

Photon

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Module performance results

SunPower panels awarded PHOTON's top 3 rankings
in world's largest outdoor test



Doubling up?

Bifacial cell research stirs new interest, but challenges to large market entry remain

More economic?

US start-up claims discovery of key to high-efficiency, low-cost crystalline cells

French flop?

Local PV makers see few benefits from EU-content rule for growing market

Going east?

As Germany celebrates another record-setting year, Bavaria loses it lead to an eastern state



Inverter test results

Inverter	Observed voltage range*1	Medium irradiation				High irradiation				PI issue
		etaP _{med}	Grade as of 2011	Grade before 2011	Position	etaP _{high}	Grade as of 2011	Grade before 2011	Position	
SMA's STP 20000TLHE-10	580 - 800 V	98.5 %	A+	—	1	98.6 %	A+	—	1	12/2011
Refusol's 020k SCI	490 - 800 V	98.2 %	A+	—	2	98.3 %	A+	—	2	7/2012
Donauer Solartechnik's High Efficiency 3.6	350 - 650 V	97.8 %	A	—	3	97.9 %	A	—	3	12/2012
Steca's StecaGrid 3600	350 - 600 V	97.7 %	A	—	4	97.8 %	A	—	4	12/2011
Steca's Stecagrid 3000	350 - 700 V	97.5 %	A	—	5	97.8 %	A	—	4	9/2012
Siemens' Sinvert PVM20	480 - 850 V	97.5 %	A	—	5	97.7 %	A	—	6	4/2011
Sungrow's SG30KTL	480 - 800 V	97.5 %	A	—	5	97.7 %	A	—	6	2/2013
Siemens' Sinvert PVM17	460 - 850 V	97.4 %	A	—	8	97.7 %	A	—	6	4/2011
Refusol's 017K	460 - 850 V	97.4 %	A	A+	8	97.6 %	A	A+	9	12/2010
Refusol's 013K	420 - 850 V	97.3 %	A	A+	10	97.6 %	A	A+	9	12/2010
Siemens' Sinvert PVM13	420 - 850 V	97.3 %	A	—	10	97.6 %	A	—	9	4/2011
Refusol's 020K	480 - 850 V	97.3 %	A	—	10	97.5 %	A	—	12	3/2012
SMA's STP 17000TL	400 - 800 V	97.3 %	A	A+	10	97.5 %	A	A+	12	12/2010
SMA's STP 10000TL-10	320 - 800 V	97.1 %	A	—	14	97.5 %	A	—	12	10/2011
Chint Power's CPS SC20KTL-0	500 - 800 V	97.1 %	A	—	14	97.4 %	A	—	15	11/2011
Siemens' Sinvert PVM10	380 - 850 V	97.0 %	A	—	16	97.4 %	A	—	15	1/2011
Delta Energy Systems' Solivia 20 EU G3 TL	350 - 800 V	97.0 %	A	—	16	97.2 %	A	—	18	3/2012
Zeversolar New Energy's Eversol-TLC 17k*2	550 - 720 V	96.9 %	A	—	18	97.3 %	A	—	17	4/2011
Mastervolt's Sunmaster CS20TL	350 - 800 V	96.9 %	A	—	18	97.2 %	A	—	18	5/2011
Power-One's Trio-27.6-TL-OUTD-S2-400	500 - 800 V	96.9 %	A	—	18	97.2 %	A	—	18	2/2013
Refusol's 011K*3	380 - 800 V	96.9 %	A	A+	18	97.2 %	A	A+	18	9/2008
Goodwe Power Supply Technology's GW4000-SS	280 - 500 V	96.9 %	A	—	18	97.1 %	A	—	22	12/2012
SMA's SMC 8000 TL	335 - 487 V	96.9 %	A	A+	18	97.0 %	A	A+	26	10/2007
SMA's SMC 11000TL	333 - 500 V	96.9 %	A	A+	18	96.8 %	A	A+	37	7/2010
Growatt's 5000MTL (version 2)	250 - 540 V	96.8 %	A	—	25	97.1 %	A	—	22	12/2012
