Anexa x

Diseminare rezultate proiect RetroKit

„Toolboxes for systemic retrofitting”

Lucrare

„ BUILDING INTEGRATED SOLAR THERMAL”

Autori: Mihai HANEK, Cornel JIVAN, Gabriel VATASELU, Icpe

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Poze eveniment:

Anexa x



SISTEM DE MONITORIZARE A STĂRII BATERIILOR
Li-Ion BMS 4X12 V
Li-Ion BMS 4X12 V

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BUILDING INTEGRATED SOLAR THERMAL

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BUILDING INTEGRATED SOLAR THERMAL

Mihai HANEK, ICPE SA
Cornel JIVAN, ICPE SA
Gabriel VATASELU, ICPE SA

Executive Summary:

Icpe is the only Romanian partener in FP7 project RetroKit, a project that aimes to develop tool kits for retrofitting existing buildings, including envelope upgrading, high performance lighting systems, energy-efficient HVAC systems and renewable energy generation systems.

This paper presents one of the studied solutions, the PVT(Photovoltaic-Thermal) system that was instaled in one of the demo buildings in Madrid. This system can convert in the same time the energy of the sun in electricity and thermal energy.

Description

The basic idea for the combined PV/solar thermal element integrated in an external thermal insulation composite system(ETICS) was to create a low-cost BIPVT element, which is prefabricated and well integrated into the building process, since the building process accounts for a much larger share of the end-user costs than the components themselves. The starting point of the project was a PV module which is connected to capillary tubes in a factory. The prefabricated element is then installed on-site integrated into the building envelope in order to contribute to the electricity and heat demand of the building.

Keywords (3-5 keywords):

BIPVT, energy efficiency, retrofitting, renewable energy.

1.1 PVT modules for Madrid demo side

The RETROKIT PVT prototype is based on modular construction of already existing technologies. As was seen in early calculations further fine tuning of construction can improve the overall properties. The modul is based on a carrier board with integrated heating and cooling mats. The CIGS PV-modul is delivered on an aluminium board which is then glued directly on the carrier board.

1.2 Adaption regarding boundary conditions during Retrokit

Important boundary conditions for this development are the costs, the photovoltaic and solar thermal energy performance and the integration into the building process.
First ideas were generated on how to design low-cost prefabricated BIPVT elements. Figure 1 presents schematic drawings of the two most promising concepts. In both cases, the module that would be attached to the masonry consists of four successive layers, the external layer of the collector, a CIGS thin film PV with 8% efficiency, a thin layer of silicone, the carrier plate and at the back of the collector, a layer of mineral wool insulation. The described module would have a total 6cm thickness. The difference between the two configurations was the position of the capillary tubes would be embedded in the carrier plate. This option offered lower production costs, because these carrier plates can also serve for other uses. In the second configuration the capillary tubes were embedded in the silicone glue, squeezed between the PV and the carrier plate. In this case, since the thermal resistance between the PV and the fluid is smaller as in the first configuration, the second configuration promises higher thermal gains.

