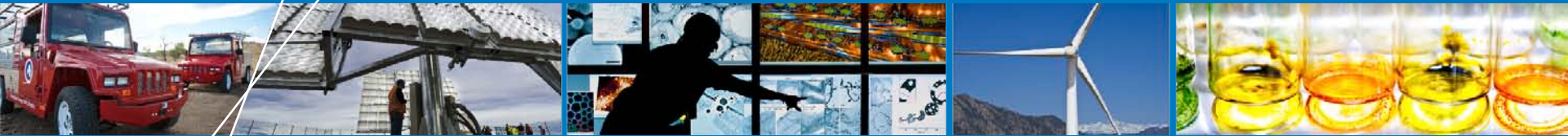


CASE STUDIES COMPARING SYSTEM ADVISOR MODEL (SAM) RESULTS TO REAL PERFORMANCE DATA



SAM Virtual Conference

Nate Blair

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Previously Presented at WREF 2012

Case Studies

- **Goal:** Real-world validation of an entire system (and not sub-component validation which is often done)
- **Goal:** Build examples for SAM users to review in building their own systems.

Case Studies

- We attempted to get a spread of systems across a range of sizes and markets.
- Comparisons were performed between the SAM model output and measured performance data, reported cost data or with reported annual performance values.
- Four of the system comparisons were released with the SAM model release version 12.2.2011. The case studies and their associated SAM project file are distributed with the SAM download.

Systems Examined

James Forrestal Building (Forrestal)

The James Forrestal Building is the U.S. Department of Energy's (DOE) headquarters in Washington, D.C. The 205 kW rooftop PV array was installed in 2008 with the goal of producing up to 8% of the building's peak energy needs.



Systems Examined

NREL Research Support Facility (RSF) Building

The RSF building is part of NREL's South Table Mountain campus located in Golden, CO. The rooftop PV array has a nameplate capacity of 449 kW, contributing to the building's net-zero energy standard.



Systems Examined

NREL Science and Technology Facility (S&TF)

The S&TF Building is part of NREL's South Table Mountain campus located in Golden, CO. The rooftop PV array has a nameplate capacity of 94.5 kW.



Systems Examined

Oklahoma City Residence (OKCity)

The Zero-Energy Home in Oklahoma City, Oklahoma features a roof-mounted 5.3 kW PV array



Description of the Primary Data Available

Site	Performance Data Source	Cost Data Source	Weather Data Source
Forrestal	DOE Solar Program (Dec. 2009 to June 2010)	OpenPV.NREL.Gov	DOE Solar Program (measured at the system)
NREL RSF	SunEdison Client Connect Portal (June 2010 - May 2011)	OpenPV.NREL.Gov	NREL's SRRL site data
NREL S&TF	SunEdison Client Connect Portal (Jan. 2010 – Dec. 2010.)	OpenPV.NREL.Gov	NREL's SRRL site data
OKCity	Measured Data used in prior NREL report	OpenPV.NREL.Gov	Proprietary Perez Satellite data for 2006

