

# HYBRID SOLAR / WIND (PVT / WT) BUILDING INTEGRATED SYSTEMS

Y. Tripanagnostopoulos<sup>1</sup> and S. Tselepis<sup>2</sup>

<sup>1</sup>Physics Department, University of Patras, Patra 26500 Greece  
Tel/Fax: +30 2610 997472, e-mail: yiantrip@physics.upatras.gr

<sup>2</sup>Centre for Renewable Energy Sources, 19<sup>th</sup> km Marathonos Av., 190 09 Pikermi, Athens, Greece  
Tel: +30 210 6603369, Fax: +30 210 6603301, e-mail: stselep@cres.gr

## ABSTRACT

Solar energy and wind energy are two renewable energy sources that can be effectively combined to produce electrical power by photovoltaics (PV) and wind turbines (WT) respectively. Hybrid PV/WT systems of several sizes have been developed and interesting results have been extracted from installations of these compound systems. Considering the application of PV and WT systems on buildings, the use of small size wind turbines is necessary. These WTs can be of horizontal or vertical axis, must be of low cut - in wind speed and also aesthetically compatible with the building architecture. PV panels are more flexible than WTs regarding size and installation requirements and have been already applied successfully in several buildings.

Photovoltaics convert a small part of the incoming solar radiation to electricity, with the greater part being converted into heat. This effect increases PV module temperature, resulting to its efficiency drop. The combination of the PV module with a water or an air heat extraction unit constitutes the hybrid photovoltaic/thermal (PVT) system, by which electrical and thermal output is simultaneously provided. Hybrid PVT systems can be integrated on buildings to cover electrical and thermal needs and are recently under development as alternative systems to the standard PV modules.

The extracted heat from the photovoltaics can be stored in water storage tank for liquid type PVT systems and in stones (or other material) for air type PVT systems. In countries where there is no special electricity buy-back tariff as well as in stand-alone applications (provided that the battery storage unit is charged), when there is surplus of electricity, then the electricity can be transformed to thermal energy and stored by the PVT system. Therefore, these multiple energy conversion systems are hybrid solar (electric and thermal) / wind (electric) systems (PVT / WT).

In this paper we present the concept of the hybrid PVT / WT systems, which combine photovoltaic, thermal and wind turbine subsystems, aiming to cover effectively electrical and thermal needs of buildings. The output from the solar part depends on the incoming solar radiation and is obtained during sunshine. On the other hand the output of the wind turbine part depends on the wind speed at the location of the installation and is obtained any time of the day or night that the wind speed is over a lower limit. Therefore the PVT and WT subsystems can supplement each other, being primarily used to cover building electrical load and secondary to increase the temperature of the existing thermal storage tank of PVT system by their surplus electrical energy.

Considerations regarding the use of hybrid PVT/WT systems in building applications are presented and basic subsystem combinations are described. Estimation about the cost and the benefits for application of them in buildings under weather conditions in Greece are given and aspects for improvements are analyzed. The resulting problems from the installation of the wind turbines on building roofs are discussed and alternative integration designs are suggested.

1 Author for all correspondence  
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