

Solar Module Yield Measurement

In a comparative measurement, the yield of more than 130 module types is measured on PHOTON's outdoor test field

Facts

- Detection of each module's yield (second-by-second) using sophisticated measurement devices
- Evaluation of the module's yield independent of other system components
- Performance measurement under real outdoor conditions for a period of 12 months
- Standardization of the monthly and annual yield to the STC power measured at PHOTON Lab
- Collection of the solar irradiation and weather data for in-depth analysis

Check the monthly test results in:

- PHOTON Profi (German)
- PHOTON – Das Solarstrom-Magazin (German)
- PHOTON – Le Magazine du Photovoltaïque (French)
- PHOTON – Il Mensile del Fotovoltaico (Italian)
- PHOTON – La Revista de Photovoltaica (Spanish)
- PHOTON – International (English)
- PHOTON – International (Chinese)
- PHOTON – The Photovoltaic Magazine (English)

The results are published in over 200,000 issues worldwide each month

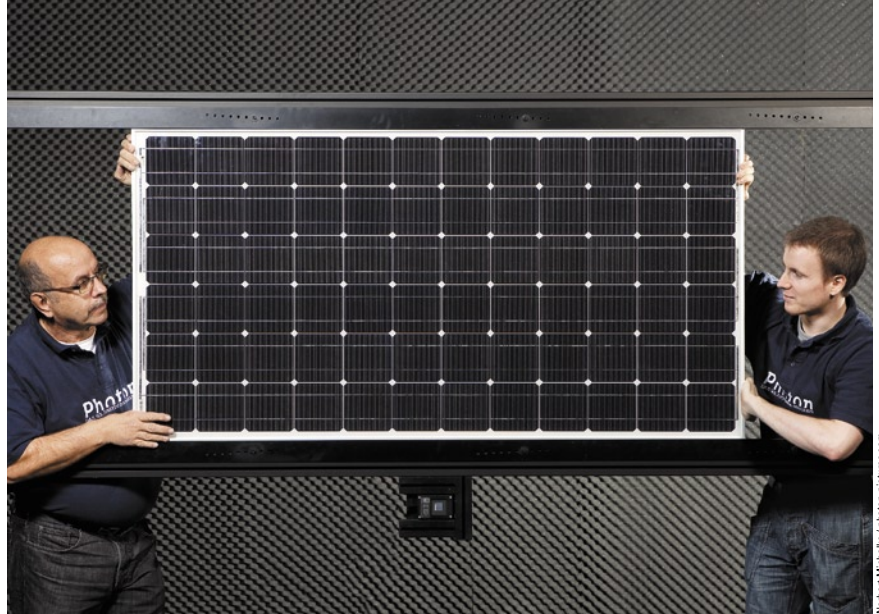
How PHOTON conducts its test

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 Lab intends to answer with its module field tests. Since 2005, a total of over 130 different module types has been installed on a piece of property – free of shadowing – where they have been monitored constantly using an elaborate measurement system.

Two to four 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.

In addition to data from the solar modules, the test field employs several highly accurate pyrano-



PHOTON Lab is using a Pasan Class AAA Sun Simulator to detect the maximum power of solar modules under STC.

meters 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

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 to-

lerance 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.

The measured yields of the individual modules installed on the PHOTON test site are standardized according to the maximum power under standard test conditions (STC), which is determined by PHOTON Lab prior to the installation using a Pasan Sun Simulator IIIb.



Romana Brantner / photon-pictures.com (6)

