Stiftung Warentest **Top Grade GOOD**
test
Tested: 13 solar modules Issue 5/2006

test Solar modules

	Importance	Modules with silicon cells					Thin film modules									
		aleo solar S_16	Kyocera KC170 GT-2	Shell Solar PowerMax Ultra 165-C	Sunways SM 170 U[3]	Scheuten Solar Multisol 180A	Schott Solar ASE-165-GT-FT/MC	Sharp NU-S5E3E[4]	Solarwatt P210-60 GET	SolarWorld SW 210 poly	Solar-Fabrik AG SF 125-130 ST	Sun Technics STM 173 F	Isofoton I-150/12 S	BP Solar 7190-S[5]	Schott Solar ASI Opak-30-SG[6]	Würth Solar WS 31100/75
Approx. total cost in euros of around 3kW output[1] (No./surface area of modules required)		13,360 (16/22 m²)	14,370 (18/23 m²)	12,760 (18/23.8 m²)	15,470 (18/24.5 m²)	13,360 (16/24 m²)	14,280 (18/23.6 m²)	13,200 (16/21 m²)	16,370 (14/23.3 m²)	14,330 (14/23.5 m²)	16,840 (24/23.9 m²)	[7] (18/26 m²)	13,950 (20/25.6 m²)	16,000 (16/20.1 m²)	167[8]	500[8]
Price per watt[1] in euros approx.		4.65	4.70	4.30	5.05	4.50	4.80	4.45	5.60	4.90	5.40	[7]	4.65	5.25	5.20[8]	6.65[8]
test Quality rating	100%	GOOD (1.9)	GOOD (1.9)	GOOD (1.9)	GOOD (1.9)	GOOD (2.0)	GOOD (2.1)	GOOD (2.2)	GOOD (2.3)	GOOD (2.3)	SATISF. (2.7)	SATISF. (2.9)	SATISF. (3.0)	SATISF. (3.3)	SATISF. (2.7)	SATISF. (3.2)
Electric Power Generation	45%	good (1.7)	good (1.6)	good (1.9)*	good (1.9)	good (2.0)	good (2.1)*	good (1.7)	good (2.3)*	good (2.3)*	satisf. (2.7)*	good (2.1)	satisf. (3.0)*	satisf. (3.3)*	satisf. (2.7)*	satisf. (2.7)
Module efficiency		+	++	+	+	+	+	++	+	+	+	○	○	++	⊖	○
Accuracy of rated output		++	++	+	++	++	+	+	+	+	○	+	○	⊖*	+	+
Consistency in output of different modules		++	++	+	++	+	+	++	++	+	+	++	+	++	+	○
Performance stability when heated		+	○	○	+	○	+	○	○	+	○	○	○	○	++	+
Durability	40%	good (1.8)	good (1.9)	good (1.7)	good (1.8)	good (1.9)	good (1.8)	good (2.5)	good (2.0)	good (2.0)	good (2.0)	fair (4.0)	satisf. (2.9)	satisf. (2.9)	satisf. (2.8)	fair (4.0)
Resistance to aging		++	+	++	+	+	++	+	+	++	++	⊖*	○	○	○	⊖*
Mechanical strength		+	+	+	+	+	+	○	+	○	○	+	+	+	+	+
Build quality		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Safety	10%	good (2.2)	good (2.3)	good (2.1)	good (2.1)	good (2.2)	good (2.1)	good (2.3)	good (2.1)	satisf. (3.1)	good (2.0)	good (2.2)	good (2.2)	good (2.2)	good (2.3)	good (2.2)
Electrical safety		+	+	+	+	+	+	+	+	○	+	+	+	+	+	+
Risk of personal injury		○	○	+	+	○	+	○	+	+	+	○	○	○	○	○
Documentation and installation	5%	satisf. (3.1)	satisf. (2.7)	very good (1.3)	good (2.2)	good (2.1)	satisf. (2.7)	fair (3.8)	satisf. (3.3)	good (1.9)	satisf. (3.3)	good (2.1)	good (2.2)	good (2.5)	good (2.4)	satisf. (3.5)
Model identification plate		○	+	++	+	++	+	⊖	⊖	++	⊖	+	++	++	++	○
Datasheet		○	○	++	+	○	○	⊖	○	++	⊖	++	○	○	○	–
Installation		○	○	+	○	○	○	○	○	○	+	○	+	○	○	+
Rated output (manufacturer's specification/measured) in watts		180/179.7	170/174.1	165/166.7	170/168	185/188.8	165/163.6	185/184.2	210/202.7	210/203.2	130/123.4	173/170.1	150/141.5	190/181.5	32.2/33.5	75/74.4
Maximum permissible system voltage (manufacturer's specification) in V		1,000	750	1,000	870	750	860	1,000	870	1,000	840	1,000	760	1,000	1,000	50
Efficiency across the active/entire surface in %[2]		14.8/13	15.6/13.6	14.9/12.6	14.4/12.4	14.4/12.6	14.5/12.5	16.3/14.1	13.9/12.2	13.9/12.1	14.1/12.4	13.4/11.8	13.3/11	16.4/14.4	6.1/5.6	11.8/10.2
Cells per module/type		50/Q-cells poly	48/Kyocera Deep Blue poly	72/Shell mono	48/Sunways poly	54/Q-cells poly	72/Main 125 polycrystalline	48/Sharp mono	60/ErSol poly	60/Deutsche Cell poly	36/Q-cells poly	54/GE Energy mono	72/Isofoton mono	72/Saturn mono	32/Amorphous silicon (ASI)	134/CIS
Length x width x depth in cm		166 x 83 x 5	129 x 99 x 3.6	162 x 81 x 4	200 x 68 x 5	150 x 100 x 4.2	162 x 81 x 5	132 x 99 x 4.6	168 x 99 x 5	168 x 100 x 3.4	1491 x 67 x 3.5	148 x 98 x 3.5	122 x 105 x 4	159 x 79 x 5	100 x 60 x 1	121 x 61 x 3.5
Weight in kg		17	16	18.4	20	20	15.5	16	24	22	12.5	17.7	17	15.4	14	12.7
Performance guarantee of 90%/80% of rated output		10/25 years	12/25 years	10/25 years	12/25 years	20 years[9]	10/25 years	10/20 years	12/25 years	10/25 years[10]	10/25 years	n.a./25 years	20 years[11]	12/25 years	n.a.	n.a.

