TEP Solar Test Yard 4350 E. Irvington Rd, Tucson AZ, 85702

Over 600 PV modules from 20 different manufacturers are grid-tied at the TEP solar test yard. TEP is field-testing 90 kW_{peak} of PV systems here. Since 2003, AC power measurements have been recorded every 5 minutes from individual PV systems. Since 2009, University of Arizona researchers have monitored AC power, DC power, irradiance and temperature every second. SOLON corp. developed a PV test yard on the TEP lot next door in 2009.

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For data and analysis see: www.UAPV.org

Figure 1. The TEP solar test yard.

Data from the test yard will answer the questions:

- How well do photovoltaic systems perform in the field?
- How quickly do photovoltaic systems degrade?
- What are the temperature coefficients of efficiency for each type of panel?
- What is the annual, daily, and 1Hz energy yield of each PV system?
- How do PV modules and inverters perform compared to their specifications?
- How can we best forecast the annual PV energy yield for any given system?

for the benefit of utility companies, homeowners, PV installers, manufacturers, and researchers.

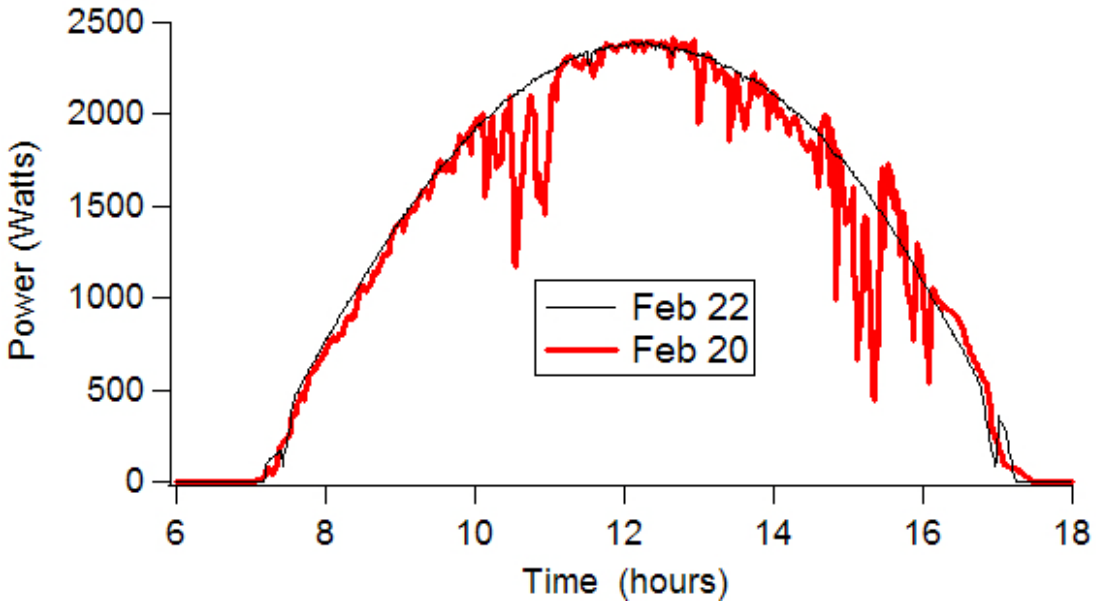

Figure 2. AC Power output every minute for two days. Feb 20 was partly cloudy. Feb 22 was clear. The system STC rating is 2640 Watts. We study de-rating factors and intermittency.

