

Energy-free PV Cooler and Water Harvester

Energy & Environment

Energy Conservation/Generation/Management/Storage (Battery)

Technology background

Commercial PVs can only convert ~15% of sunlight into electricity, with the rest wasted as heat. High PV temperatures decrease efficiency, shorten the lifetime and cause fire risks.

Solar-abundant areas are always water-stressed areas. Local residents struggle to meet their basic needs, let alone consume large precious water to cool PVs.

Critical Needs

1. Cool PVs
2. Produce H₂O

PV cooler

Fig. 10(c) demonstrates the lab test of a basic PV module (RP) and a PV module with this invention (Thermal management). Under the solar simulator (1400 W/m²), this invention provides an average temperature drop of 18 °C, increasing the PV efficiency by 9%.

Fig. 10(d) presents the field test results under the transient ambient conditions. This invention can efficiently suppress high temperatures, especially in high irradiance hours.

Water harvester

Vapor condensation, Water areas, Collected water

Water production rate: ~500 mL/(m²·h)
Daily water consumption for adults: 3.7 L/(man)

Using 1m² of this invention can produce drinking water for 2 adult men. In addition, it can be used for irrigation.

Working Principle

This invention provides a solution to this problem and is based on a desorption-sorption cycle. It enables us to use water from the atmosphere to suppress high temperatures in PVs for performance improvements. Simultaneously, we can use it to produce water for drinking, cleaning, and irrigation.

PV cooling

It desorbs water vapor under sunlight, dissipating waste heat from PV to ambient. PVs can generate more electricity in the daytime.

Moisture recovery

It absorbs moisture from the ambient at night, recovering sorbent material for the next-day thermal management.

Water harvester

It can produce drinkable water using a condensation chamber while performing PV cooling. The vapor condenses in the bottom of the chamber and then can be collected for use.

Benefit and impact

Improving PV efficiency by ~9% using atmospheric water. This method is energy-free, and high-flux, especially suitable for remote and arid areas.

Producing drinkable water for residents. Using 1m² of this invention on PV can produce drinking water for 2 adult men on a sunny day.

Integrating with agriculture and forestry. Sustainable energy and water enhance food agriculture and combat desertification.

Remarks

48th International Exhibition of Inventions Geneva (IEIG) (2023) - Gold Medal

IP Status

Patent filed

Opportunity

Commercial Photovoltaics (PV) can only convert ~15% of sunlight into electricity, with the rest wasted as heat. The resulting high PV temperatures decrease the efficiency, shorten the lifetime, and cause fire risks, thus should be suppressed. However, existing PV thermal management relies on either some active system designs with high energy/water consumption or passive designs with low cooling powers, which exhibits low practicability to solve this problem. In addition, solar-abundant areas usually face water scarcity problems. Residents struggle to meet their daily needs, let alone use water to cool PV. These dilemmas call for innovation to address PV thermal management in a high-flux, energy-free, and water-free way.

Technology

This invention provides high-flux passive cooling for the thermal management of PV via a moisture desorption-absorption process without energy consumption. It desorbs water vapor under sunlight, dissipating waste heat from PV to ambient. It absorbs moisture from the ambient at night, recovering sorbent material for the next-day cooling. The desorbed vapor can be condensed for drinking, irrigating, and PV cleaning. This invention can promote the development of efficient, reliable, and versatile solar power technologies.

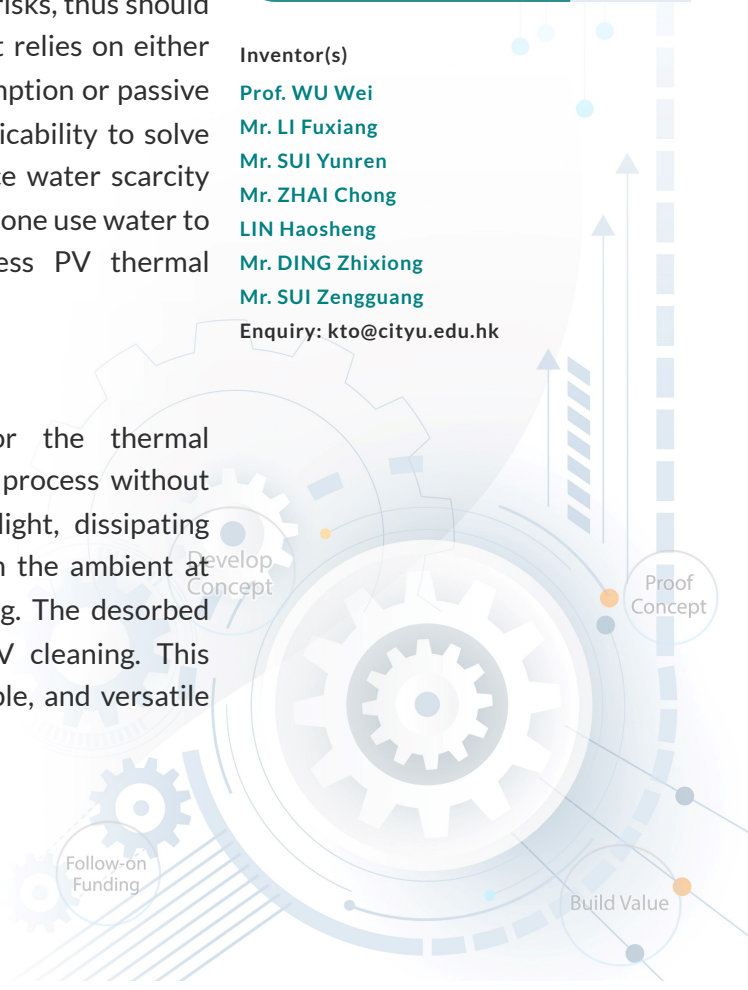
Advantages

- High flux cooling via moisture desorption and evaporation
- Energy-free and self-recovery
- High water yield

Technology Readiness Level (TRL) ?

6

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- Low-cost raw material and facile fabrication

Applications

- PV plant thermal management
- Remote and off-grid area energy and water production
- Support farming and forestry in the arid area

