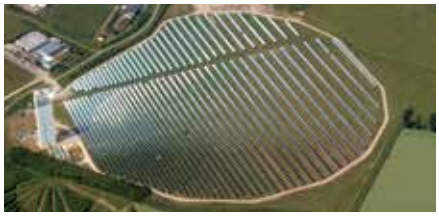
Institute of Solar Research

DLR

Research for global climate protection



The Juelich Solar Tower:
DLR's experimental solar thermal power plant.

The DLR Institute of Solar Research develops concentrating solar technologies for electricity, process heat and fuel generation. Additionally, the Institute conducts research into measurement techniques for the thermal characterisation of building envelopes.

The Institute's employees are based at the DLR sites in Cologne, Stuttgart and Juelich, as well as in Almería in the south of Spain. In Juelich, the Institute operates Germany's one-of-a-kind experimental solar thermal power plant – the Juelich Solar Tower – as well as Synlight, the world's largest artificial sun.

Concentrating solar technologies

In concentrating solar technologies, mirrors concentrate the sun's radiation in order to generate high-temperature heat. Like in conventional power plants, the heat can be converted into electricity or used in industrial processes, for instance in fuel production. Heat is easier to store than electricity, so these systems are particularly well suited for providing energy upon demand – whether or not the sun is shining. However, further cost reduction is required before this climate-friendly technology can replace fossil fuels for electricity, heat and fuel production, or in the transport sector. Additional research and development is essential for this to happen.

Our mission

The Institute of Solar Research bridges basic research and large-scale implementation. We collaborate with industry and research partners to develop solutions for application-oriented research and development tasks. The resulting cost-efficient technologies are intended to supply the growing energy market in the world's sunbelt with electric power on demand, high-temperature process heat and sustainably produced fuels. Developing new concentrating solar technologies is a long-term, complex, multi-disciplinary process – several steps are required to bring an initial idea to market maturity. The ultimate goal is to transfer the know-how especially to national and European industrial enterprises active in the global market.

Collaboration and networks

The Institute pursues a collaborative strategy with a distinctly international focus, because the economical use of concentrated solar technologies demands high direct irradiation. Therefore, the most suitable locations are deserts. Our collaboration with the Spanish research centre CIEMAT over the past three decades deserves special mention in this regard. The Institute coordinates its collaborative research strategy with other stakeholders through its active participation in national, European and international research and industry networks. The Institute of Solar Research is contributing to the establishment of concentrating solar technologies in target markets around the world.

Parabolic technology trough test facility for the advancement of direct solar steam generation at the Spanish Plataforma Solar de Almería.

Research areas

Enhancing efficiency

Improving the efficiency of conversion processes connected downstream in solar power plants is possible by increasing the temperature levels of the heat input. The Institute of Solar Research investigates which materials, heat transfer fluids and systems are particularly suitable for absorbing and transferring the required high temperatures; to do this, it develops, tests and qualifies the necessary processes, components and system solutions.

In the research for parabolic trough systems we address the use of solar power for direct steam generation and the application of alternative heat-transfer media, such as molten salts. For solar tower technologies our researchers are working on alternative concepts with air, molten salts and particles as heat-transfer fluids. Solar tower systems offer substantial potential for reducing costs, as they deliver higher temperatures, thus enabling more efficient power generation processes.

Installation of the CentRec particle receiver on the 'Research Level' of the Juelich Solar Tower.

Durability testing and performance analyses

Component manufacturers and power plant operators have a vested interest in identifying the degree to which different influences impact the service life of their components. The Institute operates special test laboratories and test rigs to provide answers to these questions. Additionally, methods developed at the Institute are used to measure and simulate components, collector systems or entire solar fields.

Preparation for a wind tunnel test to measure convective heat loss in a solar tower model.

Solar energy meteorology

The Institute of Solar Research also investigates the influence of various meteorological parameters on the performance of solar power plants and develops suitable forecasting systems.

Solar chemical processes

Thermochemical methods use concentrated solar radiation to generate solar fuels and to store the sun's energy chemically. This requires fundamental research in the fields of catalysis and redox chemistry, as well as the development and simulation of components, processes and plants. The second focus is on processes that harness solar radiation to eliminate contaminants or to produce materials such as cement or aluminium.

The QFly qualification toolbox, developed by the Institute of Solar Research: a drone takes images of the solar field, which are then analysed by the special software to identify any faults in the facility.

Thermal characterisation of building envelopes

Exact knowledge of the energetic properties of the construction materials is essential for cost-effective and resource-efficient restoring of existing buildings.

To this end, the Institute collaborates with other DLR institutes involved in aerospace research to develop contactless measurement and analysis systems, such as radar. These techniques should enable the analyses of construction material and quickly analyse the building's material and envelope to determine the causes of energy loss. The acquired data enable dynamic simulations of the building and are the basis for an energy-efficient and cost-effective restoring.

Research infrastructure

Setting up a test facility to split sulphuric acid – a sub-process in the thermochemical production of hydrogen – on the 'Research Level' of the Juelich Solar Tower.

