ASSESSING REFLECTION FROM REC PEAK ENERGY SERIES PANELS

When light hits a surface, a certain percentage is returned without being absorbed; this is reflection. In general, transmittance and absorption of light vary according to the angle of incidence of the incoming radiation, i.e., the more angled the incidence, the higher the reflectance. Solar panels are designed to capture as much light as possible in order to produce electricity, so the more angled an installation is in relation to the sun, the more light is lost due to reflection off the surface, which could otherwise have contributed to energy output. To measure reflection rates and their impact on energy production, REC Peak Energy Series panels were submitted to an assessment by a third party testing center.

Accounting for reflection in system calculations

Photovoltaic simulation software tools are frequently used for the design of solar installations and to provide predictions of performance over time. In order to achieve reliable results, the data used in the calculations must be accurate. One aspect of the required data is the amount of reflectance from the panel; getting this wrong can have a significant impact on system expectations.

The efficiency and reflectance of solar panels at a given level of radiation is a function of the sun's position relative to the panel. A value known as the Incidence Angle Modifier (IAM) accounts for expected rates of reflection when compared to incidence at the normal plane (i.e., 90°) and identifies expected impact on performance as the angle of the sun changes position in relation to the panel surface throughout the day and the year.

The IAM is defined as efficiency at the given angle of incidence divided by the efficiency at normal incidence and is therefore equal to 1 for normal incidence of direct radiation. It is generally accepted that the IAM decreases with greater angles, i.e., the higher the angle of incidence, the lower the (relative) efficiency.

Assessing the reflectance of REC panels

In order to quantify the effect reflection has on the yield of an REC panel, production panels were submitted to a study into reflection at different angles by the independent laboratory, Solar Energy Research Institute of Singapore (SERIS). In its solar panels, REC uses an anti-reflective glass treatment (AR), which reduces the amount of reflection from the panel surface, therefore a panel without AR glass was also submitted for comparison. The detailed findings are discussed below[1].

SERIS measured the reflectivity of the panel using a goniophotometer, a device for the measurement of the bidirectional reflectance and transmittance distribution (BRTD). The measurement is angular resolved. The device consists of three main components:

- A converging beam light source (xenon lamp); the spectral range of the emitted light can be restricted using filters
- The sample holder, rotated to vary the incident angle
- A rotating detector, which is mounted on an arm a constant distance around the center of the sampled area.

As energy production is one of the most important factors in monitoring panel performance, this paper considers only the results on reflectance from the cell surface which is the area relevant to yield, i.e., energy generation.[2]

One change compared to previous test methods is the increase in spectrum of light to 350 – 1100nm (from 350 – 750nm in earlier studies). This is the range of energy generating visible light and therefore is more appropriate for the purpose of the study.

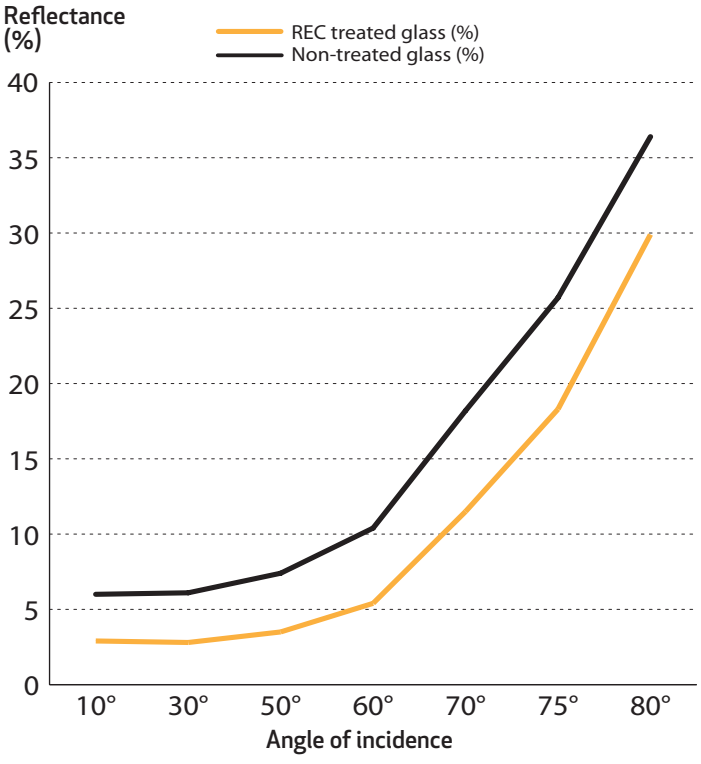
The study

An incident light beam with a diameter of approximately 20 mm was focused on the cell surface as the predominant area of the panel and the area relative to energy yield. The amount of reflection is then captured by the goniophotometer as the percentage of light reflected from the surface (assuming that the value at 10° is nearly the same as the value for normal incident):

Table 1: Measurements of cell loss due to reflectance

Angle	Non-treated glass (%)	AR-treated glass (%)	Difference (%)
10°	6.0	2.9	-3.1
30°	6.1	2.8	-3.3
50°	7.4	3.5	-3.9
60°	10.4	5.4	-5.0
70°	18.2	11.5	-6.7
75°	25.7	18.3	-7.4
80°	36.4	29.9	-6.5

Graph 1: Reflectance levels of glass types at different angles of incidence



The BRTD report results (as given in Table 1) have a relative expanded uncertainty of 5.6% with a 95% confidence level and a coverage factor of k = 2.

1 *The full report from SERIS is available from REC upon request.*

2 *Further study was carried out into glare from the complete panel surface. This is available in a separate paper.*

The results

The study undertaken at SERIS clearly demonstrates the advantage of AR-treated glass as used by REC over standard glass types. The results confirm that with higher angles of incidence, higher rates of reflection from the cell surface can be expected. With sensible system design however, the higher angles of reflectivity will only be seen when the sun is low in the sky e.g., in the winter months and at dusk and dawn, and therefore the strength of the sunlight will be at its weakest.

Applying IAM values in simulation software

When using simulation tools, there is often the option to modify the IAM values of the selected panel. As default settings in many simulation softwares are based on non-treated glass, the use of specific IAM values for REC Peak Energy Series panels is supported by the results of the SERIS study and the difference in reflection performance between the AR-treated glass used by REC and non-treated glass types. Translating the reflectance values into an IAM is done by comparing the reflectance against the 10° level, e.g.,:

$$\text{IAM @ } 50° = \frac{(100 - 3.5)}{(100 - 2.9)} \cdot 100 = 99.4\%$$

Dependent on the software (and version) used, the IAM values for REC in Table 2 (opposite) should be entered into simulation programs instead of the default values to achieve more realistic system and yield predictions.

Table 2: Conversion of reflectance rates to IAM values

Angle	Non-treated glass (%)	IAM non-treated glass (%)	AR-treated glass (%)	IAM REC panels (%)
10°	6.0	100.0	2.9	100.0
30°	6.1	99.9	2.8	100.1
50°	7.4	98.5	3.5	99.4
60°	10.4	95.3	5.4	97.4
70°	18.2	87.0	11.5	91.1
75°	25.7	79.0	18.3	84.1
80°	36.4	67.7	29.9	72.2

Conclusion

As a panel manufacturer, REC works hard to ensure any reflectance is kept as low as possible and does not lead to lost energy. The SERIS study shows the advantages of the AR glass treatment as used by REC and that the level of reflection from REC panels is only significantly affected after an angle of around 60°. The benefits of these low reflectivity values, supported by independent testing, can be seen in performance simulation software by using the above IAM values for REC panels, enabling accurate predictions of system performance.

January 2014
NE-18-09

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