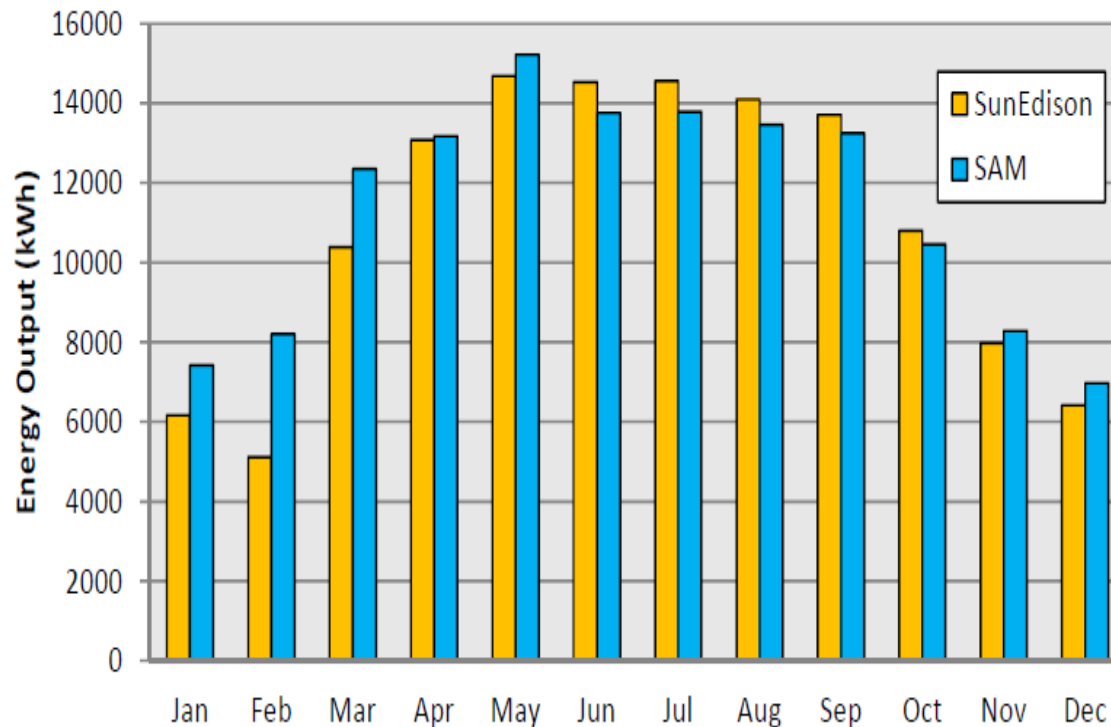
ⁱ PV system cost data available at: <http://openpv.nrel.gov/> and then filtered by installation year and system size for appropriate but nationally averaged values.

ⁱⁱ Because the system is maintained and owned by SunEdison, measured performance data was acquired from SunEdison's Client Connect portal (<https://my.sunedison.com/>). A password is required to gain access to the data, which we obtained because NREL is the site owner.

ⁱⁱⁱ This study used climate data collected at NREL's Solar Radiation Research Laboratory (SRRL) located at the South Table Mountain site.

^{iv} Barker, G. "Report on PV System Performance." NREL Subcontract # LAX-1-30480-02. 24 April 2006.

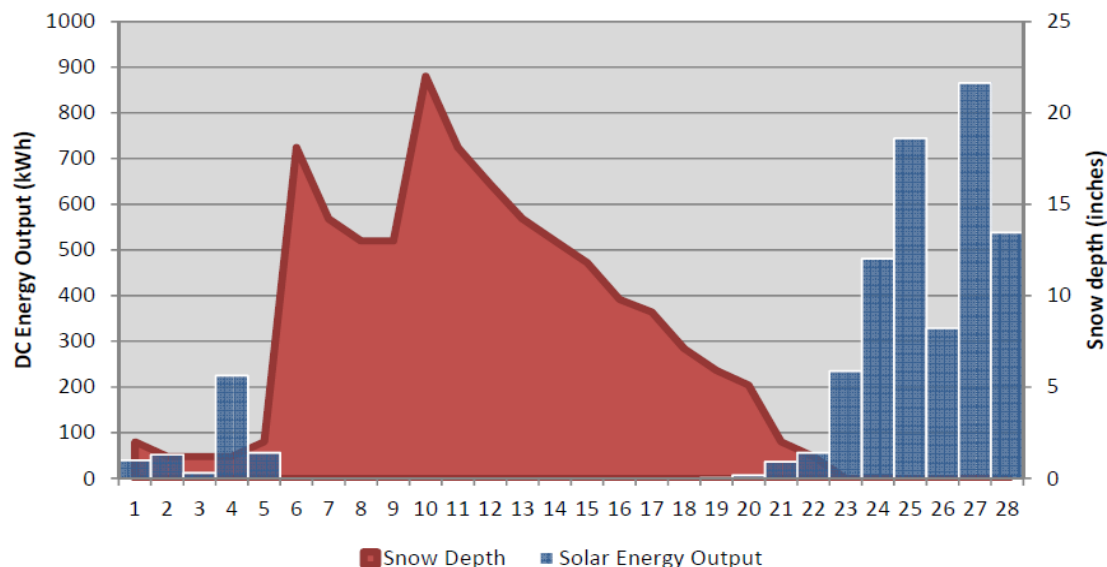
Issue: Missing Measured Data



Initial Comparison between SAM and Measured Data for the NREL S&TF Building

The first issue with comparing the simulated and measured data was missing data within the measured performance data. This happened in OK City, NREL RSF, and NREL S&TF.

