



PRODUCT AWARENESS NOTIFICATION # 003.01.07

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|----------------------------|---|
| Title: | Competitive Snapshot, SunPower comparison at 9kW (72 cell modules) |
| Scope: | Modeling Large residential/Small commercial projects in Europe |
| Groups: | Product Management / Applications |
| Technical Contacts: | Mark Shields, Luis Rangel |
| Intended Exposure | Internal |

Objective: The objective of this notification is to document the SunPower advantages in a comparison of PV modules used for median sized projects in the European residential/commercial market. Many of the European VARs and project engineers use PVsyst.com (a PV system modeling software created by the University of Geneva) to compare system configurations before deciding on a supplier. It is important for SunPower marketing and support personnel to be aware of SunPower advantages revealed by the results of system modeling using PVsyst.com software.

Background:

The SunPower Applications team pointed out PVsyst.com as a common tool used in the European PV market to sample system designs. Applications also forwarded the results made from a 9.0 kW system comparison between SunPower modules and a close competitor. The comparison had been mentioned by EVAR support personnel. Taking the modeling approach one step further, a comparison of 5 other modules were made using the same 9.0 kW model with pricing from SolarBuzz and figures from our internal competitive pricing database QuickBase. All modules in the test group were 72 cells or less.

- The basic model parameters are listed below;
 - Location: Madrid, Spain.
 - Longitude: 40.5° North, Latitude: 3.5° West.
 - Altitude: 582 meters, approximately 1,903 feet.
 - Collector plain orientation: Tilt 30°. Azimuth 0°.
 - Albedo: 0.20, Free horizon, No shadings
 - Meteo (weather) data: 1-year Madrid recorded synthetic hourly data.
 - Altitude: 582 meters, approximately 1,903 feet.
 - Inverters: 2-Sunny Mini Central 5000's.
- **Modules tested;**
 - **SunPower 230-WHT and 210-BLK.**
 - **Sanyo HIP modules; 200-NEH1, 200 DNE3 (double bi-facial)**
 - **Sharp ND-200-U1, SunTech STP-200S-18/Ub, and Kyocera KC-200GHT-2**

Summary - Conclusion/Results (chart on the next page):

- The SunPower arrays had the smallest footprint, and thus the largest energy output per unit area. Any competitors who were even close in performance parameters were either much heavier, more expensive, took up much more area or were all those disadvantages combined.
- The test results put our next level gen-C cell **SPR-230-WHT** and our basic gen-B cell **SPR-210-BLK** against the top-of-the line high efficiency modules from Sharp, Kyocera, SunTech and Sanyo. The **SPR-230** and **SPR-210** easily outperformed the others, placing #1 and #2 in;
 - Smallest footprint area.
 - Highest nominal global peak power for array size.
 - Best array efficiency.
 - Highest yearly energy output per m².
 - Highest yearly energy output per array module.
 - Lightest load or weight for the system array.
 - Highest total array energy output per year

- In addition, against the other supplier's top-of-the-line modules, the "230" and "210" were 1st or tied for first in;
 - Longest extended warranty.
 - Largest window of purchase availability.
- **Note:** The **SPR-230** and **SPR-210** arrays came in 1st and 3rd in total kWh/kWp/per year, although they were 1st and 2nd in yearly energy output per module and per array.
 - The 2nd place array in total kWh/kWp/per year was only **0.007%** higher than the 210 array. However, this array took 7.5% more area, it was **73.3% heavier, was 5.9% more expensive, 1.3% less efficient, and had one more additional module than the 210 array.**
- Those wishing to make similar comparisons with SolarBuzz and 'PVsyst' software, using different models and/or different modules, are able to download the software at <http://www.pvsyst.com/>.
- In Q1-'08, we noted that a few of the PVsyst models had too many cells for the SunPower modules, which negatively affected total energy output simulations. The number of cells per module will be corrected in PVsyst version 4.3, at the end of Q1-08.

