Photovoltaic Thermal Systems - Energy of the Future or a Gadget

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Abstract **The work presents a method of generating electric energy and thermal energy from solar radiation by means of a single PV/T system. Was also analyzed the advantages and disadvantages of such a system.**

Keywords **photovoltaics, solar collectors, photovoltaic thermal system**

I. INTRODUCTION

Constant increase of the demand for electric energy is visible in the dynamically developing field of technology connected with obtaining energy from renewable sources. The devices are characterized with higher and higher efficiency levels, and their prices fall to the level that makes them economic from the perspective of the consumers. Apart from developing the existing technologies, there are also attempts to combine them. One of such attempts is the photovoltaic thermal system.

II. WHAT IS A PHOTOVOLTAIC THERMAL SYSTEM

A photovoltaic thermal system (also referred to as a hybrid PV/T system or PVT) is a system which converts solar energy into electric energy and thermal energy. The system combines two phenomena. First of all, the system generates electric energy thanks to the photovoltaic effect, and the same device is also able to heat water thanks to the phenomenon occurring in the solar collectors (in some variations of the system, the air is heated directly). The goal of such a combination of two systems that have operated separately till now is combining their advantages [1, 2].

In order to obtain electric energy from photovoltaic sources, one must be aware that the nominal power of such sources is determined for the standard test conditions - STC, where the temperature of the cell is 25°C. Heating the elements to a certain level results in the proportional decrease of the power generation efficiency of the system. This dependency for a standard silicon battery is presented on Figure 1 [3].

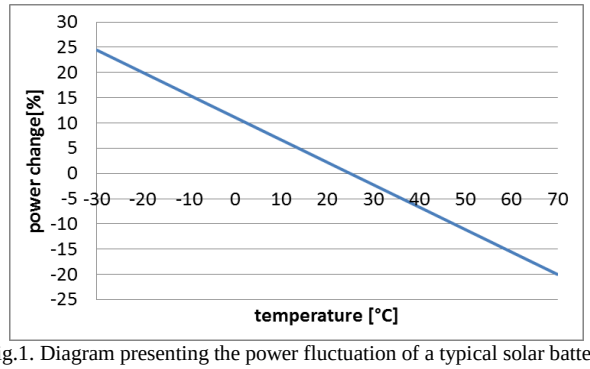

Fig.1. Diagram presenting the power fluctuation of a typical solar battery expressed as percentage in the function of temperature [4]

The cooperation of photovoltaics and solar collectors in a PVT system is focused on making the amount of electric energy generated from the PV elements independent from their temperature. Cooling the cells with liquid makes it possible to increase the efficiency of their operation during hot days. Additionally, the liquid that collects the heat can be used, for example, to heat utility water.

III. ADVANTAGES AND DISADVANTAGES OF PVT

The main advantage of using PVT, apart from lowering the operational temperature of photovoltaic cells, is combining two installations that have worked separately till now into one, thanks to which less space is required for the installation.

A disadvantage of the system is the interdependence of the two systems. The most appropriate time for the operation of the system from the point of view of system efficiency is the summer period which is characterized by high insolation and high temperatures. That is when both of the implemented systems achieve the highest operational efficiency levels. It is possible to obtain, on the one hand, low-temperature heat in the form of utility water heated to the temperature of 45°C, and on the other hand, PV operation at the lowest possible value of lowered temperature during favorable insolation conditions. Thus, in order for PVT modules to operate efficiently, the temperature of the cell should be maintained at a low level, that is 35-45°C. It must be underlined that the temperature of PV cells increases above 50°C relatively rarely.

Another disadvantage of PVT is the scale of the system. In the case of installations fitted on detached house, the photovoltaic system often takes the area of over a dozen to several dozen m^2, which means that a problem with consuming such a large amount of heat can arise in the summer period. At the same time, a hybrid PV/T will generate considerably higher heat loss than a standard collector installation in the winter period due to the lack of a selective absorber and the appropriate thermal insolation. This translates into lower temperatures of the heat medium that can be obtained from them.

IV. CONCLUSION

Although in theory PVT systems combine the advantages of two systems of growing popularity, in practice they seem to be a solution that has not been fully thought-out. Although the manufacturers assure 300 % higher efficiency in comparison to a standard PV installation, the increase will not be higher than several dozen % in real working conditions.

V. REFERENCES

[1] Mitică I., Andreea M.: "Energy efficiencies of a photovoltaic/thermal solar hybrid system", Annals of the University of Craiova, Electrical Engineering series, No. 32, 2008.

[2] Butera F.,Adhikari R. S.: "Hybrid Photovoltaic-Thermal Technology and Solar Cooling" http://www.pvdatabase.org 14:50 27.05.2013

[3] Sarnik M. T.: "Podstawy fotowoltaiki", Oficyna Wydawnicza Politechniki Warszawskiej, 2008.

[4] Szymański B..: „Małe instalacje fotowoltaiczne", Geosystem, Kraków 2013.