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If photovoltaic panels are merged with a solar thermal absorber the solar irradiation is converted to electricity and heat simultaneously. These PVT systems offer some potential advantages over a solar cogeneration system consisting of side-by-side PV panels and solar thermal collectors, enabling a faster introduction of zero-energy houses and buildings. These form the elements of a future highly renewable society, in which a maximal part of the energy demand is generated directly from renewables in a distributed manner.

Figure 1: front and back of a PVT panel.

The development of PVT concepts in the Netherlands started in 1996 with a PhD study on different concepts for photovoltaic-thermal panels and collectors. The basic concept, consisting of a standard PV laminate glued on top a sheet-and-tube solar absorber, was developed further into a prototype PVT collector. The resulting electric and thermal efficiencies were satisfactory and corroborated the numerical models developed. The research was followed by a development program of ECN, into which the Eindhoven University of Technology, Shell Solar and -later- ZEN Solar participated. The program resulted in an increased thermal efficiency of the PVT collector and an integrated manufacturing technique with proven, satisfactory quality level. The development of a manufacturing method was aimed at improving the initial, labour-intensive gluing of the construction. This resulted in a direct lamination of the PV onto the thermal substrate. The result is a product that looks identical to a normal PV laminate, producing not only electricity but solar heat as well.

PVT can be subdivided into two types: PVT panels and PVT collectors. Figure 1 shows the front and back of a PVT panel. PVT panels have no extra transparent cover and will therefore loose heat to the ambient relatively easily. When heat of low temperature is needed PVT panels give good annual efficiencies. A typical system configuration for PVT panels is with a heat pump and a vertical ground heat exchanger for seasonal heat storage. With this system a low mean temperature of the PVT panels is maintained, resulting in an increased electric gain.

PVT collectors, like most solar thermal collectors, have an extra transparent cover preventing heat loss to the ambient leading to better thermal efficiencies at relatively high collector temperatures. Therefore, PVT collectors can be used in solar combi systems, generating heat for domestic hot water or for room heating, while generating electricity with efficiencies only slightly lower than normal PV efficiencies.

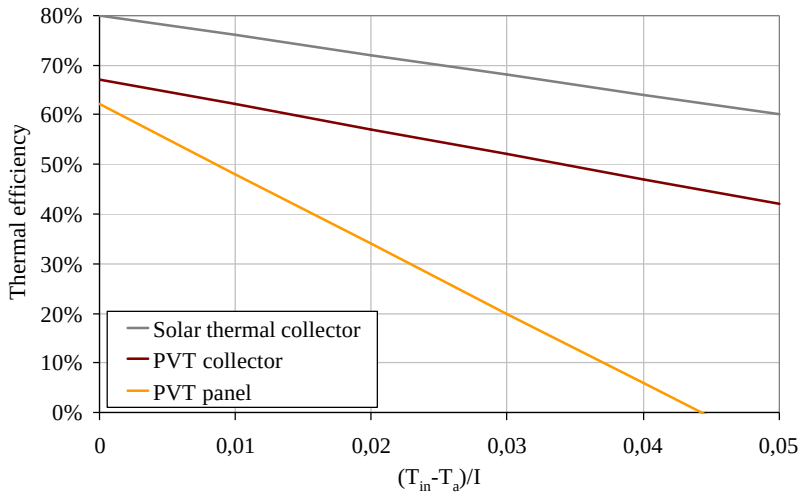

Figure 2: Thermal efficiency curves for PVT panels, PVT collectors and solar thermal collectors.

Due to the lower solar absorption of the PVT absorber, the thermal efficiency is lower than with a conventional solar thermal collector. Figure 2 gives the thermal efficiency curves for a PVT panel, a PVT collector and a solar collector. The PVT collector efficiency is about 13% lower than the conventional solar thermal collector efficiency. Due to the higher heat losses of PVT panels to the ambient the efficiency has a sharper decrease with increasing temperature difference.

A first series of PVT collectors was produced in January 2003, with a total area of 45 m^2. The collectors were installed at the new head office of the RES company in Kings Langley, near London, as part of an EU funded project. The PVT collectors, together with 150 m^2 'normal' thermal collectors, provide heat that is either stored in a seasonal heat storage or directly used to preheat the ventilation air. The building and the installation will be ready in the autumn of 2003.

PVT panels and collectors are now at the brink of market introduction. At the moment, studies are performed into the effectiveness of PVT panels in systems with heat pump and seasonal heat storage and of PVT in systems for multiple family houses. First calculations show that PVT can generate economic advantages through the more effective use of the roof area, reducing the installation costs per m^2. Also, the PV 'looks' of PVT collectors can be of aesthetic advantage. Because PVT systems make a more effective use of the roof area, low energy houses or zero energy houses can be more easily realised with a PVT roof than with a roof having solar thermal and PV side-by-side. The market introduction and the future research and development of PVT are aimed at this potential.

This is done by materials research and production technology research aimed at better thermal efficiencies and higher temperature resistance of the collectors and by developing PVT panels and collectors built from cheaper materials. At the moment, preparations for a demonstration-scale production of PVT are being made. A first series will be produced to provide several demonstration projects with PVT panels and PVT collectors in 2004, while market introduction is planned in 2005. The first markets that can benefit from PVT are PVT systems for multiple family houses and for low energy houses.

Both markets are characterised by a relatively small roof top area, available for solar energy conversion. Through their high combined efficiency, PVT systems are a first choice for these markets.