Foreword

Concentrated solar power (CSP) is a key technology of the world’s future energy mix. As an innovative renewable energy source with a base load capability and a high share of local content, CSP will substantially contribute to a sustainable development of economies and energy systems in countries of the sun-belt regions.

With their pioneering work, German companies and research institutes contributed significantly to establishing CSP as a reliable and affordable power technology. In September 2013, the association "Deutsche CSP" was founded which consists of 31 member companies and research institutes that are actively dedicated to the CSP market. The goals of the association are to consolidate and communicate Germany’s efforts in further developing the CSP market, to foster research, development and demonstration of CSP technologies and to raise public awareness of the particular benefits of CSP technologies for energy-economics and socio-economics.

At "Deutsche CSP" we are pleased to give you an overview of the CSP competence profiles of our members. Key innovations of CSP technology are being developed in German research facilities for further increasing efficiencies and reducing costs.

Yours sincerely,

Dr. Joachim Krüger
Chairman of the board
Deutsche CSP

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German manufacturing companies provide the core components for solar fields and power plants, as well as the required measurement and control technology.

German engineering companies support the development of CSP projects and have a world-class reputation as technology experts, consultants and certifiers. We hope that this brochure will support you in identifying German companies and research institutes as future business partners for your CSP endeavors.

Yours sincerely,

Dr. Joachim Krüger
Chairman of the board
Deutsche CSP
Member companies of Deutsche CSP are active across the entire CSP value chain

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* These services / components are self manufactured and warrantied
** These services / components are partially bought in additionally an offered with warranties
* Business, legal, finance, project development
** Technical and expertise, owner’s engineer
BASF Business scope in CSP
- BASF is an innovative systems supplier of heat transfer and thermal energy storage media,
- Our synthetic sodium nitrate and sodium nitrite salts are the perfect heat transfer and thermal energy storage media for all types of CSP technologies
- Our knowledge of salt chemistry and new technology concepts are contributing to a significant improvement in the efficiency of solar thermal power plants

Key Data
- Sales 2014: 74,326 Mio.
- Employees (as of December 31, 2014): 113,292
- Producer of high quality inorganic salts since 1889

Track record in CSP/USPs
Over 70,000 t of synthetic sodium nitrate supplied to various CSP plants
- Archimede, IT Parabolic Trough
- Arenales, ES Parabolic Trough
- Andasol III, ES Parabolic Trough
- Extresol III, ES Parabolic Trough
- Gemasolar, ES Solar Tower
- Crescent Dunes, US Solar Tower

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CSP Services

Business scope in CSP
- Supplier of measurement equipment for direct solar irradiation (DNI), photogrammetric 3D assembly quality control of concentrators: QFoto, deflectometric shape/intercept control of mirrors: QDec
- CSP expertise in quality assurance, performance analysis of solar concentrators and solar fields, collector development and prototype evaluation, thermal output, collector certification, acceptance testing, supervision, technical due diligence, performance prediction, solar resource assessment and corresponding expert services

Key data
- Annual turnover >2 Mio.
- Number of employees >20
- Offices: Cologne (Germany), Almeria (Spain)

Track record in CSP/USPs
- Wide-range CSP technology expertise, DLR-licensed technology
- QFoto: assembly quality control in >30 large commercial projects
- QDec: shape quality control in >90% of mirror manufacturers worldwide
- Weather stations: resource assessment for >80 sites since 2007

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Solar research at the Spanish test facility “Plataforma Solar de Almería” (Photo: DLR/Ernsting)

DLR – German Aerospace Center

Business scope in CSP
- Scientific support for technology development to produce electricity, heat, fuel and water using concentrated solar power
- Biggest research group in CSP in Germany (among Top 5 worldwide)
- System analysis groups provide energy scenarios and policy support

Key data
- Annual turnover >15 Mio. (in CSP-related activities)
- More than 200 people related to CSP
- Teams in Germany (Cologne, Stuttgart, Jülich) and Spain (Almería)

Track record in CSP/USPs
- Unique research infrastructure for CSP
- Access to Plataforma Solar de Almería owned and operated by CIEMAT (Spain)
- Research partner to German and international companies
- Active coordination of national and international networks in CSP
- Participation in leading national and international energy scenarios