Sputnik's Solarmax 13MT*4	250 - 750 V	96.8 %	A	—	25	97.1 %	A	—	22	9/2011
Diehl AKO's Platinum 6300 TL	350 - 710 V	96.8 %	A	A+	25	96.9 %	A	A+	35	2/2009
Power-One's TRIO-20.0-TL-OUTD S2-400	410 - 800 V	96.7 %	A	—	28	97.1 %	A	—	22	9/2012
Danfoss' TLX 15 k	430 - 800 V	96.7 %	A	A+	28	97.0 %	A	A+	26	6/2010
Samil Power's Solarlake 15000TL	380 - 800 V	96.7 %	A	—	28	97.0 %	A	—	26	6/2012
Zeversolar New Energy's Eversol-TL 4600	290 - 500 V	96.7 %	A	—	28	97.0 %	A	—	26	9/2011
Sunways' NT 4200	340 - 750 V	96.7 %	A	A+	28	96.8 %	A	A+	37	3/2010
Sunways' PT33k	460 - 800 V	96.7 %	A	—	28	96.8 %	A	—	37	6/2012
Conergy's IPG 15T	450 - 800 V	96.6 %	A	A+	34	97.0 %	A	A+	26	8/2010
Kinglong's KLINE Sunteams 5000	280 - 440 V	96.6 %	A	—	34	97.0 %	A	—	26	5/2012
Sungrow's SG15KTL	380 - 800 V	96.6 %	A	—	34	97.0 %	A	—	26	2/2012
SMA's SMC 700TL	333 - 500 V	96.6 %	A	A+	34	96.8 %	A	A+	37	5/2010
Sunways' NT 11000	340 - 750 V	96.6 %	A	—	34	96.7 %	A	—	44	11/2012
Danfoss' TLX 10 k	430 - 800 V	96.5 %	A	A+	39	97.0 %	A	A+	26	8/2010
Samil Power's Solarriver SR4K4TLA1	200 - 500 V	96.5 %	A	—	39	96.8 %	A	—	37	8/2011
Eltek Valere's Theia 4.4HE-t*5	230 - 480 V	96.5 %	A	—	39	96.7 %	A	—	44	11/2011
Power-One's Aurora PVI-12.5-OUTD-FS	360 - 750 V	96.4 %	B	A	42	96.9 %	A	A+	35	4/2010
Helios' HSI20	350 - 800 V	96.2 %	B	—	43	97.0 %	A	—	26	3/2012
Growatt's 5000 MTL	250 - 550 V	96.2 %	B	—	43	96.8 %	A	—	37	7/2012
Kaco's Powador 4000 supreme DCS (9 kHz)	350 - 510 V	96.2 %	B	A	43	96.7 %	A	A+	44	1/2010
Kstar's New Energy KSG-5K (version 2)	280 - 480 V	96.2 %	B	—	43	96.6 %	A	—	47	12/2012
Kstar's New Energy KSG-3	190 - 440 V	96.1 %	B	—	47	96.6 %	A	—	47	8/2012
Tranergy's PVI 4600TL	300 - 500 V	96.1 %	B	—	47	96.6 %	A	—	47	8/2012
Growatt's 5000 TL	280 - 500 V	96.0 %	B	—	49	96.8 %	A	—	37	2/2011
Fronius' IG TL 5 0	350 - 700 V	95.9 %	B	A	50	96.2 %	B	A	51	9/2010
Kaco's Powador 4000 supreme DCS (18 kHz)	350 - 510 V	95.7 %	B	A	51	96.1 %	B	A	52	1/2010
SMA's SB 5000TL-20	175 - 440 V	95.7 %	B	A	51	96.0 %	B	A	54	5/2009
Sungrow's SG4KTL	210 - 420 V	95.6 %	B	—	53	96.3 %	B	—	50	1/2011
Omron's KP100L (OD-EU)	320 - 825 V	95.5 %	B	—	54	96.1 %	B	—	52	1/2013
Sanjing Electric's SAJ Sununo TL5K	200 - 440 V	95.5 %	B	—	54	96.0 %	B	—	54	5/2012
Power-One's Aurora PVI-6000-OUTD-S	180 - 530 V	95.4 %	B	A	56	95.9 %	B	A	56	3/2009
Omnik New Energy's Omniksol-2k-TL	120 - 450 V	95.2 %	B	—	57	95.9 %	B	—	56	1/2012
Aros' Sirio 4000	250 - 450 V	95.1 %	B	A	58	95.7 %	B	A	59	12/2008
Dasstech's DSP-123K2	200 - 450 V	95.1 %	B	—	58	95.7 %	B	—	59	3/2011
Kstar's New Energy KSG-5K (version 1)	280 - 480 V	95.1 %	B	—	58	95.1 %	B	—	65	12/2012