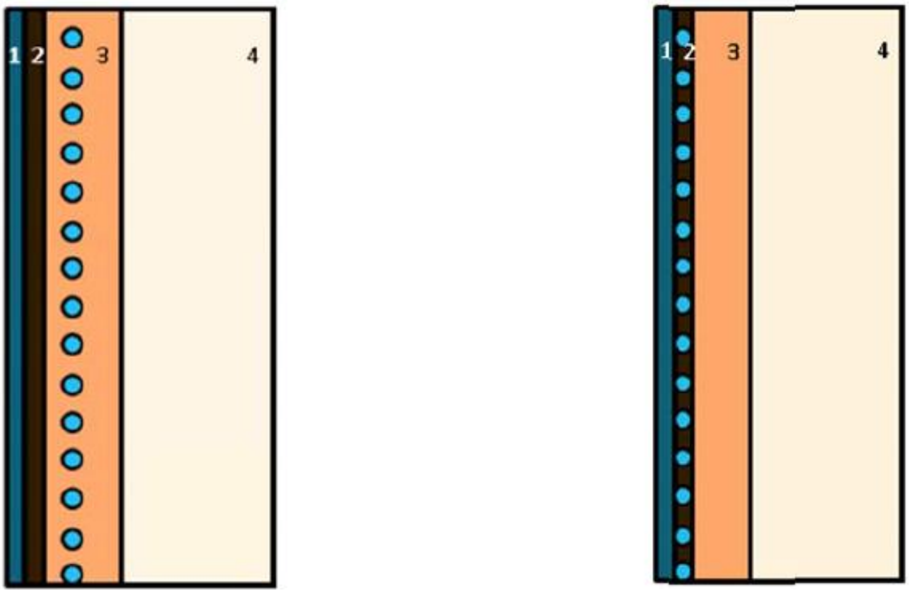


Figure 1. In configuration 1(left) the capillary tubes are embedded in the carrier plate. In configuration 2(right) the capillary tubes are embedded in the silicone glue between the PV layer and the carrier plate.

Both configurations are simulated in TRNSYS for hypothetical building facade, facing south with with weather data from Frankfurt. The collector's fluid was considered to be a water glycol solution with a 40% concentration and the simulations estimated the annual PV and heat gains for the two cases. The outlet temperature of the collector's fluid was maintained constant to a desired value by varying the mass flow of the fluid accordingly, a method called match flow control. For each configuration, a series of simulations was executed. The inlet and outlet fluid temperature varied depending on the ambient temperature and the difference between the inlet and the outlet was 5°C at all times and the annual thermal gains of the collector depended on the outlet temperature as well as the total operating hours of the system. Beggining with an inlet temperature equal with the ambient temperature and the outlet temperature five degrees higher, both temperatures were increased by 5°C with every new simulation until the collector's annual thermal gains was zero. The annual gains of each simulation for both cases are compared in figure 2. The assumption that the second configuration would return higher thermal gains is verified, since the thermal gains per year are up to 30% higher for the second configuration. Configuration 1 can be produced at lower costs to date. Therefore this configuration was investigated first. Later it was decided to investigate configuration 2, too, which was then also chosen as the configuration of the test models and of the demonstration installation in Madrid.

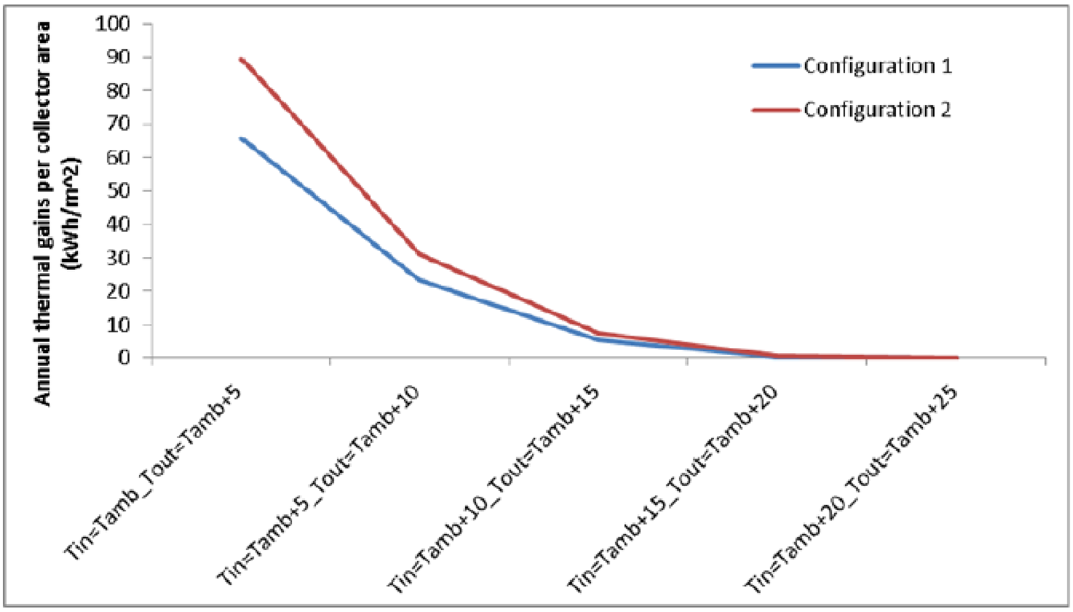


Figure 2. Comparison of two collector designes.

