Photon
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# PHOTON Yield Measurement 2010

## More than 30 module types were added to the running outdoor test where they will be monitored for at least 12 months


**Check the monthly intermediate results in our PHOTON magazines and learn which module type realized the highest yield in kWh / kW* installed over a period of one year.**

* standardized to the STC power

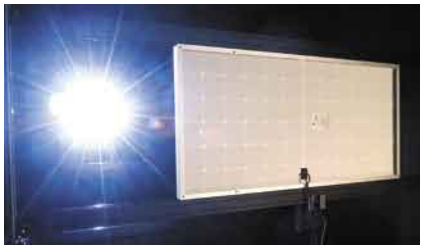
**More than 40 module types in the current test.**

# How PHOTON conducts its test

A module's nominal power is interesting, as is its efficiency – and, depending on the customer's expertise, so are a few other pieces of technical module data. But the single most important factor for PV system operators is yield: how many kilowatt-hours per kW of installed power flow from the PV system to the inverter? This is exactly the question PHOTON Laboratory intends to answer with its module field tests. Over the course of 2009, a total of 16 different module types installed on a piece of property – free of shadowing – were monitored constantly using an elaborate measurement system.

Three units of each module type are represented in the test to prevent potential faulty products or modules with below average results from distorting the results for the entire series. The modules are installed in Germany, facing south at a 28° angle and are mounted about 2.5 m above the ground, which means they have complete rear ventilation. PHOTON Lab has developed its own electronics to perform fully automated measurements at each module's output. This eliminates the possibility of errors due to false inverter adjustment or small cable cross-sections. The test set-up's measurement tolerance is currently +/- 1.85 percent.

Every second, each module is measured to capture an IV curve with a nominal 14 bit resolution composed of 2,000 measurement points and the maximum power point (MPP). This measurement process takes about 10 milliseconds, which means almost 99 percent of the test module's yield can be fed into the grid via a DC-DC converter, a DC bus and an inverter. This is important as it allows the test system to operate under real-world conditions and prevents modules from overheating due to permanent open-circuit operation.



Norbert Michalke / photon-pictures.com

**PHOTON Lab is using a Pasan Class AAA Sun Simulator to detect the maximum power of solar modules under STC. The monthly yield of each module is standardized to the measured STC power.**

In addition to data from the solar modules, the test field employs several highly accurate pyranometers to measure solar irradiation horizontally and at the module level every second, as well as other climate data such as ambient temperature, wind speed, precipitation and barometric pressure. Module and weather data is stored in synchronized databases to ensure precise correlation.

## Real power is the decisive factor

The measured yields of the individual modules are standardized according to their power under standard test conditions (STC), which is determined by the manufacturer during production. PHOTON Lab retrieved this data based on the module serial number, if the solar simulator test results were not included with the module.

For technical reasons, the solar modules in a certain series do not all have identical powers. That's why nominal power is always listed with a certain tolerance range, which manufacturers determine using very different methodologies. For instance, a few manufacturers list a module's nominal power at 100 W when the actual power of the module in question actually achieves this value. Other manufacturers, by contrast, list a 100 W nominal power for a series with a true power of between 95 and 105 W. Moreover, there are some manufacturers that list module power at 100 W when their products achieve 100 W at maximum but likely display lower nominal powers.

Of course, in a certain sense, standardization of yield according to STC power can make modules with overly optimistic nominal power specifications look better than they are: if a module with a specified nominal power of 100 W produces just 95 W under STC conditions and delivers an annual yield of 100 kWh, that's the equivalent of a yield of 1,000 kWh per kW power when standardized to nominal power. However, when standardized to STC power, that yield increases to 1,056 kWh per kW. Nevertheless, standardization according to STC power is the only way for our lab to compare all module results from its field tests. This is exactly the point where PHOTON Laboratory noticed a critical gap in its testing process: in order to obtain each test module's power measured using a solar simulator, PHOTON Lab had to contact the manufacturer and submit the module's serial number. Naturally, no test lab likes to rely on figures provided by the manufacturer. It prefers to rely on its own measurements. But, unfortunately, a good solar simulator is rather expensive.

As of November 2008, PHOTON Lab solved this problem by purchasing a Pasan Sun Simulator IIIb device. From now on, PHOTON Lab can conduct its own power measurements for each module being tested under standard testing conditions (STC).