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Pre-engineering of a 100 MW linear Fresnel CSP plant

enolcon

Business scope in CSP
- Consulting, Engineering and Design Services
- Owner Engineer, Lenders & Insurance Technical Advisor

Key data
- Turn over: approx. 1 Mio. (2016)
- Number of employees: 8
- Bietigheim-Bissingen (Stuttgart)/Germany, partner firms/business premises in UK, South Africa and Brazil

Track record in CSP/USPs
- Experience in CSP sector since 2006 (Parabolic Trough, Fresnel, Tower)
- Localization and local value chain Analysis for South Africa and Brazil (giz)
- Experience in various CSP projects, Jordan, South Africa, Kenya, India, Spain, Italy, Greece, Brazil. Total capacity > 800 MWe

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ERK Eckrohrkessel GmbH

Business scope in CSP
- HTF steam generator designs (thermal oil, molten salt etc.)
- Receiver designs (direct steam, molten salt, air)
- Rapid response back-up boiler
- Heat recovery steam generators for Integrated Solar Combined Cycle plants

Key data
- 20 people strong engineering team with decades of design expertise
- Engineering in Germany but global licensee network ensures high local content. Detail engineering jointly with licensees

Track record in CSP/USPs
- Engineering contracts for thermal energy storage system
- R&D activities on HTF steam generators and receivers

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ERK Eckrohrkessel GmbH
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Example of a modular ERK type molten salt steam generator

100 MW rapid response boiler capable to change load from 0-100% in 3 minutes
Example lender’s engineering services: 50 MW Soluz Guzman Project

Example owner’s engineering services: 30 MW Puerto Errado 2 Project

Fichtner Solar

Business scope in CSP
- Consulting, engineering and design services
- Owner’s engineer, transaction advisor, lender’s technical advisor
- Market studies, M&A, due diligence, feasibility study, conceptual design, basic engineering, permit application, preparation of tender documents, evaluation of tenders and negotiation, detail design, project and contract management, design review, site supervision and construction management, supervision of commissioning and trial operation, post-completion services

Key data (Fichtner Group)
- Germany’s biggest independent engineering and consultancy enterprise for infrastructure projects
- Annual turnover: 242 Mio. € / approximately 1,800 employees worldwide (500 thereof in home office)
- 28 subsidiaries/affiliates & 65 branch offices in more than 50 countries and project experience in more than 160 countries
- Over 1,200 ongoing projects – 500 of these in our home office

Track record in CSP/USPs
- Active more than 30 years in the CSP sector with CSP project experience in more than 25 countries
- Outstanding CSP track record with more than 90 CSP-related projects with a combined capacity of several GW
- References in all three major CSP technologies: parabolic trough, Fresnel and solar tower
- Extensive experience in all main CSP plant configurations, including direct/indirect thermal storage and integrated solar combined cycle plants
- References in different solar thermal process heat applications, such as solar desalination and solar EOR

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Web: www.fichtnersolar.com
Fraunhofer ISE

Business scope in CSP
- Scientific support for technology development to produce electricity, industrial process heat and clean water using CSP
- Specific support to product development for industrial partners
- Broad competence from material research, key component development to system engineering level
- Energy scenarios and policy group

Key data
- Annual turnover > 5 Mio. (in CSP related activities)
- More than 70 FTE related to CSP
- Access to other Fraunhofer competence in material science, industrial engineering and production logistics and automation

Track record in CSP/USPs
- Surface technology center, optics and heat transfer labs
- Collector testing and certification lab
- Extensive experimental labs, excellent dynamic system modelling
- Research partner to German and international companies
- Active participation in international standardization and networks

Contact
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GRENZEBACH Maschinenbau

Business scope in CSP
- Semi- and fully automated manufacturing concepts for all major CSP technologies (linear Fresnel, parabolic trough, tower)
- Island solutions for more flexibility and shorter reaction times
- Special concepts focusing on particular CSP requirements like moveable solution and local content for manufacturing

Key data
- Annual turnover: over 320 Mio.
- Founded 1960; today 1,600 employees worldwide
- Family-owned, German automation company with global footprint and headquarter in Hamlar, Bavaria, Germany

Track record in CSP/USPs
- Leading supplier for manufacturing solutions in CSP
- First supplied semi-automated manufacturing plant in 2011
- Enhanced manufacturing concepts in 2013 in various CSP technologies

Contact
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E-Mail: andre.angermeyer@grenzebach.com | Web: www.grenzebach.com
In HAWE’s Freising plant, hydraulic power packs for parabolic troughs and heliostats are produced, mounted, checked and prepared for delivery.