Another important question is the best orientation of the new prefabricated BIPVT elements. Therefore similar simulations were created with weather data from Madrid, for an east facade and a south facade following the same methodology as in the comparison of the two configurations. This time, both the thermal gains and PV gains were compared for both cases. According to the simulation results, the south orientation proves to be way more effective a this location than the east facade. The thermal gains for the installation on the south facade are estimated to be more than 30% higher compared with the east facade while the electrical gains due to the PV component are also around 25% higher when oriented south.

1.3 Prefabrication and technical integration

To ensure the technical integration into an ETICS facade, mass-produced components from Sto SE&Co. KGaA were used in the design of the low-cost BIPVT element. A concept was developed for the intersection between a typical ETICS facade and the BIPVT area. The PV module, the capillary tubes and the carrier plate are being assembled together with silicone glue in a factory. Profiles are connected to the carrier plate as well as to the rest of the wall structure. Therefore the prefabricated elements can easily been clipped to the wall(Figure 3). The connection system is already marketed by Sto and offers the opportunity to replace the BIPVT elements easily e.g. after 20 years when there are low-cost modules with high efficiency. Even in case of failure, elements can be replaced easily without affecting the entire facade.

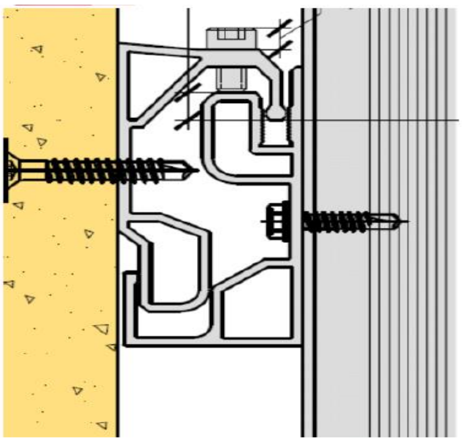


Figure 3. Schematic drawing of the carrier plate(left), the two profiles clipped together and rest of the wall structure(right).

1.4 Energetic parameters(U-value, air tightness, thermal bridges and renewable energy performance)

Figure 4 presents a photo of the test model of the prefabricated element, wich was measured at the TestLab Solar Facades of Fraunhofer ISE and schematic drawing. The U value of this BIPVT element was measured to be 3.39 ± 0.11. The prefabricated element is combined with a wall structure which can include as much insulation as desired by the building owner. The gap between the carrier plate and the rest of the wall structure can also be filed with insulation material to further decrease the U value.

Figure 3. Schematic drawing of the prefabricated BIPVT element and photo of the test model measured at the TestLab Solar Facades at Fraunhofer ISE.

Typically, the prefabricated BIPVT elements are airtight, but the layer of BIPVT elements is not. However, the rest of the wall structure is usually airtight which means that the facade is airtight, too.

The BIPVT elements do not lead to thermal bridges. Instead, the U value deacreases by adding the prefabricated element to the rest of the facade.

1.5 Comfort aspects

The measurement results show that even during stagnation, when no fluid mass flow removes heat from the BIPVT element, the temperature of the surface facing the interior does not exceed 31°C. Considering that there is usually insulation between the element and the building interior by the rest of the wall structure, the BIPVT element will not lead to thermal discomfort. The renewable heat and electricity can be used to improve the thermal comfort in the building.

The clipping systems allows moisture exchange between the wall structure and the ambient. The rest of the wall is air-tight. Therefore the BIPVT facade can contribute to a high air quality.

Noise issues are expected to reduce when adding insulation and a BIPVT element to a facade.

The BIPVT elements can therefore contribute to the comfort of the people who live in the building.