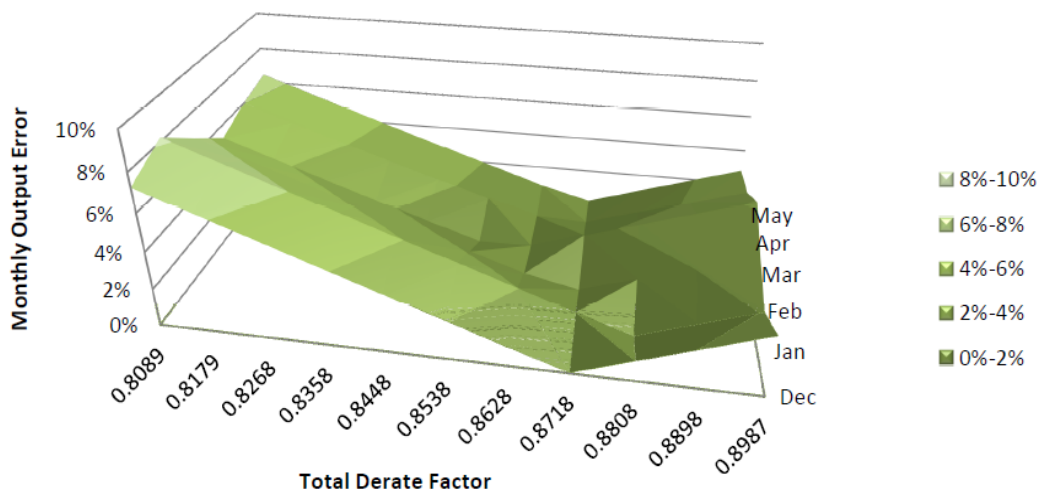
Issue: Snowfall Impact on Measured Data



Snow depth (red) and DC energy output (blue) for each day in February 2010, clearly showing the two Mid-Atlantic blizzards (6th and 10th) and the impact on solar energy generation.

- Another major discrepancy was due to snowfall causing a reduction in measured output. This was a major issue in comparing to simulated data for all systems.
- Another factor (for SAM currently) is that if a climate file contains snow data, the ground albedo for snowy days increases and actually enhances the simulated system performance. This issue is being investigated.

