Giacomo Gori

SOLBIAN: flexible photovoltaic panels for yachting

FROM AN IDEA OF GIOVANNI SOLDINI AND MARCO BIANUCCI ABOUT 10 YEARS AGO SOLBIAN WAS FORMED. THE CHALLENGE: TO BRING PHOTOVOLTAIC SYSTEMS EFFECTIVELY ON BOARD RACING AND CRUISING YACHTS.

The sailing experience of the great Italian skipper and Bianucci's know-how in energy sources – she is an expert physicist – converge in a common passion for renewable energy.
Until that time, photovoltaic solar panels were big and heavy (they had a rigid glass screen), and they were not very suitable for the marine environment and had a big problem with shade. With the support of Salerno University, a solution was specially developed with 15 small, independent photovoltaic modules, each piloted by its own electronics, with which Soldini equipped his Class 40. It was 2007, and Giovanni won the Transat Jaques Vabre and the Ostar, thanks also to the lower weight of fuel needed for his generator, and then the word spread: with photovoltaic panels you don't need generators to produce electrical energy. The trend to using this technology spread among friends, acquaintances and competitors of Soldini, first on racing boats, then also on cruising yachts. In the space of 2/3 years Solbian was founded. After a few years the experience of Giovanni Soldini and the competences of Marco Bianucci were joined by those of physicist Luca Bonci, current managing director of Solbian.

Photovoltaic cells of crystalline silicon

Among the various types of photovoltaic cells, those based on silicon on, perfected by Bell in 1954, at the most widespread and reliable. They may be monocrystalline or polycrystalline (they are generically

Solbian panels installed on the deckhouse of a Vismara Fast Cruiser. (Solbian archive).

Giovanni Soldini on board the VOR70 Maserati. (Solbian archive).

Solbian managing director Luca Bonci demonstrates the flexibility of a panel. (Giacomo Gori).

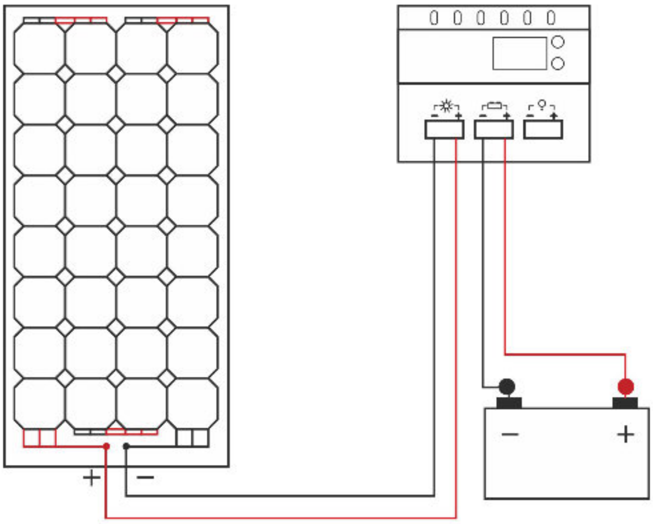
called crystalline silicon cells) and are distinguished by their efficiency and mechanical strength. Solbian uses monocrystalline silicon cells which it acquires from primary producers. Apart from space technologies, they are today the most efficient available. A crystalline silica on cell generates about 0.5 V and a current proportional to the intensity of the light – zero in the dark, but it can reach a maximum of 8 A depending on the size of the cell and its efficiency.

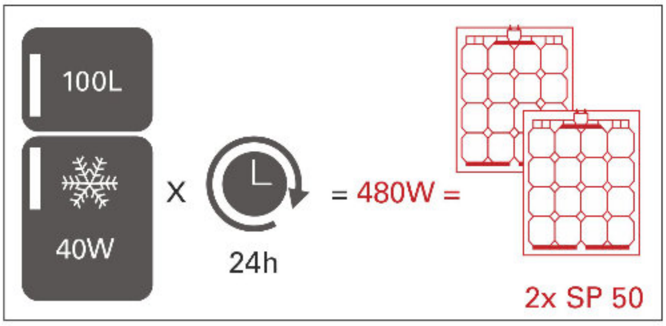
Flexible panels for humid environments

The panels produced today use high-efficiency crystalline cells that also cost relatively little – they are the most widespread on the market and tolerate damp environments well. Crystalline silicon is not very flexible: using encapsulation technology with eight layers of polymers and various kinds of surface treatment, it is protected inside the panel by a cladding inside which the very fragile cells (often less than 0.2 mm thick) become a flexible, manoeuvrable and strong panel. The polymer protection maintains a good degree of transparency over time and also, exploiting continuous research for higher performance materials, is continually improved. The protective surface is undulated to give the panel more grip, make it non-slip and very resistant to UV radiation. The characteristic undulations increase the surface of the panel, which by its nature gets very hot (40°/50°), and so dissipates the heat better. Bonci adds: "the panels we produce a very strong, thin (less than 2 mm) and flexible, to adapt to curved surfaces like the deckhouse of a boat, and they are light: 2.1 kg/m², compared with the 12 kg and more of traditional panels. Installation is very easy and can be done with structural adhesive or with special eyelets. Our product is guaranteed for five years."

