4 % increased energy collection demonstrated from 83 kW_p test array in Germany using BP Solar premium Saturn 7 Series with anti-reflection coated glass.

1. Introduction

a. Anti-reflective coatings on the outer glass surface can increase the coupling of light into a photovoltaic (PV) module and therefore increase its conversion efficiency.

b. Recent advances in glass coating technology have improved the ability of the coatings to survive the outdoor environment even with acidic rain.

c. Pairs of modules tested outdoors in Germany and Australia showed AR gains of 4-6 % depending on the time of year and location.

d. In order to further evaluate the performance of AR coated glass a larger size pilot run was conducted. The AR and control modules built in the pilot run have been installed in two otherwise identical 41.5 kW_p systems in Germany. The performance of the two systems has been monitored continuously since 1 April 2005 by activ solar to determine the energy production of each over an extended period of time.

2. Module production

a. Modules made using the AR glass have been subjected to BP Solar's extended version of the IEC 61215 test sequence.

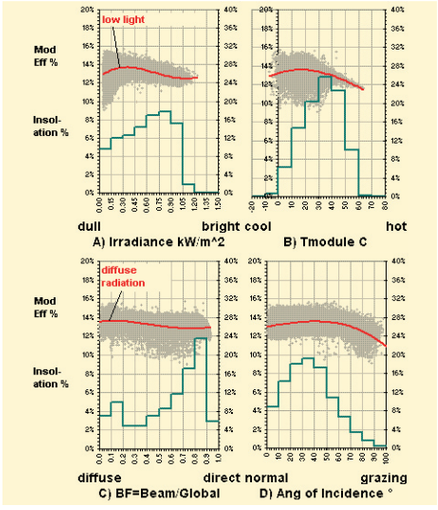
b. The modules made with the AR coated glass successfully passed the qualification tests without any visual evidence of degradation of the coatings or power loss from the modules.

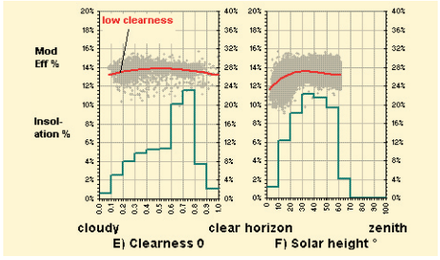
c. The pilot run included 231 AR coated glass modules and 231 control modules made with standard low iron glass.

3. BP 7180 are optimised to have high efficiency under all conditions

a. The top lines show the high efficiency of the BP1780ARC under all weather conditions, note that there is a very high efficiency under low irradiance (A left), diffuse light (C left) and low clearness (E left).

b. Graphs (B) and (F) show that there are only slight drops at high module temperature (B right) and low solar height (F left) when the proportion of energy is small anyway. The module temperature is very rarely more than 60°C in ISET.





4. The array

a. The pilot run modules were commissioned on the roof of a building in Assamstadt, Germany in March 2005.

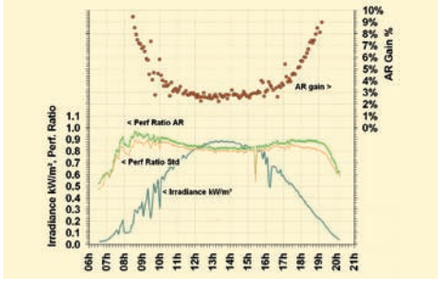
b. The two arrays are tilted at 20°, oriented almost due south and suffer no shading. Each array has 7*SB5000 inverters with 11*3*~180W_p modules feeding each inverter.

5. Outdoor measurements

a. The Sunny Boy Control system takes measurements every 5 minutes of tilted plane irradiance, ambient and module temperatures, wind speed and the DC voltage and DC & AC power of each of the 14 inverters.

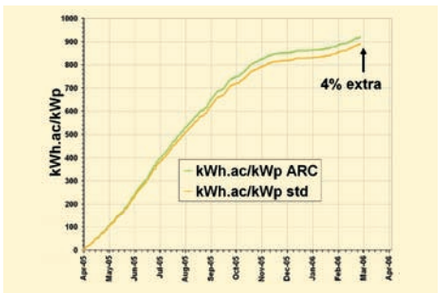
6. Array Performance vs time

Below Figure shows the AC performance ratio of the AR vs control arrays on a sunny day.
The AR gain varies from ~3 % at noon to around 8 % at the beginning and end of the day.



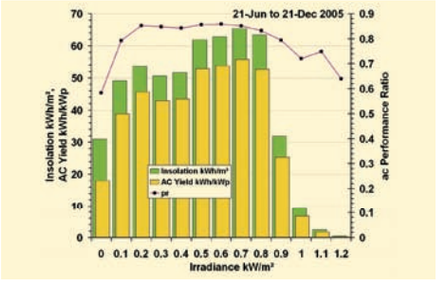
7. Cumulative AC kWh/kW_p

4 % increased energy collection (YF kWh/kW_p) of the AR array vs the control array from April to late January 2006.



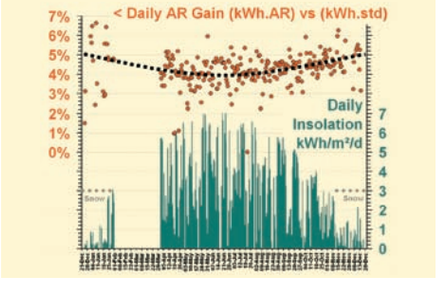
8. AC performance vs light level

Below figure shows the sum of the insolation kWh/m² and AC Yield kWh/kW_p for the half year 21-Jun to 21-Dec-2005 as a function of irradiance. Also shown is the AC performance ratio showing good performance from 0.1 to 1.1kW/m² where almost all the irradiant energy occurs.



9. Daily AR gain

Below graph shows the daily daily AR gain (kWh, AR vs kWh.std) of about 4% for the AR modules vs the controls, also showing the insolation in kWh/m²/d. There was some snow November to January.



10. Conclusions

- AR glass resulted in significant (2.4 to 3%) increases in STC power output.
- Outdoors these modules are producing in excess of 4% more energy kWh/kW_p.
- The difference in performance is due to the coating reducing the amount of reflected light at non normal incidence.
- BP Solar have been using this new glass all Saturn 7 Series modules since summer 2005.

11. References

More than 70 of BP Solar's papers since 2000 are on the following website
http://www.bpsolar.com/techpubs

12. Acknowledgements

The authors would like to acknowledge the assistance of André Pohl (activ solar), Peter Funtan (ISET) and Stephen Poropat (BP Solar Australia) for their help in this work.

S. J. Ransome, BP Solar, Chertsey Road, Sunbury on Thames, TW16 7XA, UK **K. Deponte,** BP Solar, Max-Born-Straße 2, 22761 Hamburg, Deutschland **J. M. Fernandez,** BP Solar, Poligono Industrial, Zona Oeste, Tres Cantos, 28760 Madrid, Spanien **J. H. Wohlgemuth, D. W. Cunningham, A.M. Nguyen, J. Shaner,** BP Solar International, 630 Solarex Court, Frederick, MD 21754 USA