Peter Brantner / photon-pictures.com

PHOTON LAB'S OUTDOOR MODULE TESTS: RESULTS FOR OCTOBER 2011

Manufacturer	Model	Cell type	Origin	STC power in W	Yield in kWh/kW		Deviation from test winner (%)	Installed in
					October	January - October		
REC	REC230AE*1	Multi	Sweden	228.6	89.5	1,062.6	0.0	2010
NexPower	NT-125AX*1	µc-Si / a-Si	Taiwan	125.4	83.5	1,061.8	0.1	2010
Siliken	SLK60P6L 230Wp	Multi	Spain	229.7	87.9	1,053.5	0.9	2009
CH Solar	CH Solar 180 mono*1	Mono	China	184.4	88.2	1,043.7	1.8	2010
CSG PV Tech	CSG180S1-35/36*3	Mono	China	184.1	88.1	1,042.2	1.9	2010
CNPV Solar	CNPV-185M	Mono	China	193.8	87.6	1,040.8	2.0	2010
Win Win Precision	Winaico WSP-235P6	Multi	Taiwan	240.1	87.7	1,039.3	2.2	2010
SolarWorld	Sunmodule Plus SW 225 mono	Mono	USA	233.4	87.2	1,037.3	2.4	2010
CSG PV Tech	CSG230M2-30*4	Multi	China	228.3	87.1	1,033.1	2.8	2010
Bisol	BMU-215-2/221	Multi	Slovenia	229.1	86.2	1,032.2	2.9	2010
Upsolar	UP-M180M	Mono	China	181.5	87.4	1,031.3	2.9	2010
Trina Solar	TSM-180DC01	Mono	China	176.2	86.3	1,027.9	3.3	2009
Conergy	Conergy PowerPlus 220P	Multi	Germany	224.2	86.7	1,027.0	3.4	2010
Trina Solar	TSM-225PC05	Multi	China	233.0	86.0	1,026.8	3.4	2010
PV Power Technologies	PVQ3 220	Multi	India	223.6	83.5	1,026.5	3.4	2009
Aleo Solar	aleo S_18 225	Multi	Germany, Spain	230.5	86.7	1,026.0	3.4	2010
Kioto Photovoltaics	KPV 210 PE*1	Multi	Austria	206.6	86.1	1,025.5	3.5	2009
S-Energy	SM-220PA8	Multi	South Korea	224.4	82.9	1,023.8	3.7	2009
Solarfun (now Hanwha SolarOne)	SF160-24-1M175 (scac)	Mono	China	183.0	85.5	1,022.8	3.7	2010
Sunpeak-Vertrieb	ALP235W*1	Mono	India	233.0	85.9	1,021.7	3.8	2010
Win Win Precision	Winaico WSP-230P6	Multi	Taiwan	234.4	83.9	1,021.4	3.9	2009
Mage Solar	Mage Powertec Plus 225/6PJ	Multi	China	232.0	85.7	1,019.6	4.0	2009
Sonalis*2	SL-180CE-36M	Mono	China	185.1	86.7	1,015.9	4.4	2010
Frankfurt Solar	FS215W-POLY	Multi	China	221.3	82.7	1,014.8	4.5	2009
Perfectenergy	PEM-180/185-72M-SCC	Mono	China	191.3	85.4	1,009.0	5.0	2010
Emmvee Photovoltaics	ES-230P6*5	Multi	India	234.0	84.9	1,008.5	5.1	2010
Shell Solar (now SolarWorld)	Shell SQ 150-C*1	Mono	Portugal	155.8	85.0	1,008.3	5.1	2006
Sunrise Solartech	SRM 180D72-GE	Mono	China	181.5	82.2	1,005.9	5.3	2009
First Solar	FS-265	CdTe	USA	65.4	82.6	1,004.8	5.4	2007
SolarWorld	Sunmodule Plus SW 210 poly*5	Multi	Germany	212.2	85.4	1,000.0	5.9	2006
Sovello	Pure Power SV-X-200 (LV)	Ribbon	Germany	205.0	83.7	998.5	6.0	2011
Shell Solar (now SolarWorld)	Shell PowerMax Eclipse 80-C*1	CIS	USA	90.8	82.6	998.1	6.1	2007
Evergreen	EC-120*1	Ribbon	USA	121.0	84.0	996.8	6.2	2006
Photowatt	PW 1650-175W	Multi	France	171.4	82.6	994.1	6.4	2006
Solar-Fabrik	SF 130/4-130*1	Mono	Germany	130.7	83.1	973.3	8.4	2010
Canadian Solar	CS6A-170P	Multi	China	174.4	80.6	970.1	8.7	2007
Isofoton	I-110/24*1	Mono	Spain	102.5	81.0	964.6	9.2	2006
Solarfun (now Hanwha SolarOne)	SF160 M5-24 (175 W)*1	Mono	China	174.6	80.3	961.4	9.5	2007
Kyocera	KC170GT-2*1	Multi	Japan	178.4	80.5	957.0	9.9	2006
Isofoton	IS-170/24*1	Mono	Spain	172.8	78.4	956.5	10.0	2009
Schott Solar	ASE-300-DG-FT (300 W)*1	Ribbon	USA	308.1	79.1	942.0	11.3	2007
Solar-Fabrik	SF 145A*1	Ribbon	Germany	145.8	78.2	941.1	11.4	2005
Sunways	MHH plus 190 (190 Wp)*1	Multi	Germany	199.5	78.4	939.2	11.6	2005
Evergreen	ES-180-RL*1	Ribbon	Germany	185.4	77.5	936.8	11.8	2007
BP Solar	BP 7185 S*1	Mono	Spain, India	185.1	75.9	929.4	12.5	2005
Sharp	NT-R5E3E*1	Mono	Japan	187.9	77.0	915.7	13.8	2005

