



OPTIMIZING SOLAR POWER

CONSULTING AND EXPERT SERVICES

QUALITY ASSURANCE CONCEPTS

SPECIFIC MEASUREMENT TECHNOLOGY



OPTIMIZING SOLAR POWER

Focusing on the highest solar heat and power output

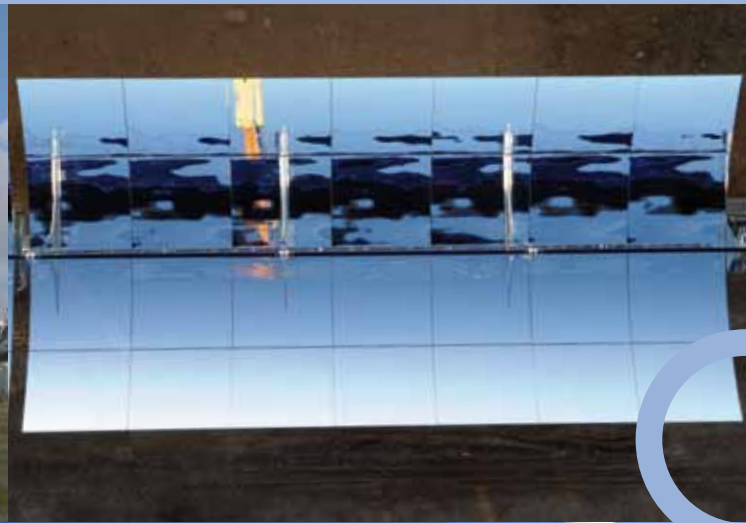
CSP Services' business scope and main activities are optimizing concentrating solar systems and maximizing their heat and power output. Utilizing its wide-ranging experience and know-how, CSP Services has developed specific, high-precision measurement technologies and evaluation tools for all concentrating solar power (CSP) applications. They provide data in the production of high-quality components for solar field installations – be it in the development, manufacturing or operation stage – and details on how their performance can be continuously improved.

Based in Cologne, Germany, and in Almería, Spain, CSP Services was founded in 2007 as a spin-off company of the German Aerospace Center (DLR). Today it is a globally recognized supplier and partner for quality assessment in all deployment phases of concentrating solar power projects. DLR has been engaged for decades in research and development work for concentrating solar thermal power stations, while CSP Services applies such development results, knowledge and experience in the industrial, technical field. CSP Services successfully offers consultancy and measurement services to reduce technical risks, and to improve project performance and solar power production. This way it optimizes profitability for investors, contractors, operators and owners, and makes concentrating solar power an economic and reliable technology to utilize solar energy and combat climate change.

The range of products that CSP Services offers includes geometry and shape measurement systems for mirrors, collectors, concentrators and heliostats; weather stations with solar irradiance sensors, measurement systems for trough receiver tubes, and other specialized equipment for solar field optimization.

The offered expert services include unique measurement capabilities for collectors and components, weather data analysis, component certifications, inspection services and acceptance testing for solar fields, concentrating solar power project support and consulting services, performance modeling and prediction, and technical due diligence.





SOLAR FIELD EXPERT SERVICES

Analyzing solar concentrators with leading-edge technology

Qualification of concentrators and optimization of solar fields

Accurate concentrator shape in solar field assembly is crucial for obtaining high optical efficiency in concentrating solar applications. CSP Services has extensive experience in the assessment and optimization of the optical quality of a wide range of solar concentrators and offers this expert knowledge and measurement services to clients worldwide. Its innovative and specific measurement techniques, software tools and expert know-how has proved to be of great value to many clients for the optimization of prototype collector designs and quality assurance of large-scale solar field assemblies.

CSP Services provides measurement services including all aspects of quality control in development, production and assembly, such as on-site measurements and supervision, data analysis and interpretation, technical reviews, performance modeling, specification and qualification of components. CSP Services' technical reports are highly recognized in the field.



