

## REC: Best power output performance in a real-world setting

REC is committed to providing high performance solar energy solutions and long-term value for solar system owners. The efficiency and reliability with which a solar system produces electricity is due in large part to the quality of design and manufacture of the solar module, the solar power system's most important component.

However, solar system owners purchase not only solar modules, but more important, they purchase the electricity those modules produce, thereby gaining the financial benefits that inexpensive, renewable energy can provide. They also expect to contribute to the production of green energy and thus do their part to combat global climate change.

Most solar modules are sold by "watt class", also referred to as the module's "nameplate" rating, which states the nominal power rating of a module as tested under ideal factory conditions. But the actual output of an installed solar module depends upon weather, local solar irradiation, the angle of the array, inverter efficiency, and many other factors not easily repeatable in the laboratory. The module's electrical production on the roof top or on the ground is far more significant to the solar system owner than the factory's nameplate wattage.

To demonstrate what to expect from REC modules installed in the field, REC initiated a test with Fraunhofer Institute for Solar Energy Systems (Fraunhofer ISE) to test REC modules alongside a leading Chinese brand and a leading European brand.

### FRAUNHOFER ISE SOLAR MODULE PERFORMANCE TEST

#### Executive Summary:

"Performance ratio" is one of the most important measures for comparing similarly rated solar modules. It is defined as the ratio of actual measured output over a given period of time divided by the nominal power (nameplate rating) during that time. In this 12 month study Fraunhofer Institute compared the performance ratio of REC modules against those of a leading European manufacturer and a leading Chinese manufacturer.

The year's data demonstrated that REC solar modules with Sunarc<sup>®</sup> Technology anti-reflective treated glass had the highest performance ratio among the three manufacturers' modules tested - 4.8 percent higher than the Chinese brand and 1 percent higher than the European brand.

The REC modules using Sunarc Technology anti-reflective(AR) surface treatment on the glass achieved a 1.8 percent increase in performance ratio over identical REC modules without treated glass.

#### Background:

REC initiated this test to demonstrate to solar system owners the difference in performance between several commonly available solar modules, and the direct relationship of those differences to the modules' power output. An increase in power output creates significant financial benefits to a solar system owner.

The secondary purpose of the test was to demonstrate the increase in power output due to the Sunarc Technology anti-reflective surface treatment on the REC module glass.

Chosen for its long, respected track record in research related to solar technology, Fraunhofer Institute for Solar Energy Systems set up and conducted the two-year test.

Fraunhofer ISE installed and are continuously monitoring four solar systems installed on the premises of REC Solar AS, Sweden. Each system is installed with one SMA Sunny Boy 1700 inverter, plus modules from either REC or the Chinese or the European manufacturer. Of the two REC systems, one used modules with REC's standard Sunarc Technology anti-reflective treated glass and the other used identical modules except with glass that was untreated.

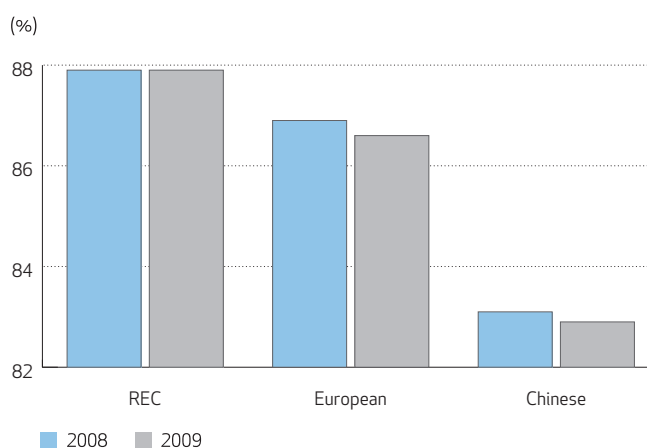
#### Modules Tested:

- 8 REC 215W modules with Sunarc Technology anti-reflective(AR) treatment
- 8 REC 215W modules without AR treatment
- 8 200W European-brand modules
- 9 210W Chinese-brand modules

This report is based upon measurements taken continuously from March 29, 2008 to March 29, 2009. All four inverters operated with very similar efficiencies during the study. This fact, along with the equivalent setup of the systems, provided Fraunhofer with a neutral baseline for comparing the modules in the specific climatic conditions experienced during the measurement period.

#### Test Description:

The test evaluated monthly irradiations, energy yields, component efficiencies, performance ratios, and AC energy generated. The irradiation dependence on various system parameters such as module current, module efficiency, inverter efficiency, and input voltage of the inverter were evaluated based on 5 minute averages. The test results are normalized to enable correct comparison between the different installed systems.



