

The possibility of developing hybrid PV/T solar system

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Abstract. An alternative and cost-effective solution to developing integrated PV system is to use hybrid photovoltaic/thermal (PV/T) solar system. The temperature of PV modules increases due to the absorbed solar radiation that is not converted into electricity, causing a decrease in their efficiency. In hybrid PV/T solar systems the reduction of PV module temperature can be combined with a useful fluid heating. In this paper we present the possibility of developing a new hybrid PV/T solar system. Hybrid PV/T system can provide electrical and thermal energy, thus achieving a higher energy conversion rate of the absorbed solar radiation. We developed PV/T prototype consisted of commercial PV module and thermal panel with our original solution of aluminium absorber with special geometric shapes. The main advantages of our combined PV/T system are: removing of heat from the PV panel; extending the lifetime of photovoltaic cells; excess of the removing heat from PV part is used to heat the fluid in the thermal part of the panel; the possibility of using on the roof and facade constructions because less weight.

1. Introduction

Increased energy consumption and environmental degradation to climate change is one of the biggest global problems in the 21st century. Solution to both problems is in more intensive use of renewable energy sources, with an important role of solar energy [1]. The aim of this paper is to explore the possibilities for the development of combined PV/T solar panel that simultaneously converts solar radiation into electricity and heat. This panel is composed of a photovoltaic (PV) and thermal (T) modules assembled into a single unit.

Popularity of PV/T solar systems is increasing as they are reliable, flexible and environmentally friendly. Well-designed PV/T system, with appropriate efficiency, solves the problem of electricity and thermal energy supply of various residential buildings. The system is fully automatically controlled and maintains heating and cooling of thermally well insulated building, CO₂ emission-free.

2. Production and technical and geometric characteristics of new PV/T solar panel

For development of efficient PV/T system the structural characteristics and efficiency of PV/T panels that can be found on the market were analyzed. Obtained results showed that critical part of such hybrid system is mainly the thermal side. Thermal panels are usually made of copper pipes with flat absorber and the different quality of surface absorption. Considering the advantages and disadvantages of existing solutions, to increase efficiency and improve the design, the new solution for thermal panel is designed [2].



It takes into account the weight of the panel, primarily due to the load on the roof or facade construction, which can be significant, especially if the larger number of panels are installed [3]. Aluminium has good technical characteristics in terms of heat transfer and the possibility of adequate long-term surface protection. New thermal panel represents the integration of functional design and appropriate materials with special geometric shapes. The panel consists of a series of specially designed aluminium fins, placed in a aluminium thermo-insulated casing.



Figure 1. Absorber surface of solar panel with a schematic connection of absorber lamellae (cross-section)

The plate thermal panel is geometrically designed so that it can be combined with a commercial photovoltaic panel. All the necessary connections are adjusted for the system to function as a single unit – PV/T panel.

The PV panel characteristics:

Dimensions	1654x989x40 mm
Dimensions of cell	156x156 mm
Number of cells	60
Type of cell	Polycrystalline cells with 3 busbar technology
Maximum permissible load	6000 Pa
Front cover type	Micro structured solar glass in 3.2 mm thick
Frame material	Anodized aluminum
Panel mass	18,2 kg
Water content	5 kg
Nominal electric output	250 W



Figure 2. PV panel

When installing the PV/T system it was noticed that the most delicate is the problem of merging PV and T panels, where the most important is to achieve good surface contact for better transfer of heat from the PV to the T panel. This contact is improved by applying thermal paste [4].



Figure 3. PV and thermal part of solar panel before finishing

The PV/T panel characteristics:

Dimensions	1654x989x40 mm
Effective area	1,62 m ²
Panel mass	28 kg
Water content	5 kg
Nominal electric output	250 W



Figure 4. Finished PV/T solar panel

3. Conclusion

- The dissipation of heat from PV to the of thermal panel (water-cooling), results in longer service life of PV cells and the whole PV/T panel due to the better working conditions, while producing more electricity than a conventional PV panel;
- The excess heat which is removed from the PV part is used to heat the fluid in the thermal part of the panel;
- Less surface area is required for the installation of PV/T system compared to conventional PV and thermal panels which results in lower load to the bearing structures in the period of exploitation;
- More precise effects and results of this model PV/T panel can be expected after the completion of thermal testing, and through monitoring in operation for a longer period of time.

References

- [1] Tripanagnostopoulos Y, Souliotis M, Makris Th, Georgostathis P and Sarris M 2010 *Design and Performance of a Hybrid PV/T Solar Water Heater*, CP1203, 7th International

- Conference of the Balkan Physical Union, pp 1019-1024
- [2] Dobrnjac M, Latinović T, Dobrnjac S and Živković P 2016 Increasing the Efficiency of Solar Thermal Panel, *IOP Conf. Ser.: Mater. Sci. Eng.* **144** 012011
- [3] ***Deutsche Gesellschaft für Sonnenenergie 2005 *Planning and Installing Solar Thermal Systems: A Guide for Installers, Architects and Engineers*, Earthscan
- [4] Kozić Đ and Dobrnjac M 2013 *Development of solar collectors regarding efficiency increasing and the price decreasing*, International Conference on Sustainable Energy & Environmental Protection SEEP 2013, Maribor, Slovenia