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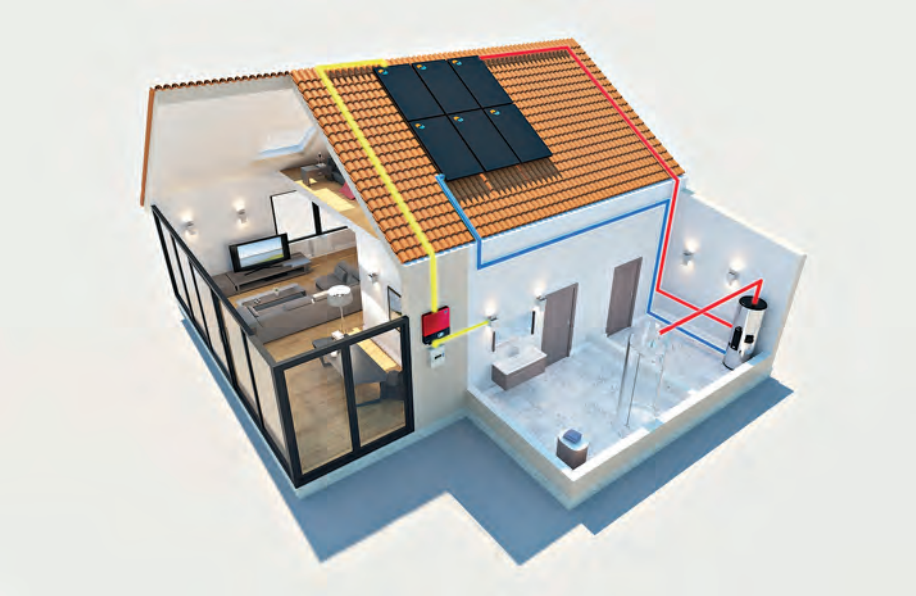
Two-in-one solar panels

This innovative hybrid system combines photovoltaic cells with a molybdenum-containing stainless-steel heat exchanger. It produces both electricity and domestic hot water at the same time, greatly increasing the amount of solar energy extracted per square meter.

A young Marseilles-based startup founded in 2010 by two recent engineering graduates has developed an innovative product that relies on molybdenum-containing stainless steel in an essential role.

Typical commercial silicon-based photovoltaic (PV) panels have a relatively low electrical conversion efficiency of about 15–20%. Because they are heated by the sun, they also trap untapped thermal energy. Unfortunately, existing solar thermal collector designs were incompatible with PV designs, so no product or system combined the two technologies satisfactorily. The engineers' concept was simple: bring together both thermal and PV technologies in a hybrid design. Progress in PV systems has been rapid because of the large number of teams around the world working to increase efficiencies by using advanced concepts like copper-indium-gallium selenide (CIGS) PV cells that use molybdenum as an important component of the cell structure. While offering higher efficiency, these concepts still need to deal with heat build-up, so a hybrid panel approach is useful as well.



Heat and electricity for the house thanks to two-in-one panels. © DualSun

A hybrid panel – PV on one side, thermal on the other

The inventors wanted to cool PV cells to capture unexploited heat and produce domestic hot water. To do this, they developed an innovative hybrid panel containing a PV array backed by a heat exchanger. In this design the PV cells themselves become thermal collectors.

The design employs a heat exchanger thermally bonded to the back of a PV panel. The heat exchanger cools the PV cells and stabilizes their temperature. This increases the panel's electrical efficiency by lowering its operating temperature. At the same time it captures heat to produce hot water for the building. The result is a panel with a total combined efficiency of 30–60% instead of the 15% of a typical PV installation.

Ultra-thin stainless steel heat exchanger

The ultra-thin but rigid heat exchanger is incorporated into the solar panel. It comprises two stainless-steel sheets, one formed to produce a 2-mm-high waffle motif. The "waffled" sheet is welded to a second, flat sheet at its contact points. A glycol/water coolant is pumped through the open volume at low pressure (1.5 bar), reaching a maximum temperature of 75°C during operation. The thickness of the finished hybrid panel is only four centimeters.

Unlike other candidate materials, the mechanical properties of stainless steel are hardly affected by the operating temperature of the heat exchanger. This is one of the reasons stainless steel is widely used for PV panel frames. In this case, designers chose a Type 444 (UNS S44400) ferritic stainless steel containing 1.85% molybdenum. It combines good mechanical properties with excellent corrosion resistance. Molybdenum contributes significantly to pitting and crevice-corrosion resistance in both the water/glycol coolant and the external environment. This grade's expansion coefficient is similar to that ›

of glass, an important requirement because the heat exchanger is mated to the PV cell assembly. Type 444 has better thermal conductivity than austenitic grades and is easy to form and weld.

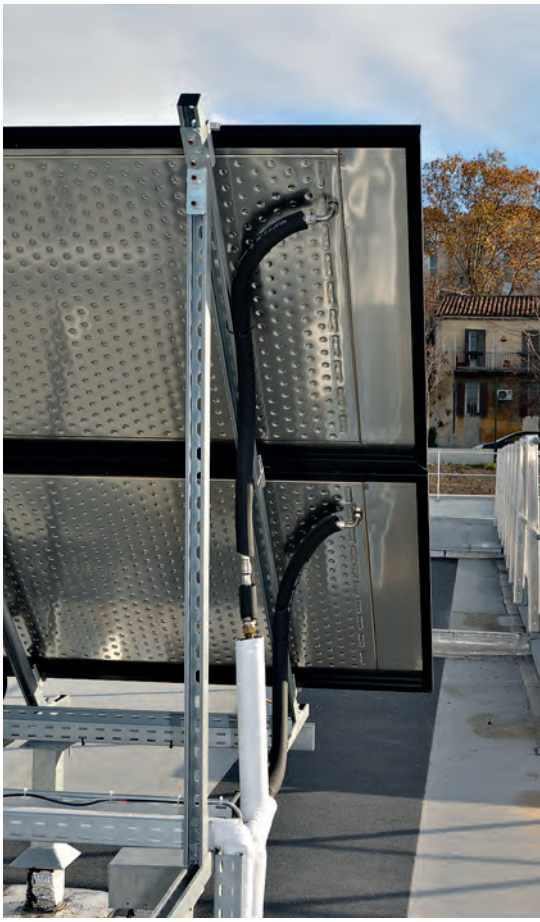
The integrated hybrid system uses a conventional inverter to produce electricity, and a heat exchanger/storage tank system for domestic hot water. The system is stationary, silent and thin, and is easily incorporated into any type of roof. The panels produce both domestic hot water and electricity in the space required for the PV panels alone. They provide a space-efficient installation for homeowners or businesses looking for a more sustainable alternative energy solution.

Green from beginning to end

The PV industry recognized the need for recycling in order to preserve precious resources and raw materials at an early stage. It created PVCYCLE, the worldwide not for profit member-based organization supporting the recycling of PV materials. Stainless steel fits perfectly into this philosophy of resource stewardship, since it is completely recyclable. Thus, the heat exchangers that are so important to the efficiency gains in the hybrid system will find a home in new applications and technologies when they reach the end of their lives in about 25 years.

A bright idea becomes a new technology

The young engineers' idea for a hybrid panel with molybdenum-containing stainless steel has quickly made its mark. It has been certified to European solar energy PV and thermal standards, and already equips corporate headquarters, industrial buildings, apartment buildings, swimming pools and private homes in Europe, the Near-East, North and South America. (TP)



Coolant flows inside the stainless steel heat exchanger just beneath the solar panel, stabilizing its temperature and transferring its heat through another heat exchanger to produce domestic hot water. © DualSun