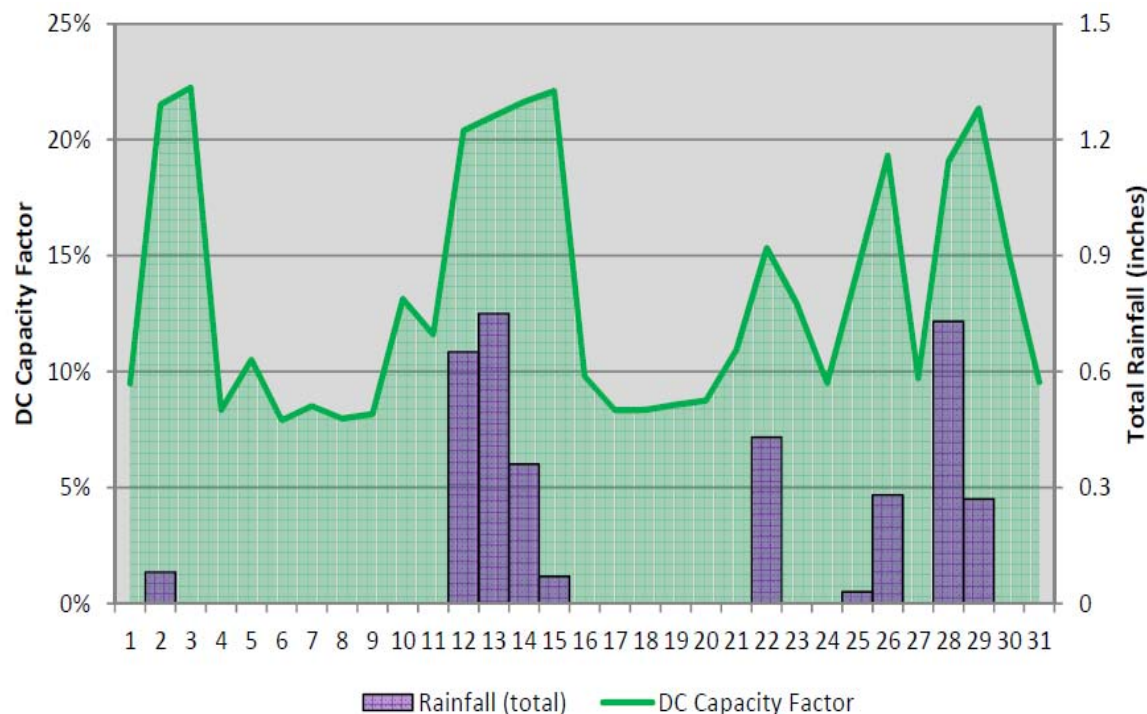
Issue: Derate Defaults Impact



For the NREL RSF system, a total derate factor in SAM of about 87% would minimize the difference between SAM's calculated output values and the measured values.

The final factor that seems to consistently lead to underprediction of performance values by SAM is the overall derate value. The SAM default derates (based on the derates first presented in PVWatts), are conservative when looking at this very small sample set of relatively new systems.

Issue: Soiling Impacts



For the Forrestal building, a strong correlation between DC capacity factor (green) and total rainfall (purple) during March 2010

Related to the issue of appropriate general derates, the Forrestal system raised the issue of the episodic impact of heavy soiling on the system. The system on the roof of the Forrestal building is flat. The capacity factor for the system increases dramatically after each rain event.

Results

- **S&TF System**

We were able to get within 0.3% of the measured annual output and within 3.7% of the measured value for every month except November and December which had an output error of less than 5%.

- **Forrestal Building**

Five of the seven months studied were within 2.5% of the measured data while the other two (December 2009 and January 2010) were within 5.6% of the measured DC output values.

- **Oklahoma City Zero Energy Building**

SAM results were within 1.9% of the measured system output for each of the 8 months that did not include flawed data or array performance issues.

- **NREL RSF System**

SAM results were within 1.5% of the measured energy output for each of the 6 months that were studied.

Summary

- NREL has completed four PV case studies related to the System Advisor Model (SAM).
- In the case of the Oklahoma City system, building load data was also available so we were able to demonstrate to the SAM user how to include load data and link this to a time of use rate.
- After adjusting the measured system output for snow days and missing data, reasonable agreement was achieved. Calibrating the overall SAM derate value to minimize the differences further improved agreement to within 1% for all four cases at an annual level.

Summary (cont)

These case studies have revealed several issues:

- It remains difficult to obtain high quality measured PV system output and synchronous radiation and meteorological data.
- The treatment of snowfall and snow cover has a major impact on most large systems and isn't generally captured in the models accurately. In fact, snow cover raises the ground albedo in SAM simulations, thereby increasing system output.
- Evidence suggests that the default values used for derates in SAM (and PVWatts from which the data comes) should be updated (based on several of these systems where an annual derate increase of several percent improved the agreement between measured and simulated data).

Questions ?

Find the Case Studies at

<https://sam.nrel.gov/content/resources-learning-sam>

Nate Blair



Nate Blair is the group manager of the Data Analysis and Visualization Group and the Energy Forecasting and Modeling Group in the Strategic Energy Analysis Center at NREL. Nate has been at NREL ten years and has been working renewable energy and efficiency system modeling (TRNSYS, REEDS, WinDS, SAM, PVWatts, etc.) for twenty years.

Education and background training

- » M.B.A., 2002, University of Wisconsin-Madison School of Business
- » M.S. in mechanical engineering, 1993, University of Wisconsin-Madison Solar Energy Laboratory
- » B.A. in physics, 1992, Gustavus Adolphus College

Phone number: 303-384-7426

E-mail: nate.blair@nrel.gov