Key to the test result ratings:
++ = very good (0.5-1.5)
+ = good (1.6-2.5)
○ = satisfactory (2.6-3.5)
⊖ = fair (3.6-4.5)
– = poor (4.6-5.5)

When the quality rating is the same, products are listed in alphabetical order

n.a. = not information available
* Results in marking restriction (see "SELECTED ..." below)

1) Refers to peak output in kilowatts or watts (peak)
2) Measured values
3) New product name from beginning of 2006. Purchased under the name MHH plus 170
4) According to supplier, also sold as the Sharp NU 185 E1
5) Supplier says latest version has been improved
6) Frameless: suitable for facade and roof installations
7) No pricing information from supplier – only complete systems offered
8) Price is for a single module
9) Applies to total rated output
10) Based on 91%/81% of rated output
11) Based on 85% of rated output

Selected – tested – evaluated

On test: 15 solar modules with outputs up to 210 W (Wp), including 2 thin film moduls for comparison purposes. **Test samples purchased:** October/November 2005. **Prices:** Suppliers surveyed in February/March 2006. All subjective judgements were made by five experts in the field.

Quality marking restrictions

The Stiftung Warentest quality rating could not be higher than the score for electric power generation. If the nominal output was judged to be just "fair", the score for power generation could be no more than one grade higher. If the resistance to aging was just "fair", the score for durability could not be higher.

Electric power generation: 45%

Stiftung Warentest measured the current-voltage characteristics on a test rig (sun simulator) and from this calculated the rated output. They determined the **module efficiency** for the active cell surface and module surface area. **Accuracy of rated output** – Stiftung Warentest checked the tolerances stated by the manufacturer, how far in percent the MPP performance (ave-raged over five modules) deviated from the rated output and the initial drop in output after 15 kWh per m² under outdoor conditions (see "Durability"). They assessed the **consistency in output of different modules** on the basis of five samples (deviation from average value). **Performance stability when heated** looks at the temperature increase under outdoor conditions when 600 W of solar radiation is applied per m², and at the output reduction in percent per °C in the MPP.

Durability: 40%

The assessment of **resistance to aging** is based on climate chamber tests. Stiftung Warentest measured the drop in output after the modules had been subjected to 1,000 hours of damp heat at 85°C und 85% humidity; they assessed the affect of temperature variations (200 cycles from minus 40 °C to over 85 °C); then they visually inspected each module for deterioration. Stiftung Warentest tested the **mechanical strength** of each module at 2,400 pascal (one hour each tensile and compression stress) and 5,400 pascal (compression). In addition, Stiftung Warentest carried out a visual inspection of the **build quality** of the modules (blemishes and irregularities on cells, string connectors and other components).

Safety: 10%

Stiftung Warentest tested **electrical safety** by applying an impulse voltage of 6 kV to each module. They checked for electrical problems when the rear coating was damaged (cut test). Stiftung Warentest assessed the **risk of injury** from sharp corners and edges on the module frame.

Documentation an installation: 5%

Stiftung Warentest checked the **model identification plate** and **datasheet** for completeness and assessed the ease of **installation** from the point of view of cabling and electrical connections.