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Experience on the behavior of different BiPV solution: electrical and thermal performance of roof and façade mounted micromorph modules

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Abstract

Renewable energy systems, such as Photovoltaics (PV), play an important role in the scenario identified by the European Directive on Net Zero Energy Building (ED 2010/31/EU) [1] and are mandatory if we would like to reduce the energy performance of buildings and to force the rational use of energy.

When installing Photovoltaic on Building, the mounting system significantly affects the heat-exchange between the module and the building envelope and the operating temperatures of the PV modules that strongly influence the energy yield of the PV system. For this reason it is important to be able to simulate and evaluate in advance the behavior and the possible advantages of a certain type of installation. This work will present monitoring results of two examples of building integrated PV system when installed as façade cladding system or as roof tile. The investigated parameter (such as module temperature, electrical parameter, Energy Yield) can be used to predict the behavior of such a modules on real building.

1. Background

There exist today a number of innovative and advanced products for building integration that can be used in new or retrofitting installations, either as roof integrated system or as façade cladding system. Roof-mounted PV systems, which are usually applied on top of an existing roofs are rarely ventilated. While in BIPV façade installations, ventilated mounted systems are more often used like curtain walls systems or rear-ventilated cladding systems suitable for both new and existing buildings. Even more BIPV solutions and prototypes have been developed for better integration into the building envelope fulfilling different functions as a building component that not only aesthetically pleasing and representative. Some of many of these solutions are presented in Fig. 1.

Fig. 1:Examples of BIPV system integrated as building envelope in new and existing buildings: (1) Kindergarten, Sant Celoni, Barcelona, Spain. Source: VidurSolar S.L.; (2) Residential building in Germany "Köln-Bocklemünd (II)" Source: ©Ecofys Germany GmbH; (3) Stuttgart University's Shimmering Solar Decathlon Home+, Technische Universität Darmstadt's surPLUShome, Solar Decathlon Competition; (4) Solar plant for Greenpeace, Bad Oeynhausen (Germany) - Source: Solar Fabrik AG; (5) Umwelt Arena – Source: Meyer Burger Technology AG; (6) Provincial Offices, Ex-Post building, Bolzano, Italy. Michael Tribus Architecture, Jan Steiger – Photo Source: Cristina Polo

2. Description of the test facilities

The outdoor test facilities were built on the roof of one of the buildings at SUPSI (in Lugano, Switzerland). A real BIPV module integration was reproduced in two outdoor experimental test facility: the first reproduces two vertical facades and the second a roof installation.

The two facades were installed at 90° (vertical position) and each made by four modules. The left façade is natural ventilated and the right has no ventilation, both are thermal insulated.

The roof was built with wood beam sub-structure and 3cm wood plywood in order to have a flat plate where to place the nine BIPV modules .