Inverter test results

Inverter	Observed voltage range ^{*1}	Medium irradiation				High irradiation				PI issue
		etaP _{mod}	Grade as of 2011	Grade before 2011	Position	etaP _{high}	Grade as of 2011	Grade before 2011	Position	
Conergy's IPG 5 S	275 - 750 V	95.0 %	B	A	61	95.8 %	B	A	58	9/2009
Fronius' IG Plus 100	230 - 500 V	94.8 %	C	B	62	95.0 %	B	A	69	11/2010
SMA's SB 3000HF-30	210 - 560 V	94.7 %	C	—	63	95.2 %	B	—	63	2/2012
Yisun New Energy Tech's Yisun-2K-TL	120 - 450 V	94.6 %	C	—	64	95.4 %	B	—	62	12/2012
Fronius' IG Plus 150 V-3	230 - 500 V	94.6 %	C	—	64	95.1 %	B	—	65	10/2012
Sunways' AT 4500	250 - 600 V	94.6 %	C	B	64	94.8 %	C	B	73	7/2008
Sungrow's SG3KTL (version 2)	180 - 420 V	94.5 %	C	—	67	95.7 %	B	—	59	8/2011
Fronius' IG Plus 50	230 - 500 V	94.5 %	C	B	67	94.8 %	C	B	73	8/2008
Phoenixtec's PVG 2800 (updated model)	250 - 450 V	94.4 %	C	B	69	95.1 %	B	A	65	5/2008
Kaco's Powador 8000xi (new software; since Jan. 2010) ^{*3}	350 - 600 V	94.4 %	C	B	69	94.7 %	C	B	77	3/2010
Kaco's Powador 2500xi DCS	350 - 600 V	94.3 %	C	B	71	95.0 %	B	A	69	1/2010
Sunways' AT 2700	181 - 600 V	94.3 %	C	B	71	94.8 %	C	B	73	8/2009
Sputnik's SolarMax 6000S	220 - 550 V	94.3 %	C	B	71	94.7 %	C	B	77	11/2009
Effekta's ES5000 (new software, PV00113L)	150 - 450 V	94.2 %	C	—	74	94.8 %	C	—	73	2/2012
Carlo Gavazzi's ISMG150DE	200 - 450 V	94.1 %	C	B	75	95.0 %	B	A	69	5/2010
Xantrex's GT5.0SP ^{*6}	240 - 550 V	94.1 %	C	B	75	94.7 %	C	B	77	1/2009
Conergy's IPG 5000 vision ^{*3}	301 - 706 V	94.0 %	C	B	77	94.7 %	C	B	77	7/2007
Kaco's Powador 8000xi (old firmware; till Jan. 2010) ^{*3}	350 - 600 V	94.0 %	C	B	77	94.7 %	C	B	77	3/2010
Kostal's Piko 10.1	400 - 850 V	94.0 %	C	B	77	94.4 %	C	B	89	7/2009
Delta Energy Systems' SI 3300 ^{*3}	150 - 435 V	93.9 %	C	B	80	94.7 %	C	B	77	5/2008
Mitsubishi's PV-PNS06ATL-GER	260 - 650 V	93.9 %	C	B	80	94.6 %	C	B	83	6/2008
SMA's SMC 7000HV	335 - 560V	93.9 %	C	B	80	94.2 %	C	B	91	9/2009
Sunways' NT 2600 (lower range) ^{*3}	350 - 623 V	93.8 %	C	B	83	95.1 %	B	A	65	11/2007



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Inverter test results

Inverter	Observed voltage range ^{*1}	Medium irradiation				High irradiation				PI issue
		etaP _{med}	Grade as of 2011	Grade before 2011	Position	etaP _{high}	Grade as of 2011	Grade before 2011	Position	
Steca's Stecagrid 9000 3ph ^{*3}	350 - 680 V	93.8 %	C	B	83	95.0 %	B	A	69	7/2010
Sputnik's SolarMax 2000C ^{*3}	165 - 515 V	93.8 %	C	B	83	93.1 %	D	C	104	4/2007