THE FOLLOWING MODULES WERE INSTALLED AFTER JANUARY 2011
(SORTED ALPHABETICALLY)

Manufacturer	Model	Cell type	Origin	STC power in W	Yield in kWh/kW		Deviation from test winner (%)	Installed in
					October	January - October		
Aide Solar	AD195M5-Aa	Mono	China	198.0	87.9	-	-	9/2011
Alex Solar	ALM-190D-24	Mono	China	187.8	86.5	-	-	7/2011
Axitec	AC 236P/156-60S	Multi	Germany	232.9	90.7	-	-	2/2011
Bisol	BMU-215-2/233	Multi	Slovenia	234.2	88.5	-	-	2/2011
Bosch Solar	Bosch c-Si M 60 230	Mono	Germany	233.2	88.8	-	-	2/2011
BP Solar	BP 3220 T	Multi	China	232.5	92.3	-	-	7/2011
BP Solar	BP 3280 T	Multi	-	287.4	87.7	-	-	5/2011
Calrays	CPM 250-A-96	Mono	-	244.0	86.1	-	-	7/2011
CEEG	SST 240-60M	Mono	China	239.0	88.6	-	-	2/2011
CEEG	SST 265-72P	Multi	China	281.0	88.2	-	-	2/2011
Changzhou Eging	EGM-185	Mono	China	188.4	87.9	-	-	2/2011
CNPV Solar	CNPV-190M	Mono	China	197.4	87.8	-	-	7/2011
CNPV Solar	CNPV-220P	Multi	China	224.2	90.0	-	-	7/2011
CNPV Solar	CNPV-240M	Mono	China	249.7	88.1	-	-	7/2011
CNPV Solar	CNPV-240P	Multi	China	243.1	89.2	-	-	7/2011
Day4 Energy	Day4 48MC 185	Multi	Canada	186.5	86.6	-	-	2/2011
ET Solar	ET-P660240	Multi	China	236.1	91.1	-	-	7/2011
Evergreen	ES-A-210-fa2	Ribbon	USA	210.0	88.3	-	-	3/2011
Evergreen	ES-E-210-fc3	Ribbon	USA	211.2	88.1	-	-	2/2011
Ferrania Solis	AP 60-230	Multi	Italy	228.8	90.8	-	-	7/2011
Galaxy Energy	GS260m-96	Mono	Germany	252.9	88.2	-	-	2/2011
Hareon Solar	HR-230P-18/Bb	Multi	-	230.6	90.4	-	-	7/2011
IBC Solar	IBC MonoSol 240 TT	Mono	Germany	246.0	87.9	-	-	2/2011
Jetion Solar	JT230(30)P1655x992	Mono	China	232.4	88.4	-	-	2/2011
Jinko Solar	JKM190M-72	Mono	-	191.1	90.3	-	-	7/2011
Jinko Solar	JKM255M-96	Mono	-	259.7	88.4	-	-	7/2011
Kenmec	TKSA-23001	Multi	-	235.0	89.1	-	-	7/2011
Kinmac Solar	KSS-6P6A-230	Multi	Taiwan	234.1	91.4	-	-	2/2011
Kyocera	KD210GH-2PU	Multi	EU	212.1	86.6	-	-	2/2011
Latitude Solar	Latitude P6-60/6 (235)	Multi	Sweden	240.5	58.1	-	-	2/2011
Lilie Energie	Lilie SPL 185	Mono	-	185.3	87.9	-	-	2/2011
Lilie Energie	Lilie SPL 185-I	Mono	-	187.1	87.4	-	-	2/2011
Linsun Renewable	SK60P6	Multi	-	228.3	89.8	-	-	7/2011
Linuo Group	LN180(36)M-185	Mono	-	191.8	89.4	-	-	7/2011
Linuo Group	LN240(30)P-225	Multi	-	236.5	88.4	-	-	7/2011
Luxor Solar	LX-185M/125-72+	Mono	China	188.4	88.1	-	-	2/2011
Mage Solar	Mage Powertec Plus 230/6PH-US	Multi	USA	231.8	89.3	-	-	7/2011
Mage Solar	Mage Powertec Plus 230/6PO	Multi	China	229.9	72.9	-	-	2/2011
Magi Solar	MGSM-240D-60	Mono	China	246.1	88.1	-	-	7/2011
Magi Solar	MGSM-295-D	Mono	China	294.0	88.7	-	-	7/2011
Nelumbo	NEI 230-3VA	Multi	Czech Republic	228.5	90.3	-	-	2/2011
Ningbo Solar	Sun Earth TDB125x125-72-P 160W*1	Mono	China	161.6	88.2	-	-	2/2011
Ningbo Solar	Sun Earth TDB125x125-72-P 180W*1	Mono	China	179.2	89.6	-	-	2/2011
Q-Cells	Q.SMART UF 95	CIGS	Germany	97.3	92.4	-	-	2/2011