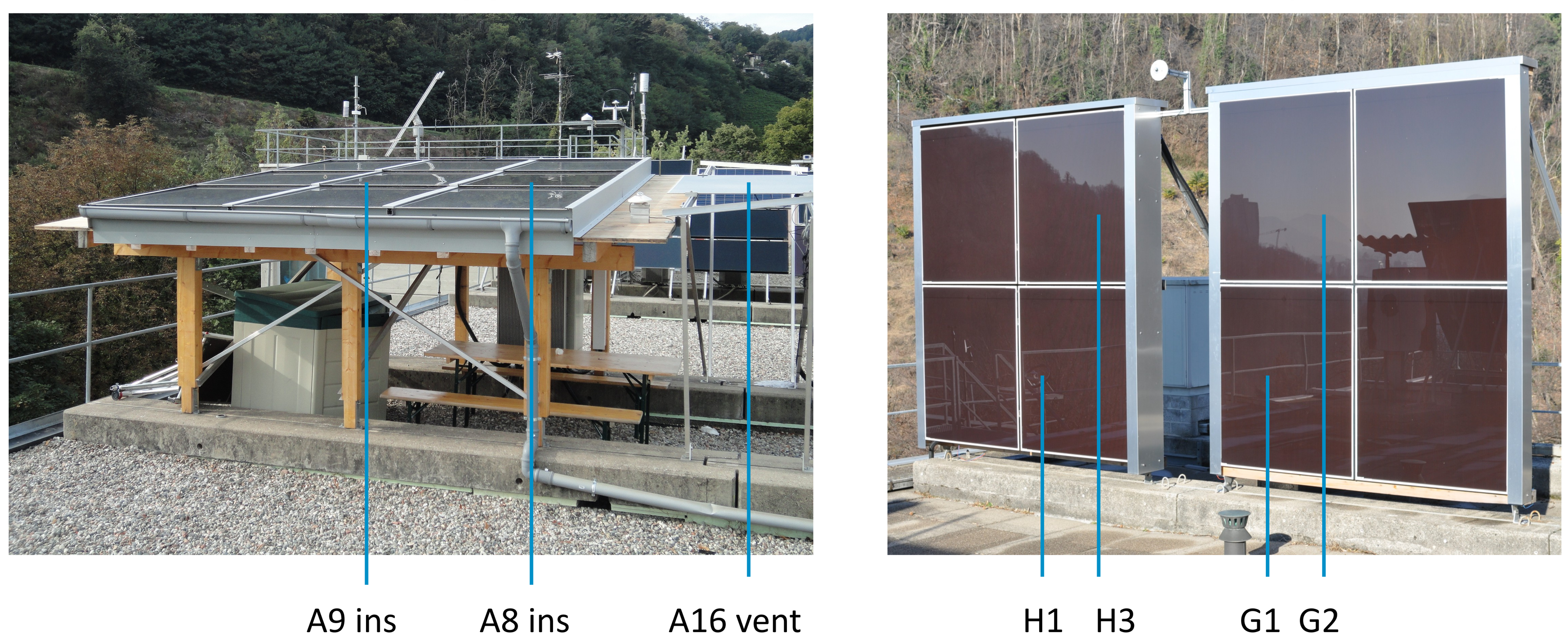

Fig. 2: Two vertical facades and a roof top BIPV installation are compared with reference free-standing modules.

3. TEMPERATURES & IRRADIATION COMPARISON

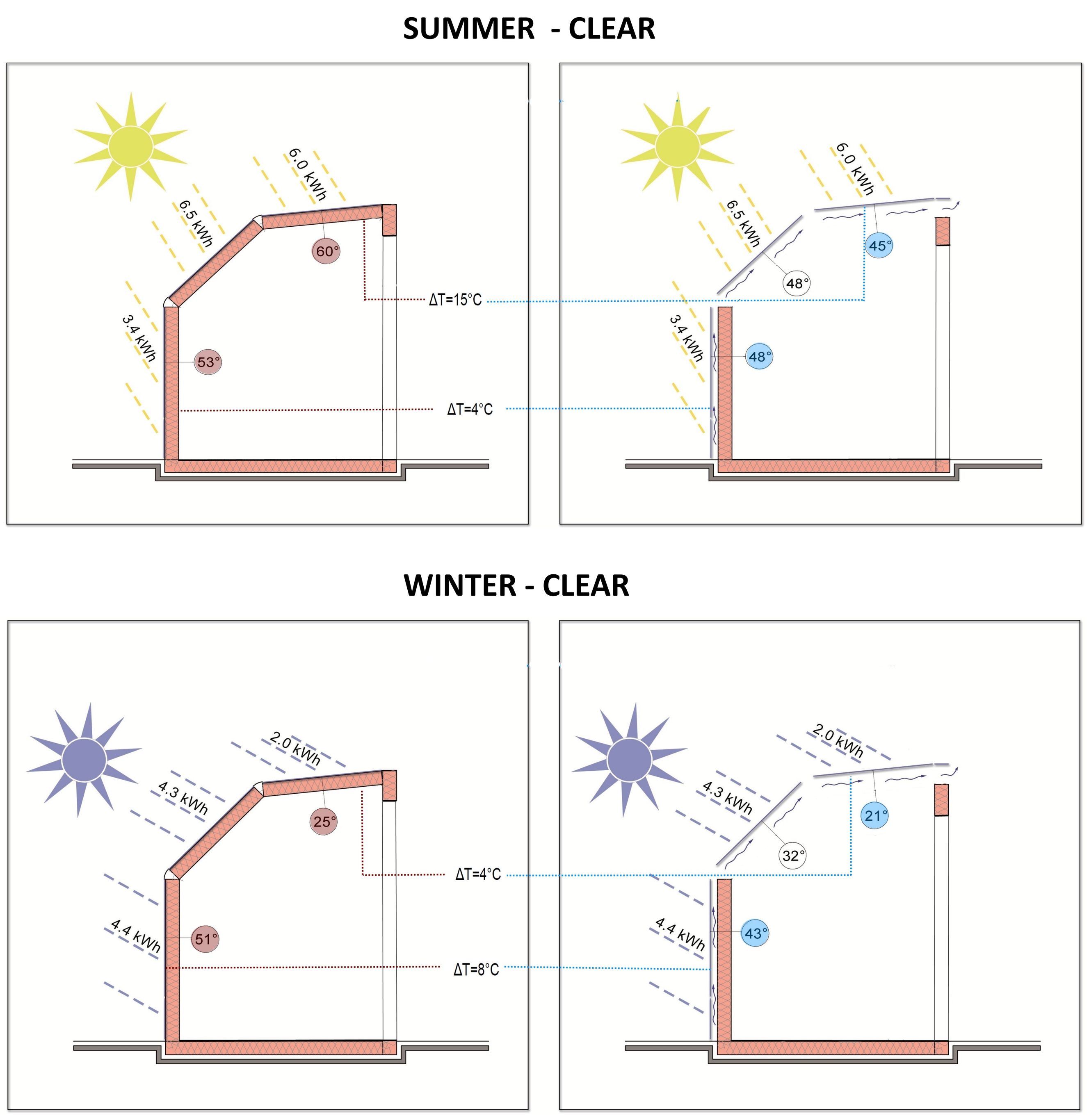

Fig. 3: Scenarios with daily average module temperature (G>0W/m²) and daily average irradiation for two different months of the year (August/summer and January/winter) and under clear sky con-