Sungrow's SG3KTL (version 1)	180 - 420 V	93.7 %	C	—	86	95.2 %	B	—	63	8/2011
Kaco's Powador 4202	200 - 510 V	93.7 %	C	B	86	94.6 %	C	B	83	10/2010
SMA's SB 2100TL	200 - 480 V	93.7 %	C	B	86	94.6 %	C	B	83	6/2009
Oelmaier's PAC 4	330 - 600 V	93.6 %	C	B	89	94.6 %	C	B	83	12/2009
Mastervolt's Sunmaster XS6500	180 - 480 V	93.6 %	C	B	89	94.1 %	C	B	92	2/2010
Ingeteam's Ingecon Sun 3.3 TL	159 - 414 V	93.4 %	D	C	91	94.3 %	C	B	90	8/2007
SMA's SB 3800	208 - 395 V	93.2 %	D	C	92	93.6 %	C	B	96	2/2007
Dasstech's DSP-123KH	350 - 600 V	93.0 %	D	C	93	94.6 %	C	B	83	10/2010
Diehl AKO's Platinum 4600S	320 - 628 V	92.9 %	D	C	94	93.3 %	D	C	101	4/2008
Power-One's Aurora PVI-2000-OUTD-DE	210 - 530 V	92.8 %	D	C	95	94.0 %	C	B	93	2/2010
Diehl AKO's Platinum 2100S	206 - 390 V	92.8 %	D	C	95	93.3 %	D	C	101	10/2009
Kaco's Powador 3501xi ^{*3}	125 - 391 V	92.6 %	D	C	97	92.9 %	D	C	105	6/2007
Kaco's Powador 2500xi ^{*3}	350 - 597 V	92.5 %	D	C	98	93.4 %	D	C	98	12/2007
Sunways' NT 2600 (upper range) ^{*3}	476 - 749 V	92.3 %	D	C	99	93.9 %	C	B	94	11/2007
Solon's Satis 40/750 IT ^{*7}	375 - 575 V	92.3 %	D	C	99	93.5 %	C	B	97	11/2008
Mastervolt's QS 2000 ^{*3}	212 - 366 V	92.3 %	D	C	99	92.7 %	D	C	106	1/2008
Opti-Solar's GT 4000 (new software, V2.07)	250 - 400 V	92.1 %	D	—	102	94.6 %	C	—	83	6/2011
Powercom's SLK-4000	205 - 408 V	92.0 %	D	C	103	93.4 %	D	C	98	11/2010
Phoenixtec's PVG 10000	320 - 720 V	91.8 %	F	D	104	93.3 %	D	C	101	6/2010
Riello's HP 4065REL-D ^{*8}	255 - 435 V	91.7 %	F	D	105	93.9 %	C	B	94	9/2007
Effekta's ES5000 (old software)	150 - 450 V	91.7 %	F	—	105	92.2 %	D	—	107	2/2012
Fronius' IG 30	150 - 397 V	91.4 %	F	D	107	92.2 %	D	C	107	1/2007
Powercom's SLK-4000 (new software, V2.07)	250 - 450 V	91.1 %	F	—	108	93.4 %	D	—	98	6/2011
Siemens' Sitop solar 1100 Master ^{*3}	200 - 552 V	90.2 %	F	D	109	91.7 %	F	D	110	5/2007
Danfoss' ULX 1800 HV IN	260 - 500 V	89.2 %	F	F	110	91.3 %	F	D	112	4/2010
SMA's SB1100	139 - 320 V	89.1 %	F	F	111	90.5 %	F	D	114	10/2009
Opti-Solar's GT 4000 (old software, V1.09)	200 - 450 V	87.8 %	F	—	112	92.1 %	D	—	109	6/2011
Ehe New Energy's EHE-N2K5	200 - 400 V	87.4 %	F	—	113	91.4 %	F	—	111	7/2011
SunnySwiss' SSP-6000	250 - 480 V	86.8 %	F	—	114	91.2 %	F	—	113	2/2011
Ehe New Energy's EHE-N5K	300 - 650 V	80.3 %	F	—	115	86.3 %	F	—	115	7/2011
Phoenixtec's PVG 2800 (original model) ^{*3}	255 - 435 V	78.4 %	F	F	116	85.8 %	F	F	116	2/2008

