

What if your Entire Roof Generated Power?

Recycled plastic has been turned into a renewable energy generation product that serves as an aesthetic solution for architects to consider as an alternative to unsightly solar panels in building design, while using recycled materials.



Eric Solot pictured at the 6th Southern African Energy Efficiency Convention

In an attempt to try and eliminate mountains of un-recycled plastic in Belgium, an innovative idea came about to manufacture roof tiles using this material. The first tile was produced in 2000, followed by required testing in laboratories in Germany to improve the UV and impact resistance of the tiles.

Through development and testing, small solar panels were later incorporated into the tiles, resulting in a power generation product for roof space.

Eliminate mountains of un-recycled plastic

The Sun Roof Tile is an architect's dream for incorporating renewable energy into a building without compromising the aesthetic appeal of the design. The product is light, moss resistant, which is an issue in Europe, has high heat and impact resistance, is easy to install and fault-find, with the only compromise being a reduced efficiency (Wp/m^2) when compared with conventional solar paneling.

Development through testing

Standard testing was undertaken in Germany where ice and hail blocks were hurled at the tile at various velocities. The specific resistance of the tile was then measured

and the results showed that the tiles were UV, water, frost and hail resistant.

However, the tiles originally were only manufactured in black, which caused excessive heat generation. In an attempt to limit the heat transfer in summer to the rest of the house, a decision was made to build ventilation channels inside the tile to provide natural cooling.

Another solution designed around the heat problem was to capture the heat at the apex of the roof and direct that heated air to a heat pump to improve its efficiency, as well as utilising it for home heating applications.

Improvements for a viable solution

In appearance, the Sun Roof Tile looks similar to a normal ceramic tile and the first roof projects were completed in Belgium in 2000. But the payback period of these projects was fairly long – at around 10 years – and it was therefore decided to integrate a PV panel inside the tile. Now the tile has three different functions:

- The roofing structure,
- Hot air can be used for heating applications, and
- Electricity generation.

The only downside of this aesthetic solution, compared with unsightly standard PV panels, is a reduction in efficiency when compared with a standard PV panel. This is due to the fact that the PV modules are encased inside the plastic tiles, resulting in a reduction in Wp/m^2 . However, on the upside, the integrated cooling system allows the PV modules inside the tile to be cooled quite efficiently as the cooling air flows through the channels behind the PV modules to the next tile.



Tile construction

Photovoltaic cells are silica based, amorphous and thin film. They consist of multiple layers with scale resistant tempered glass on top, then the actual PV cells followed by the black backing and wiring. Colours currently available are lavender, red, army green, yellow and black. The efficiency of coloured PV modules is approximately 25% less than black units.

As the roof contracts and expands during the day due to temperature changes, the connectors between the tiles need to remain intact to avoid bad connections developing over time. The actual link between tiles is kept stable and allows play through a spring insert.

Stainless steel is used as it is a good conductor and is corrosion resistant, but especially because it can be soldered. The PV modules have a double silicone seal and are pressed inside the tile, which acts as a support structure to the PV module. Each PV tile has its own connectors that clamp into the connectors of the adjacent tiles.

Installation

Installation is extremely simple to execute. All the existing tiles must first be removed and if need be, the battens re-positioned as it's critical that they run parallel to each other. The Solar Tiles are then laid, secured to the battens with screws and wired to the inverter. The minimum roof pitch required in Europe is 13 degrees. Typically, in Belgium, a standard roof installation of an average dwelling is accomplished within a day and the electrical connection requires a registered electrician's services the day after.

Depending on the power management requirement of the installation, the whole tile field can be segmented into four or eight sections to enable active power management of individual roof sections.

Faultfinding is simplified as the tiles are connected in series in each row. The system allows only the affected tiles to be withdrawn from service for repairs

to be carried out when needed, which means the rest of the roof can still operate uninterrupted. Each of these tiles is fitted with a bypass diode.

Coming together

A number of different types of technologies had to come together first for the successful development of the Solar Roof Tile, including plastic processing, photovoltaic cells (finding small PV panels that would fit inside the tiles) and the connectors for the assembly of the tiles, as well as installation of cabling and inverters.

The connectors between the tiles need to remain intact to avoid bad connections developing over time

Alpha Power Solutions can now offer two different types of tile to the South African market: an 8 Wp and a 12.5 Wp tile. The first solar roof was successfully installed in 2007. The smaller version is the most common tile used in Europe with a peak output of about 70 Wp/m². The larger version has greater efficiencies with a peak output of 120 Wp/m².

As this is an aesthetic solution, the cost per Wp is higher when compared with standard PV panels, but it has other characteristics which might offer solutions to architectural design dilemmas.

Accolades

Eric Solot holds a Master of Applied Engineering (Electrotechnology) from the University College in Ghent (Belgium). He is currently managing director at Alpha Power Solutions, specialists in power factor correction and harmonic filtration and importers of the Solar Roof Tile.

For two years in a row (2010 and 2011), Alpha Power Solutions won the best double exhibition stand award at the Southern African Energy Efficiency Convention.

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