| Supplier | | SunPower | Sanyo | Sanyo | SunTech | Kyocera | Sharp | SunPower |
|--|---|-----------------------------------|------------------------|---|--|---|--|--|
| Product | | SPR-210-BLK | HIP-200 NEH1 | HIP-200 DNE3 | STP 200S-18/Ub | KC 200GHT-2 | ND-200-U1 | SPR-230-WHT D |
| Description | | SunPower basic distribution Gen-B | Top-of-the-line module | Top-of-their line double Bi-facial New product | Suntech higher efficiency line of PV modules | Kyocera high efficiency top-of-their KC line PV modules | Sharp higher efficiency line of PV modules | SunPower72 high efficiency Gen-C cells |
| Basic Module Spec's | Voc (volts) | 47.70 | 49.60 | 50.30 | 32.80 | 32.80 | 35.50 | 48.20 |
| | Vmp (volts) | 40.00 | 40.00 | 40.70 | 26.20 | 26.30 | 28.50 | 40.50 |
| | Isc (amps) | 5.75 | 5.50 | 5.40 | 8.00 | 8.21 | 7.82 | 6.05 |
| | Imp (amps) | 5.25 | 5.00 | 4.92 | 7.63 | 7.61 | 7.02 | 5.67 |
| | Area (square meters) | 1.244 | 1.253 | 1.307 | 1.470 | 1.411 | 1.630 | 1.244 |
| | Weight (kilograms) | 15.00 | 15.00 | 26.00 | 17.00 | 18.50 | 21.00 | 15.00 |
| Simulation Pvsysts, 9.0 kW Model parameters; 1-year in Madrid, Spain using Sunny-mini Central 5000W inverters. | | SPR-210-BLK | HIP-200 NEH1 | HIP-200 DNE3 | STP 200S-18/Ub | KC 200GHT-2 | ND-200-U1 | SPR-230-WHT D |
| Array-model material information | Number of Modules | 44 | 44 | 45 | 44 | 44 | 45 | 40 |
| | Total Area (square meters) | 54.74 | 55.13 | 58.82 | 64.68 | 62.08 | 73.35 | 49.76 |
| | Total Weight of array (Kg). | 660.00 | 660.00 | 1170.00 | 748.00 | 814.00 | 945.00 | 600.00 |
| | Approximate Cost of array in dollars | \$ 38,180.00 | \$ 38,456.00 | \$ 40,590.00 | \$ 34,848.00 | \$ 36,080.00 | \$ 36,270.00 | \$ 38,180.00 |
| | Availability; Status / Region | On-demand / Global | Limited / Europe | Limited / Europe | On-demand / Global | Limited / Japan | Limited / USA | On-demand / Global |
| | Array Extended warranty | 25 years | 20 years | 20 years | 25 years | 2 years | 2 years | 25 years |
| Array-model output data and information | Nominal global power in kWp | 9.2 | 8.8 | 9.0 | 8.8 | 8.8 | 9.0 | 9.2 |
| | 1-year energy output in MW | 13.729 | 13.083 | 13.386 | 12.892 | 12.781 | 13.015 | 13.801 |
| | 1-year energy output per module, in kW | 312.02 | 297.34 | 297.47 | 293.00 | 290.48 | 289.22 | 345.03 |
| | Array Efficiency | 14.13% | 13.37% | 12.82% | 11.23% | 11.60% | 10.00% | 15.63% |
| | kWh/kWp/year | 1486 | 1487 | 1487 | 1465 | 1452 | 1446 | 1501 |
| | Yearly output per unit area (kW/m2) | 250.82 | 237.30 | 227.60 | 199.32 | 205.87 | 177.44 | 277.35 |
| | From Array purchase cost; 20-year cost of energy per kWh, in dollars. | \$ 0.139 | \$ 0.147 | \$ 0.152 | \$ 0.135 | \$ 0.141 | \$ 0.139 | \$ 0.138 |