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1. Problem

Solar energy is clean, abundant, and sustainable. However the wide-spread adoption of solar energy is hindered by three grand challenges, low efficiency, high cost, and intermittence of solar technologies. Even thought the rapid progress of technology has decreased the price of photovoltaic panel by factor 90% from 2009, solar energy is far from the main stream of power supply yet, up to the present, solar energy still contributes less than 3.5% to the global power supply. In order to make solar energy the main stream of the global power supply and ready to replace fossil fuel to reduce carbon emission and reverse the trend of global warming, revolutionary technologies are necessary to address the three grand challenges.

2. Solution

2.1. Technology description

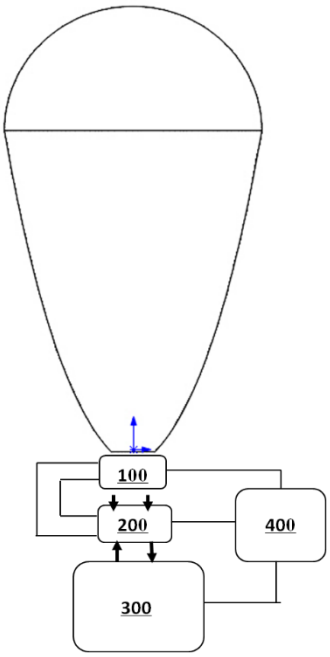

Fig.1 Schematic indication of the system configuration

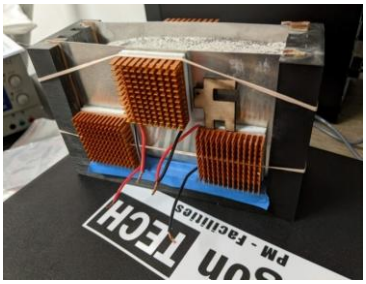

Fig.4 Sand thermo-electric energy storage package

As shown in Fig.1, this project proposes a thermo-electric energy storage system based inflatable non-imaging non-tracking solar concentrator CPVT power system comprising an inflatable non-imaging non-tracking solar concentrator, a hybrid photovoltaic and solar thermal panel as receiver **100**, thermo-electric modules **200**, a sand thermal storage package **300**, and an automatic control system **400**. Wherein, the inflatable non-imaging non-tracking solar concentrator is assembled with an inflatable non-imaging concentrator and a domed flexible optical cover made of divergent Fresnel lens. When sunlight obliquely incidents on the top of the solar concentrator, it will be diverged first by the divergent Fresnel lens then concentrated by the inflatable non-imaging concentrator to realize high concentration ratio. The concentrated sunlight is coupled onto the hybrid photovoltaic and solar thermal panel as receiver to cogenerate electric power and thermal energy. The cogenerated thermal energy is extracted, boosted up in temperature by the thermoelectric modules which are working in the heat pump mode, and stored into the sand thermal storage package during daytime. During nighttime, the stored thermal energy is extracted by the thermal electric modules which are working in generator mode to regenerate electric power. The control system is employed to switch the modes of the thermo-electric modules and control other actions of the system.

In this configuration, SolenSphere's patented inflatable non-imaging non-tracking solar concentrator is deployed to dramatically shrink the area of the receiver and tremendously reduce the cost of the entire CPVT system; the hybrid photovoltaic and thermal panel is adopted to increase the efficiency about 20% of the conventional pure photovoltaic system to total efficiency about 70% of the hybrid photovoltaic and solar thermal cogeneration system; sand is selected as thermal storage medium, and the mode switchable thermo-electric modules are selected to boost temperature of the cogenerated heat for storage and extract

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Fig.2 Prototype of the inflatable non-imaging non-tracking solar concentrator based CPVT system as an e-bike solar charging trailer

Fig.3 The inflatable non-imaging solar concentrator without domed flexible divergent Fresnel lens cover

the stored heat to regenerate electric power.

3. Accomplishments and Team

1) Experimentally Verification of the Inflatable Non-imaging Non-tracking Solar Concentrator Based CPV System

The goal of this experiment is to verify the function of the domed flexible divergent Fresnel lens on the top of the inflatable non-imaging solar concentrator through comparison of the photovoltaic performances of the CPV systems with and without the domed flexible divergent Fresnel lens cover. Shown in Fig.2 is the inflatable non-imaging solar concentrator with domed flexible divergent Fresnel lens cover. Shown in Fig.3 is the inflatable non-imaging solar concentrator without domed flexible divergent Fresnel lens cover. In the experiment, the inflatable non-imaging solar concentrator is mounted on a small trailer with 156x156 mm mono-crystalline silicon solar cell laminated in between of two transparent polycarbonate sheets to form a panel as receiver to form a CPV system.

2) Experimentally Verification of the Sand Thermo-Electric Energy Storage System

One of the key points of the present approach in addressing large scale solar power generation and energy storage is to employ sand as the thermal medium to store the thermal energy cogenerated by the CPVT system. Shown in Fig.4 is the thermo-electric energy storage package, in which 2 sets of 4 thermoelectric modules are arranged on both sides of the package.

4. Request for Technical Assistance

1) Research and development of silicon rubber based divergent Fresnel lens as the domed flexible cover.
2) System integration and testing assistance from national labs or other research labs.
3) Product development assistance from any organizations
4) Product manufacture assistance from any organizations
5) Technology commercialization assistance from any organizations
6) Financial assistance from any organizations
7) Product design assistance from any organizations
8) Advertisement business development assistance from any organization
9) RV EV charging station business development assistance