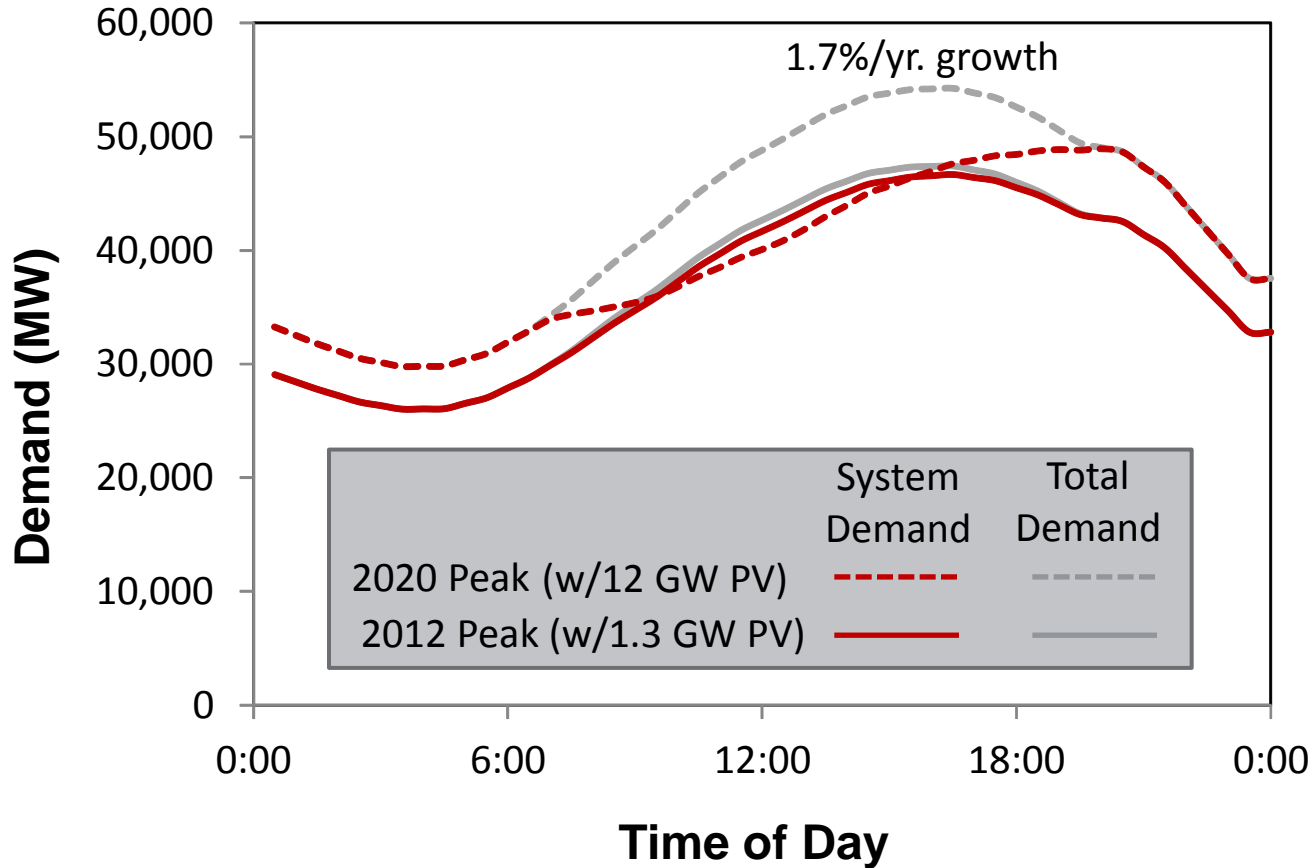
- PV system modeling (FleetView)
- PV benchmarking (DataCheck)
- PV fleet variability



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Predicting Fleet Output for Resource Planning

