

## PV-Thermal collectors going commercial

Herbert Zondag, Joakim Byström, Jan Hansen

### What is a PV/T collector?

A Photovoltaic-Thermal collector (or PV/T collector) combines the functions of a solar thermal collector and a PV module, converting the solar radiation to both electricity and heat. It is essentially a solar thermal module in which PV is integrated in the absorber. In this way, more solar energy is generated per unit surface area than with separate photovoltaic panels and solar thermal collectors side-by-side. Since only one type of module has to be installed instead of two, one single installer will be responsible for the whole installation and installation costs can be reduced. In addition, the fact that only one building element is required to produce both forms of solar energy has the aesthetical advantage of providing a more homogeneous roof or façade appearance.

Different types of PV/T collectors exist, ranging from flat-plate liquid modules to PV/T air collectors, concentrating PV/T modules and PV façades in which the heat is recovered and put to use. Most of these types can be either glazed or unglazed.



**Figure 1: (a) Ventilated PV façade of the Mataro public library in which the heat is recovered and used for space heating and solar cooling, (b) concentrating PV/T system (Vattenfall), (c) PV/T air collector (Grammer KG).**

### **IEA SHC Task 35 – PV/Thermal Solar Systems**

*At this moment, worldwide only a very small number of commercial PV/T products exists and the amount of realized projects with these collectors is small. This is in marked contrast to the large potential that is seen for such systems as a standard solar component in both renovation and new housing projects, in particular if the available area is limited, such as for multifamily buildings. As a first step towards realizing this potential, a group of experts has worked together in the framework of the International Energy Agency (IEA) Solar Heating and Cooling (SHC) Programme, Task 35 on PV/Thermal Solar Systems to generate awareness for PV/Thermal Solar Systems and to catalyse the further development and marketing of PV/T systems. To achieve these aims, several activities have been carried out. An overview of commercially available PV/T systems was made and a market study was carried out for which a number of architects and solar companies were interviewed. In order to show the potential of PV/T systems an overview report on realised PV/T installations is under preparation. Furthermore, the task has focused on developing a testing procedure (building on the PV/T testing guidelines developed in the PV-Catapult project) and on testing a number of PV/T collectors, in order to build up market confidence. Finally, software is being developed for quick and easy prediction of PV/T system performance for architects and engineers.*



**Figure 2: (a) PV/T testing site in Padova, visited by a number of IEA SHC Task 35 members, (b) PV/T testing site at the Danish Technological Institute with PV-Solarwall collectors.**

### ***PV/T modules available in the market***

At this moment, a small number of PV/T systems is commercially available, among which are both air and liquid collectors. PV/T air systems are marketed by four companies. The Canadian company Solarwall is marketing its PV-Solarwall system in which PV modules are connected to the Solarwall transpired air collector. The Danish company Aidt Miljø has been selling its summer house package, consisting of a glazed collector in which a small PV module is integrated that drives the collector fan. The German company Grammer is marketing its Twinsolar collector (with a small integrated PV area, also for the summer house market) and its Hybridkollektor (with PV over the entire collector surface). Finally, Secco Sistemi in Italy is marketing a flexible façade system, that also may contain an integrated PV/T air collector.

PV/T systems with a liquid as the collector fluid can be obtained in both flat plate and concentrating form. A glazed flat-plate PV/T liquid collector is marketed by the Dutch company PVTWINS, while the Israeli company Millennium Electric is selling an unglazed PV/T collector that produces both hot water and hot air. Concentrating PV/T collectors can be obtained from the Swedish company Arontis, the USA based company Heliodynamics and the Canadian company Menova Energy. Although the number of commercially available PV/T products is still limited, they are available and their number has shown a significant increase in recent years.