1.6 Constructional variability

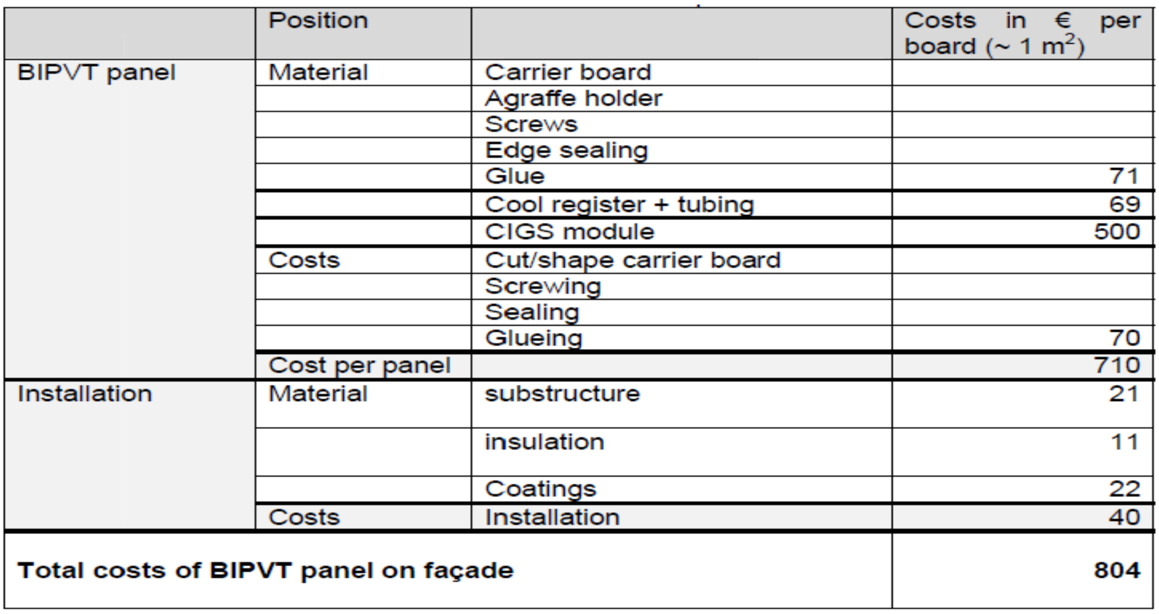
In principle, the outer dimensions of the prefabricated BIPVT elements can be chosen freely. For economic reasons, available sizes of PV modules and carrier plates can be chosen. The capillary tube mats can adapt to this dimensions.

With the clipping system presented in Figure 3, the gap between the BIPVT elements and the rest of the wall structure can be filled with air or with an insulation material in order to decrease the U value and increase the solar thermal performance.

Instead of the clipping system, the prefabricated BIPVT elements can also be mounted directly on the exterior insulation as presented by Figure 1.

1.7 Costs

The costs for the BIPVT panels and installed in Madrid are summarized in the table 1.



	Position		Costs in € per board (~ 1 m^2)
BIPVT panel	Material	Carrier board	
		Agraffe holder	
		Screws	
		Edge sealing	
		Glue	71
		Cool register + tubing	69
		CIGS module	500
	Costs	Cut/shape carrier board	
		Screwing	
		Sealing	
		Glueing	70
	Cost per panel		710
Installation	Material	substructure	21
		insulation	11
		Coatings	22
	Costs	Installation	40
Total costs of BIPVT panel on façade			**804**

Table 1. Costs for the BIPVT panels

1.8 Installation

Since the BIPVT elements are being prefabricated in a factory, the construction workers on site have only few steps to do with limited possibilities for mistakes.The multifunctional insulation boards described in chapter 3.2 can be used to connect the PV inverter and the solar thermal storage with the collector field. At the boundary between the collector field and the rest of the facade, the edges are being sealed to be weather-proof. For the area of the collector field, an insulation layer can be installed first if there is no functional insulation yet. Then the first profile of the clipping system is mounted as presented by Figure 4.