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(SORTED ALPHABETICALLY)

Manufacturer	Model	Cell type	Origin	STC power in W	Yield in kWh/kW		Deviation from test winner (%)	Installed in
					October	January - October		
REC	Premium 210	Multi	Sweden	212.2	90.9	-	-	2/2011
REC	REC230PE	Multi	Singapore	237.6	90.1	-	-	2/2011
Risen Energy	SYP185S-M	Mono	China	191.7	88.5	-	-	7/2011
Scheuten Solar Systems	Multisol P6-60	Multi	Germany	238.1	87.6	-	-	6/2011
Schott Solar	SCHOTT POLY TM 220	Multi	Czech Republic	224.7	86.5	-	-	2/2011
Seraphim Solar	SRP-220-6PB	Multi	China	226.1	92.1	-	-	10/2011
Sharp	NU-185E1	Mono	UK	186.1	86.8	-	-	3/2011
Solar Modules Nederland	TC245-MO	Mono	Netherlands	246.7	90.2	-	-	2/2011
Solar-Fabrik	Premium L poly (225)	Multi	Germany	223.6	86.4	-	-	2/2011
Solarfun (now Hanwha SolarOne)	SF160-24-1M180	Mono	China	178.6	87.3	-	-	2/2011
Solaria Energia	S6P2G225	Multi	Spain	232.7	88.9	-	-	5/2011
Solarwatt	M220-60 GET AK (230)	Mono	Germany	231.5	88.5	-	-	2/2011
SolarWorld	Sunmodule Plus SW 225 poly	Multi	Germany	228.6	89.2	-	-	2/2011
Solon	SOLON Blue 230/07(225)	Multi	Germany	226.9	90.7	-	-	2/2011
Sovello	SV-X-205-fa1	Multi	Germany	206.1	86.8	-	-	2/2011
Sunage	SAM 96/5	Mono	Switzerland	256.6	88.2	-	-	7/2011
Sunerg Solar	XP 60/156-230	Multi	Italy	226.0	91.5	-	-	2/2011
Sunlink PV	SL220-20M230	Mono	China	237.9	89.1	-	-	2/2011
Suntech	STP190-18/Ub*1	Multi	China	182.9	85.2	-	-	2/2011
Suntech	STP205-18/Ud	Multi	China	213.8	89.1	-	-	2/2011
Swat International	SWAT-240-PS	Multi	-	245.1	88.3	-	-	5/2011
Topray Solar	TPS105T-180W	Mono	China	184.8	88.8	-	-	5/2011
Topsolar Green Energy	TSM72-125M-190W	Mono	China	185.9	89.1	-	-	7/2011
Upsolar	UP-M185M	Mono	China	189.2	87.3	-	-	2/2011
Upsolar	UP-M220P	Multi	China	219.2	90.2	-	-	2/2011
Vikram Solar	ELDORA 220	Multi	-	233.3	89.6	-	-	7/2011
Yingli	YL210P-29b	Multi	China	214.3	87.3	-	-	2/2011
Zentralsolar Deutschland	Genius SDM 185-10004-185	Mono	-	190.6	88.6	-	-	7/2011
Zhejiang Sunflower	SF125x125-72-M(180)	Mono	China	176.6	89.2	-	-	2/2011
Znshine PV-Tech	ZX250(48)MS	Mono	China	252.3	89.7	-	-	7/2011
Zytech Engineering	ZT 230P	Multi	China	230.8	88.0	-	-	2/2011

