Sun catcher in the spin cycle

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DLR has developed the 'CentRec' centrifugal receiver, an innovative concept for solar tower power plants

In a new radiation receiver developed for solar tower power plants, ceramic particles of around one millimetre in size are heated to 1000 degrees Celsius. The particles are held in a drum inside the rotating receiver by centrifugal force, until they become hot enough to drive the steam turbine in a power plant, for example. An initial receiver prototype has been developed at the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) Institute of Solar Research in Stuttgart.

Heat transfer system and storage medium in one

In a solar tower power plant, numerous moving mirrors known as heliostats focus the Sun's radiation and reflect it onto the top of the tower, where the radiation is absorbed by a 'receiver' and converted into heat. With the new CentRec concept, ceramic particles are irradiated directly in the receiver, absorbing the solar energy. The heated particles then gradually fall out of the washing-machine-drum-shaped receiver, which is pointing downwards, into thermally insulated containers. There, the solar heat energy can be used directly and coupled to the power generation process to produce electricity. Another advantage of the concept is that the heated ceramic particles can also be used as a storage medium, by being stored in unpressurised, insulated containers. When heat energy is stored in this way, a power plant remains capable of feeding electricity into the grid after the Sun has set.

Flexible usage options

Reiner Buck, head of the Department of Point Focussing Systems at the DLR Institute of Solar Research, sees another major advantage of the CentRec concept in its great flexibility: "The rotation speed of the drum enables control of the period of time that the particles spend in the receiver, and so their temperature when they leave it – regardless of the process the heat energy is to be used for." Besides its use in the power generation process, the heat energy stored in the ceramic particles can also be used as high-temperature process heat in industry. In such cases, the heated particles, which have a very high energy density, can easily be transported to the place of use.

Greater effectiveness through higher process temperatures

The ceramic particles can be heated to up to 1000 degrees Celsius. This is significantly hotter than the liquid salts currently used as heat transfer agents in power plants, which can only be heated to 565 degrees Celsius. "Ceramic particles enable power station operators to work at higher process temperatures of between 600 and 800 degrees Celsius and achieve a higher level of efficiency in the power generation process," explains Buck. The researchers also expect lower power production costs from the relatively low component costs of the system, especially the receiver and the ceramic particles.

The prototype receiver, which has a capacity of 10 kilowatts, has been successfully tested using the high-flux solar furnace at DLR Cologne. In the coming years, the researchers intend to test the CentRec concept at the DLR solar tower in Jülich , using a larger centrifugal receiver with an output of 500 kilowatts.

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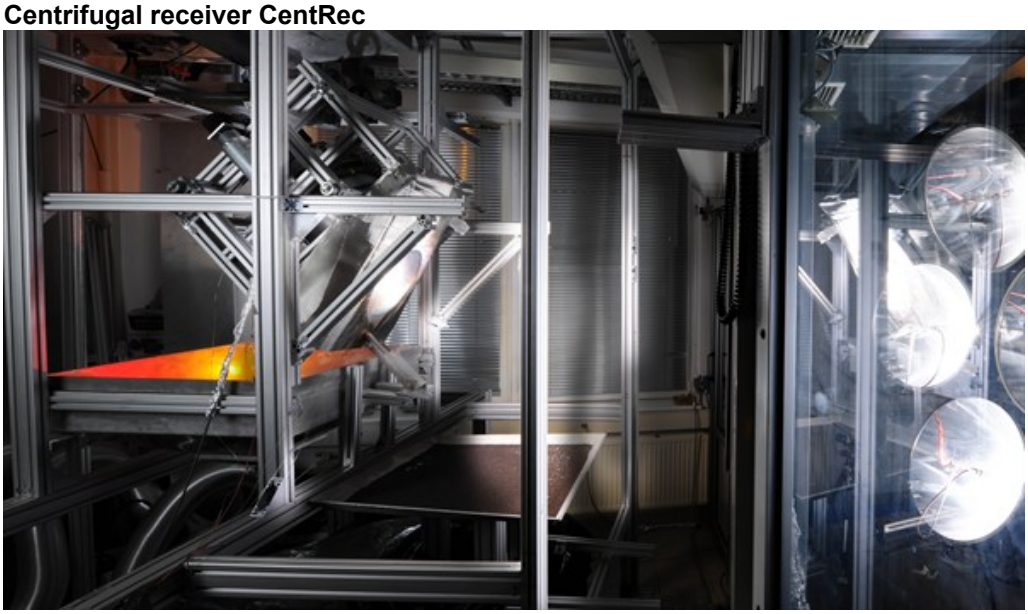
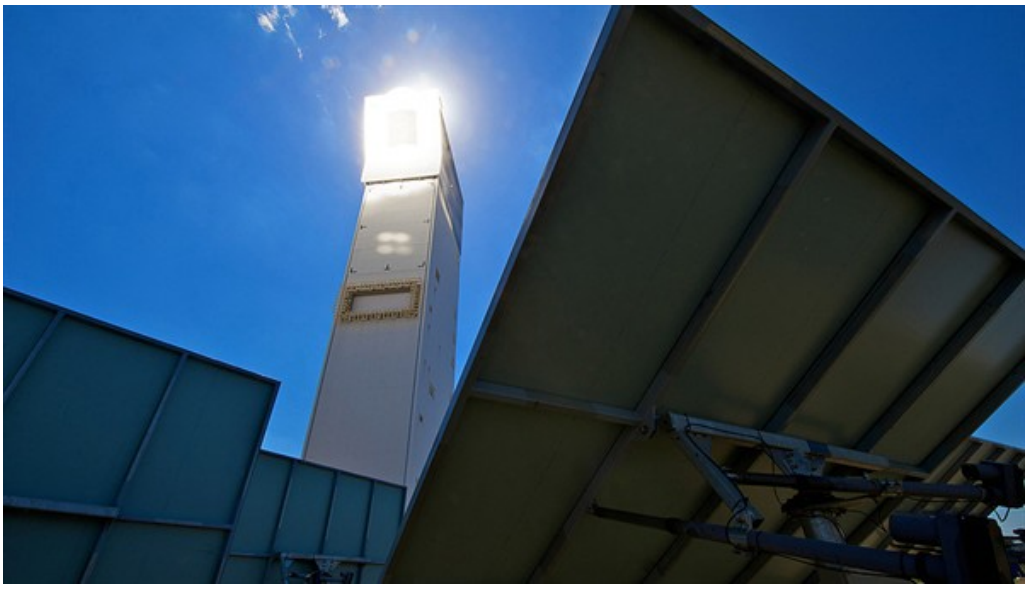
Centrifugal receiver CentRec



Novel receiver being tested with high-performance radiators at the DLR solar furnace in Cologne.

Solar Thermal Test and Demonstration Power Plant Jülich



The solar tower power plant in Jülich serves as a pilot plant and reference for commercial power plants in Southern Europe and North Africa. A nearly identical power plant is currently at the detailed planning stage in Algeria. Technology developed in Germany is being utilised in regions

where solar radiation is highest. Here, solar thermal power plants have the greatest potential to play a major role in the desert electricity project DESERTEC.

Credit: DLR/Lannert.

Heat exchangers and storage medium in one

Ceramic particles about one millimetre across are directly irradiated in the receiver – they act as both heat exchangers and a storage medium.

Credit: DLR (CC-BY 3.0).

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