4. PERFORMANCE RATIO COMPARISON

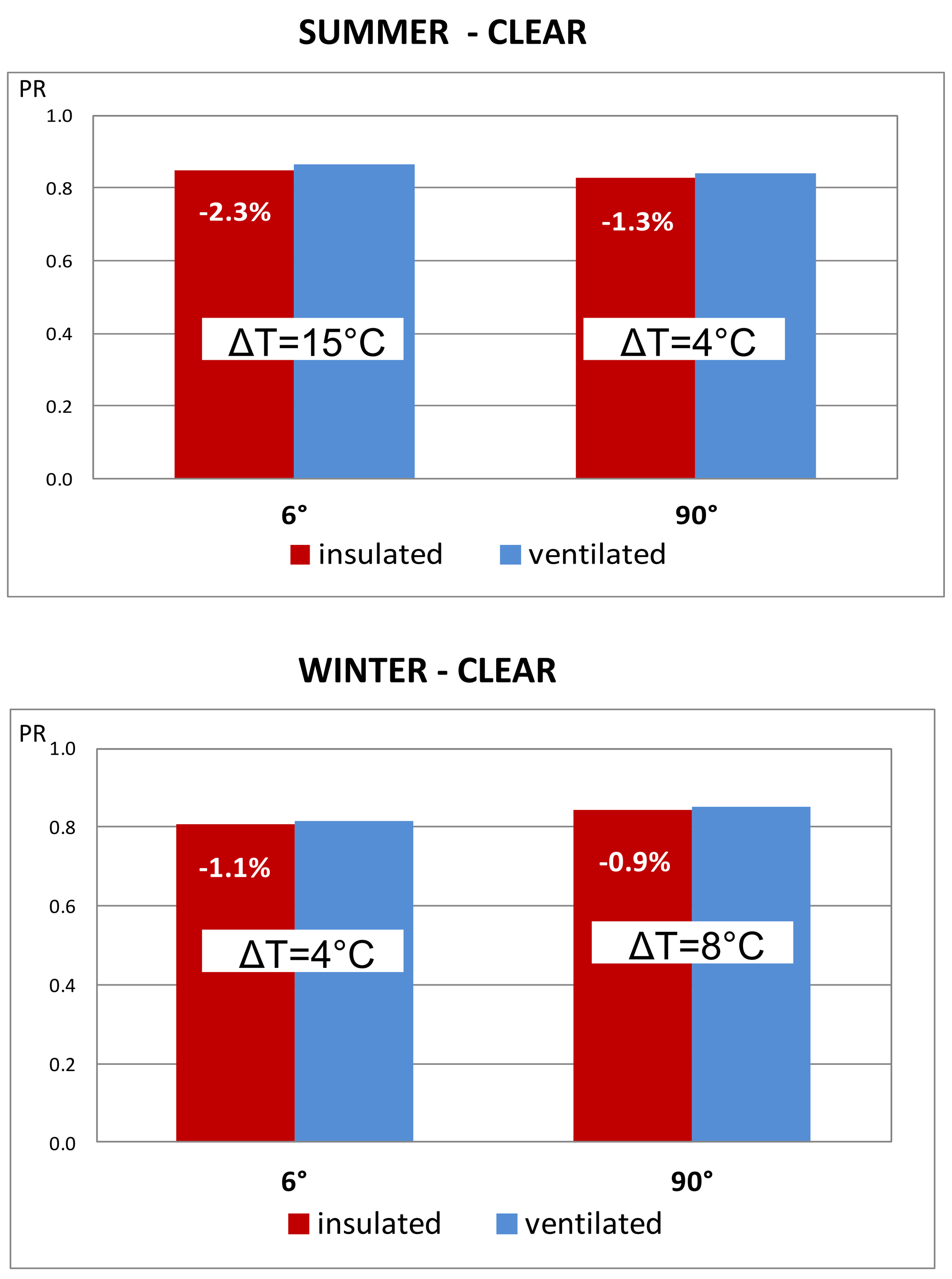

Fig. 4: Monthly mean Performance ratio and differences respect to the ventilated modules for the facade and roof top installation.

5. CONCLUSIONS

There are nowadays BiPV technologies able to be integrated as façade elements or roofs tiles, becoming part of the building envelope and that offer a good performance in terms of electrical power and thermal insulation whatever the type of installation is in direct contact with the building envelope or in a ventilated facade system. These photovoltaic systems could be used also as alternative added BAPV elements or integrated BIPV photovoltaic for retrofit solutions by combining high thermal insulation without compromising electrical performance and energy efficiency of the PV devices meaningfully.

Outdoor energy yield measurements confirmed, that façade or roof top integrated micromorph modules leads to the same performance, independently of the level of integration (thermal back insulation or back ventilation). The thermal losses (due to the negative temperature coefficient measured to be -0.3% °C) of the insulated façade modules are almost fully compensated by the annealing effects occurring at higher temperatures. The same case can be argued for the roof-top integrated modules.

Another aspect to be considered is the technological integration of the BIPV module in the building system by means of proper fastening system in order to secure the weather protection and guarantee the indoor comfort of the people.

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