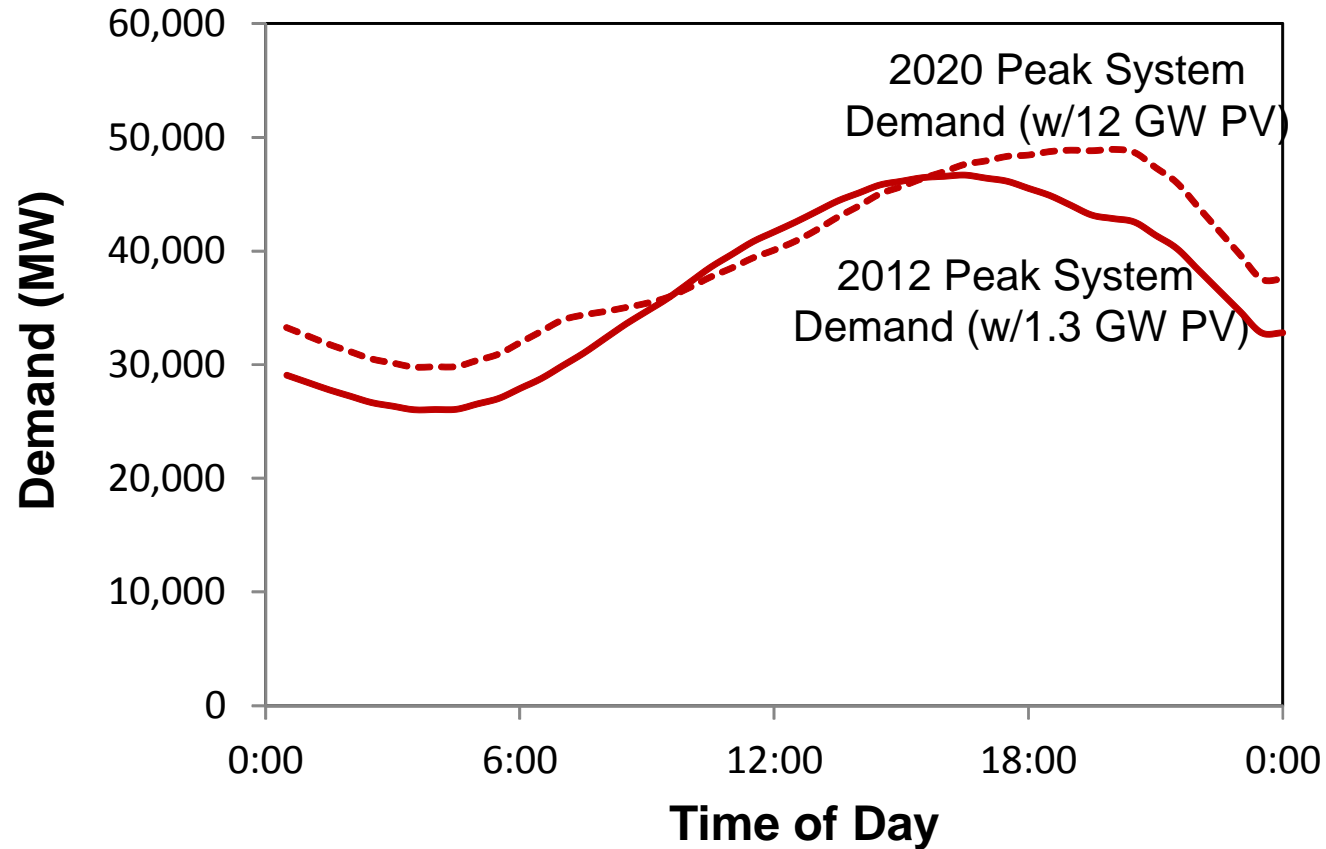
Peak Day: August 13, 2012



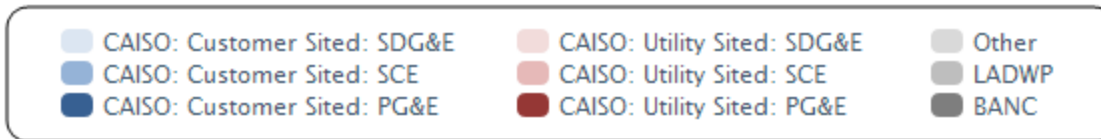
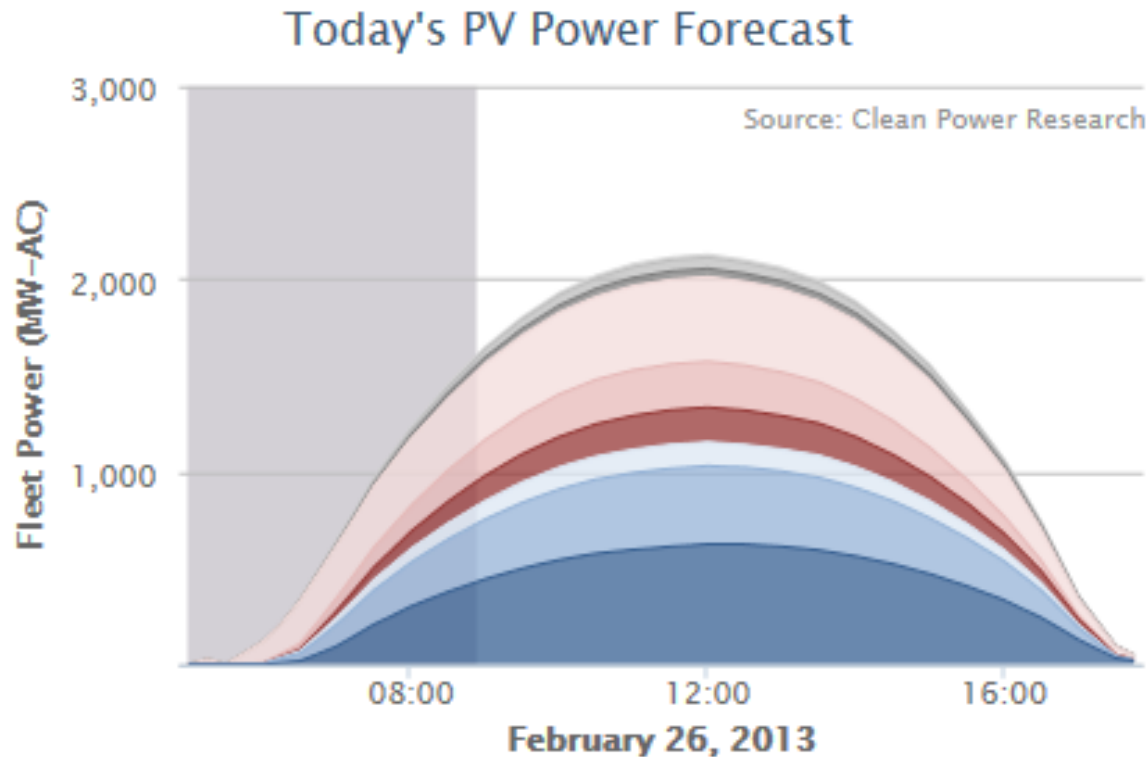
Note: Full analysis requires examination of all days of the year

Predicting Fleet Output for Resource Planning