A practical example: a boat fridge

A 100 L fridge consumes about 40 W. If it remains switched on for 12 hours a day it will consume 40w x 12h = 480Wh. On a summer's day, using two top-range SP50 panels in monocrystalline silicon (total power 100 W), this need will be covered.





A practical example: the boat fridge. (Solbian archive).

An off grid photovoltaic system: it consists of a photovoltaic module, a battery and, between these, a charge regulator. (Solbian archive).

The TU Delft Solar Boat Team and solar powered boat with Solbian photovoltaic cover. Avigliana (TO), July 17, 2018. (Giacomo Gori).

The system: off-grid

A photovoltaic panel transforms direct or indirect sunlight into electrical energy and is made of photovoltaic cells. The photovoltaic cell, when sunlit, creates almost constant voltage and current proportional to the intensity of the light falling on it: by connecting the cells in series you obtain a higher final voltage. So a photovoltaic module behaves like an electrical generator where the voltages equal to half the number of cells (0.5 V x number of cells), while the maximum current will be of the order of 6 A in the individual cell and in the entire panel. In a panel of 36 cells connected in series the current will be about 6 A, while the tension will be 18 V. The wattage is obtained by multiplying volts by amps, so a module of this kind will supply (under the summer sun) maximum power of 18v x 6A = 108W. Using the electricity produced directly is not the best solution for exploiting solar energy. It is better for the electrical energy produced by a photovoltaic module to be accumulated off-grid and released, even later, according to requirements. An off- grid system must be structured in this way: a photovoltaic module to generate energy, a battery to accumulated and release it when needed, and between these an efficient charge regulator that can charge the battery correctly and exploit the photovoltaic module in the best possible way. The charge regulator used as of the MPPT - Maximum Power Point Tracking type and can constantly follow, tracing it several times a second, the point of maximum power the panel can produce in that moment according to the power of the sun. The solar radiation on the photovoltaic surface may change when a cloud passes or simply because the boat (and any other means of transport in movement fitted with panels) modifies their orientation as it moves. Customisation of the electronics also makes it possible to increase or reduce the tension of the panels, thus freeing the size of the photovoltaic panel from the value of the voltage of the battery.

Photovoltaic sails: an objective for the future

Today many concepts of sailing boats or motorsailers with photovoltaic sails are being studied. But it doesn't seem likely that we will realistically see efficient systems of this kind in the near future.
Bonci explains the problems: "The panels we use currently are not perfectly suited for sails, at least as long as sails are expected to have the high performance profiles sailors want! For now we can imagine small areas of the sail with semirigid inserts where we can put flexible panels." Among the solutions that could be used in the future for this are those with thin film (CIGS, organic photovoltaics and others). "Thin film cells are not made with silicone," says Bonci, "they are more flexible and can also be rolled up, so they could actually be installed on sails. They are less efficient (the efficiency of thin-film can reach 16-17% against 23-25% for monocrystalline silicon), though exploiting the larger surfaces of sails this would not be a problem." The problem of shade is another obstacle: "With the sail it is difficult to have a lot of small panels each with its own electronics. I can fill the entire surface of the sail with photovoltaic cells, but in the end the electrical contacts are along the edge of the sail and it's not easy to lay 50 cables… And if I connected all the panels in series – above all thin film has a higher voltage than crystalline cells – in the end I would have to handle very high voltages (300/400v) which is not exactly ideal on a boat! It's still not clear how to carry the current out of the sale in the safe and efficient way." What's more, sails have two sides: how do you exploit this in the best way? "Crystalline silicon is two sided, while thin film is typically one-sided even if it would be possible to make it with two sided characteristics." A final problem, and not a small one, is that thin film cells are sensitive to humidity. Protecting them from humidity with several layers of polymer could in the end result in something similar to the flexible crystalline cells available today. So it's unlikely that all the obstacles in the way of having sails that perform in terms of profiles and in terms of photovoltaic energy production will be overcome in the near future. Says Luca Bonci: "Yachting is obviously the main market, but the panels Solbian makes are used today on campers, refrigerated lorries, ambulances, intelligent refuse containers, various kinds of architectural applications, electric bicycle recharging stations, solar chargers for mobiles and tablets and also on solar powered racing cars. Solbian also sponsors the TU Delft Solar Boat Team which takes part in the world solar powered boat championship with a sophisticated hydrofoil powered by a dedicated photovoltaic covering. They are sold all over the world, in more than 60 countries."

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