^{*1} range at which the model was tested and to which the grade applies, ^{*2} Eversolar New Energy Co. Ltd. and Zof New Energy Co. Ltd. merged at the end of 2011 and altered their name to Zever-solar New Energy Co. Ltd.; Zever-solar now calls the device the Eversol TL 17k; however, the power data differs from the tested Eversol-T, ^{*3} device no longer being produced, ^{*4} renamed Solarmax 13MT3 since April 2012, ^{*5} name changed from Eltek Valere to Eltek, ^{*6} now Schneider Electric Industries SA, ^{*7} prototype; device no longer being produced, ^{*8} the identical solar inverter brands Helios Power (Riello UPS) and Sirio (AROS) are now marketed under a single brand, AROS Solar Technology GmbH, and distributed by AROS Neufahrn

New grades in PHOTON Lab's inverter test as of 2011

The table showing the results achieved by the inverters tested by PHOTON Lab looks slightly different due to a new grading system as of 2011. All of the inverters tested before that point have two grades: one based on the old system and one related to the new method.

The grades are based on the PHOTON efficiency at medium and high irradiation. More detailed information about the invert-

ers can be found in the corresponding test reports (the issue in which each report was published is noted in the last column of the table). The rankings are also based on the PHOTON efficiency.

The changes to the grading system were made to reflect the current status in the sector; and the system will be updated again in the future to reflect technical advancements. Now, inverters have to get a higher PHOTON efficiency

to secure a better grade: what would have gotten an A in 2010 with 96.4 percent, would now get a B. Should manufacturers further improve their devices, these inverters could even get downgraded to a C as our grading system changes to reflect the current times.

Moreover, to align grades with our US sister publication, we have changed the letter »E« to »F,« based on the American school grading system.

Grading system for inverter tests as of 2011

	A++	A+	A	B	C	D	F ^{*1}
PHOTON efficiency	≥ 99	≥ 98 - < 99	≥ 96.5 - < 98	≥ 95 - < 96.5	≥ 93.5 - < 95	≥ 92 - < 93.5	< 92
Deviation from next grade	0.5	1	1.5	1.5	1.5	1.5	—

^{*1} to align grades with our US sister publication, we have changed the letter »E« to »F«