PHOTOGRAMMETRIC MEASUREMENT SYSTEM QFOTO

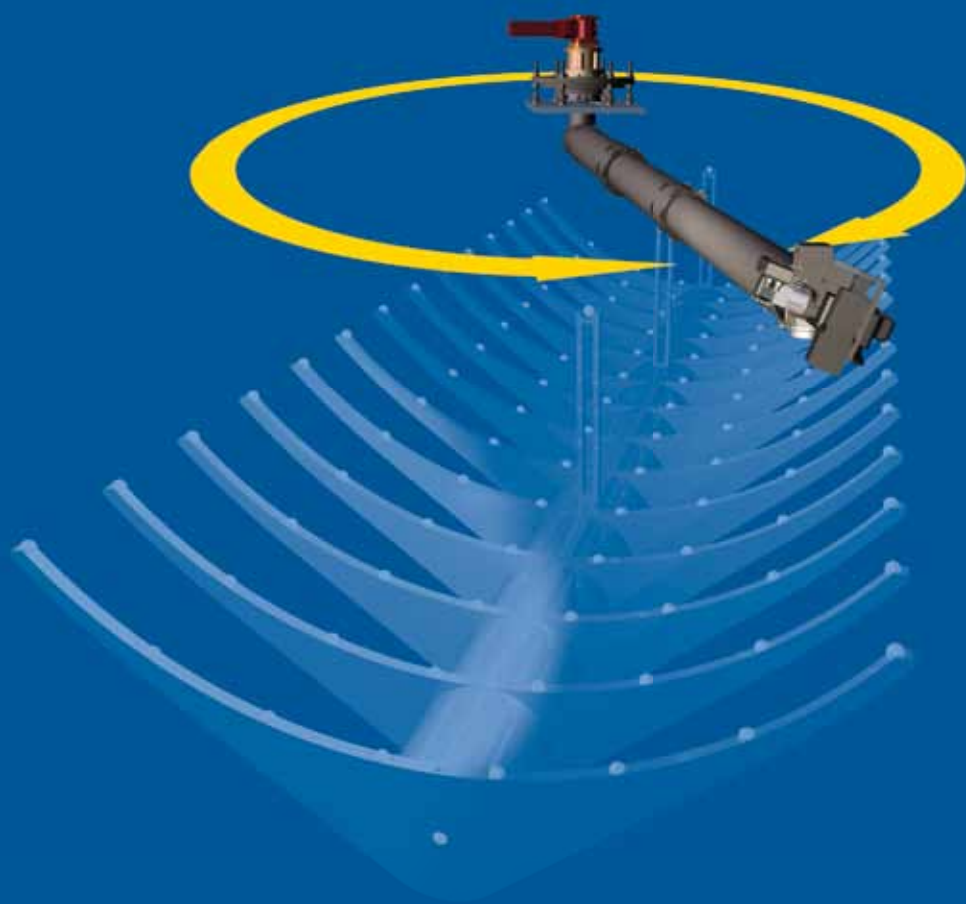
Assuring 3D accuracy in collector assembly