Peak Day: August 13, 2012



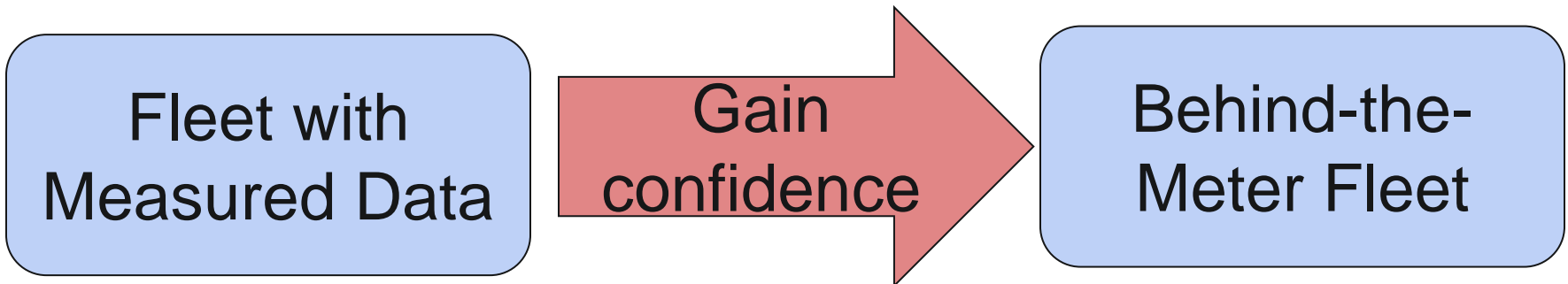
Predicting Fleet Output for Net Load Forecasting



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

How to Validate Forecast Accuracy When Historical Data is Unavailable?