The demonstration model shows the compact dimensions of HAWE Hydraulic’s drive. The power pack is directly mounted on one of the cylinders.

Hawe Hydraulik

Business scope in CSP
- Hydraulic tracking mechanisms for PV-, CPV-solar tracker
- Hydraulic tracking mechanisms for CSP, trough, heliostats and parabolic dish systems
- Engineering and testing support at prototypes

Key data
- Sales: 295 Mio. in 2016
- Number of employees: approx. 2000 in 2016
- Headquarter in Munich, Germany
- 16 subsidiaries plus worldwide sales partners

Track record in CSP/USPs
- More than 30,000 drives since 2005 in the field
- CSP trough prototypes running in KJ (US) and PSA (Spain)
- Thousands of PV trackers running worldwide
- CPV trackers running in Alamosa US
- Dish prototypes running in Mongolia
- Several commercial Parabolic trough and Central receiver plants are equipped with HAWE drives worldwide

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hogrefe Consult

Business scope in CSP

- Strategic business consulting and operational implementation of Arab-German business relations
- Market information and analysis
- Development and operationalization of market entry strategies
- Selection and evaluation of local cooperation partners
- Assistance in public affairs and communication
- Organization of marketing campaigns, events and workshops

Key data

- Founded 2009 in Berlin, Germany
- Focus on the MENA-region
- Multi-national and experienced team
- Local partners in UAE, Qatar, Saudi Arabia, Algeria and Morocco

Track record in CSP/USPs

- Advising German CSP companies in the region since 2009
- Strong networks with key personalities in Germany / MENA region
- Highly specialized and experienced in cross-culture issues

Contact

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IA Tech

Business scope in CSP
- Comprehensive advisory for CSP systems, focus: (dynamic) simulation and optimization of (hybrid: fossil/PV+CSP) ST and PT CSP plants regarding its economic and technical performance
- Strategic advisory for CSP value chain suppliers and stakeholders
- Services: (Pre-) feasibility studies, owners’ and lenders’ engineer, due diligence for CSP company and project M&As, project development and assistance services and capacity building programs

Key data
- Spin-off of Solar-Institut Jülich, Offices: Jülich, Munich (Germany)
- CSP and PV Projects and activities in Germany, Italy, Algeria, Jordan, Morocco, Indonesia, India, Pakistan, Australia and Brazil
- Clients: investors, lenders, governments, industry

Track record in CSP/USPs
- Own CSP project software solutions for mapping (volumetric/pressurized) air and molten salt central receiver, parabolic troughs and related storage technologies
- Leading role in project development of Solar Tower Jülich
- Feasibility study for ISCC Solar Tower Plant Project in Algeria

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IA Tech GmbH played a leading role in project development of the Solar Tower Jülich
ILF Consulting Engineers

Business scope in CSP
- Site evaluation, geological survey, solar resource assessment
- Pre-feasibility/feasibility/FEED/PMC/due diligence
- Owner’s and lenders engineering
- Construction supervision and commissioning management

Key data
- 1,800 employees in the ILF Group
- 30 offices worldwide, CSP center of excellence in Munich, Germany

Track record in CSP/USPs
- Pre-feasibility/feasibility studies over more than 500 MWel of capacity for CSP technologies:
  - Parabolic trough
  - Solar tower
  - Linear Fresnel power plants
- Technical review and due diligence for international CSP project developers

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KAEFER

Business scope in CSP
- Complete innovative professional thermal insulation solutions
- Surface and fire protection
- Scaffolding
- Engineering and technology development
- R&D laboratory tests
- Worldwide project supervisory and local support
- Significant experience in numerous CSP technologies

Key data
- Annual turnover 1,400 Mio.
- Headquarters in Bremen, Germany. Present in more than 50 countries with 20,000 employees

Track record in CSP/USPs
- Thermal insulation of more than 60% of the CSP plants in Spain
- Development of a high-temperature solar receiver micro-turbine system for decentralized electricity and heat production
- Cooperation with DLR & Solinova for the SMILE Project, Brazil

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Gemasolar solar thermal plant, owned by Torresol Energy ©SENER

R&D and engineering of thermal insulation solutions for high temperature solar receivers. Research platform CNRS Proms - France
The Solar Tower Power Plant Jülich was built by Kraftanlagen München as the general contractor.

