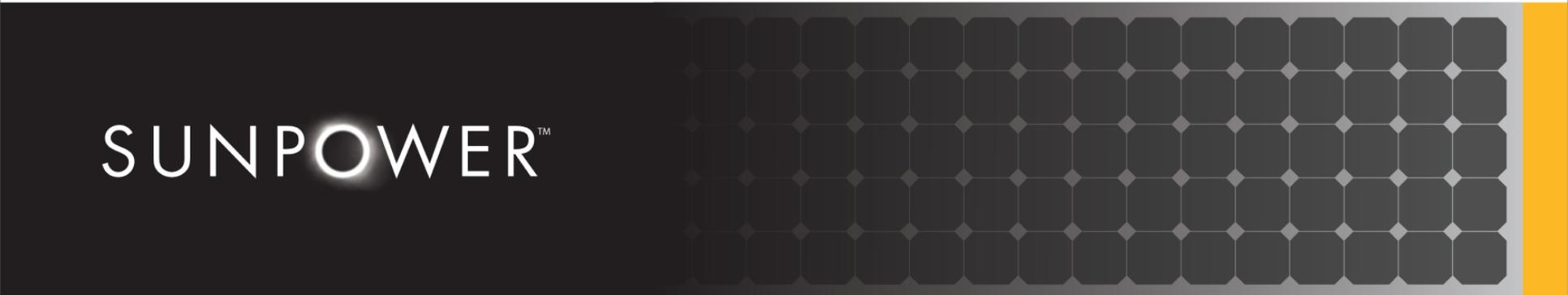


Differentiating Quality PV

Standards & Methodology for Underwriting Certainty

PV Modeling Accuracy & Bankability



SUNPOWER™

Ben Bourne

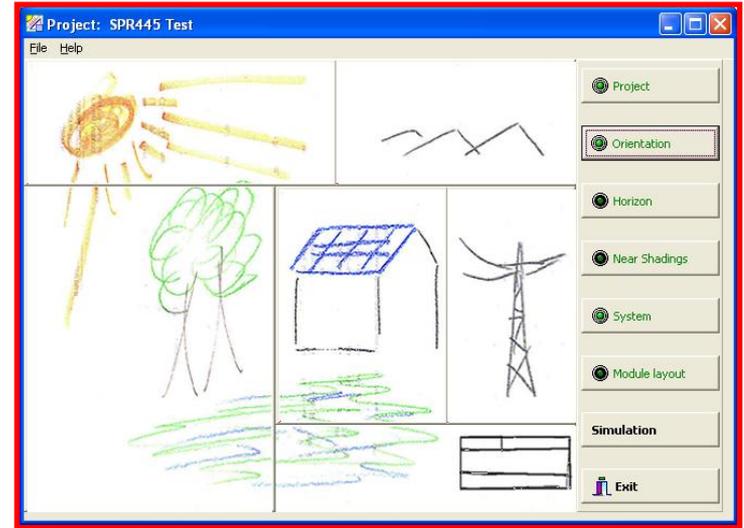
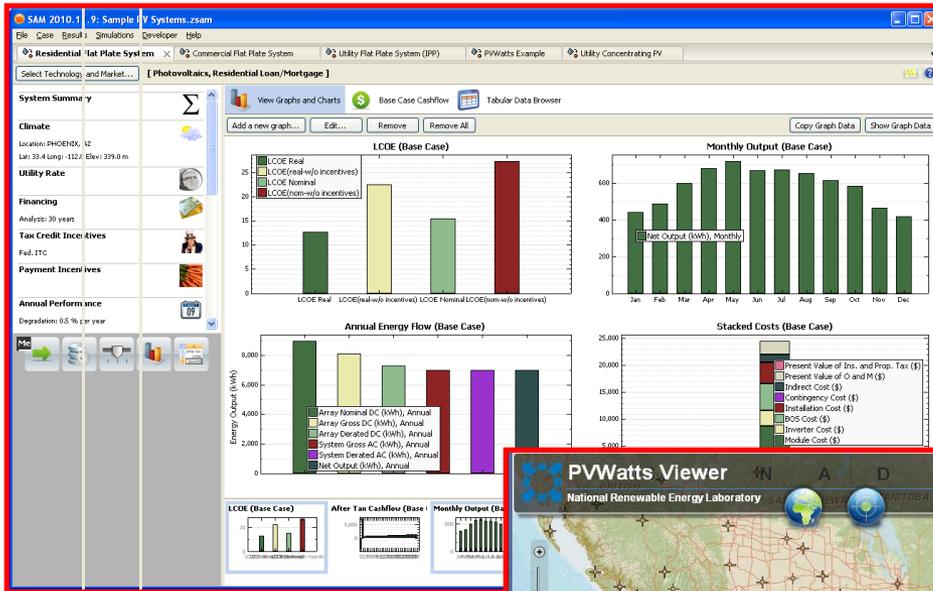
SunPower Corporation