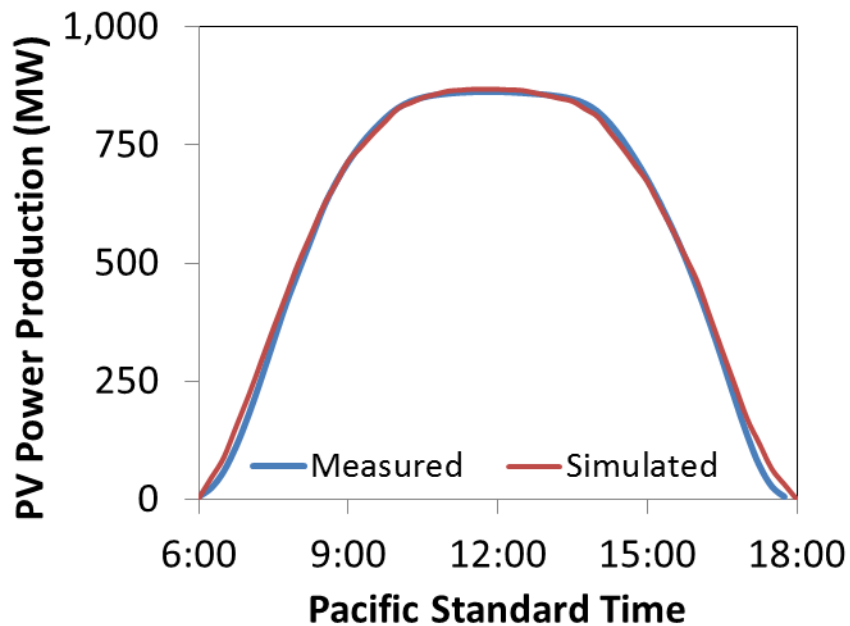
- Validate accuracy using measured PV production
 - Use backcasting to:
 - Validate PV performance model
 - Identify PV performance issues
 - Quantify forecast accuracy
- Gain confidence in behind-the-meter fleet forecast



Validate PV Performance Model Using Backcast

March 12, 2013

Complete Fleet



Measured Data Source

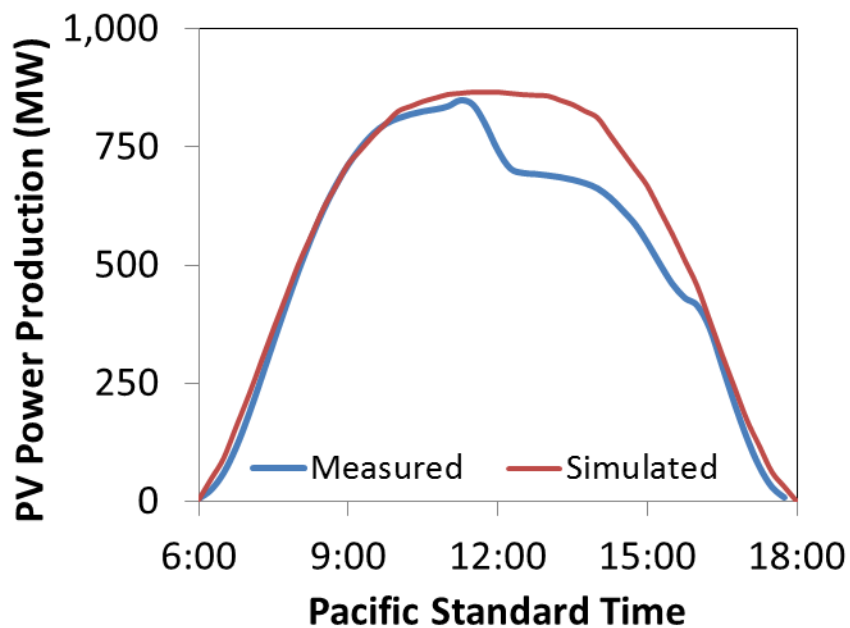
- CAISO
- 45 PV Systems
- 4 second output
- Averaged to 15 minutes



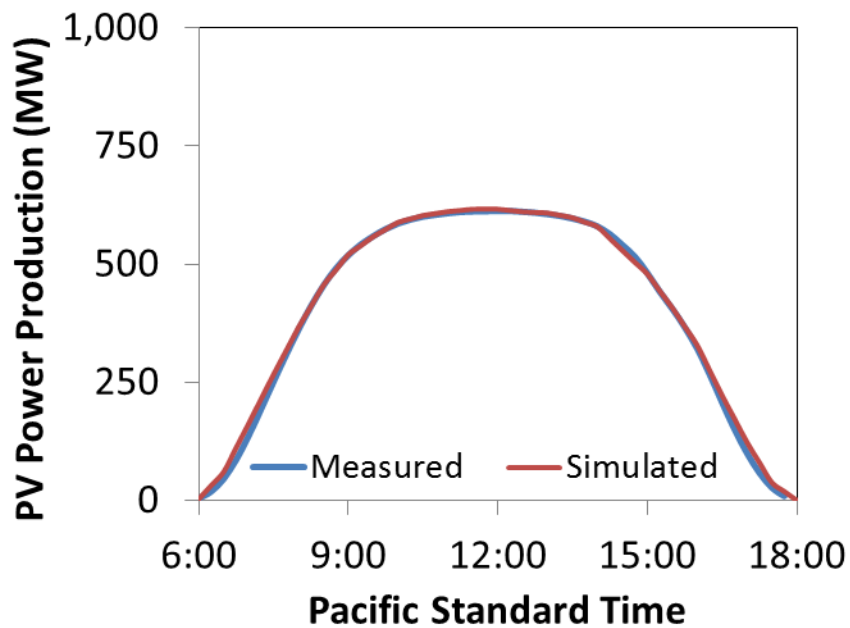
Identify Performance Issues Using Backcast

