CosinSolar

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COSIN SOLAR TECHNOLOGY CO., LTD.

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*To Provide **Low-cost, High-quality** and **Clean** Energy!*

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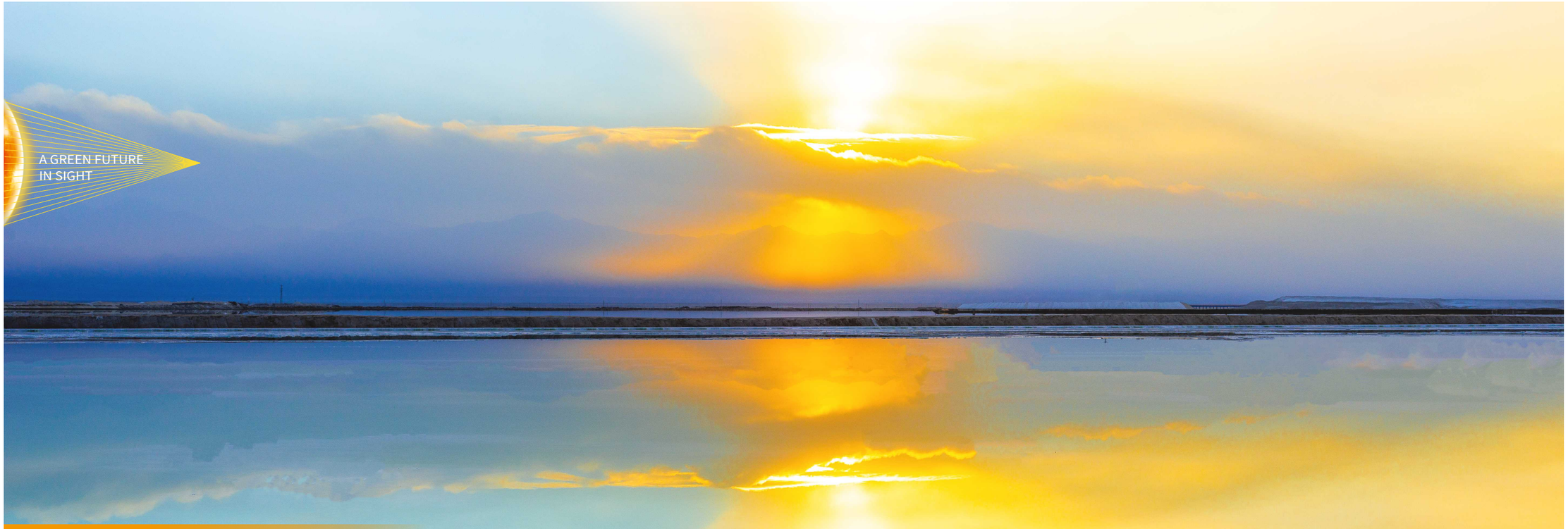
A GREEN FUTURE
IN SIGHT



INTRODUCTION

Concentrating Solar Power——
A Ultimate Solution to Energy Issues

What is CSP

Concentrating Solar Power (CSP for short), also referred to as Solar Thermal Electricity (STE for short), is an important type of solar energy utilization, using a great number of reflectors to concentrate sunlight and collect thermal energy through heat storage media, generating high-pressure and high- temperature steam to drive the turbine and generate power.

Roles of CSP

- **Flexible & Dispatchable power:** CSP has strong capability of peak load and is able to rapidly respond to the grid dispatching order. Furthermore, CSP can hybrid with Solar PV and Wind Power to enhance output stability and consumption of renewable energy in the power system.
- **Stable base load power:** Blessed with the low-cost energy storage system in large capacity, CSP can operate like a conventional thermal power station to provide base load power to the power system, realizing 24-hour continuous and stable power generation or supplying power at peak time or night time based on system demand.
- **Grid stability enhancer:** CSP has the same characteristics as conventional synchronous power supply, which can provide effective rotational inertia and reactive power to power system, and stabilize the systems' frequency and voltage, so as to ensure the safe operation of power grid.

