TÜV Rheinland Energie und Umwelt GmbH
Renewable Energies

Short Report

Energy Yield 2010

TÜV Report No.: 21213805-6

Cologne, 1st August 2011

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Energy Yield 2010

Client	Schott Solar AG Carl-Zeiss-Str. 4 63755 Alzenau
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1 Setting of tasks

According to orders of below mentioned manufacturers the following module types have been tested in a one year energy yield comparison measurement within the project “Energy Yield 2010” performed by TÜV Rheinland Energie und Umwelt GmbH (TEU):

Manufacturer	Module Type	Maximum Power (Pmax rated)	Cell Type
Conergy Solar Module GmbH	Conergy PowerPlus 220P	220 Wp	poly
	Conergy PowerPlus 180MC	180 Wp	mono
Martifer Solar S.A.	MTS225P	225.07 Wp	poly
Day4 Energy Inc.	DAY 60MC-I	235 Wp	poly
Winergy Solar GmbH	WSP-220-P6	220 Wp	poly
Yingli Green Energy Holding Co., Ltd.	YL240C-30b	240 Wp	mono
	YL180P-23b	180 Wp	poly
Changzhou Trina Solar Energy Co., Ltd.	TSM-220PC05	220 Wp	poly
Siliken S.L.	SLK60P6L 230W	230 Wp	poly
Solarwatt AG	SOLARWATT P210-60GET AK	235 Wp	poly
Solon SE	Solon Black 230/07	220 Wp	mono
Canadian Solar Inc.	CS6P-230P	230 Wp	poly
Schott Solar AG	Schott Poly 225	225 Wp	poly

Table 1.1: List of participating module types

The results of the energy yield measurement are analysed quarterly. In the quarterly report every manufacturer is informed about the results of the own module in comparison to the others in an anonymous way.

2 Measurement procedure

2.1 Initial / Final measurements

After delivery of the required components two test specimen per module type participating in the project were subjected to the initial measurement testing sequence. This sequence includes a visual inspection, an electroluminescence (EL) image and determination of the electrical characteristics. The measurement of the I-V-characteristics is performed at STC under a class AAA pulsed solar simulator according to IEC 60904-9. A primary crystalline reference cell is used for solar simulator calibration.
After completion of the initial measurements the reference module is stored under laboratory conditions and the test module is used for energy yield measurement.

2.2 Energy Yield measurement

2.2.1 Measurement procedure

The entire measurement system is to be subdivided into the following three areas:

- Central logging of meteorological data
- Logging of module temperatures an global irradiation in plane
- Performance measurement of the modules

The central logging of meteorological data serves the measurement of all relevant environmental conditions, as well as the provision of this data for all existing test equipment on the outdoor test rig.
Furthermore a measurement system is deployed to record the module temperatures and the global irradiation in plane, which are also logged in a 30 second interval. The temperatures are regarded together with the meteorological data.
A third system is run for the performance measurement, which comprises the MPP tracking and recording of the I-V-curve.
Each 30 minutes the MPP-tracking will be interrupted by a curve measurement. After completion the auto tracking will be performed again. The procedure of recording the I-V-characteristic and the MPP-tracking mode takes place cyclically as long as the irradiation does not drop below the defined threshold irradiation limit.

2.2.2 Evaluation procedure

For the evaluation of the specific energy yield all data sets stored in the data base are taken into account. The following points are influencing the number of available data sets and the accumulated yield for each participant:

- Failures of hardware or software
- The irradiation threshold limit of 15 W/m²
- The MPP tracking of the electronic loads
- The number of modules to be compared

To accumulate the specific energy yield only data sets are used where all participating modules are operating in the MPP. The result cannot lead to an absolute produced energy yield but it keeps all participating products 100 percent comparable.