March 13, 2013

Complete Fleet



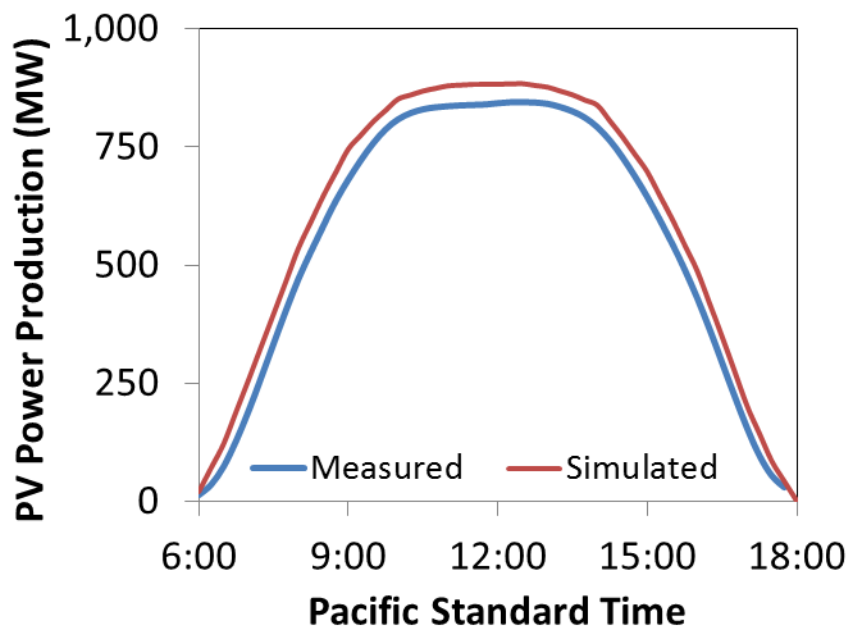
Remove 1 Large System



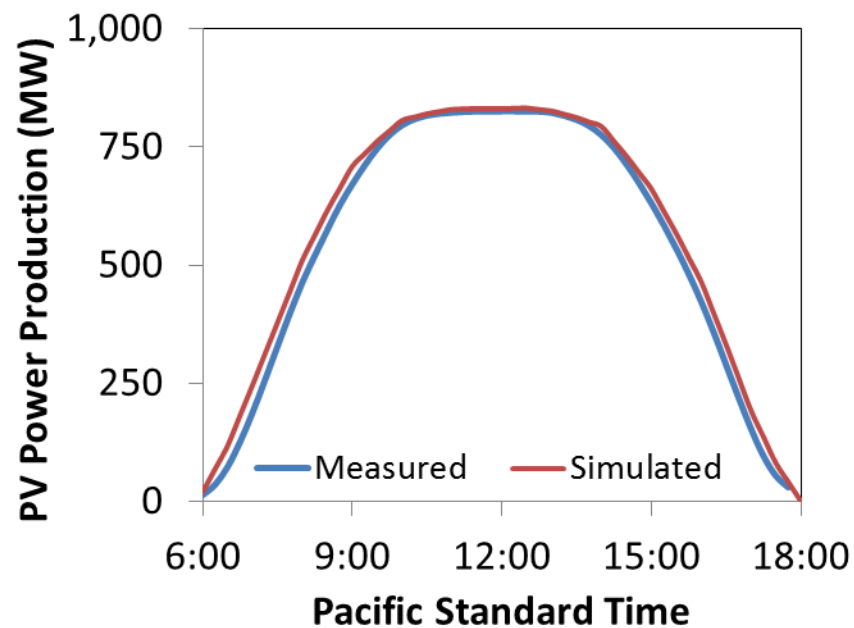
Identify Performance Issues Using Backcast