René Düpont, Jochen Siemer

### PHOTON's 2009 module test results

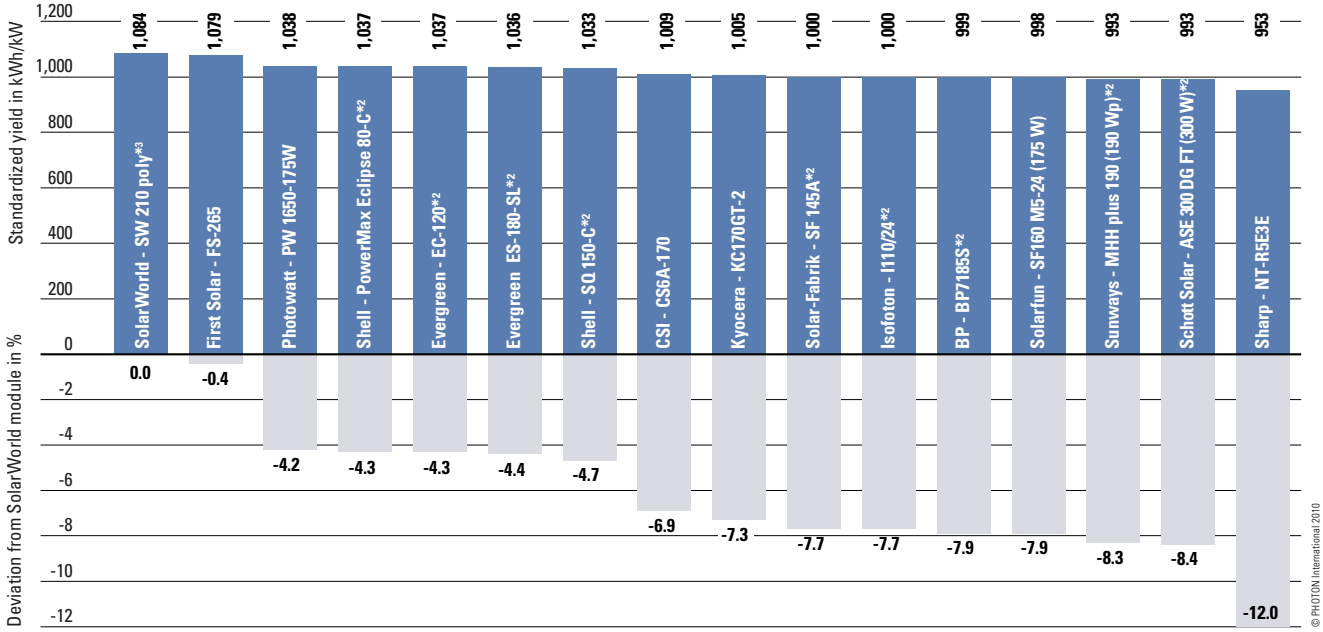
The frontrunner in PHOTON's 2009 outdoor module test is the same as last year – SolarWorld's SW 210 poly model (see PI 2/2009, p. 132). Like in 2008, the module from the Bonn, Germany-headquartered company performed the best among the 16 models tested in 2009. Under the western German sun, the SW 210 poly generated 1,083.7 kWh per kW. A thin-film module came in at second place: First Solar's FS-265 produced 1,079.3 kWh per kW – just 0.4 percent less than SolarWorld. After a considerable gap, a group of modules from Photowatt, Shell and Evergreen, deviate negatively from the best module by around 4 percent. The third group of modules – with a gap of between 6.9 and 8.4 percent from the test winner – is led by a Chinese module from Canadian Solar. The worst performer by far was the product from Sharp: its monocrystalline NT-R5E3E module generated just 953.2 kWh per kW – that's 12 percent less than the SolarWorld product tested.

PHOTON Lab constantly adds modules to its testing field, which has strongly increased to 40 modules for the 2010 cycle. To receive more info about the test and how to participate, please contact PHOTON Lab's head Martina Siebmanns at martina.siebmanns@photon-laboratory.com.