March 6, 2012 - San Francisco, CA

Introduction

- Model accuracy, data quality, and weather variability have direct impact on project bankability and risk:
 - Simulation tool selection (PVSyst, SAM, PVWatts, etc.)
 - How well does the simulation tool predict installed performance?
 - Model selection (CEC/Sandia, Perez/Hay irradiance, etc.)
 - How well do the models match test data?
 - How well do test protocols & data reduction characterize installed performance of PV components?
 - Data quality:
 - How representative is the available weather data
 - How accurate?
 - How variable?
 - What is the accuracy of and uncertainty in the measurements used to predict energy production and assess installed system performance?

Modeling Tool Selection



PV Walls Click on Calculate if default values are acceptable, or after selecting your system specifications. Click on Help for information about system specifications. To use a DC to AC derate factor other than the default, click on Derate Factor Help for information.

Station Identification:

WBAN Number: 93193
 City: Fresno
 State: California

PV System Specifications:

DC Rating (kW):
 DC to AC Derate Factor:
 Array Type:

Fixed Tilt or 1-Axis Tracking System:

Array Tilt (degrees): (Default = Latitude)
 Array Azimuth (degrees): (Default = South)

Energy Data:

Cost of Electricity (cents/kWh):

Modeling Tool Selection

PVSim V1.2.3.9 - HARDWARE - Microsoft Internet Explorer provided by SunPower Corporation

File Edit View Favorites Tools Help

★ ☆ PVSim V1.2.3.9 - HARDWARE

SUNPOWER

User: bbourne

LOCATION

HARDWARE

SIZING

LOSSES

SUMMARY

RESULTS

CONFIGURATION

Log Out

Mounting

System: T0 Tracker

Ground slope: °

Location type: Urban Open space

Ground slope orientation relative to N-S axis: °

System azimuth relative to N-S axis: °



Modules

Module: SunPower SPR-435NE-WHT-D AR

Nameplate rating (STC): 435 W
Flash test rating (STC): 436.0 W
Module area: 2.16m²
Number of cells: 128