3 Measurement results

3.1 Evaluation of overall ranking

Technology based differences in energy yield of the modules can only be observed by looking at the specific energy yields related to the maximum power output measured by TÜV Rheinland (P measured). Related to the module with the highest specific energy yield the difference between the PV module with the highest ranking and the PV module with the lowest ranking is 3.4%. For the assessment of the specific energy yields the consideration of measurement uncertainties is crucial. The following influences have to be taken into account:

1. relative accuracy of P_{MPP} tracking
2. relative measuring uncertainty of measuring P_{MPP} (outdoor)
3. relative inaccuracy of reproduction of STC measurement
4. relative measuring uncertainty of STC measurement

Under this consideration the total measurement uncertainty is +1% / -1.5%.

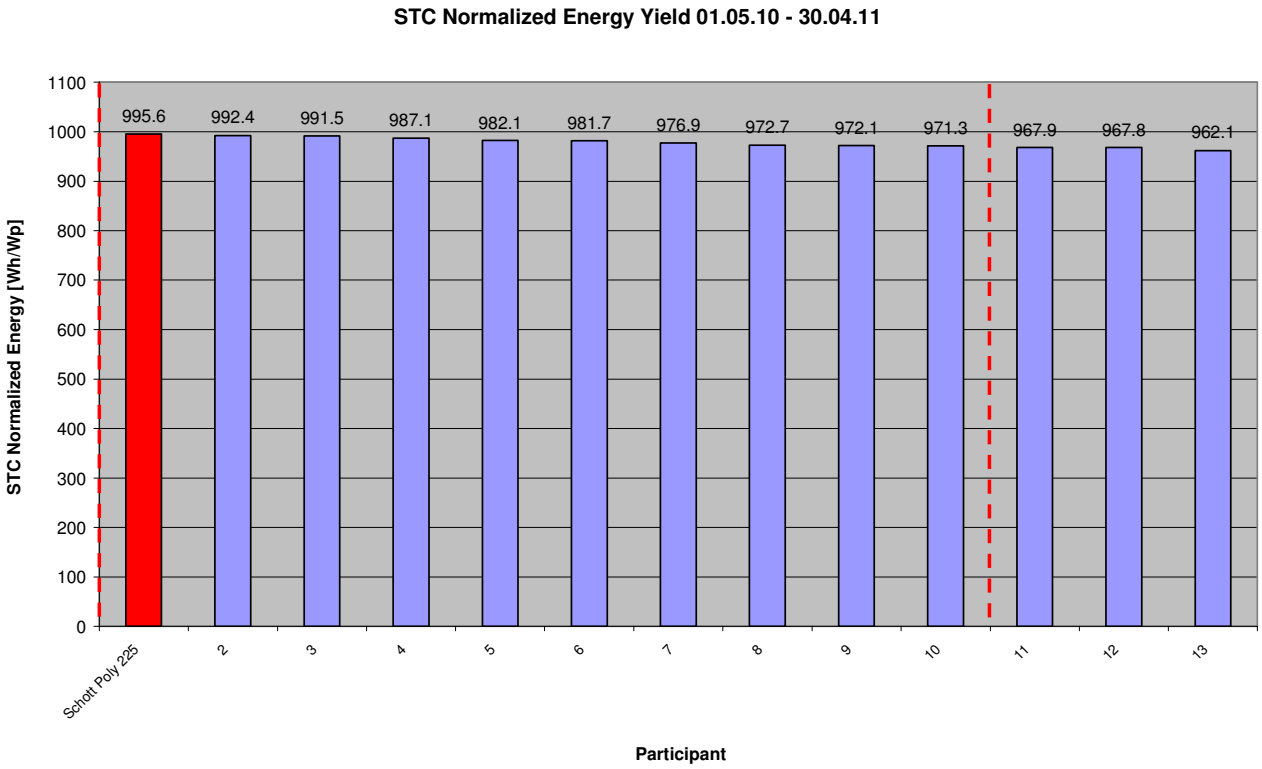

Fig. 3.1: *STC normalized Energy Yield entire period with tolerance range*

Under these circumstances a tolerance range as shown in Fig. 3.1 can be derived, which covers all theoretically possible positions within the overall ranking, whereas the red column represents the most likely position.

Cologne, 1st August 2011

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