PHOTON Lab's outdoor module tests: Results of 2012 yield measurements

Rank	Manufacturer	Model	Production dates*1	Installed in	Yield in kWh/m ²	Performance ratio	Yield in kWh/kW	Deviation from test winner (%)
1	SunPower	SPR-327NE-WHT-D	—	2012	228.7	95.2%	1,144.1	—
2	SunPower	SPR-320NE-WHT-D	—	2012	227.6	94.9%	1,140.1	0.35%
3	SunPower	SPR-245NE-WHT-D	—	2012	225.3	94.8%	1,139.4	0.42%
4	Seraphim Solar System	SRP-220-6PB	—	2011	156.1	93.6%	1,125.5	1.63%
5	Yingli Green Energy	YL240P-29b	—	2012	169.2	93.1%	1,118.7	2.22%
6	ET Solar	ET-P660240	—	2011	161.6	92.8%	1,115.3	2.51%
7	Sunerg Solar	XP 60/156-230	—	2011	154.6	92.8%	1,115.0	2.55%
8	Siliken	SLK60P6L 230WP	—	2009	158.0	92.7%	1,114.2	2.61%
9	Jinko Solar	JKM190M-72	2010	2011	166.1	92.5%	1,112.2	2.79%
10	Huanghe	HH230(30)P	—	2012	157.1	92.5%	1,112.1	2.80%
11	Jinko Solar	JKM235P-60	—	2012	156.8	92.5%	1,111.4	2.86%
12	Apollo Solar	235G6M	2011	2012	163.9	92.3%	1,109.0	3.07%
13	CSG PV Tech	CSG180S1-35/36*8	2008	2010	159.1	92.0%	1,106.1	3.32%
14	NexPower Technology	NT-125AX*12	2009–2010	2010	87.7	92.0%	1,105.9	3.34%
15	Linsun Renewable	SK60P6	—	2011	155.8	92.0%	1,105.6	3.36%
16	Huanghe	HH190(36)M	—	2012	164.7	91.9%	1,104.5	3.47%
17	Nelumbo	NEI 230-3VA	—	2011	153.8	91.8%	1,103.7	3.53%
18	Schott Solar*15	SCHOTT PERFORM Poly 235	Since 2011	2012	139.7	91.8%	1,103.4	3.56%
19	Conergy	Conergy PowerPlus 235P	—	2012	162.2	91.7%	1,101.8	3.70%
20	SolarWorld	Sunmodule Plus SW 225 mono	2009	2010	153.8	91.6%	1,100.4	3.82%
21	Upsolar	UP-M220P	2010–2011	2011	147.8	91.5%	1,099.3	3.92%
22	Aleo Solar	Aleo S_18 225	2005	2010	154.5	91.5%	1,099.3	3.92%
23	ZN Shine PV-Tech	ZX250(48)MS	—	2011	163.1	91.5%	1,099.1	3.93%
24	CNPV Solar	CNPV-240P	2006	2011	162.9	91.4%	1,099.0	3.94%
25	Himin Clean Energy	HG-190S/Ba	—	2012	167.0	91.4%	1,098.9	3.95%
26	REC	Premium 210	Until 2008	2011	141.2	91.4%	1,098.0	4.03%
27	REC	REC230AE*12	2007–2010	2010	152.1	91.4%	1,097.9	4.04%
28	Win Win Precision	Winaico WSP-250P6	—	2012	164.9	91.3%	1,097.6	4.06%
29	Chint Solar / Astronergy	CHSM5612M-185	—	2012	160.6	91.3%	1,097.1	4.11%
30	V-Energy	VE260PV	—	2012	155.1	91.3%	1,097.1	4.11%
31	Hareon Solar	HR-230P-18/Bb	—	2011	156.1	91.3%	1,096.9	4.13%
32	Solar Modules Nederland	TC245-M0	2010–2011	2011	165.0	91.3%	1,096.7	4.14%
33	Kinmac Solar*13	KSS-6P6A-230	2010	2011	156.5	91.3%	1,096.7	4.14%
34	Kioto Photovoltaics	KPV 210 PE*2	2008–2010	2009	152.0	91.2%	1,095.9	4.21%
35	BP Solar	BP 3220 T	Until 2011	2011	152.4	91.1%	1,094.5	4.34%
36	Solon	SOLO Blue 230/07(225)	2008	2011	151.4	91.1%	1,094.3	4.36%
37	ITS Innotech Solar	EcoPlus ITS220ECU5*10	2011	2012	160.6	90.9%	1,092.2	4.53%
38	SolarWorld	Sunmodule Plus SW 245 poly	—	2012	160.4	90.9%	1,092.1	4.54%
39	Amerisolar	AS-5M-190W	—	2012	166.4	90.9%	1,092.1	4.54%
40	Win Win Precision	Winaico WSP-235P6	—	2010	157.9	90.8%	1,091.7	4.58%
41	REC	REC230PE	2010	2011	157.1	90.8%	1,091.0	4.64%
42	Eurener	PEPV230	—	2012	153.7	90.8%	1,090.8	4.66%
43	CNPV Solar	CNPV-220P	2006	2011	150.0	90.8%	1,090.7	4.66%
44	Sunlink PV	SL220-20M230	—	2011	157.2	90.7%	1,090.6	4.68%
45	CH Solar	CH Solar 180 mono*2	Until 2010	2010	157.1	90.7%	1,090.2	4.71%
46	China Sunergy	CSUN260-60M	—	2012	170.9	90.7%	1,090.1	4.72%
47	Amerisolar	AS-6P30-230W	—	2012	157.3	90.6%	1,089.2	4.80%
48	CNPV Solar	CNPV-185M	2006	2010	164.9	90.6%	1,089.0	4.82%
49	Upsolar	UP-M180M	2010–2011	2010	154.3	90.5%	1,087.9	4.91%
50	M-Prime	M 235P	—	2012	162.6	90.5%	1,087.4	4.95%
51	Sunflower Light	SF125x125-72-M(180)	—	2011	150.0	90.5%	1,087.3	4.96%
52	Risen Energy	SY185S-M	—	2011	162.8	90.5%	1,087.3	4.97%
53	PV Power Technologies	PVQ3 220	2008	2009	150.0	90.4%	1,087.0	4.99%
54	SWAT-International	SWAT-240-PS	—	2011	162.3	90.4%	1,086.2	5.06%
55	Bisol	BMU-215-2/233	2009	2011	156.0	90.4%	1,086.0	5.08%
56	Conergy	Conergy PowerPlus 220P	2009	2010	149.4	90.3%	1,085.8	5.09%
57	CEEG Solar*6	SST 240-60M	2005	2011	160.2	90.3%	1,085.6	5.12%
58	China Sunergy	CSUN250-60M	—	2012	166.4	90.3%	1,085.4	5.13%
59	Linuo	LN180(36)M-185	2003	2011	162.6	90.3%	1,085.2	5.15%
60	JCS Solar*11	JCSM290M-72*12	—	2012	166.1	90.3%	1,085.2	5.15%
61	Galaxy Energy	GS260m-96	—	2011	164.3	90.3%	1,085.0	5.17%
62	Mage Solar	Mage Powertec Plus 225/6PJ	Until 2011	2009	153.4	90.2%	1,084.4	5.22%