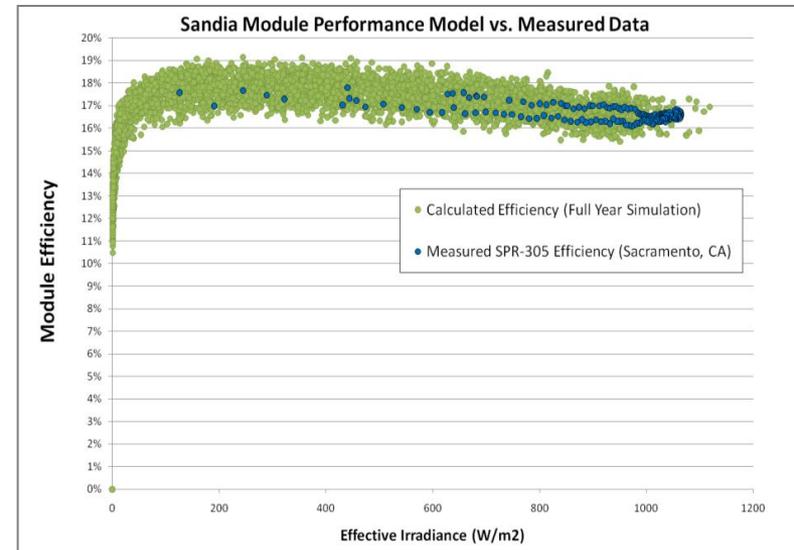
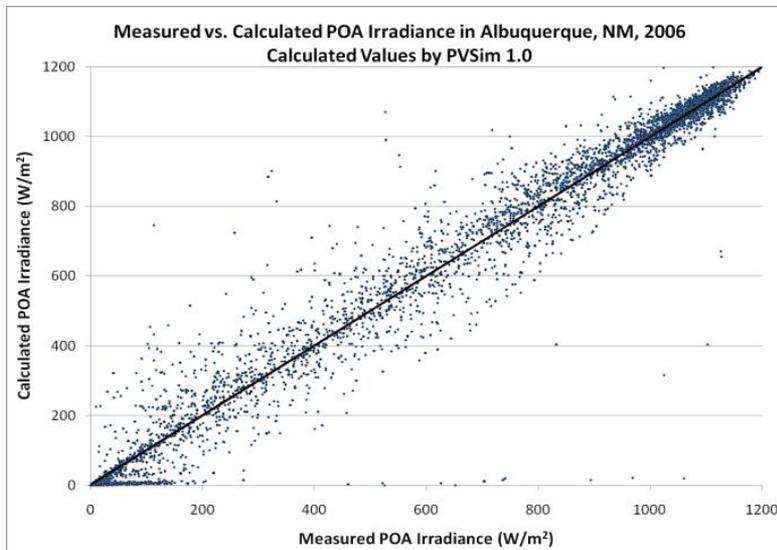
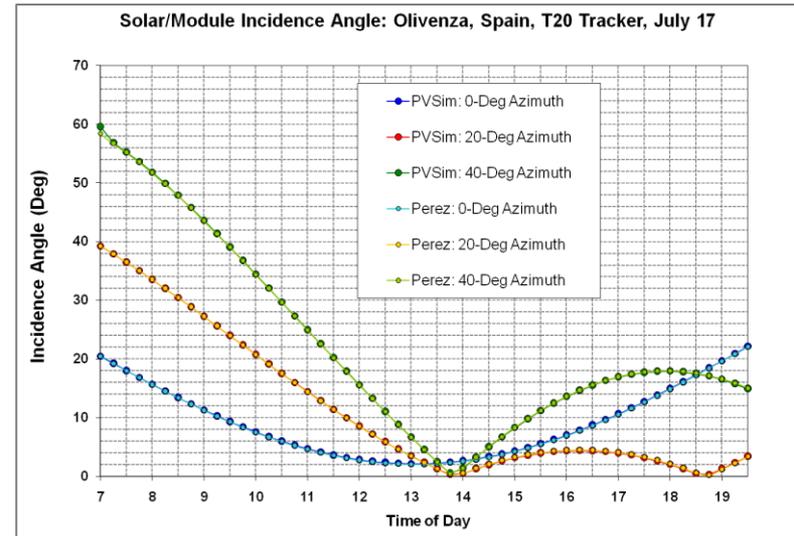
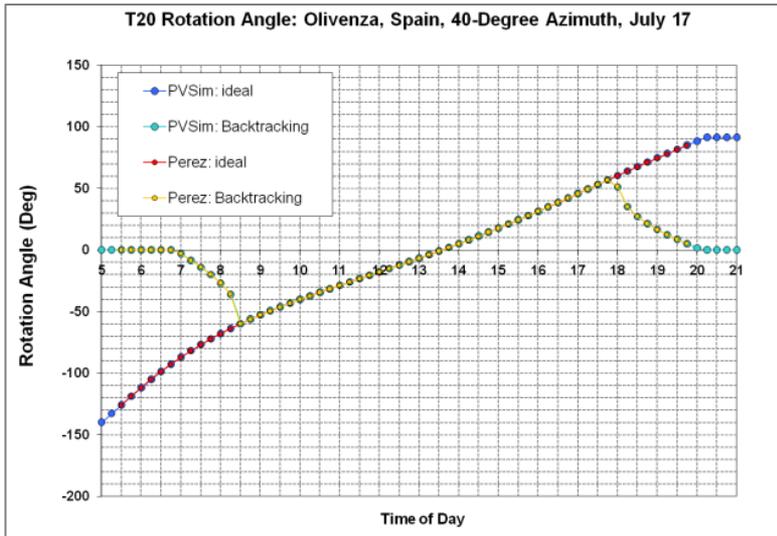
SIMULATE NOW

Save Configurations: Bens Config Changed

Site: Germany, Berlin	System size: 520.7 kWp
Lat: 52.53°	Modules: 1197 SunPower SPR-435NE-WHT-D AR
Long: 13.42°	Mounting: T0 Tracker
Site elev: 44m.	Logging detail: 2 <input type="button" value="↓"/>
Time Zone: GMT+1.00	Metric <input type="button" value="↓"/>

