TECHNICAL REPORT

EFFECTS OF OPERATING TEMPERATURE

Photovoltaic panels are sensitive to temperature. Panels based on crystalline silicon cells are more sensitive than the ones based on thin films and different crystalline cells react in different ways.

As a general rule we can say that the power (W) and the voltage (V) of a panel decrease as the temperature increases, while current is almost stable.

The electrical values reported in the panel data-sheet are the so called Standard Test Condition (STC) values, which refer to a "sun power" of 1000 W/m^2 and to a temperature of 25°C (77°F). When you buy a, let's say, 120 Wp (Watt peak) panel you must be aware that 120 is the peak power you can reach when, and only when, all the conditions are optimal. If, as an example, the panel is not well oriented, or its temperature is higher than 25 °C, you cannot read 120 W on your instruments.

MAY I KNOW THE EXPECTED POWER IN NON STANDARD CONDITIONS?

The answer is yes, the change of power, current and voltage as a function of the temperature is known, and is usually reported in the data-sheet in the form of Temperature Coefficient.

A simple example will help. Let's consider the Power Temperature Coefficient (P_{tc}), this is usually expressed as XX%/°C where XX is a number, a typical value for mono crystalline silicon cells panels is $P_{tc.}$ = -0.43%/°C that means: for a temperature increase of one degree, the power of the panel decreases by 0.43%.

If we have a 120 Wp panel and the temperature of the panel (actually the temperature of the cells, but let's suppose they are the same) is 45 °C we need to proceed as follows.

Viale Gandhi 21b - 10051 Avigliana (TO) - ITALY - Telefono: +39 011.966.35.12 - Fax: +39 011.966.47.20 - sales@solbian.eu - www.solbian.eu

Considering that 120 Wp is related to 25 °C (STC temperature) we have a difference of 20 °C (ΔT) between STC and the real condition.

- Percentual power decrease: $\Delta P = P_{tc} * \Delta T = 20*0.43\%$, namely 8.6%
- The calculated drop being 120*0.086 = 10.3 W, we expect a power $P_{T=45}$=109.7 W.
- The same calculation can be repeated for the voltage (considering that a typical Voltage Temperature Coefficient is -0.33%/°C).

BUT WHICH IS THE TYPICAL OPERATING TEMPERATURE OF A PANEL?

The answer is not so simple, there are so many different reasons for a temperature increase or decrease. Obviously there is the power of the sunlight, then the air temperature, then the wind, and the way the panel is made and the way the panel is mounted... but, as a matter of fact, solar cells are made to absorb solar light and thus they stay quite hot under the sun if some active cooling actions are not taken, as water cooling or similar.

A measure of the Normal Operating Condition Temperature (NOCT) can be made in the testing lab (and it is usually shown in the datasheet). It follows a detailed technical procedure trying to mimic the usual panel installation. The results change a bit, depending on the panel structure, but usually the NOCT values are in the range of 40-50 °C.

HOW IMPORTANT IS THE OPERATING TEMPERATURE IN A MOBILITY INSTALLATION (MARINE, CAMPER, ETC.)?

All is important, but let's repeat the previous calculation for two extreme conditions, a very well cooled panel with a NOCT = 40° and a badly installed panel (i.e. on a black hot surface) with a NOCT = 50°. In the first conditions the panel effective power is 120*(100-15*0.43)/100 = 112.3 W while in the bad condition the power will be 120*(100-25*0.43)/100= 107.1 W.

Between the two extreme conditions we have a power difference of 5.1 W (4.6%)

SOLBIAN VS GLASS PANELS

We want now to compare Solbian panels with rigid glass panels.

Solbian panels are usually installed sticking them directly on some surface. That obviously prevents air from flowing under the panel and it is often argued that for those reasons

Solbian panels should reach a higher operating temperature. That conclusion is not generally true because of the different thermal properties of Solbian protective front layer when compared with glass. In a standard panel, cells are encapsulated in polymers, but on the front we find a 4 mm glass sheet and glass is well known for its thermal insulating properties. The only way to keep the cells from becoming too hot in a standard panel is to dissipate heat from the rear of the panel, usually made of polymers and much thinner than the front glass surface. This is why the general advice is to leave enough room on the back to allow the proper air flow.

In Solbian technology, the front glass is replaced by a ten times thinner (0.4 mm) polymeric film and so the natural heat dissipation path is from the front, a much more efficient way also considering that the air is always free to flow on the front of the panel.

This is why a Solbian panel has a NOCT comparable, if not smaller, to the NOCT of standard panels in the same conditions.

SP SERIES, THE BEST ONE

Solbian SP Series uses genuine Sunpower back-contact cells. They are the best cells in the market for several reasons: they are the most efficient, the most beautiful, the best in low light and boast a great mechanical resistance to impacts. But Sunpower cells have another advantage too, they are less sensitive to the temperature.

Their P_{tc} coefficient is in fact equal to -0.32%/°C, a value smaller than the standard cells' one. An example can clarify: in very hot climates the cells can reach a temperature of 75 °C, namely 50 °C beyond the STC temperature. In such extreme conditions a standard silicon crystalline cell can show a power drop of 50*0.43 = 21.5%, while a Sunpower cell would suffer a drop of only 50*0.32 = 16% !