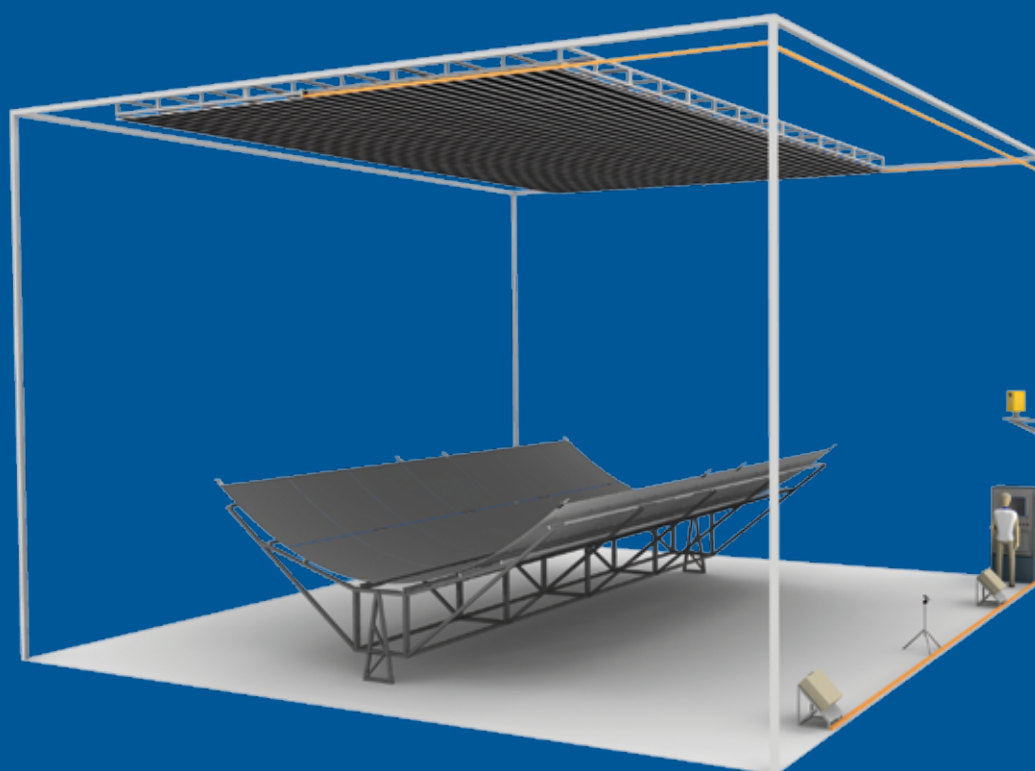
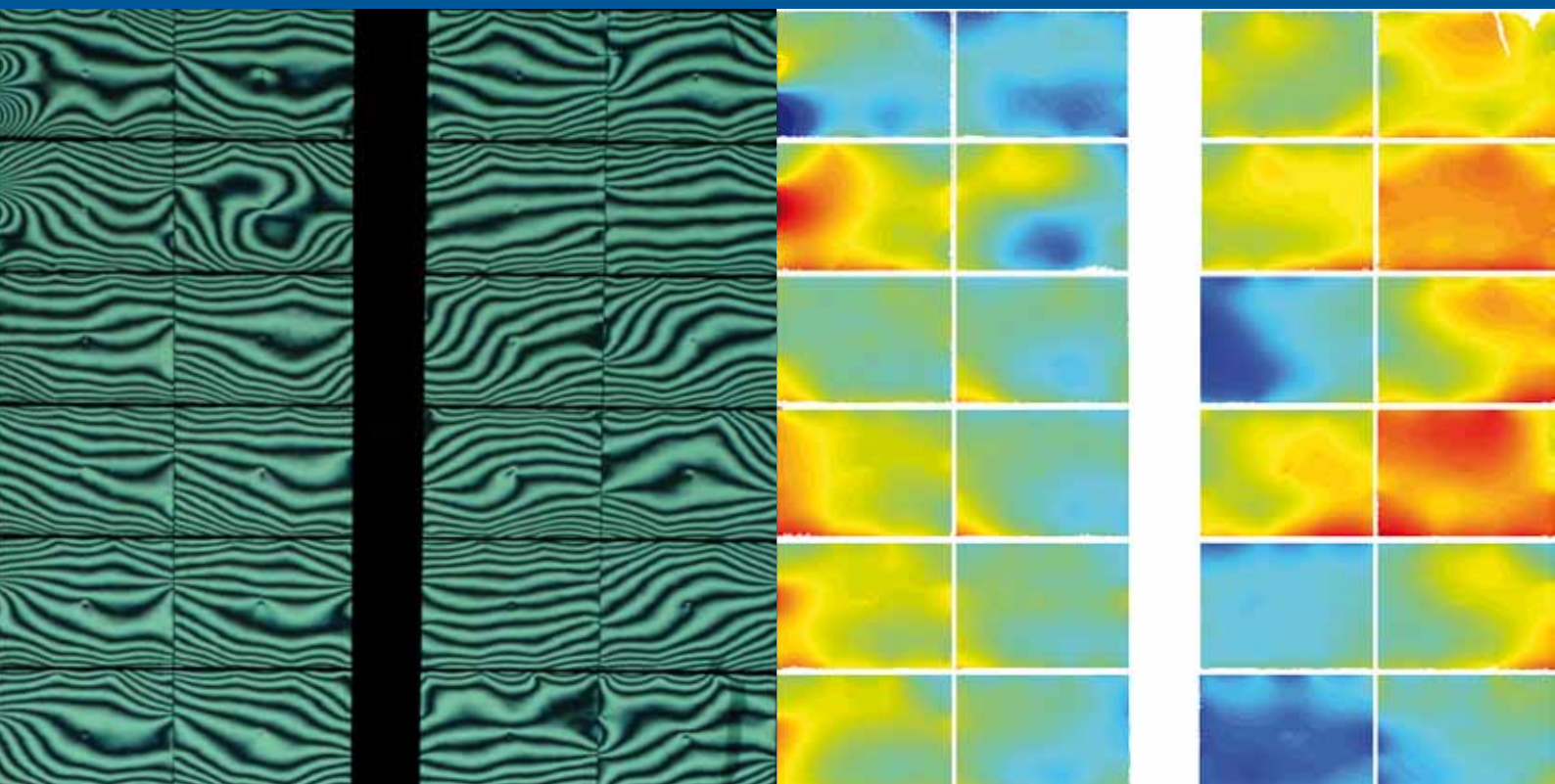
Inline quality control of solar concentrator structures