Local intranet 100%

PVSim: Validation Practices



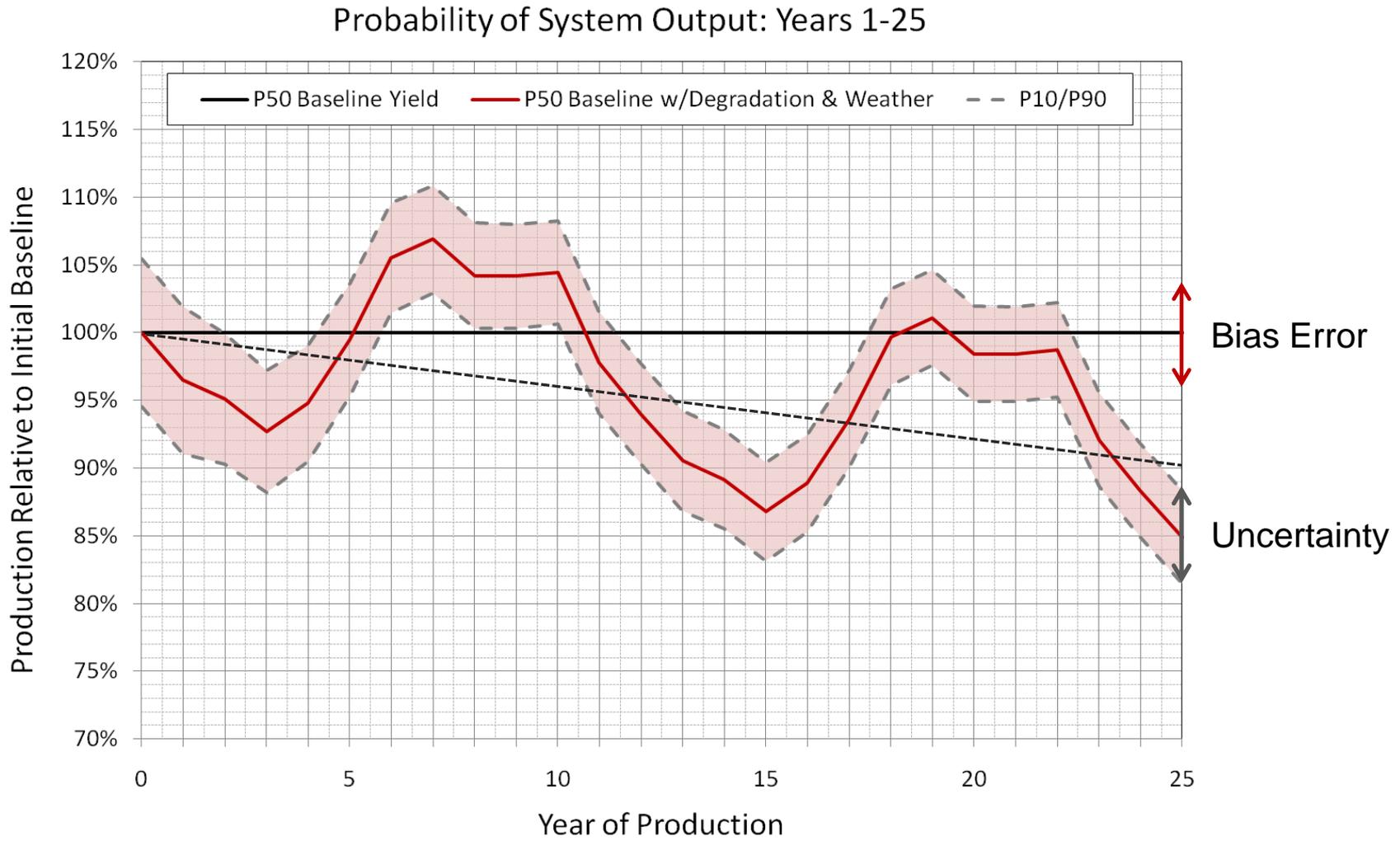
PVSim: Calculated Losses & Adjustments

- Energy Out = Solar Energy In + System Inefficiencies + Bias/Uncertainty

Time Range	Gh (kWh/m ² /day)	Ipoa (kWh/m ² /day)	AC Energy (kWh)
Jan	1.94	2.61	330
Feb	2.92	3.77	424
Mar	4.32	5.09	598
Apr	5.80	6.33	692
May	7.38	7.49	828
Jun	7.83	7.66	816
Jul	7.83	7.77	852
Aug	7.02	7.45	820
Sep	5.86	6.89	741
Oct	3.97	5.14	615
Nov	2.53	3.55	433
Dec	1.76	2.53	327
Year 1	4.94	5.53	7,477