**Figure 3: left to right: PV/T liquid collector by PVTWINS, concentrating PV/T from Arontis, PV/T air collector from Grammer Solar.**

## **Realized PV/T installations**

Not only commercial PV/T modules are available, but also a significant number of PV/T installations has been realized in market introduction projects and demonstration projects over the past two decades. In an inventory by IEA SHC Task 35, 70 projects have been identified, ranging from small PV/T systems to very large ones. Of these systems, 39 are air based. Most of these projects have been built by the German manufacturer Grammer Solar using their unglazed PV-air collector. Another large number of projects was realized in national Danish projects led by the Danish consultant Cenergia, applying ventilated PV facades with heat recovery. The oldest residential PV/T air installation found in the project was realized in the USA by Sunwatt in 1987; it is still in operation. With respect to liquid collectors, a large number of the systems was realized recently in Thailand, in which 5 large-scale PV/T systems were installed on various governmental buildings over a period of about 2 years. These systems have been developed by NSTDA and are mostly glazed PV/T collectors using amorphous silicon, but in one project also unglazed PV/T collectors were used. The largest of these systems is a 152 m<sup>2</sup> system on the Queen Sirikit hospital in Chonburi. Another project to be mentioned is a 54 m<sup>2</sup> glazed PV/T liquid project that was realised by the Dutch companies ECN, Shell Solar and ZEN Solar in the UK in 2003. This PV/T work has been continued by the ECN spin off company PVTWINS, that in 2007 has realized a 27 m<sup>2</sup> glazed PV/T liquid system on a Dutch governmental building and five 2.8 m<sup>2</sup> systems in a residential renovation project, while more market introduction projects have been planned for 2008.

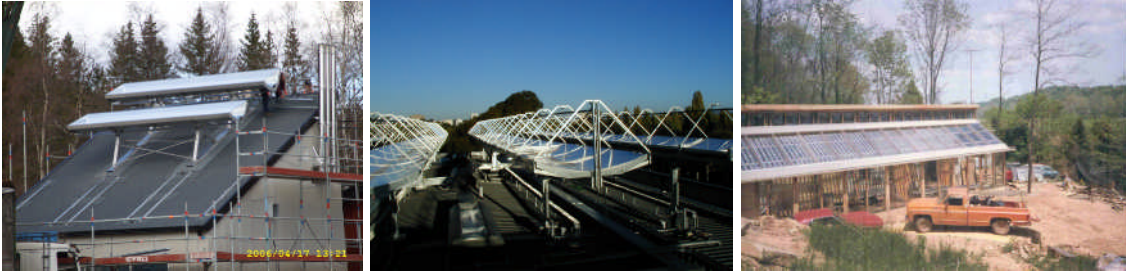
Finally, a large number of systems was realised by the company Solor, with a PV/T collector that can heat both water and air. Solor has realized projects with unglazed PV/T collectors from 1991 onwards, among which a number of PV/T systems installed at 6 off-grid residences in Klil village, 2 PV/T systems in a recreation village in the Negev desert and 2 PV/T systems on an alpaca farm. In 1999, the PV/T activities of Solor were taken over by Millennium Electric.



**Figure 4: PV/T air projects realized by (a) Solarwall, (b) Cenergia, (c) Grammer Solar**



**Figure 5: PV/T liquid projects realized by (a) ECN / PVTWINS, (b) Millennium Electric, (c) NSTDA**



**Figure 6: Concentrating PV/T projects realized by (a) Arontis, (b) Australian National University, (c) Sunwatt**

## ***Market survey***

Within IEA SHC Task 35 on PV-Thermal systems, a market survey was carried out among solar companies in Canada and the USA (8), Germany (9), Italy (10), Spain (6) and Sweden (7), as well as architects in the USA (8), Germany (10), Denmark (8) and Italy (3). Interviews were carried out by task experts in their respective countries. It was found that, in general, almost all solar companies are very positive regarding PV/T and expect that adding a PV/T system to their product range would increase business opportunities. For PV/T as a commercial product, they stressed the importance of increasing the cost efficiency relative to normal solar systems. It was indicated that a substantial increase in production volume is necessary to obtain large cost reductions, and that involvement of the large heating system manufacturers is therefore important. A point of attention was that in many cases the solar companies indicated that they did not know if PV/T would qualify for their national subsidy programs. This is important since the profitability of a PV/T system strongly depends on whether PV/T qualifies for the subsidies for PV and/or solar thermal.

Also the architects expressed their enthusiasm for PV/T systems and indicated that if PV/T systems would be sufficiently cost effective, they would consider applying them. Many of them were interested in the publicity generated by PV/T demonstration projects. When the architects were asked to list the most important factors for a successful system, all stressed the importance of building integration. However, many of the architects also stressed that system economy is the main issue and that the PV/T system should be more cost effective than a side-by-side system. Both solar companies and architects stressed that a mature product with certifications and a proven track record is a requirement in order to apply the system; both because reliability is important and also because a certificate is often required for subsidies.

