High Efficiency Concentrated Solar Power System
Technology #16037

Applications

Concentrated Solar Power (CSP) refers to a method of harvesting solar energy, using an array of mirrors (heliostats) to reflect sunlight onto a heat engine in a central receiver. The heat engine converts the reflected thermal energy into mechanical energy, typically by heating a fluid to power a steam turbine. The technology here proposes a system of heliostats and a ground-based receiver that improves on the overall efficiency of existing CSP systems.

Problems Addressed

Current CSP systems are highly inefficient for several reasons. Firstly, in order to maximize the amount of sunlight reflected onto the receiver, the receiver must be placed as high off the ground as possible. However this incurs additional construction costs; requires additional energy to pump the fluid to such a height; and incurs additional heat loss as the fluid travels the greater distance. Secondly, CSP systems cannot distribute energy at night. Unfortunately, the current cost of batteries do not make it cost effective for the extra energy harvested during the day to be distributed once the sun has set. Thirdly, the fluids used to store heat can typically only store energy to a certain temperature, wasting the remaining thermal energy.

All of these inefficiencies mean that CSP systems must typically be supplemented by fossil-based energy sources, in order to provide a consistent and sufficient energy supply.

Technology

The current technology addresses these challenges by proposing a system configuration where the array of heliostats is placed on a hillside — the arrangement of which can be determined by this complementary technology (MIT Case 14620) — and sunlight is reflected towards a receiver that is buried in the ground. Elevating the heliostats in such a manner allows the angle between the sun and receiver to be optimized without having to raise the receiver off the ground.

With the receiver placed in the ground, the system no longer needs to incur additional energy and costs to pump the heat storage medium around — instead, it is fixed in place in a tank, where the ground can serve as an added natural insulator. Additional features of this receiver can also allow it to store thermal energy much more effectively than existing solutions, as detailed in this complementary technology (MIT Case 16038). Instead of a fluid, this receiver can also contain molten salt, the composition of which can be designed to store a greater amount of thermal energy, as detailed in this complementary technology (MIT Case 13251).

Advantages

- Leverages natural landscape to increase efficiency
- Allows storage of excess thermal energy
- Reduces financial and energy cost of circulating a heat storage medium
The overall system is lower cost and more efficient as a result

**Related Technologies**

High Efficiency Concentrated Solar Power System is connected to High Efficiency Concentrated Solar Power Receiver, Case Number 16038. It is also connected to Solar Absorption Material for Concentrated Solar Power, Case Number 13251, as well as High Efficiency Concentrated Solar Power System, Case Number 16037.

**Categories For This Invention:**

- Energy
- Energy Storage
- Thermal Storage
- Solar
- Solar Thermal Conversion

**Intellectual Property:**

Concentrated solar power system  
Issued US Patent  
9,273,883

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**Publications:**

- Preliminary Optical, Thermal and Structural Design of a 100 kWth CSPonD Beam-down On-sun Demonstration Plant  
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  August 2015
- Design of a 100 kW Concentrated Solar Power on Demand Volumetric Receiver With Integral Thermal Energy Storage Prototype  
  July 2015
- Experimental Investigation of Divider Plate Assisted Thermocline Storage  
  June 2015
Optimal Design and Operation of a Solar Energy Receiver and Storage
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July 7, 2011

External Links:
Precision Engineering Research Group
http://pergatory.mit.edu/

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