Advantages of CSP

- **Environment-friendly:** CSP is greenest power compared to all other technologies, with life cycle carbon emission equals to only 2% of conventional thermal power' s emission, and 15% of PV power' s emission, to be one ultimate solution to climate change, decarbonization and energy transition.
- **Continuity, Stability, Dispatchability:** CSP is high friendly to power grid. Configured with large-scale thermal storage system, CSP can provide continuous, stable and dispatchable high-quality power for both base load and peak load demand, enabling higher capacity of the power system to consume more renewable energy from PV and Wind power and thereby increasing the proportion of renewable energy in the system.
- **Promising Cost Reduction:** Huge potential of cost reduction with industry expansion, maturity and technological breakthroughs. Parity to that of fossil fuel energy could be achieved in the future.
- **Industries promotion:** Construction of CSP plant consumes large amount of steel, glass, cement and other chemical products, and also promotes the development of advanced equipment manufacturing, industrial automation, big data and artificial intelligence technologies.

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A GREEN FUTURE
IN SIGHT

Company Profile

Cosin Solar Technology Co., Ltd. (Cosin Solar for short) , previously named as Zhejiang Supcon Solar Technology Co., Ltd., was founded in 2010. Cosin Solar is one of the Reliable Provider for Molten Salt Tower CSP Solutions, focusing on the R&D of Tower CSP and Molten Salt Energy Storage technology, equipment and engineering, aiming to use advanced and efficient CSP technology to provide high-quality and low-cost clean energy.

Through years of dedication in CSP R&D and project development, Cosin Solar has successfully mastered integrated molten salt tower CSP technologies, established complete domestic manufacturing & supply chain of CSP core equipment in China. At the same time, Cosin Solar has developed a set of High-temperature Molten Salt Energy Storage solutions and owned large-scale equipment supply ability.

Based on the technology excellence, Cosin Solar has achieved a series of milestones as follows:

2013 SUPCON SOLAR Delingha 10MW Molten Salt Tower CSP Plant was synchronized to the grid, which became the 1st commercially operated CSP plant in China.

2014 SUPCON SOLAR Delingha 10MW Molten Salt Tower CSP Plant became China's 1st and unique CSP plant entitled to Feed-in tariff at 1.2RMB/KWh.

2016 The Molten Salt System of SUPCON SOLAR Delingha 10MW Tower CSP Plant was completed, upgrading to China's 1st Molten Salt Tower CSP plant.

2018 As one of China’ s first batch of CSP Demonstration Projects, SUPCON SOLAR Delingha 50MW Molten Salt Tower CSP Plant was synchronized to the grid.

2019 POWERCHINA Gonghe 50MW Molten Salt Tower CSP Plant was synchronized to the grid, which is one of China’ s first batch of CSP Demonstration Projects. Cosin Solar is the technology and equipment provider of the solar island and is also awarded with commissioning service for the whole plant and subsystems.

2022 Since 2022, Cosin Solar have won a total of 1250MW Tower CSP projects widely distributed in Qinghai, Gansu, Xinjiang, Jilin and other provinces which are under execution now.

