RUTGERS
THE STATE UNIVERSITY OF NEW JERSEY

Photovoltaic and Thermal System

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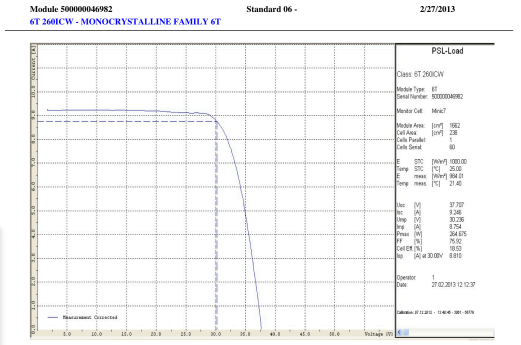
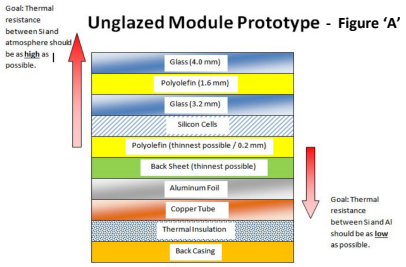
ABSTRACT

Photovoltaic Systems (PV) have been developed over the years as an alternative way to resolve the issue of limited energy resources; however, due to its operating properties, this clean source of energy is very inefficient. Solar panels are usually installed on rooftops, and can reach very high temperatures. In a normal PV system, this heat is wasted energy. In this project, combining conventional PV with a thermal system is shown to radically increase the overall efficiency of a system up to 65%, compared to less than 20% for a PV system without a thermal component.



DESIGN



The design of our project is based on a 6T solar panel. This is the standard panel used for a rooftop PV system. The first six layers in Figure 'A' are the usual layers of a PV system. The bottom four layers constitute our project's customization. We affixed an aluminum sheet to the back of the panel to help spread the heat over the entire surface area, and a network of copper piping touching the aluminum. The aluminum and the piping were covered with insulation, and a plywood board screwed into the solar panel frame to squeeze the layers together. We tested the input and output water temperature at various flow rates using a thermal couple probe and the incident solar energy using a solar data logger.

Pictures of Our System

RESULTS

Our testing revealed that the thermal efficiency was between 37% and 47%, depending on the flow rate of water through the pipes. (Figure 'B') This means that an average of 42% more energy is being utilized than in a stand-alone PV system. The overall efficiency is the addition of the electrical and thermal efficiencies, and this value ranges from 55% to 65%. A large percentage of a building's energy usage goes to creating hot water for facilities and heat. With a PVT system, almost all of a residence's energy needs can be met.

Our system would be a wonderful fit for areas of the world that rely solely on electric for heat and hot water. In areas with natural gas, the return on investment varies. However, in the electric only areas, our system is a great choice. Figure 1 illustrates areas of the US and their use of various fuel sources. It is clear from this graph that quite a few areas in the US would benefit from our system because of the predominance of electric heating.

Figure 'B' – Performance Analysis of PVT Module

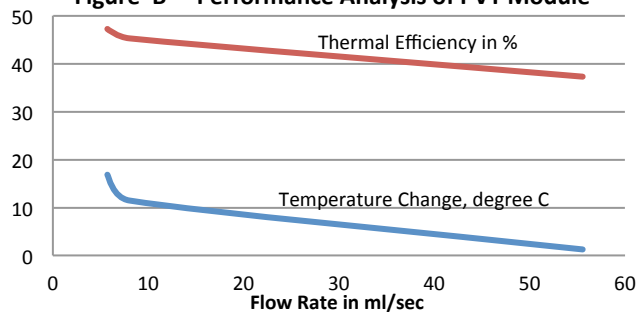
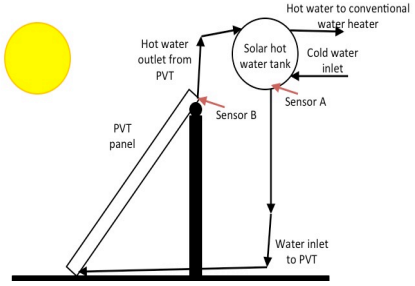


Figure 'C' - Schematic of PVT solar system



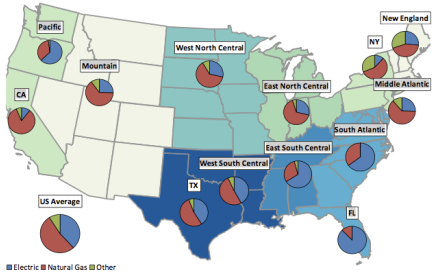


Figure 1. Regional distribution (by U.S. census region) of the number of houses using a particular water heating fuel type

Source: EIA 2005