The study also indicated that the markets are different in different countries. In Canada, air collectors have a substantial part of the collector market and the PV/T air products developed by SolarWall are well-known. In the other markets the focus is much more on liquid-type collectors and PV/T air systems receive little attention. In Germany, it was indicated that PV/T could be interesting for the solar collector replacement market. Several Spanish solar companies asked for PV/T combined with solar cooling. The Italian solar companies and architects often mentioned limited roof area as a problem for the application of solar energy, and the compactness of PV/T systems was seen as an important advantage. In Sweden a large gap exists between PV integrators and Solar Thermal companies. The Swedish solar companies indicated that the PV market consists largely of public buildings, while the solar thermal market consisted of residential

systems for ‘private enthusiasts’. Consequently, all Swedish respondents worried about the difficulty to combine the two different professions in installing PV and installing solar thermal. This is not the case in Germany, Italy and Spain where the installers generally install both PV and solar thermal.

The main conclusion of the survey is that both architects and solar companies are very interested in PV/T, e.g. for generating publicity and additional business. Opportunities for PV/T are generated by the limited roof space available, possible cost reduction (e.g. due to lower installation costs), building integration and the fact that a PV/T system has a more uniform appearance than a side-by-side system.

### ***PV/T modules towards the market***

From the market survey, a number of conclusions can be drawn:

- Especially in Europe, more awareness should be created on the potential of PV/T. It was suggested by some of the architects that a regularly updated website on PV/T or an electronic newsletter e.g. every 3 to 6 months would be useful.
- It is very important that it becomes clear for which subsidies PV/T is eligible, and whether it is possible to combine PV and solar thermal subsidies.
- Among architects, building integration is seen as the most important issue for PV/T development. It is therefore important to develop flexible plug-and-play system components that allow reliable and flexible building integration.
- The fact that PV/T requires less area than a side-by-side system is especially relevant in multifamily building. Consequently, countries that have a large share of multifamily buildings such as Italy and Spain are interesting markets. Other interesting niche markets are seen in hotels for PV/T liquid systems and commercial or public buildings with ventilation preheating or solar cooling demand for PV/T air systems.
- It is very important that PV/T qualifies as a certified and reliable product. Therefore, more PV/T demonstration projects should be carried out and the results of these demonstration projects should be more widely published. Also, dedicated testing procedures should become established.
- It is important that energy consultants, installers and architects have access to fast and easy-to-use software tools for the calculation of the yield of a PV/T system.

Within IEA task 35, a number of these issues has received attention, among which the efforts in developing PV/T testing guidelines, a report on PV/T demonstration projects and the development of tools for PV/T modeling. These activities are intended to inform stakeholders in the building sector, from architects and urban planners to installers and HVAC manufacturers, of the potential of PV/T systems and to enhance the confidence in the market on PV/T collectors as a product. Most important at this early stage is the generation of awareness and the establishment of best practices and confidence through realized PV/T installations. The results of demonstration projects should be published widely, to which this IEA task has contributed strongly. After a long market preparation phase in PV/T development, we hope that the results obtained in this task will contribute to the final take-off of the PV/T market.

## **References**

- [1] PVT ROADMAP - A European guide for the development and market introduction of PV-Thermal technology, [www.PVTforum.org](http://www.PVTforum.org)
- [2] PVT performance guidelines – Guidelines for performance measurements of liquid-cooled non-concentrating PVT collectors using c-Si cells, [www.PVTforum.org](http://www.PVTforum.org)
- [3] Commercially available PVT products, [www.iea-shc.org/task35](http://www.iea-shc.org/task35)
- [4] PVT platform [www.ecn.nl/egon/extra/extranet/pvt-platform/het-pvt-platform/](http://www.ecn.nl/egon/extra/extranet/pvt-platform/het-pvt-platform/)
- [5] Photovoltaics/thermal Solar Energy Systems - Status of the technology and roadmap for future development Report IEA PVPS T7-10: 2002, [www.iea-shc.org/task35](http://www.iea-shc.org/task35)