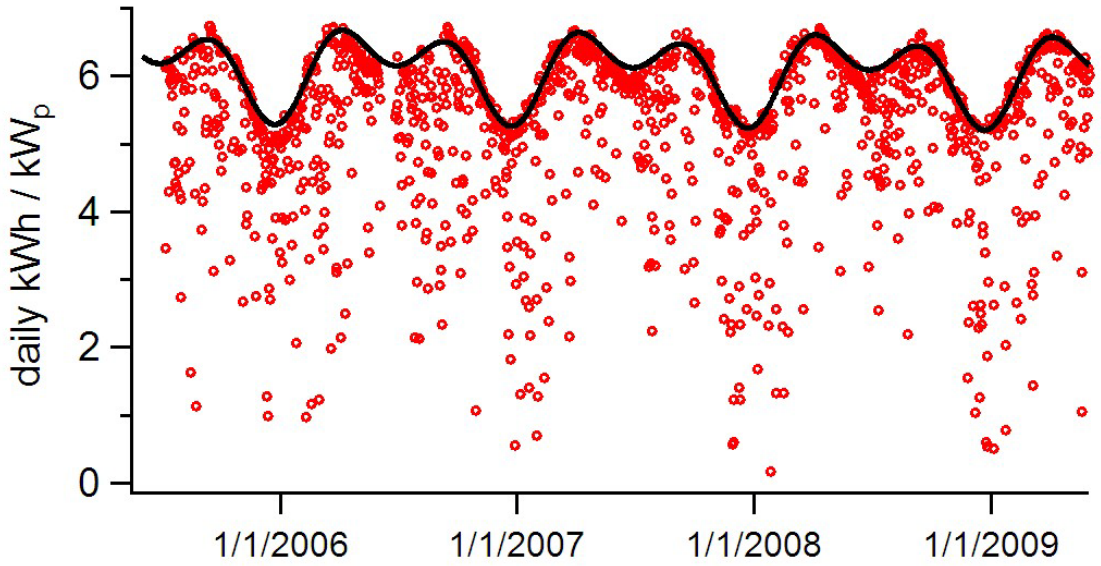

Figure 3. AC energy (kWh) every day for 4 years, normalized to the system's STC (kWp) rating. Low points are from cloudy days. The black curve is a prediction based on clear skies, a solar position algorithm, a temperature coefficient of efficiency, and 0.5% degradation per year. We study degradation rates and PV system output forecasts.

Table I. Comparison of flat-plate fixed-angle (32° South) PV systems in Tucson

SYST. NO.	Module Type	material	a#	Daily kWh / kW_p	Annual kWh / kW_p	Efficiency @ STC (%)	Degradation Rate (%/yr)
1	Sharp	px-Si	17	4.6	1679	14.1	not enough data
2	Kyocera	px-Si	12	4.4	1606	12.7	- 0.7
3	BP 3150U	px-Si	10	4.3	1570	12.9	0.4
4	Unisolar	MJ-Si	9	5.3	1935	6.9	- 0.1
5	Sanyo	HIT Si	4	4.5	1643	15.6	1.1
6	BP MST50	MJ-Si	6	3.6	1314	6.4	4.5
7	ASE DGF17	px-Si				13.3	1.3
8	BP SX140	px-Si	11	4.4	1606	12.1	- 0.5
9	ASE DGF50	px-Si				13.3	2.1
10	GSE	CIGS	2	3.6	1314	5.8	2.9
11	Shell	CIS	3	4.3	1570	11.1	2.7
12	Sanyo	HIT Si	5	4.9	1789	17.0	0.4
13	BPMST50	MJ-Si	7			6.4	not enough data
14	Solarex	a-Si	1	4.0	1460	6.4	-0.1
15	Shell					12.9	
16	Astro		18	4.7	1715	12.4	1.7
17	BP MST43	MJ-Si	8	4.4	1606	5.5	1.3
18	ASE DGF17	px-Si	13	4.0	1460		- 0.3
19	SunPower	x-Si					not enough data
20	ASE DGF50	px-Si	14	5.7	2080		- 0.3
21	GSE SL					8.7	
22	BP 4170					14.7	
23	Evergreen						not enough data