**Kraftanlagen München**

**Business scope in CSP**
- Complete solar tower power plants as EPC
- Supply of key components:
  - Receiver and hot air cycle
  - Heat storage system
  - Heliostat field (license for local production)
  - Engineering and design (both electrical and non-electrical applications)

**Key data**
- Personnel capacity 2100 employees (annual average 2015)
- Headquarters in Munich, Germany and a number of offices in central Europe, Romania and Middle East (Bahrain)

**Track record in CSP/USPs**
- Joint development of the open volumetric receiver together with DLR (since 2002)
- Solar Thermal Tower Plant Juelich
- Usage of air as heat transfer media leads to flexibility in a large variety of electrical and non-electrical applications

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KSB

Business scope in CSP
- Complete program of pumps and valves for
  - Parabolic trough systems incl. thermal storage
  - Solar power towers
  - Power block
- Complete engineering and support – from design to implementation and throughout operation

Key data
- 2,322 Mio. € turnover in 2014
- Approximately 16,000 employees worldwide
- Headquarter in Frankenthal, Germany. 29 factories mainly in Europe, China, India, US, Brazil, South Africa, more than 120 sales and service facilities worldwide

Track record in CSP/USPs
- Boiler recirculation pumps for Ivanpath (US)
- Feedwater pumps for Nevada Solar One (US)
- HTF auxiliary pumps for Los Arenales (Spain)
- Auxiliary and condensate pumps for CSP plants (South Africa)

Contact
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We plan and supervise projects from initial design through tendering, construction, commissioning and O&M.

Lahmeyer International

Business scope in CSP
- Technical and economic planning and consulting services
- Project management, market analysis, economic studies, due diligence, design review, construction supervision, operational supervision, training, tendering support, rehabilitation support

Key data
- Turnover 147 Mio.
- 1,560 employees
- Headquarters Bad Vilbel, Germany. Projects in 165 countries, company sites and subsidiaries in 21 countries

Track record in CSP/USPs
- Feasibility studies >25 Projects (>1,320 MW)
- Due diligence >20 Projects (>850 MW)
- Construction supervision >3 Projects (>80 MW)
- O&M supervision >2 Projects (>45 MW)

Contact
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Integrated and optimized cable-connect-controlbox solution.

LEONI

Business scope in CSP
LEONI helps EPC contractors of CSP plants to realize significant cost savings:
· In-factory pre-assembly, cutting and testing of the cable systems (plug-and-play cable solutions)
  > significant reduction of on-site installation time
· Specific cable and electrical engineering services
  > optimal cable way and cable engineering
· Automotive-grade logistics services
  > fast response-time

Key data
· Generated sales of 3,920 Mio. in 2013
· Employs about 60,000 people
· Worldwide presence comprises 98 production facilities
· Represented in 32 countries

Track record in CSP/USPs
· LEONI has delivered cable solutions for many of the largest CSP projects around the globe, e.g. in Abu Dhabi, Spain and US

Contact
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Turbine hall with air-cooled condenser for a Fresnel-type direct steam CSP plant

**M+W Group**

**Business scope in CSP**
- Full EPC contractor for complete project delivery as single point of interface to the client
- Experienced in power block construction, cooling, energy storage
- Local presence in the Gulf
- World class EHS record

**Key data**
- 3.3 bn. USD sales and 3.3 bn. USD order intake in 2015
- 6,600 employees, mainly in technical sector
- Headquarter in Stuttgart Germany, hubs in Singapore and USA, MENA offices in Riyadh and Abu Dhabi

**Track record in CSP/USPs**
- EPCM for Linear Fresnel project in Murcia, Spain with water steam cycle, turbine house, energy storage, dry cooling, solar field integration. Concept design for molten salt CSP + storage
- Experience in all relevant system packages for CSP projects

**Contact**
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protarget’s technology and training center for the research and development of CSP components

With its modular design, protarget’s parabolic trough system significantly reduces investment cost and construction time.

