JIMMY CHACIGA **PHD THESIS ABSTRACT**

TITLE: DEVELOPMENT OF SOLAR THERMAL ENERGY STORAGE TECHNOLOGY FOR OFF GRID COOKING APPLICATIONS

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ABSTRACT

This study presents the design and development of a solar photovoltaic (PV) cooker integrated with a energy storage system (TES). Thermic AXCL heat transfer oil and rock pebbles were used as sensible energy storage materials. Two types of TES systems were developed; a single tank TES system with an internal cooker, and a dual tank TES with an external cooker. A heating funnel in the form of Y-shape was integrated in each design to charge a small volume of heat transfer oil. A cooking unit sits on top of the heating funnel. 1.8 kW solar PV array was used to generate and supply DC electricity through an MPPT load controller to the DC/AC resistive heating element. During charging, the oil at the top of the funnel attains higher temperatures in a short time; this allows for immediate cooking. The funnel barrier height and oil flow rate can be regulated to vary the temperature at which hot oil overflows into the tank. The hot oil expands, and overflows into the TES tank while cold oil enters the funnel from the bottom to be heated. The system is based on self-circulation without mixing of cold and hot oil and no pumping was required. It was observed that, the funnel system was able to charge the oil to an average temperature of 200 ^{o}C in less than 1 hour. The single tank and dual tank can store energy up 2.5 kWh and 9.0 kWh respectively suitable for cooking. Cooking can be done during charging and discharge process. Several cooking tests were demonstrated using the systems; 10 L of water boiled in 25 minutes consuming 0.986 kWh of energy; 3 kg of rice boiled in 1 hour consuming 0.556 kWh. In addition, 1.26 kWh of energy was used for boiling and simmering of 3 kg of beans within 2-3 hours. A charging efficiency of 71.9 % was obtained for single tank and 57.4 % for the dual tank system. Cooking efficiency of about 75.0 % and 59.4 % were obtained during charging and discharge cycles respectively. A low-cost Arduino data logger for temperature and power logging was able measure and records data as a stand-alone device useful for field deployment. The systems are easy to operate and highly scalable for indoor household and institutional solar cooking with a lot of potential to reduce the use of woodfuels.

Keywords: Solar Cooking; Funnel system; Photovoltaic (PV) heating; Single tank system; dual tank system; energy storage system.