Phase Change Material Based Thermal Energy Storage for Higher Efficiency Photovoltaics

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The solar to electrical conversion efficiency of photovoltaic panels suffers when they operate at elevated temperatures. It was hypothesized that a passive phase change material (PCM) based thermal energy storage system would improve the efficiency of photovoltaic panels at low cost. Two identical solar panels were kept in the sunlight under identical ambient conditions. One panel was fitted with the thermal energy storage system and the other unmodified panel was the control; each panel was connected to a water heater. Coconut oil was used as the phase-change material. The panel temperatures, voltage, and current were measured at regular time intervals. The bare panel temperature increased 39° F above ambient while the panel with the PCM attained a maximum temperature of 9° F above ambient. Due to lower operating temperatures, about 9% more electrical energy was obtained from the panel with the PCM. The cost of such a system is estimated to be about 6% of the cost of the panel, making it cost effective. The PCM absorbed heat from the attached solar panel, thus keeping the photovoltaic cells closer to optimal temperature. Complete solidification of the PCM overnight was observed so the process could continue again the next day. Computer simulations were conducted to evaluate the effectiveness of such a system in 51 different US cities. Results showed that the PCM based system will provide an approximately 16 to 20% increase in energy conversion by photovoltaic panels in the southwest and 8 to 12% in the north.

Awards Won:

Third Award of $1,000