March 22, 2013

Complete Fleet



Remove 3 Small Systems

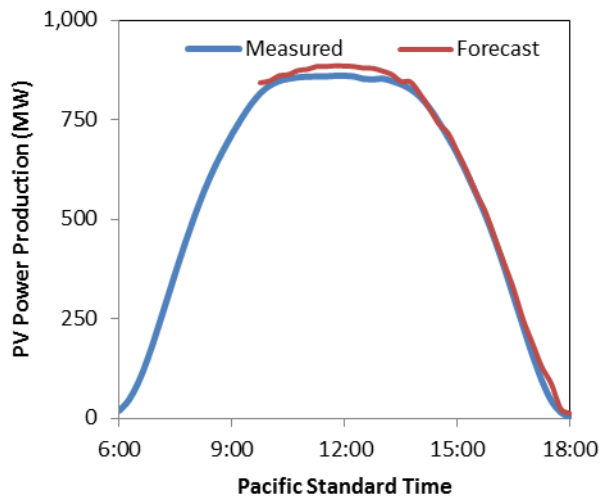


Short-Term Forecast Validation (Clear Day)

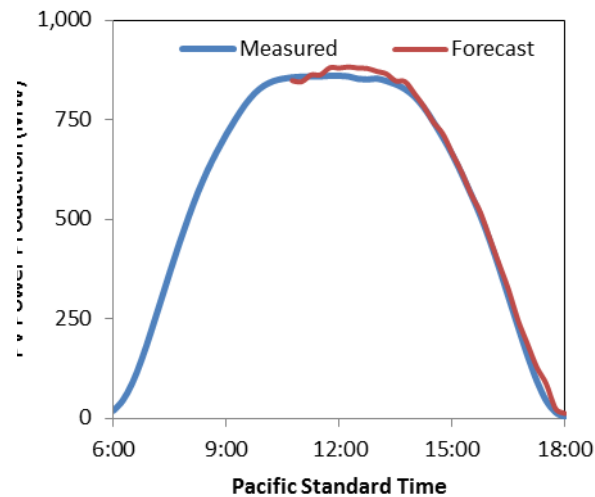
March 24, 2013

Time Horizon (Relative to Forecast Delivery)

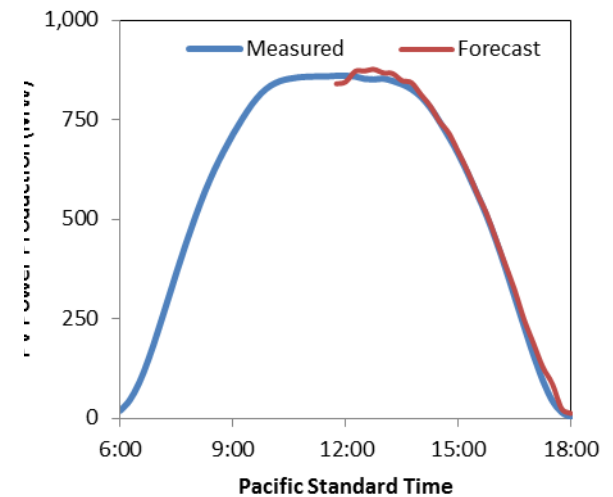
0 – ¼ Hours



1 – 1¼ Hours



2 – 2¼ Hours



Add 45 minutes to obtain time horizon relative to **image creation time**

Short-term forecasts are available after visible, daylight satellite images are obtained

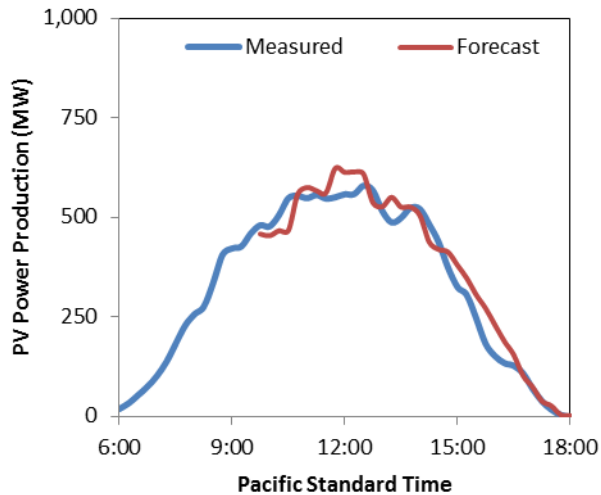


Short-Term Forecast Validation (Cloudy Day)