## PHOTON'S 2009 MODULE TEST RESULTS

| Manufacturer | Model | Cell type | Origin | Yield in kWh/kW*1 | Deviation from test winner | Installed in |
|---|---|---|---|---|---|---|
| **SolarWorld** | SW 210 poly*3 | Multi | Germany | 1,084 | 0.0 % | 2006 |
| **First Solar** | FS-265 | CdTe | USA | 1,079 | -0.4 % | 2007 |
| **Photowatt** | PW 1650-175W | Multi | France | 1,038 | -4.2 % | 2006 |
| **Shell** | PowerMax Eclipse 80-C*2 | CIS | USA | 1,037 | -4.3 % | 2007 |
| **Evergreen** | EC-120*2 | Ribbon | USA | 1,037 | -4.3 % | 2006 |
| **Evergreen** | ES-180-SL*2 | Ribbon | Germany | 1,036 | -4.4 % | 2007 |
| **Shell** | SQ 150-C*2 | Mono | Portugal | 1,033 | -4.7 % | 2006 |
| **CSI** | CS6A-170 | Multi | China | 1,009 | -6.9 % | 2007 |
| **Kyocera** | KC170GT-2 | Multi | Japan | 1,005 | -7.3 % | 2006 |
| **Solar-Fabrik** | SF 145A*2 | EFG | Germany | 1,000 | -7.7 % | 2005 |
| **Isofoton** | I110/24*2 | Mono | Spain | 1,000 | -7.7 % | 2006 |
| **BP** | BP7185S*2 | Mono | Spain, India | 999 | -7.9 % | 2005 |
| **Solarfun** | SF160 M5-24 (175 W) | Mono | China | 998 | -7. 9 % | 2007 |
| **Sunways** | MHH plus 190 (190 Wp)*2 | Multi | Germany | 993 | -8.3 % | 2005 |
| **Schott Solar** | ASE 300 DG FT (300 W)*2 | EFG | Germany | 993 | -8.4 % | 2007 |
| **Sharp** | NT-R5E3E | Mono | Japan | 953 | -12.0 % | 2005 |

*1 all standardized to STC power, *2 not manufactured anymore, *3 not manufactured anymore; the successor – though technically slightly modified – is the Sunmodule plus SW 210




# PHOTON Databases: solar modules and inverters

On an annual basis, PHOTON asks all solar module and PV inverter manufacturers to provide the technical data of their products which is then comprised in the PHOTON Databases.

The PHOTON Databases which currently include of over 17,000 solar modules and more than 2,900 inverters are made available online for your individual research.

Accessing the online PHOTON Databases is free of charge and does not require an individual registration.

Manufacturers of simulation software are given the opportunity to include these comprehensive database in their software tools. The commercial use of the database requires of a license. For detailed information on the licensing terms, please contact Petra Boehne (petra.boehne@photon.de).

Are you a manufacturer and would you like to add further technical product data to the PHOTON Database? Your contact person Beate Knoll (beate.knoll@photon.de) looks forward to receiving your information.

**www.photon.info -> publishing -> databases**

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# Order

**Ordering Party**

Company _____

Contact Person _____

Street _____

Zip Code / City _____ _____

Country / State _____

Phone _____

Fax _____

E-Mail _____

**1. Starting point**

By signing this document, the ordering party commissions PHOTON Laboratory GmbH to grant the license of a set of measuring data.

The data, which is put at free disposal for the ordering party, includes the following parameters:

- Annual energy yield for the calendar year
- Annual energy yield adjusted for the nominal sun year
- Module power parameters at different irradiation levels, ambient temperatures, and angles of incidence
- Provision of data for the single and dual diode model
- Comprehensive measuring data, indicating potential improvements of the module design to achieve higher yields

Test results and evaluations (including partial and interim results) generated during the 12-month test period will be released in the publications of PHOTON Europe GmbH and PHOTON USA Corp,.

**2. Prerequisite**

The prerequisite of a generally accepted, conclusive and realistic test is that the three modules provided by the ordering party for the test are regarded as standard modules with serial numbers randomized from the current production. By signing this document, the ordering party confirms the compliance of the modules with this vital prerequisite.

**Ordering party**

Manufacturer: .....

Module type: .....

Serial number: .....

Production date: .....

**3. Right of use**

The ordering party shall be entitled to use the published test findings for advertising purposes. In doing so, the ordering party's advertisements shall be designed in such a way that the consumer will not get an incorrect impression of the quality and performance assessment of the advertised module type from the test findings. The ordering party shall always mention the date of evaluation or release by PHOTON.

**4. Payment**

€ 9,700 net, due within 14 days after date of invoice.

**5. Transfer of ownership**

After receipt of the measurement data package, PHOTON Laboratory GmbH shall become the owner of the three tested modules plus accessories and documents. PHOTON shall ensure that the modules received will not be disposed, nor shall they be made available gratuitously to third parties.

The signatory assures that he or she has company authorization to sign this order.

Location, date _____ Signature _____

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