Test opportunities at the Jülich solar towers

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Research for solar thermal power plants, for future solar fuels and CO_2-free industrial processes

At DLR Jülich the Institute of Solar Research is testing new components and processes to further develop solar tower power plants. The aim is to reach higher temperatures and better efficiency in order to lower the electricity production costs. The focus is on heliostats, solar absorber, different heat transfer media and energy storage systems and the effective use, as well as theoretical and computer-aided analyses and automation. Depending on the development status and goal, individual components, functional groups or even a complete solar power plant system can be tested, evaluated and optimized.

In addition, the DLR Institute Future Fuels is investigating manufacturing processes for solar fuels such as hydrogen and the use of high-temperature solar heat for industrial processes.

Two solar towers, four experimental levels

In front of the two Jülich solar towers, there are more than 2 000 heliostats each with an area of 8.2 square meters. HeliOS, a control software developed at DLR, can align subsets of heliostats in such a way that several experiments can take place on the two solar towers at the same time. The larger of the two towers is a functioning solar tower power plant, so it can actually produce electricity.

A volumetric air receiver at the top of the tower picks up the concentrated sunlight, heats the ambient air to up to 700 degrees Celsius which drives a water steam cycle. A ceramic 10 MWh heat storage is integrated into the power plant. The nominal electrical output of the system is 1.5 megawatts. Modifications and assistance systems can be added to the plants control system to test e.g. autonomous operation and artificial intelligence supported systems in a safe environment. The tower is 60 meters high and has a research level at half height, on which different experimental setups can be set up. In the large-scale experiments carried out so far, the focus was on the further development of volumetric receivers and processes for the solar thermal production of hydrogen.

Since 2020, the solar tower power plant has been supported by the somewhat smaller so-called multifocus tower. There are three levels with special equipment for the installation of specific experiments. On the upper level, scientists from the Institute of Solar Research test a particle receiver with ceramic beads as a heat transfer, storage and transport medium. The middle level is specially equipped for thermochemical applications. There, high-temperature processes for solar water splitting are tested. On the lower level, the focus is on molten salt as a carrier medium for high-temperature heat. This is also where the pump, tank and heat exchanger for this system are installed and used.

Test equipment at experimental levels

The experimental levels at the multifocus tower have an almost identical equipment. Each have an area of 64 square meters and a height of six to nine meters. Test stands up to a weight of 100 tons can be placed there. Water cooling of 2 megawatts and an air ventilation with more than 10 000 m³/h is supplied. Optical and infrared supervision cameras give a good insight into the progress of the experiments if access is restricted for safety reasons. The experimental levels can be accessed via the external lift. Technical gases (CO_2, CH_4, N_2, H_2, O_2, He, SO_2, pressurized air) can be fed into the experiments from the gas storage at the outside of the towers. The experimental level at the solar tower is equipped for slightly smaller test stands as weight limit is 10 tons and the usable height of the room is three meters. The maximum energy and flux density delivered by the heliostat field is similar for each experimental level. The maximum energy is limited only by the cooling capacity and the flux can reach more than 1 000 kW/m².

Research facility	Jülich Solar Power Tower		Multi Focal Tower		
	Research platform	Experimental power plant	Platform 1	Platform 2	Platform 3
DLR site	Jülich, Germany				
Max. solar power [kW]	1000 (limited due to cooling capacitiy)	11700	2000 (limited due to cooling capacitiy)		
Peak flux density [MW/m²]	1*	1*	1*		
Max. aperture (width x height) [m x m]	7 x 3	-	4 x 4.5		4 x 5.5
Useable test space (area x height) [m² x m]	90 x 3	-	64 x 6.4	64 x 7.5	64 x 9.4
Max. weight of test object [t]	10	-	100		
Cooling	water cooling 2 MW	-	water cooling 2 MW + air ventilation up to 4m³/s		
Connections	AC, water, CH_4, press. air, Ethernet	-	AC (100kW + 20kW UPS), water 60L/min, gases (CO_2, CH_4, N_2, H_2, O_2, He, SO_2, press. Air), Ethernet		

* at 850 W/m² direct normal irradiation

Outdoor infrastructure

The site offers access for large trucks. Test stands and facilities can be prepared at the wide assembly area directly besides the towers. There is sufficient space to lift in components with mobile cranes. For components up to 5 m * 2 m and a weight up to 4 tons the lift behind the multifocus tower can be used. At different areas of the site it is possible to temporarily place containers for interim storage of components and spare parts. A gas storage area which is connected to the multifocus tower is located south of the towers. Each of the towers has its own cooling facility, the solar tower with more than 5 megawatts capacity and the multifocus tower with 2 megawatts. Test stands are supervised and operated from the control rooms inside the towers. Heliostats can be controlled flexibly from different locations adapted to the requirements of the experiments.