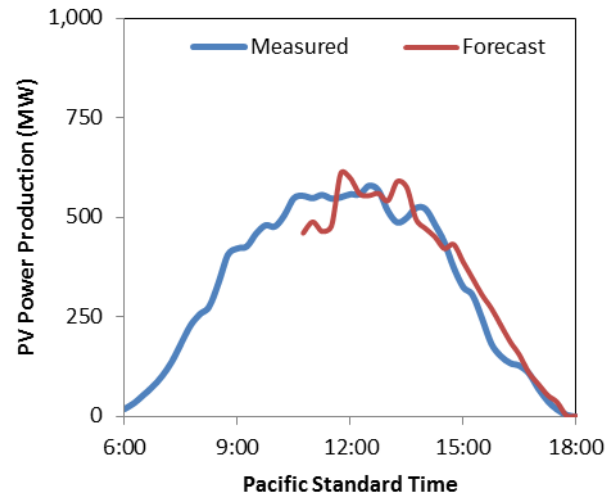
March 20, 2013

Time Horizon (Relative to Forecast Delivery)

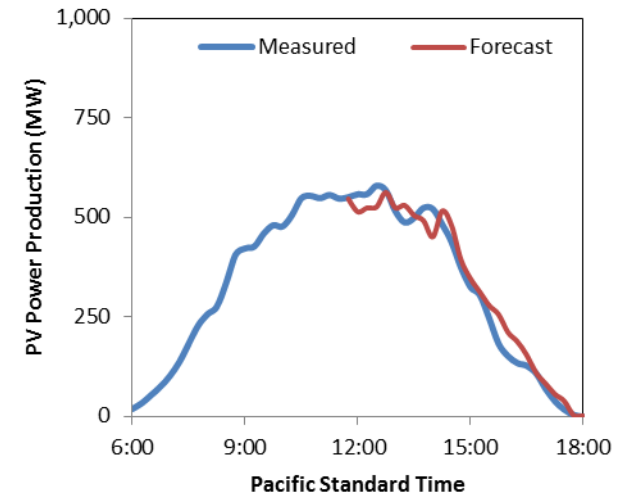
0 – ¼ Hours



1 – 1¼ Hours



2 – 2¼ Hours

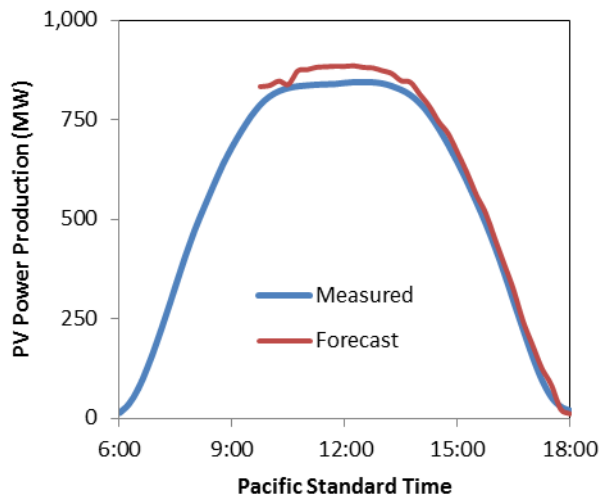


Short-Term Forecast Validation (Spec Issue)

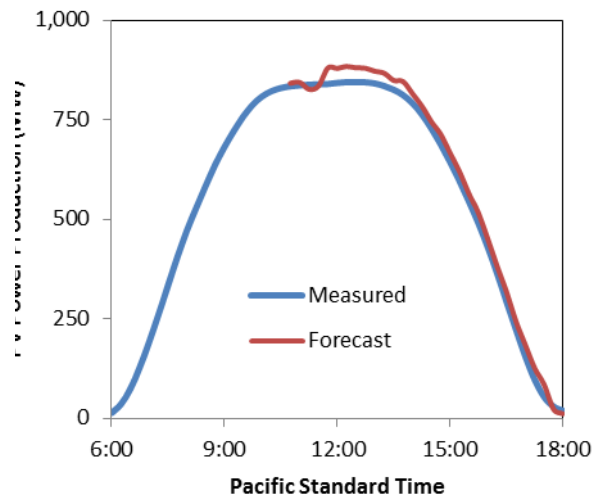
March 22, 2013

Time Horizon (Relative to Forecast Delivery)