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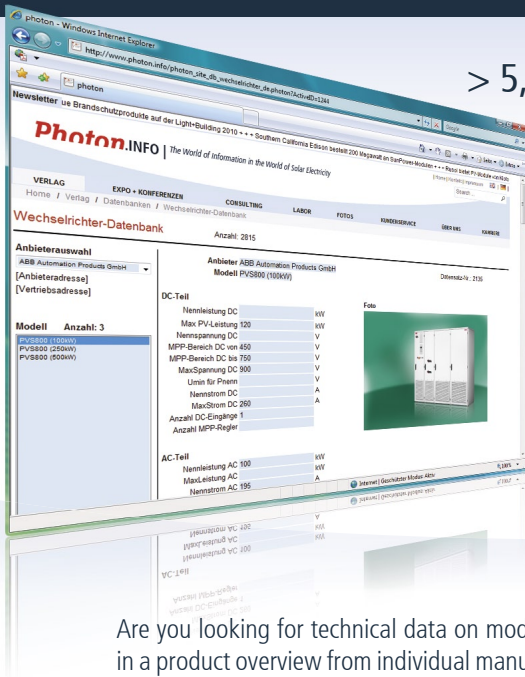
Yield data can only be fully assessed once a year of testing has been completed; the data provided here only allows for preliminary assessments; all yield data is standardized to STC or, more exactly, to the average values recorded for each module model

*1 not manufactured anymore, for manufacturer Ningbo Qixin Solar Electrical Appliance Co. Ltd., *3 former model name: CSG180S1-35/1589x807, *4 former model name: CSG230M2-30/1640x992, *5 former model name: SW 210 poly, *6 former model name: ES-200-P60(230)

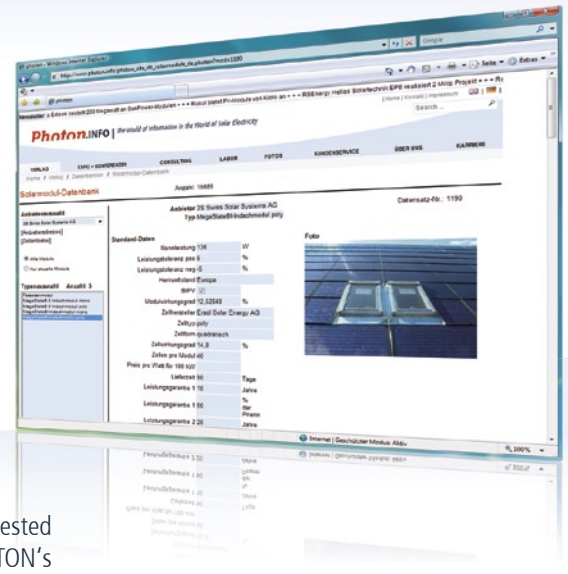
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PHOTON module & inverter database



> 5,550 inverters



> 40,500 modules

Are you looking for technical data on modules and inverters? Are you interested in a product overview from individual manufacturers? Simply check out PHOTON's online inverter and module databases for comprehensive information.

PHOTON's module and inverter databases are continuously updated by a team of editors and can be accessed free of charge.

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