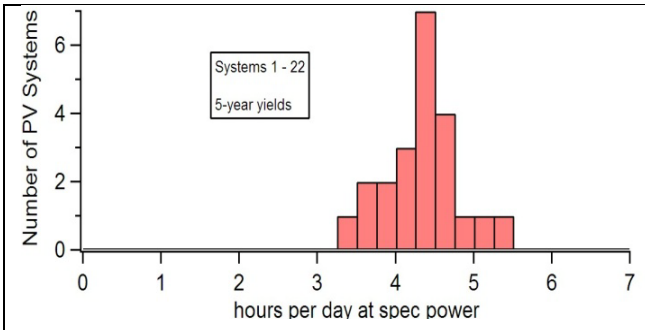

Figure 4. Hours per day at spec power, based on 4 years of data for 20 PV systems. Most PV systems produce energy each day in the amount: 4.5 hours * spec power. De-ratings are due to inverters, mismatched modules, and temperature effects.

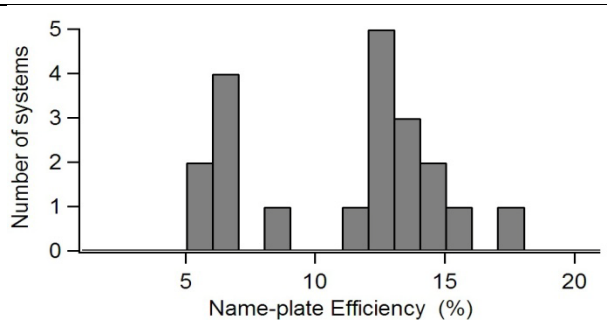

Figure 5. Manufacturer's Nameplate Efficiency (STC rating / Area / 1000 W/m2). We are still analyzing irradiance data to report field-condition efficiency for each system.

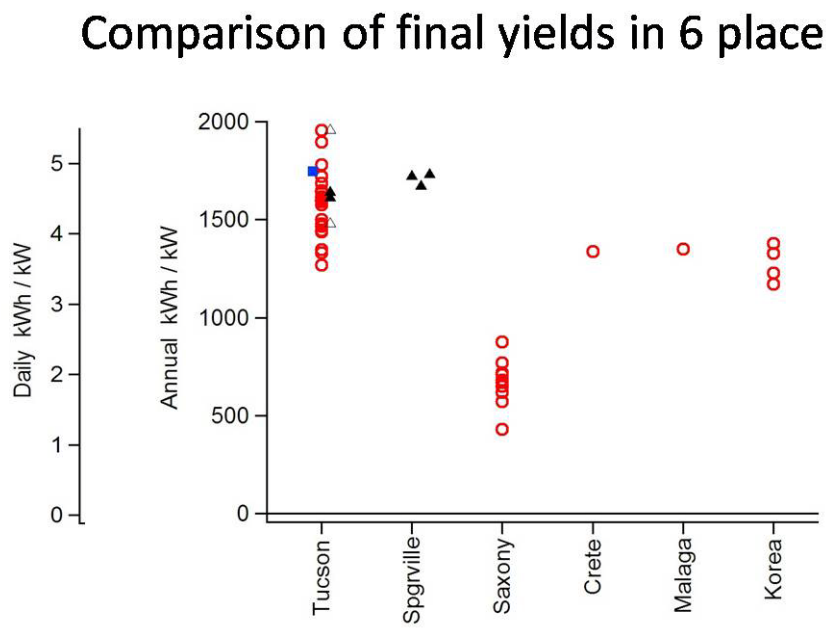

Figure 6. Average daily and annual outputs for grid-tied PV systems, normalized to their STC sticker ratings, are shown for 6 locations. Yields are higher in Tucson than other places.
References:

Tucson: This research (2010) www.UAPV.org
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Outlook:

The TEP solar test yard serves as a field-testing laboratory for PV hardware. Data from the TEP solar test yard is available to publish. UofA researchers coordinated by AZRISE and Dr. Cronin will continue working with TEP to field-test new concentrator and thin film PV systems.

Tours for students, researchers, homeowners, and industry personnel are available on a regular schedule (check: www.UAPV.org) and by request. PV education and outreach using the TEP solar test yard are coordinated by docents led by Deanna Lewis.

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