Business scope in CSP
- protarget being manufacturer and EPC, is specialised in the development, construction and operation of turnkey solar power plants in the range of 1-30 MW electric and solar boiler systems from 250kW to 50 MW thermal
- The modular design and the standardised sizes of protarget’s systems, are particular suitable for independent power and process heat supply of industrial customers.
- Equipped with an integrated thermal storage system, our power plants are capable to supply electricity or process steam 24/7 if required. The systems are also designed to integrate options like water desalination or cooling.

Key data
- Founded in 2009, 35 Employees
- Cologne, Germany – Engineering and solar module assembly
- Chemnitz, Germany – Receiver tube development and production

Track record in CSP/USPs
- Pilot plant in Munich, Germany in operation since 2012
- Solar steam boiler projects under construction in Cyprus and India
- Further projects in development in Algeria, Chile and Namibia

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schlaich bergermann partner, sbp sonne

Business scope in CSP
- Parabolic Trough Technology provider: EuroTrough, UltimateTrough
- Stellio heliostat field turn-key supply with Stellio consortium partners
- Optics evaluation and optimization (field layout and optimization, aim point strategy, Intercept factor, flux density distribution)
- Concept and design of controls and drives / mechanical engineering
- Feasibility studies, project management and consulting

Key data
- Number of employees: 17
- Main Office Stuttgart, Berlin, New York, Sao Paulo, Shanghai, Paris

Track record in CSP/USPs
- 30+ years of experience in CSP: Trough, Tower, Dish
- > 350 MWel, parabolic trough fields installed in Spain, India, US, Egypt; 120 MW under construction (Kuwait, Saudi Arabia) & 100 MW in design
- SolarPACES Technology Innovation Award 2010, 2013 and 2015
- CSP today Engineering Performance Award for the development of heliostat field evaluation and optimization code “sbpRAY” in 2016

Contact
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500m² Fresnel dish for HelioFocus, Dimona, Israel
(Copyright: HelioFocus)

50 MW parabolic trough power plant Andasol 1, Guadix, Spain
Test rig for granular material-based thermal storage systems. The tested prototype is a high temperature (800°C) air-sand heat exchanger (Copyright: SIJ).

Solar-Institut Jülich, FH Aachen

Business scope in CSP
- Scientific support for technology development to produce electricity, process heat, fuel and water using concentrating solar power
- Central scientific institution of the Aachen University of Applied Sciences
- System analysis in the field of solar power plant simulation and sustainable energy scenarios

Key data
- Annual turnover: 2 Mio.
- 50 people dedicated to renewable energy research

Track record in CSP-USPs
- Access to Germany’s only solar tower testing facility in Jülich, owned and operated by DLR
- Research partner for German CSP industry
- Co-operation with DLR and other CSP research institutions
- Development of concepts and technical solutions of receivers, storage systems and heliostats with high-level test and qualification facilities
- System simulation based on detailed energy scenarios
- Capacity building in the field of CSP (e.g. in the MENA region)

Contact
Solar-Institut Jülich (SIJ), FH Aachen, Aachen University of Applied Sciences | Prof. Dr.-Ing. Ulf Herrmann Heinrich-Mußmann-Strasse 5 | 52428 Jülich | Germany
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Email: herrmann@sij.fh-aachen.de | Web: www.sij.fh-aachen.de
The Solarlite parabolic trough SL4600+ is designed for operating temperatures up to 400°C.

Solarlite CSP Technology

Business scope in CSP
- EPC (Engineering, Procurement, Construction) for parabolic trough power plants up to 30 MWel
- Solar field design and construction
- Direct steam generation operating concept
- Development and manufacturing of parabolic trough collectors
- Individual solutions for process heat applications for industries with high energy demand

Key data
- Head office in Germany
- Business model with high local content
- Specialized knowledge in basic and detailed engineering

Track record in CSP/USPs
- 2011 – "TSE1" Kanchanaburi, Thailand, 5 MWel CSP power plant
- 2008 – "Wolwou" solar thermal power plant for fish farm (220 kWth)
- 2012 – "TRESERT" Thailand Tri-Generation demonstration project
- 2012 – "Duke" Spain, Direct steam generation research project