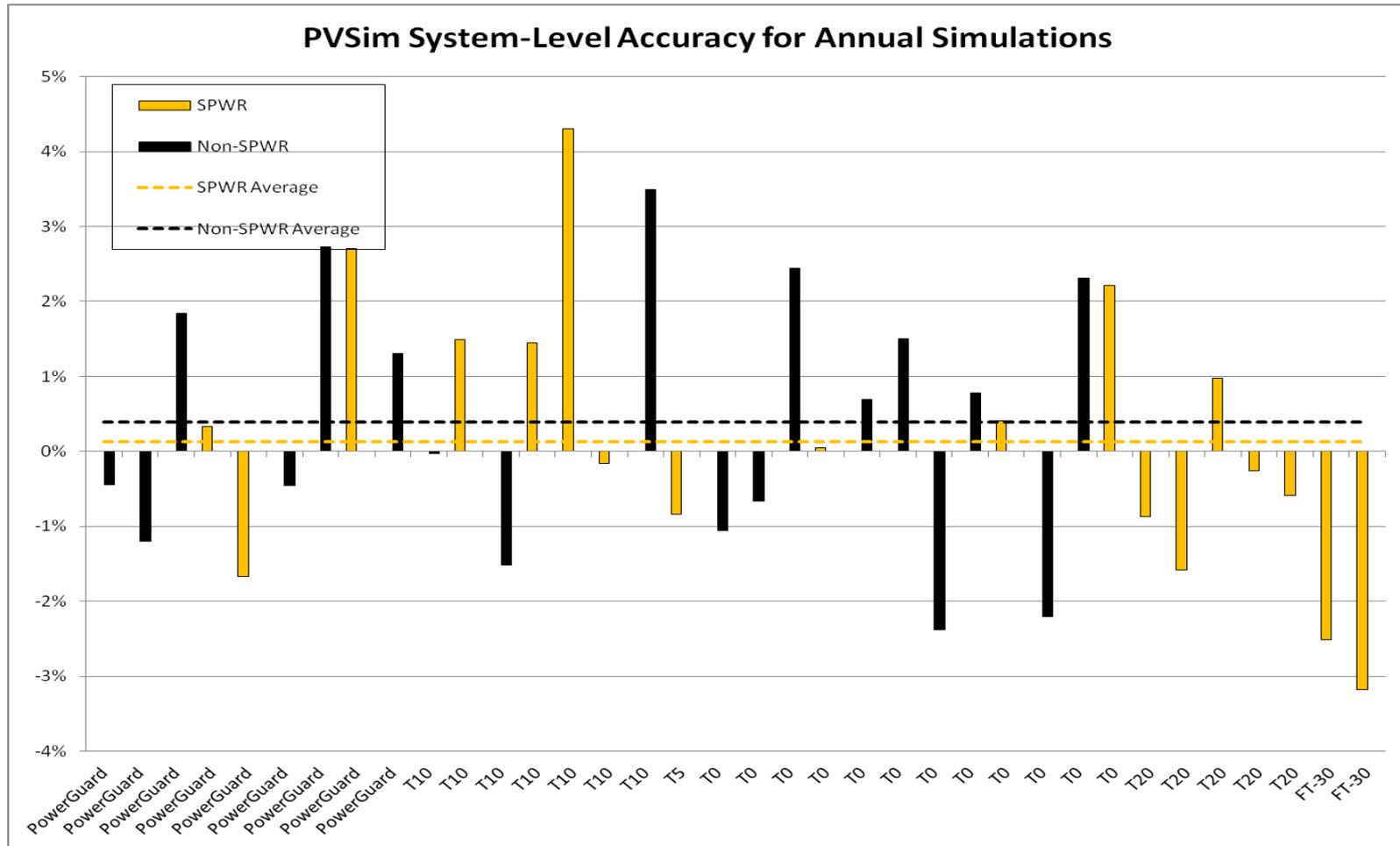
Itemized Annual Energy Losses	%
Shading Loss	0.00
Soiling Loss	-5.00
Angle-of-Incidence Loss	-3.62
Air Mass Adjustment	0.24
Operating Temperature Adjustment	-4.78
Efficiency vs. Irradiance Adjustment	-1.31
Module Flash Adjustment	0.65
Module Mismatch Loss	-2.00
DC Wiring Loss	-1.00
Inverter DC Limit Loss	0.00
Inverter Efficiency Adjustment	-4.75
Inverter AC-Capacity Clipping Loss	-4.21
Transformer Efficiency Loss (Day)	0.00
Transformer Efficiency Loss (Night)	0.00
AC Wiring Loss	-0.20
Site Shading Loss	0.00
Auxiliary Load Loss	0.00
Annual Availability	98.00