PHOTON Lab's outdoor module tests: Results of 2012 yield measurements

Rank	Manufacturer	Model	Production dates*1	Installed in	Yield in kWh/m ²	Performance ratio	Yield in kWh/kW	Deviation from test winner (%)
63	CEEG Solar**5	SST 265-72P	2005	2011	157.0	90.2%	1,084.1	5.24%
64	Axitec	AC 236P/156-60S	Until 2011	2011	152.1	90.2%	1,084.0	5.25%
65	SolarWorld	Sunmodule Plus SW 225 poly	2004-2011	2011	147.5	90.2%	1,084.0	5.25%
66	Solaria Energía	S6P2G225	2010	2011	154.8	90.2%	1,083.8	5.27%
67	CSG PV Tech	CSG230M2-30**7	2008	2010	151.7	90.1%	1,083.3	5.31%
68	Trina Solar	TSM-180DC01	2007	2009	149.1	90.1%	1,083.2	5.33%
69	Trina Solar	TSM-225PC05	—	2010	153.9	90.1%	1,083.1	5.33%
70	Ningbo Solar	Sun Earth TDB125x125-72-P 180W**2	Until 2010	2011	151.6	90.1%	1,083.0	5.34%
71	Vikram Solar	ELDORA 220	—	2011	156.8	90.0%	1,082.2	5.41%
72	Mage Solar	Mage Powertec Plus 230/6PH-US	—	2011	154.7	90.0%	1,081.5	5.47%
73	Daqo New Energy	DQ235PSCa	—	2012	157.8	89.9%	1,080.5	5.56%
74	Magi Solar	MGSM-295-D	2011	2011	163.7	89.9%	1,079.9	5.61%
75	Eging Photovoltaic Technology	EGM-185	2010	2011	159.0	89.9%	1,079.9	5.61%
76	Linuo	LN240(30)P-225	2003	2011	155.6	89.8%	1,079.0	5.69%
77	S-Energy	SM-220PA8	—	2009	152.0	89.6%	1,076.9	5.87%
78	Bosch Solar	Bosch c-Si M 60 230	2009-2010	2011	153.0	89.6%	1,076.5	5.91%
79	Frankfurt Solar	FS215W-POLY	—	2009	147.9	89.5%	1,075.7	5.98%
80	Zentralsolar Deutschland	Genius SDM 185-10004-185	—	2011	160.2	89.5%	1,075.6	5.99%
81	Hanwha SolarOne**3	SF160-24-1M175 (scac)	—	2010	153.8	89.5%	1,075.6	5.99%
82	Topray Solar	TPS105T-180W	—	2011	155.3	89.5%	1,075.6	5.99%
83	BP Solar	BP 3280 T	Until 2011	2011	155.3	89.5%	1,075.4	6.00%
84	Bisol	BMU-215-2/221	2007	2010	150.2	89.5%	1,075.3	6.01%
85	Talesun Solar	TP572M-195	2011	2012	164.7	89.5%	1,075.1	6.03%
86	Solarwatt	M220-60 GET AK (230)	2005	2011	149.9	89.4%	1,075.0	6.04%
87	Solarbest Energy-Tech	ZSB M190	—	2011	156.2	89.4%	1,074.6	6.08%
88	Jinko Solar	JKM255M-96	—	2011	164.1	89.4%	1,074.3	6.10%
89	Kenmec Mechanical	TKSA-23001	—	2011	153.9	89.4%	1,074.3	6.10%
90	Fluitemek	FTS-220 P	—	2011	153.7	89.4%	1,074.1	6.11%
91	Runda PV	RS230P-60	—	2012	155.7	89.3%	1,073.8	6.15%
92	Suntech Power	STP205-18/Ud	—	2011	156.2	89.3%	1,073.7	6.15%
93	Magi Solar	MGSM-240D-60	—	2011	162.0	89.3%	1,073.1	6.20%
94	Sunrise Solartech	SRM 180D72-GE	—	2009	152.2	89.3%	1,072.9	6.22%
95	Yingli Green Energy	YL210P-29b	2009	2011	141.0	89.3%	1,072.8	6.23%
96	Lillie Energie	Lillie SPL 185	—	2011	155.3	89.3%	1,072.8	6.23%
97	SolarWorld	Sunmodule Plus SW 210 poly**16	2004	2006	135.5	89.2%	1,072.5	6.26%
98	Zytech Engineering	ZT 230P	—	2011	150.9	89.2%	1,072.5	6.26%
99	Solargate	SG-2350	—	2012	163.0	89.2%	1,071.9	6.31%
100	Topsolar Green	TSM72-125M-190W	—	2011	155.3	89.2%	1,071.6	6.33%
101	Upsolar	UP-M185M	2010-2011	2011	158.3	89.1%	1,071.3	6.37%
102	CNPV Solar	CNPV-240M	2006	2011	163.1	89.1%	1,071.2	6.37%
103	Sonalis**14	SL-180CE-36M	—	2010	154.7	89.0%	1,070.0	6.48%
104	Scheuten Solar	Multisol P6-60	—	2011	153.4	89.0%	1,069.7	6.50%
105	China Sunergy	CSUN240-60P	—	2012	160.9	89.0%	1,069.5	6.52%
106	Sunage	SAM 96/5	—	2011	154.1	88.9%	1,068.8	6.58%
107	Ningbo Solar	Sun Earth TDB125x125-72-P 160W**2	—	2011	134.8	88.8%	1,067.8	6.67%
108	Chint Solar / Astronergy	CHSM-6610P-230	—	2012	152.5	88.8%	1,067.7	6.68%
109	Ferrania Solis	AP 60-230	2010	2011	210.5	88.8%	1,067.3	6.71%
110	Hanwha SolarOne**9	SF160-24-1M180	—	2011	148.8	88.7%	1,066.4	6.79%
111	Sunpeak / Alpexsolar**4	ALP235W**2	2009-2010	2010	154.3	88.7%	1,066.3	6.80%
112	Jetion Solar	JT230(30)P1655x992	2005	2011	151.1	88.7%	1,066.0	6.83%
113	Alex Solar	ALM-190D-24	2009	2011	157.6	88.7%	1,065.8	6.84%
114	CNPV Solar	CNPV-190M	2006	2011	164.3	88.7%	1,065.6	6.86%
115	Aide Solar	AD195M5-Aa	—	2011	164.7	88.6%	1,065.0	6.91%
116	Helios Technology	H3A230P	—	2012	151.5	88.5%	1,063.5	7.04%
117	Luxor Solar	LX-185M/125-72+	2007	2011	156.4	88.4%	1,062.7	7.12%
118	Axitec	AC-250M/156-60S	—	2012	162.1	88.4%	1,061.9	7.19%
119	Lillie Energie	Lillie SPL 185-1	—	2011	155.2	88.3%	1,061.6	7.21%
120	Evergreen Solar	ES-E-210-fc3	—	2011	136.3	88.1%	1,058.8	7.45%
121	Win Win Precision	Winaico WSP-230P6	2009	2009	149.4	88.0%	1,057.9	7.53%
122	Shell Solar (now with SolarWorld)	Shell SQ 150-C**2	Until 2005	2006	124.5	87.8%	1,054.9	7.79%
123	Solar-Fabrik	Premium L poly (225)	—	2011	142.0	87.7%	1,054.3	7.85%
124	Day4 Energy	Day4 48MC 185	2006	2011	152.3	87.6%	1,053.3	7.93%