Synlight is equipped with three radiation test chambers. In the first series of experiments conducted at the facility, DLR scientists are testing processes for the solar generation of hydrogen. Image: DLR/Hauschild

Solar tower at Plataforma Solar de Almería – Europe's pre-eminent research facility for concentrating solar power technologies.

Developing concentrating solar technologies requires powerful infrastructure in order to deliver high radiation flux densities. The Institute operates large-scale facilities, test laboratories and rigs at three locations in Germany and at its research partner CIEMAT's Plataforma Solar de Almería facility, all of which have set new global standards. This infrastructure offers solar researchers ideal conditions to conduct basic research, for application-oriented projects and to provide services to customers in the industrial sector and the research community.

Juelich Solar Tower

DLR has owned the experimental solar thermal power plant since 2011. It is used for research purposes and as a reference facility for future commercial power plants. The concentrated solar radiation is converted into heat in a ceramic honeycomb structure, the volumetric receiver, which was developed by the Institute, in cooperation with the Solar Institute Juelich and industrial partner Kraftanlagen München GmbH. In 2017, the Institute started operating the heliostat test platform HELITEP for the qualification of new heliostats right next to the solar tower's heliostat field.

Synlight® – the world's largest artificial sun

Synlight offers entirely new opportunities for solar process engineering, the solar thermal power plant industry and the aerospace sector. Its applications focus on developing production processes for solar fuels, as well as on testing the thermal load of components for use in solar thermal power plants, aeronautics or aerospace. Specialists from the Institute of Solar Research assist users in the preparation and execution of the experiments. Three test chambers installed at the facility can be exposed to a radiation of up to 310 kilowatts and a flux density of up to 12,5 megawatts per square metre.

Solar furnace and high-flux solar simulator in Cologne

The solar furnace in Cologne achieves a flux density of up to five megawatts per square metre with a maximum thermal output of 20 kilowatts. The high-flux solar simulator permits the same performance tests with a flux density of up to four megawatts per square metre, irrespective of weather conditions.

QUARZ® Center

The DLR QUARZ Center operates test rigs to analyse the performance and durability of components and systems in concentrated solar power facilities. This includes the thermal qualification of absorber tubes, optical qualification of mirrors and continuous load testing of moving components such as bellows or ball joints. The test facilities are located at the DLR site in Cologne and at the Plataforma Solar de Almería.

Plataforma Solar de Almería (PSA; owned and operated by CIEMAT)

Scientists at the Institute of Solar Research use test facilities at the PSA in southern Spain to conduct their own tests and developmental work on solar power in close cooperation with their Spanish partners. The Institute has its own branch office in Almería.

Services

Qualification

The QUARZ Center of the Institute of Solar Research uses proprietary methods to test and evaluate industrial components used for solar thermal power plants under laboratory conditions and in commercial operation. These are used to develop guidelines and quality standards for concentrated solar power systems.

Special test rigs at the QUARZ Center measure the optical characteristics of the receivers, absorber tubes and solar mirrors.

Radiation tests in the solar furnace and with artificial light

The solar furnace, high-flux solar simulator and Synlight offer researchers and users from science and industry a broad variety of opportunities to experimentally use highly concentrated sunlight.

Possible applications include proof of concept and optimisation of methods for solar fuel generation, thermal load testing of receiver components or component tests for aerospace applications.

Radiation resources

Our specialists in energy meteorology measure and model the meteorological parameters relevant to solar power plants and identify possible influences on concentrated solar power systems performance.

The DLR solar furnace: the mirrors of the concentrator focus the radiation onto an experimental set-up inside the laboratory building.

Simulation and forecasts

The Institute of Solar Research develops software tools that assist in the design of single components as well as entire systems. Moreover, the institute provides tools for the techno-economic assessment of concentrated solar power systems.

Support in R&D projects and consulting

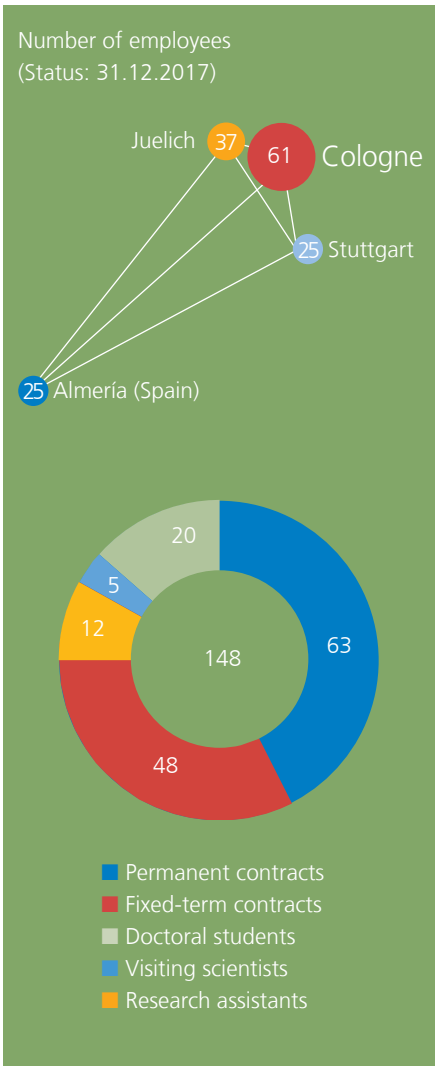
Scientists at the Institute of Solar Research support research institutions, industrial companies and project developers in all phases of R&D projects. Examples of their consultancy services include feasibility studies, support in site-specific technology selection and advice on innovative power plant projects.