Understanding Weather Variability & Risk



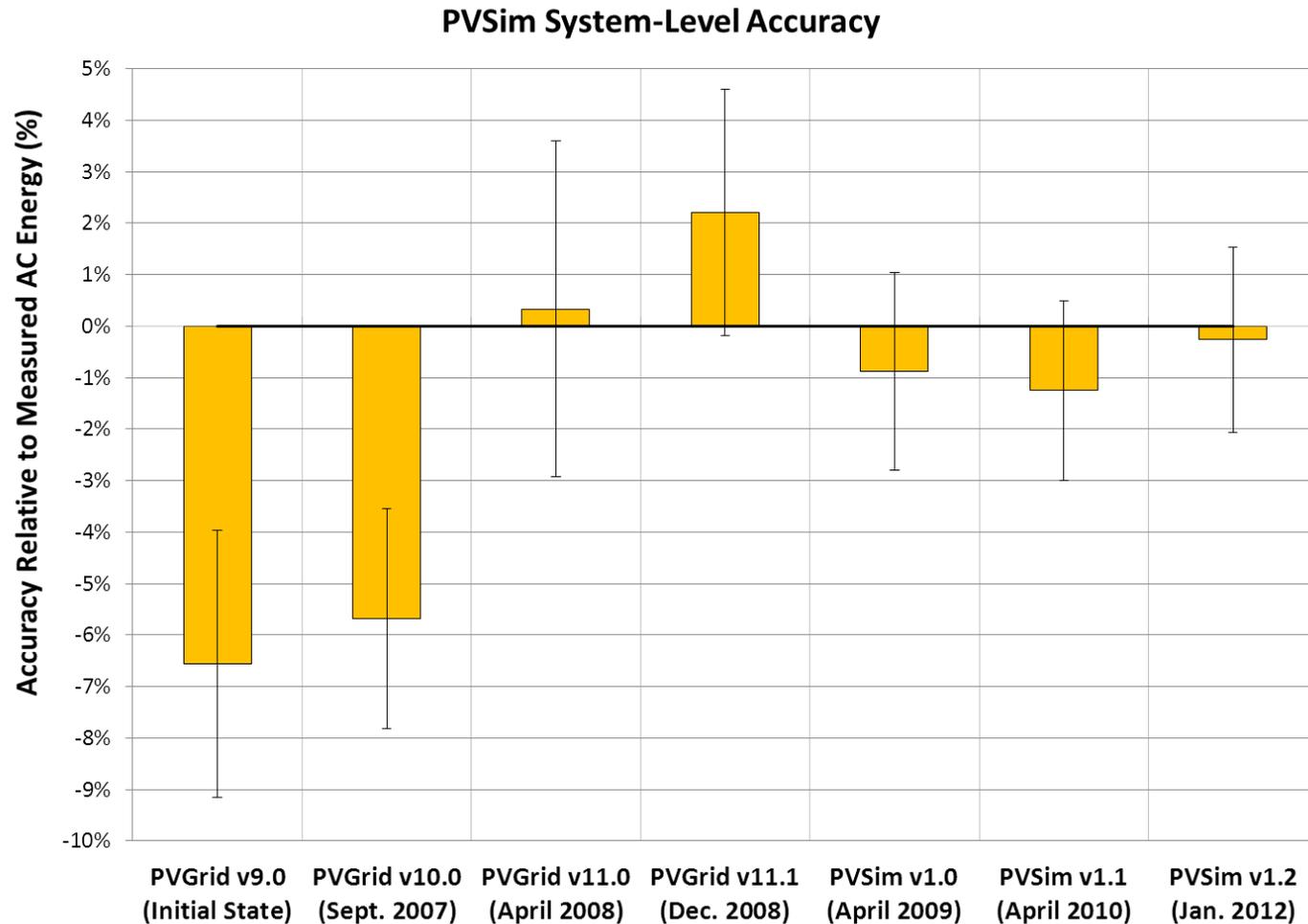
System Level Validation

- SunPower's current simulation accuracy: $-0.86\% \pm 1.58\%$



Improving PV Models and Accuracy

- SunPower is constantly working to improve our modeling accuracy



Thanks!