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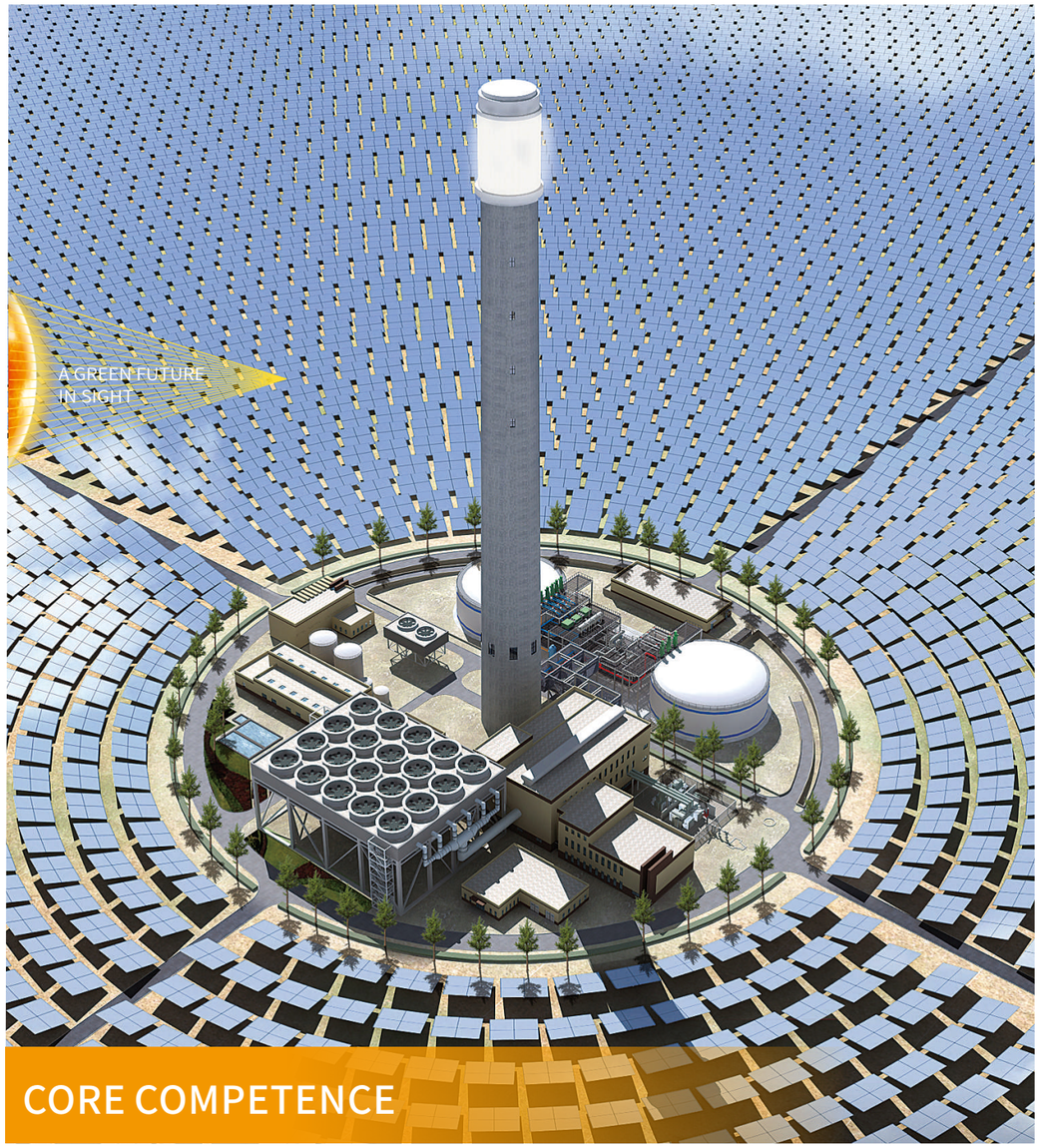

CORE COMPETENCE

Leading Technical Advantages

CSP is a highly complex technology that involves various science fields. With years of endeavor in R&D, Cosin Solar has mastered integrated technologies of molten salt tower CSP and owns complete intellectual property rights on the technology of solar concentration, thermal collection, thermal storage & exchange, customed equipment design for harsh environment, construction and O&M, which have been sufficiently proved on commercially operated projects and other engineering practices.

Core Technology

- **High precision Concentrating:** Cosin Solar has developed data acquisition technology of solar field in multiple time and large samples based on machine vision, as well as automatic sun tracking calibration algorithm with the optimal parameters, which can solve the problem of solar concentrating accuracy shift caused by the mechanical wear and change of the surroundings and seasonal weather conditions.
- **Design & Manufacture of Intelligent Heliostat:** Cosin Solar heliostat has the function of fault self-detection and abnormity self-protection. With the environmental adaptability design such as low temperature resistance, ultraviolet resistance and sand proof, the heliostat is highly protected and can be safely and reliably operated under various extreme harsh conditions.
- **Large scale heliostats control technology:** Cosin Solar has developed a complete set of system solutions including heliostat electronic control system, heliostats field control system software, server and communication network, which can be used to manage the large-scale heliostats filed (more than 100,000 sets of heliostats) with excellent performance in equipment management, solar concentrating, real-time control, safety interlocking and online upgrade, so as to reduce the manual operation at maximum.
- **Design & Manufacture of Receiver with Thermal Shock & Fatigue Resistance:** With rich experience in material selection, structural design, equipment manufacturing and operation, Cosin Solar has developed a complete set of design and manufacturing technology of high temperature molten salt receiver.
- **Design of Large-scale High-temperature Molten Salt Tank:** With deep research on the equipment materials, structural design, manufacturing optimization and performance analysis, Cosin Solar has developed a complete set of design of large-scale high-temperature Molten Salt Tank .
- **Load change of Molten Salt Heat-exchanger:** As for ultra-high temperature and high-pressure parameters of molten salt energy storage, Cosin Solar has developed a molten salt thermal exchange system with wide and fast variable load exchange, enabling to achieve higher flexibility and faster ramp-up rate compared to conventional thermal power plant.
- **Thermal Storage & Exchange Process Package:** Using energy storage medium made of two nitrate mixture, Cosin Solar is able to design large-scale, cost-effective, safe and reliable thermal energy storage and exchange system, to meet the high-quality energy requirement of the user.
- **Optimal design of the system:** With optimal solar field efficiency considering cosine effect, shadowing, blocking, attenuation and Spillage, as well as making full use of electricity tariff policy, financing terms and land cost, Cosin Solar is capable to design most efficient CSP plant with best economic return.
- **Optimal operation solution:** Cosin Solar has developed a series of advanced operation system such as energy coordination & control system based on flux density of receiver, cloud prediction, whole process simulation system and intelligent operation optimization system, which efficiently improves the automation level and overall operation capacity of power plant.