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Suntrace

Business scope in CSP
- Specialist for solar projects: CSP & PV
- Technical: solar resource, engineering, yield modeling, 3D-animation
- Economic: contracts, financing, financial modeling
- Covering all CSP technologies, storage, hybrid, on-grid, off-grid
- Support projects during development – from greenfield to operation
- Scope: e.g. site identification, feasibility studies, engineering, tendering, financing, independent expert
- Project financing and financial advisory for solar projects

Key data
- > 10 experts + associated partner
- Germany (Hamburg), Spain, South Africa, India, Chile

Track record in CSP/USPs
- Independent expert for > 2,000 MW of CSP & PV projects
- Owners and lenders engineer, financial advisor, solar resource
- Advisor to industry, institutions, governments
- Reference: solar mapping of India (51+ measurement stations)
- Reference: CSP for Enhanced Oil Recovery, techno-economic modeling
- Reference: REDIMENA, for Dii: Project funding for MENA region

Contact
Suntrace GmbH | Martin Schlecht
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Wind tunnel test of parabolic trough field with wind fence

Test field/qualification of heliostat system

toughtrough

Business scope in CSP
- Project development, management and controlling for small and mid-sized solar projects
- Engineering and optimization of components and overall collector structures
- Development and design on component and system level
- Complex qualification and testing (structural/optical) of components and overall CSP collectors/structures

Key data
- 10 employees
- Bremen/Berlin (Germany)

Track record in CSP/USPs
- 10+ years of experience in CSP: trough, tower, Fresnel and dish system design
- Wind-tunnel studies and evaluation of design data basis for small and large solar fields
- Supply of composite mirror systems

Contact
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On-site control works of drive pylon at SKAL ET collector

TSK Flagsol Engineering

Business scope in CSP
- EPC contractor for complete solar thermal power plants
- Referenced expertise as technology provider in parabolic trough (PT) technology (solar field, HTF system, thermal energy storage [TES])
- Two proprietary PT collector designs (Skal-ET & HelioTrough®, patented)
- Process and simulation expertise not only in PT, but also in central receiver (solar tower) and Fresnel systems for EPC project cooperation with technology partners

Key data
- More than 20 years of activities in CSP (as Flagsol GmbH and predecessors)
- Establishment of TSK Flagsol Engineering GmbH on 22. November 2013
- 100% affiliate to TSK group Spain
- TSK Group realizes with >1000 people worldwide an annual turnover of more than 800 Mio.

Track record in CSP/USPs
- Andasol 1: 50 MW with TES, PT, (Spain)
- Andasol 2: 50 MW with TES, PT, (Spain)
- Andasol 3: 50 MW with TES, PT, (Spain)
- El Kuraymat, ISCCS: 150 MW (20 MW solar), PT, (Egypt)
- Los Arenales: 50 MW with TES, PT, (Spain)
- La Florida, 50 MW with TES, PT, Spain
- La Dehesa, 50 MW with TES, PT, Spain
- La Africana: 50 MW with TES, PT, (Spain)
- Puerto Errado II: 2 x 30 MW, Fresnel, Direct Steam Generation, (Spain)
- Bokpoort: 50 MW with TES, PT, (South Africa)
- Ouarzazate: 160 MW with TES, PT, (Morocco)
- Ashalim*, 110 MW with TES, PT, (Israel)
- Shagaya*, 50 MW with TES, PT, Kuwait

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TÜV Rheinland

Business scope in CSP
Consultancy and supporting services along all project phases:
• Side evaluation and planning (feasibility studies, yield assessment, environmental impact assessment studies)
• System design (supplier assessment)
• Manufacturing (QA/QC supply chain services, component testing)
• Construction (incoming goods inspection, supervision services)
• Start up (acceptance testing, certification)
• Operation (OHSAS, yield evaluation, monitoring services)

Key data
• Group turnover 1,700 Mio.
• 19,300 people in 500 locations in 65 countries
• Headquarters in Cologne, Germany

Track record in CSP / USPs
• Independent certifier at Novatec’s PE2
• Safety analysis of HTF-Circuit at Andasol
• Safety analysis and operator training at Jülich Test Solar Tower Plant

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