Even a few millimeters or a few tenths of a degree of deviation in collector assembly are relevant for considerable performance improvements. The photogrammetric QFoto system automatically measures the metal structure of troughs, heliostats or dishes and evaluates the 3D-data with proprietary specialized software. Measurement targets are placed on the structure and high-resolution digital cameras take photos of the object. The fully automatic measurement quantifies any deviations from the design 3D data, simultaneously gauges slope deviations – as the only system on the market – of all mirror mounting supports, and issues standardized quality reports. With a QFoto system, CSP Services brings all its expertise to your assembly workshop.

QFoto has been used for quality control in numerous solar concentrator fabrication lines worldwide and helped to successfully install solar fields of concentrating solar power plants already totaling more than two gigawatts of electrical power. CSP Services is the market leader in 3D-measurements for quality control in assembly lines for parabolic trough collectors and heliostats.







DEFLECTOMETRIC MEASUREMENT SYSTEM QDEC

Leading reference in solar mirror shape quality assurance

High-resolution shape measurement of mirror panels and solar concentrators

The deflectometric measurement system QDec, developed and applied at DLR and CSP Services, is a digital photographic measurement system which analyzes the reflected images of patterns taken by high-resolution cameras. It is especially suitable for the measurement of the shape and surface slopes of concentrator mirrors.

During the measurement, line patterns are projected onto a white screen and reflected by the glass or mirror panel. Images of the reflected patterns are taken and evaluated by fast proprietary software to determine the shape of the reflector, as well as the expected flux distribution and intercept factor for given receiver geometries. The measurement principle, together with QDec's supreme evaluation algorithms, leads to unmatched accuracy in surface slopes, high spatial resolution and measurement speed suitable for inline production integration.

QDec is flexibly utilized for a wide range of concentrator types and shapes, such as individual mirrors or glasses for CSP and CPV systems, as well as for complete solar concentrators such as parabolic trough modules, heliostats, dishes and their segments. It is successfully applied for quality assurance by most solar mirror and several collector manufacturing companies worldwide. CSP Services is well recognized as the leader in high-quality shape measurement by all major CSP mirror manufacturers.