PHOTON Lab's outdoor module tests: Results of 2012 yield measurements

Rank	Manufacturer	Model	Production dates* ¹	Installed in	Yield in kWh/m ²	Performance ratio	Yield in kWh/kW	Deviation from test winner (%)
125	Sharp	NU-185E1	2005	2011	148.3	87.5%	1,052.1	8.04%
126	Evergreen Solar	ES-A-210-fa2	2008	2011	140.7	87.5%	1,052.0	8.05%
127	Perfectenergy	PEM-180/185-72M-SCC	2008	2010	157.0	87.4%	1,050.8	8.15%
128	Hanwha SolarOne* ⁹	SF160 M5-24 (175 W)* ²	—	2007	143.2	87.4%	1,050.0	8.22%
129	Kyocera	KD210GH-2PU	2009	2011	149.3	87.2%	1,048.5	8.35%
130	Sonalis* ¹⁴	SL-190CE-36M	—	2012	154.7	87.2%	1,047.8	8.42%
131	First Solar	FS-265	2006–2011	2007	94.8	86.9%	1,043.9	8.76%
132	Emmvee Photovoltaics	ES-230P60* ⁸	2008–2011	2010	144.0	86.5%	1,039.9	9.11%
133	Schott Solar* ¹⁵	SCHOTT POLY TM 220	2008–2009	2011	157.9	86.4%	1,038.1	9.27%
134	IBC Solar	IBC MonoSol 240 TT	Until 2011	2011	153.7	86.3%	1,036.9	9.37%
135	Suntech Power	STP190-18/Ub* ²	2005	2011	128.8	86.1%	1,034.8	9.55%
136	Sovello	SV-X-205-fa1	—	2011	135.3	85.8%	1,030.7	9.91%
137	Calrays	CPM 250-A-96	—	2011	149.7	85.3%	1,024.7	10.43%
138	Solar-Fabrik	SF 130/4-130* ²	2006–2010	2010	133.8	85.2%	1,023.7	10.52%
139	Evergreen Solar	EC-120* ²	2004–2006	2006	120.1	85.1%	1,022.7	10.61%
140	Sovello	SV-X-200-fa* ¹³	2009–2011	2011	132.3	84.9%	1,019.8	10.87%
141	Canadian Solar	CS6A-170P	2007 (purchased)	2007	135.9	84.3%	1,013.4	11.43%
142	Sunways	MHH plus 190 (190 Wp)* ²	2003–2005	2005	141.2	83.6%	1,005.0	12.16%
143	Solar-Fabrik	SF 145A* ²	2003–2004	2005	118.8	83.4%	1,002.4	12.38%
144	Isofoton	IS-170/24* ²	2007	2009	137.5	83.4%	1,002.4	12.39%
145	Isofoton	I-110/24* ²	Until 2005	2006	119.4	83.3%	1,001.7	12.45%
146	Kyocera	KC170GT-2* ²	Until 2006	2006	140.1	83.0%	997.1	12.85%
147	ASE (now with Schott Solar)	ASE-300-DG-FT (300 W)* ²	1997–2006	2007	126.3	82.5%	992.0	13.29%
148	BP Solar	BP 7185 S* ²	—	2005	145.2	81.6%	980.6	14.29%
149	Photowatt International	PW 1650-175W	2005 (purchased)	2006	125.1	81.4%	978.1	14.51%
150	Evergreen Solar	ES-180-RL* ²	2006–2008	2007	119.0	80.1%	962.6	15.86%
151	Sharp	NT-R5E3E* ²	2003	2005	137.2	79.0%	949.2	17.04%

*¹ when date of production was unavailable, the date when PHOTON Lab bought the module was used (if possible)

*² no longer manufactured

*³ referred to as Pure Power SV-X-200 (LV) in previous issues

*⁴ manufactured by Alpexsolar; available through Sunpeak-Vertrieb Unternehmensgruppe Ratio-Data

*⁵ CEEG is the manufacturing company of license holder China Sunergy

*⁶ previous model designation: CSG180S1-35/1589x807

*⁷ previous model designation: CSG230M2-30/1640x992

*⁸ previous model designation: ES-200-P60(230)

*⁹ previously manufactured by Solarfun Power Holdings Co. Ltd.

*¹⁰ previous model designation: Economy New ITS220ECU5

*¹¹ previous manufacturer designation: JZ Solar

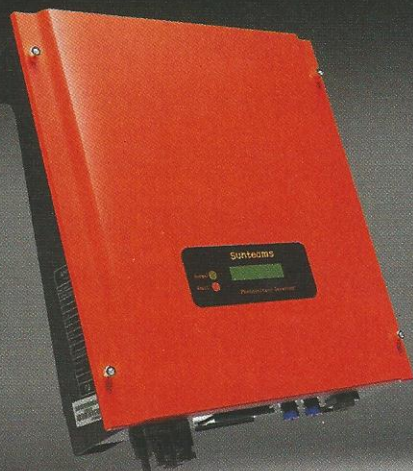
*¹² previous model designation: JZM 290M-72

*¹³ company has changed its name to Inventec Energy

*¹⁴ manufactured by Ningbo Qixin Solar Electrical Appliance Co. Ltd.

*¹⁵ company has withdrawn from crystalline silicon PV manufacturing

*¹⁶ previous model designation: SW 210 poly



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