Solar Photovoltaic Thermal (PVT) Co-generation System

Technology Indigenously Developed by CSIR-CEERI

The solar water heaters market size was valued at USD 2.05 billion in 2016 and is predicted to exhibit a CAGR of 8.1% by 2025[1]. This can be attributed to increasing energy prices, growing global population, and rising demand for energy-efficient water heaters. As per the report published by the MNRE, there is a demand of 586.41 ktoe/annum of low temperature heating application. If this demand is met by solar thermal technologies, the estimated total savings will amount somewhere in excess of 13 billion INR[2]. In addition, Government of India has targets to deploy 40 GW of rooftop solar PV under the National Solar Mission scheme. If these targets have to be met, innovative technologies have to be deployed. **Keeping current trends and requirements in mind, CSIR-CEERI has developed an indigenous hybrid dual output photovoltaic thermal system.** Conventional solar photovoltaic panels operate at an efficiency of about 15-20% losing most of the input solar energy as waste heat. Solar Photovoltaic Thermal (PVT) Co-Generation system has significant potential to extract the waste heat from the solar panels at the same time maintain the electrical efficiency of the panel.

The concept is realized by deploying a heat exchanger below the solar cells which effectively cools the solar cells and at the same time converts the waste heat energy into useful form of energy. The PVT system has been developed in two different configurations: Single glass mode where PV panel substrate is directly placed over the heat exchanger resulting in better electrical output and double glass mode where an additional glass pane is placed above the solar panel to trap the heat resulting in higher thermal output. The system has been optimized keeping in mind the various aspects of the PVT system such as configuration and material of the heat exchanger, air gap between the glass pane and solar panel, back insulation material, number of tubes in heat exchanger and so on. The field testing results of 1 kW_e and 2 kW_{th} PVT system has been very promising with outlet water temperature in the range of 50-60˚C at volume flowrate of 250-300 LPD of water. The additional advantage of this system is that the electrical and thermal energy output of the system can be tuned depending on the requirements of the customer.

Further, the technology is integrated with IoT system for real time performance monitoring and predictive maintenance. The predictive maintenance framework enables to understand soiling phenomenon which can cause upto 10-20% drop in performance over a period of 1 month. Intelligent control algorithms implemented with the IoT framework maintains the system at optimal performance by controlling water flow rates, notifying cleaning schedules and so on.

[1] Solar Water Heaters Market Size, Share & Trends Analysis Report, By Technology (ETC, FPC, UWC), By Application (Residential, Commercial, Industrial), By System, By Region, And Segment Forecasts, 2018 - 2025

[2] https://mnre.gov.in/sites/default/files/uploads/Solar_Applications_in_Industries.pdf

Figure 1. 300 W_e PVT system

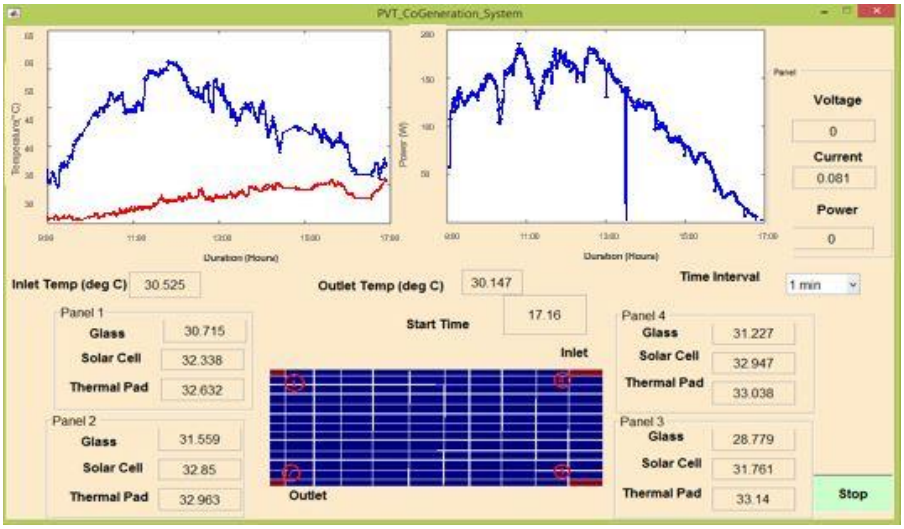

Figure 2. Dashboard for data acquisition system

The technology can be deployed on the roof tops of domestic as well as commercial buildings and industrial roof-tops such as textile, automobile industry, dairy-pasteurisation industry etc. requiring low temperature heat where the hot water from the PVT systems can be directly utilized or can be used as pre-heater. The solar PVT system is anticipated to provide >20% cost savings and >50% roof space savings compared to standalone solar PV and solar thermal systems. The technology holds potential especially for GRIHA and LEEDS rated Net Zero Energy Building where roof top area is premium.