RECEIVER PERFORMANCE TESTING SYSTEMS QREC

Gauging receiver performance according to current standards

Testing equipment for parabolic trough receiver tubes

Receiver tubes for parabolic trough collectors are tested with equipment based on technology from the DLR QUARZ Center. The linear solar simulator test bench QRec-O is prepared for optical performance tests with a short cycle time. The thermal test benches QRec-T and QRec-A are applied for heat-loss testing and thermal ageing of receiver tubes.

Receiver tubes are a high-tech key component for parabolic trough collectors. The advanced optical coatings on glass envelope and steel absorber tube, the isolating vacuum and the corresponding sealing are crucial for the performance requirements of the market. The QRec product line permits suppliers and testing laboratories to gauge optical efficiency and thermal losses as well as ageing effects on those tubes according to current standard methods. With DLR licenses and the ongoing collaboration with the DLR QUARZ Center, a wide acceptance of the measurement methodology and results is guaranteed.

- **QRec-O:** Linear solar simulator test bench for gauging optical efficiency
- **QRec-T:** Heat loss measurement at operational temperature
- **QRec-A:** Thermal ageing cycles at elevated temperature







SOLAR RESOURCE ASSESSMENT AND PLANT MONITORING

Solar irradiance – the fuel for concentrating solar power systems

Automated weather stations MDI for deserts and MHP for fully-maintained sites

Direct solar beam irradiation (DNI) is the fuel for concentrating solar power systems. For the development of large solar power projects with investments in the order of millions to billions of dollars, reliable information about the solar resource at specific sites is required to properly predict technical and economic project performance.

MDI weather stations for solar resource assessment at remote sites and desert regions use an RSI (rotating shadowband irradiometer) sensor for reliable irradiation measurements. This type of sensor with its low sensitivity to soiling, together with proper DLR calibration and specific data processing, has proven to be the premium choice for unattended DNI measurements in solar resource mapping, site selection and project development.

MHP weather stations on the other hand, with high-precision solar sensors, pyranometers and pyrheliometers mounted on a sun tracker, provide accurate online irradiance data at well maintained sites and thus serve as a reference for solar thermal power plant operation.

CSP Services supplies the stations with autonomous power supply and fully installs them on site. Equipment calibration, operation and maintenance services as well as daily data checks and evaluations, ensure high-quality and bankable data for the purpose of feasibility studies, project performance calculations, support of project financing and solar power plant operation monitoring. CSP Services' portfolio includes irradiance satellite data from renowned partners and typical meteorological / representative solar year (TMY/RSY) data.



CONSULTING AND ENGINEERING, ADVANCED TECHNICAL SUPPORT

Converting knowledge and experience into success

Special tasks, technical and feasibility studies, due diligence reports, technical reviews, performance prediction, site supervision, specifications, training seminars

CSP Services, together with its network of collaboration partners for specific tasks, covers all technical aspects of concentrating solar technology. It applies this knowledge and broad experience to all project stages from development, prototyping and demonstration, over mirror and receiver product testing according to the latest guidelines and highest standards, solar field production and commissioning, up to monitoring and optimization of operating solar fields.

Based on extensive know-how, experienced staff and close cooperation with research, CSP Services continuously introduces new services and products to the market. This includes performance tracking and condition monitoring in solar fields, cloud analysis, shortened acceptance test methods, receiver tube lifetime analysis, heat transfer fluid sampling, large-scale optical measurements with UAVs, field performance and intercept for solar towers, as well as new maintenance processes to tackle relevant performance threads and claims.

CSP Services' track record includes numerous successful large-scale projects from pre-feasibility via technical support and due diligence right up to the operation phase. A quick and efficient response to your needs can be relied upon, even when new issues or special tasks arise at short notice.





Picture: DLR



AREA OF EXPERTISE

There are only a few experts around the world who have been continuously engaged in the development of concentrating solar power technology in the last two decades. We are proud to say we are one of them. Consequently, we can refer to an extensive network which has grown over many years of DLR solar energy research and CSP Services commercial project work. This is what makes our technical expertise so unique.



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