The short-term forecast system WOBAS calculates real-time irradiation values on the solar field and how they will develop in the next 15 minutes. The image shows a cloud camera in the La Africana solar power plant.

The Institute in numbers

Since its inception in 2011, the Institute of Solar Research has continually expanded its research activities and services. The available annual budget reached 15 million euro in 2017. A significant portion of its resources is provided by public-sector funding bodies within the framework of competitive calls for industrial consortium projects. This is reflected in the high quota of third party funding, which reached 70% in 2017. The high share of project related income lead to a fluctuating budged over the years.

Between 2011 and 2017 the institute invested 15 million euro in developing its infrastructure, whereof the largest part was dedicated to the development of the Juelich site. The total number of employees has grown from 98 at its foundation to 148 at the end of 2017, located at four sites in Germany and Spain.

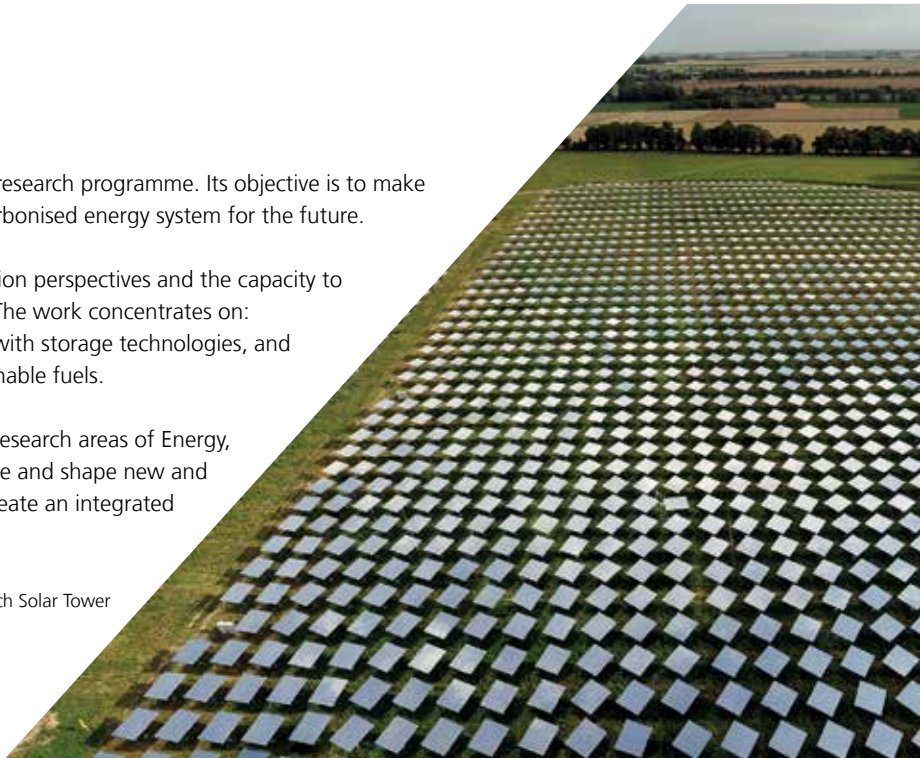


DLR energy research

The Institute's work is an integral part of the DLR energy research programme. Its objective is to make cutting-edge contributions to the development of a decarbonised energy system for the future.

DLR's energy research focuses on issues with real application perspectives and the capacity to make a substantial contribution to the energy economy. The work concentrates on:
- energy delivery technologies in intelligent combination with storage technologies, and
- technologies for the generation and utilisation of sustainable fuels.

Exploitation of the unique synergy potential between its research areas of Energy, Transport, Aeronautics and Space allows DLR to contribute and shape new and unparalleled insight and technological opportunities to create an integrated energy and transportation system for the future.



Heliostat field of Juelich Solar Tower

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DLR at a glance

The German Aerospace Center (DLR) is the national aeronautics and space research centre of the Federal Republic of Germany. Its extensive research and development work in aeronautics, space, energy, transport, security and digitalisation is integrated into national and international cooperative ventures. In addition to its own research, as Germany's space agency, DLR has been given responsibility by the federal government for the planning and implementation of the German space programme. DLR is also the umbrella organisation for the nation's largest project management agency.

DLR has approximately 8000 employees at 20 locations in Germany: Cologne (headquarters), Augsburg, Berlin, Bonn, Braunschweig, Bremen, Bremerhaven, Dresden, Goettingen, Hamburg, Jena, Juelich, Lampoldshausen, Neustrelitz, Oberpfaffenhofen, Oldenburg, Stade, Stuttgart, Trauen, and Weilheim. DLR also has offices in Brussels, Paris, Tokyo and Washington D.C.

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German Aerospace Center