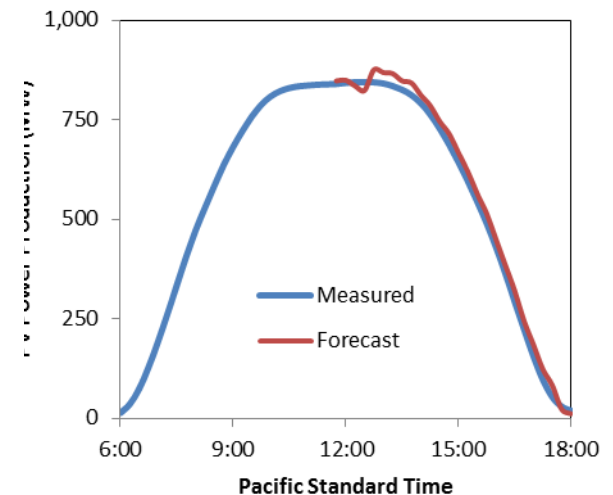
0 – ¼ Hours



1 – 1¼ Hours



2 – 2¼ Hours

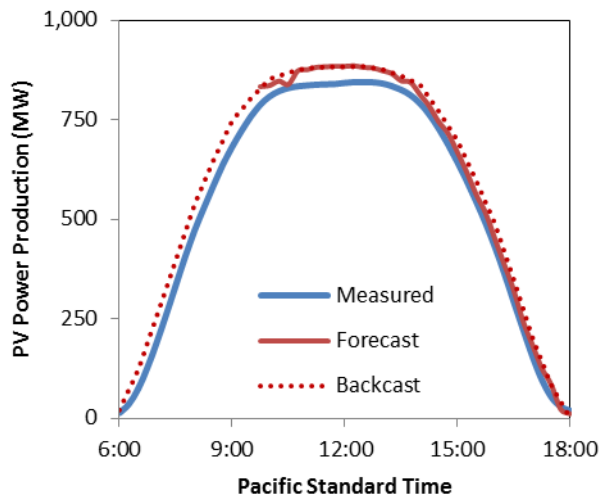


Short-Term Forecast Validation (w/ Backcast)

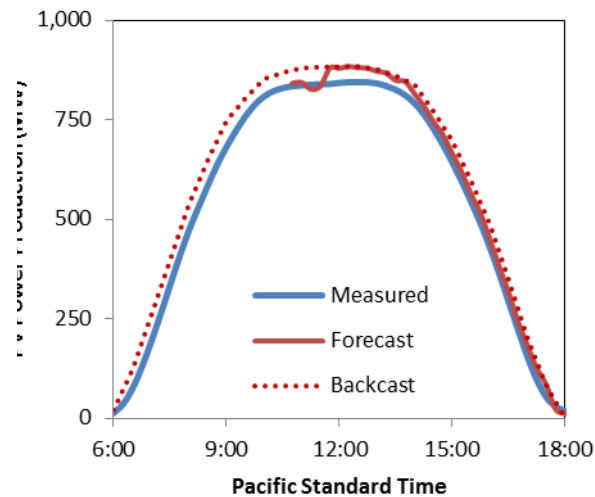
March 22, 2013

Time Horizon (Relative to Forecast Delivery)

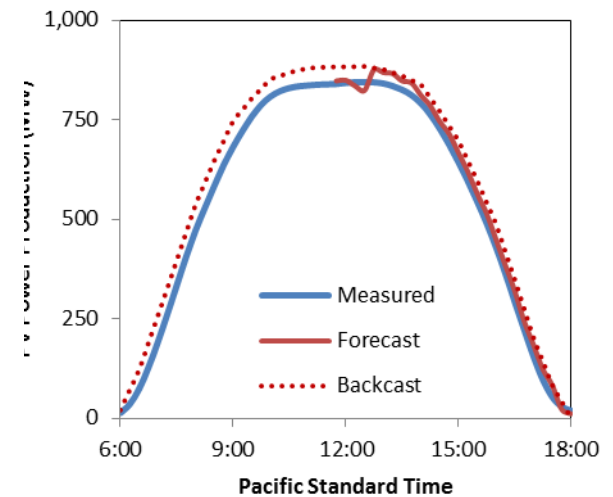
0 – ¼ Hours



1 – 1¼ Hours



2 – 2¼ Hours



Conclusion

- Satellite-derived PV simulation holds good promise for a low-cost method for addressing grid-integration issues through PV planning and forecasting
- Measured data can be used to validate satellite forecast methods and then the same methods can be used to forecast behind-the-meter PV systems



Next Steps and Areas of Improvement

- Further validation (including long-term forecast)
- Improved source of equipment specs
- PV power curve that better reflects actual plants
- Incorporation of operating status (esp. for large plants)
- Extension of cloud motion vector approach to early morning using satellite infra-red channels



Acknowledgements

Project Lead



Project Partners



Primary Funders



Power Industry



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