Figure 4. Photo after the installation on the first clipping profile

For the connections, a plan is developed by the planner of the building services as presented by Figure 5. Typically, one cable and one pipe is needed from the ends of the collector field to the area where the connecting cables and pipes to the inverter and thermal storage enter the collector area. In Figure 5 this is at the centre of the collector field. Then the BIPVT elements are installed and connected hydraulically and electrically one element after another, according to the plan. The connectors are presented in Figure 6 and Figure 7. The electric conectors have been used in numerous PV installations and the hydraulic connectors in many thermally activated building systems. They are easy to use and very reliable. The BIPVT elements can therefore quickly be mounted. Figure 8 presents a photo of the installed collector field.

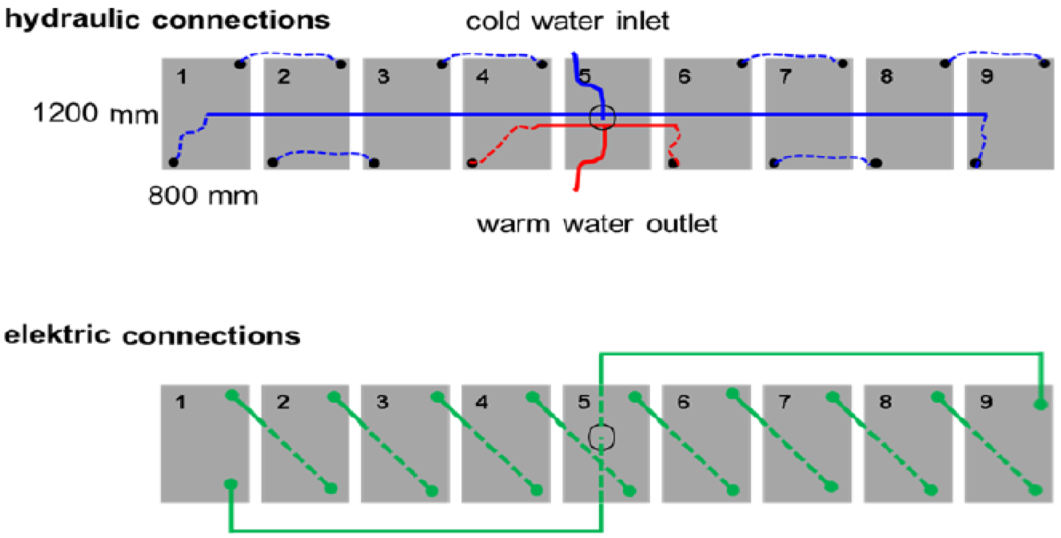


Figure 5. Schematic drawing of the hydraulic and electric connections between the BIPVT elements.In this case, the cables and pipes to the inverter and the storage enter the collector field at the centre.

Figure 6. Photo of an electric connector to the PV module.

Figure 7. Photo of a hydraulic connector.

Figure 8. Photo of the installed BIPVT collector field on the facade of a demonstration building.

1.9 Maintenance

The maintenance of the BIPVT facade itself is comparable to a conventional facade with clipping system and to the maintenance of a conventional EIFS facade. The facade is weather-proof. If a very aesthetic appearance is requested, the facade can be cleaned if there should be dirt.

The building services are olso designed to work properly for the whole service life of the system. One year after the commissioning, an experienced person can have a look at the available data to see if there is any potential for improving the control of the system. The people who live in the building can also participate by watching their consumption of fossil fuels and e.g. the temperatures of the solar thermal storage.This can lead to energy savings by increased awareness on the one hand. On the other hand, they can see when the system should not work as intended. Then craftsmen can look for the reason. The participation of residents can olso contribute disseminate the technology amongst the friends and acquaintances of the participating residents.

Towards the end of the designed service life, a craftsman can check the components of the BIPVT system. Many components can be used further, but some components should probably be exchanged improve the reliability and performance in the following years. For example, the BIPVT facade elements can be easily exchanged by elements with even higher efficiency.

1) Acknowledgement

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For more information about the project, please visit: http://www.retrokitproject.eu/

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