Performance ratio test results

## Results:

SYSTEM	nominal (rated) power	monthly irradiation	energy yield	inverter efficiency	module efficiency	performance ratio	AC energy	AC Energy pr installed
	P <sub>nom</sub> (Wp)	G <sub>mod</sub> (kWh/m <sup>2</sup> )	Yield (kWh/kWp)	$\eta_{inverter}$ (%)	$\eta_{modules}$ (%)	PR (%)	AC (kWh)	watt (Wh)
REC SCM 210 AR	1.72	926	814	89.9	12.7	87.9	1401	815
REC SCM 210	1.72	926	800	89.9	12.5	86.3	1375	799
Chinese supplier	1.98	926	769	89.8	13.2	83.1	1454	734
European supplier	1.60	926	805	89.6	11.6	86.9	1288	805

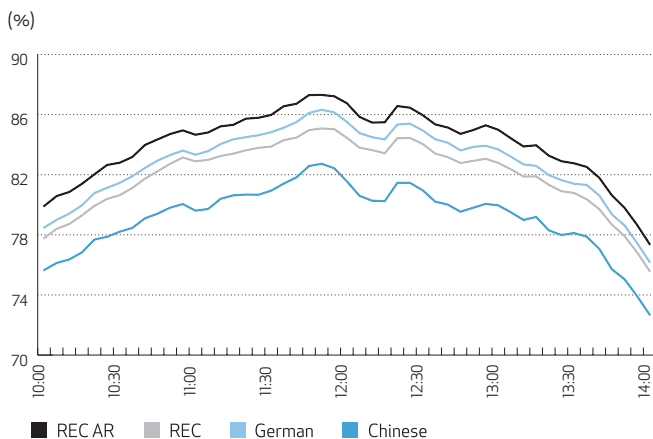
NOTE: REC changed the model name of this module from "REC SCM 210" to "REC A-Series" in January 2009.

The REC module with the Sunarc Technology anti-reflective glass recorded the highest performance ratio of 87.9 percent. The European brand at 86.9 percent and the Chinese module measured a performance ratio of 83.1 percent.

The REC module with anti-reflective treatment recorded a performance 1.8 percent higher than the identical but untreated REC module.

### Solar owner benefit: Increased electricity production

The improvements in performance ratio translate to the same level of increased electricity production. And the increased power output with a well designed and manufactured module – even an increase as seemingly modest as 1 percent – represents a significant financial gain for the solar system owner, as well as environmental benefit, over the 25-year life of the module.



Performance ratio results during peak hours June 27, 2009.

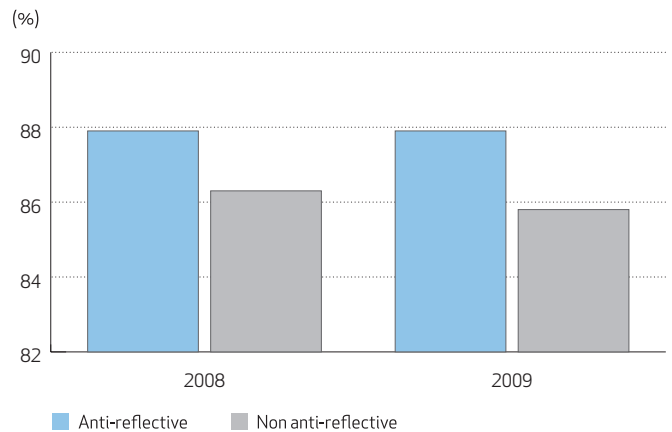
### Conclusion:

From the Fraunhofer Institute's year-long study, we concluded that REC modules performed better under real-world conditions than the other modules tested. Based on the test results, and controlling for rated output, the tested REC modules produced 4.8 percent more power than the leading Chinese brand tested, and 1 percent more than the leading European brand tested.

REC's vertical integration and quality manufacturing processes translate into more actual power, meaning more economic benefit for the solar system owner over the life of the system.

Superior design and manufacturing is at the core of REC's high performance and reliability. REC modules are further improved by making use of Sunarc Technology treated glass. The use of Sunarc Technology anti-reflective treatment on the REC modules

offers an improvement on the capture for both diffuse and direct sunlight on the PV module, increasing its power output by 1.8 percent over identical modules with untreated glass. And increased performance in the real world means more money in the pockets of solar system owners.



Performance ratio for REC modules with and without anti-reflective coating.

### About REC

REC is the leading vertically integrated player in the solar energy industry. REC Silicon and REC Wafer are among the world's largest producers of polysilicon and wafers for solar applications. REC Solar is a rapidly growing manufacturer of solar cells and modules, and is also engaging in project development activities in selected segments of the PV market.

REC had revenues of NOK 8191 million and an operating profit of NOK 2529 million in 2008. Close to 3000 employees work in REC's worldwide organization. See [www.recgroup.com](http://www.recgroup.com) for more information about the company.



**REC**

Renewable Energy Corporation ASA  
Kjørboveien 29  
PO Box 594  
No-1302 Sandvika  
Norway

[www.recgroup.com](http://www.recgroup.com)

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