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A GREEN FUTURE
IN SIGHT

Research and Development strength

Cosin Solar owns a R&D team of around 100 people with strong education background and comprehensive experience in CSP. Through continuous R&D investment for many years, Cosin Solar has set up a provincial R&D Center for high-tech enterprises which is the largest incubation platform with most complete functions and equipment for solar thermal technology and equipment R & D in China. Cosin Solar's self-developed intelligent heliostat, large-scale heliostats control technology, high-temperature molten salt storage and thermal exchange technology have been recognized as international advanced level.

- Independently win the SolarPACES 2020 Technology Innovation Award (First Asian CSP company)
- Leading the development of the IEC standards "Technology specification for solar field control system of solar tower power plant" (IEC 62862-4-2) and "Technical requirements and design gualifcation of heliostats for solar power tower plants" (IEC 62862-4-3)
- Execution of the 2nd phase of the World Bank CRESP program
- The self-developed design and core equipment for Molten Salt Tower CSP Plant certified by International Authoritative Organization

First Prize for Scientific and Technological Progress of Qinghai Province

First Prize for Scientific and Technological Progress of Zhejiang Province

SolarPACES2020
Technology Innovation Award

Manufacturing & Integration

Whole Industrial Chain Manufacturing & Integration

Cosin Solar has mastered the design and integrated manufacturing of heliostat, receiver, salt tank, heat exchanger, solar field control system and heliostat auto-cleaning machine. Through collaborating with high-quality suppliers and adopting automatic assembly lines, Cosin Solar is able to ensure the quality and productivity of core CSP equipment.

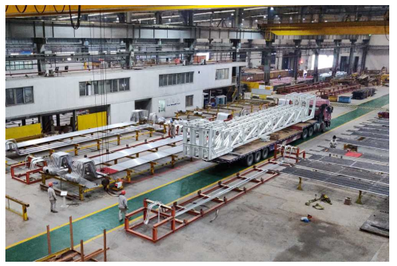
Quality Assurance System

Cosin Solar has established a quality assurance system, which guarantees the quality and performance of the equipment throughout the design, manufacturing and installation stage by means of Supplier Certification, Technical Specification, Manufacturing Supervision, Standard Tooling, Automatic Inspection System, Acceptance Specification and Installation Specification.

Equipment Optimization

In view of high-altitude, low-temperature, windy and dusty characteristics in most regions with abundant solar energy in China, Cosin Solar customizes core equipment with environmental adaptability. Through continuous Running Test, Temperature Cycling Test, Accelerated Weathering Test, Wind Tunnel Test, IP Test, Neutral Salt Spray Test, Cosin Solar is able to ensure anti-freezing, windproof, anti-UV, corrosion-proof performance of the core CSP equipment. Years of on-site operation have proved that weather adaptability of Cosin Solar's equipment is well above the average level of tower CSP industry.

Heliostat Assembly Workshop



Receiver Panel Assembly Workshop

Column Erection

Mirror Installation

Receiver Installation

Salt Tank & Thermal Exchange Platform Construction

Construction & Operation

With the experience of constructing several commercially operated power plants, Cosin Solar has fostered an experienced team of project implementation and supervision, and established complete project implementation standards and scientific progress control system. Cosin Solar could effectively optimize construction period to help the clients in investment control, while ensuring the performance of the plant.

As per specific needs of the clients, in addition to providing solar field and thermal storage & exchange system, Cosin Solar is also able to undertake EPC management of the whole plant with performance assurance.

Construction management

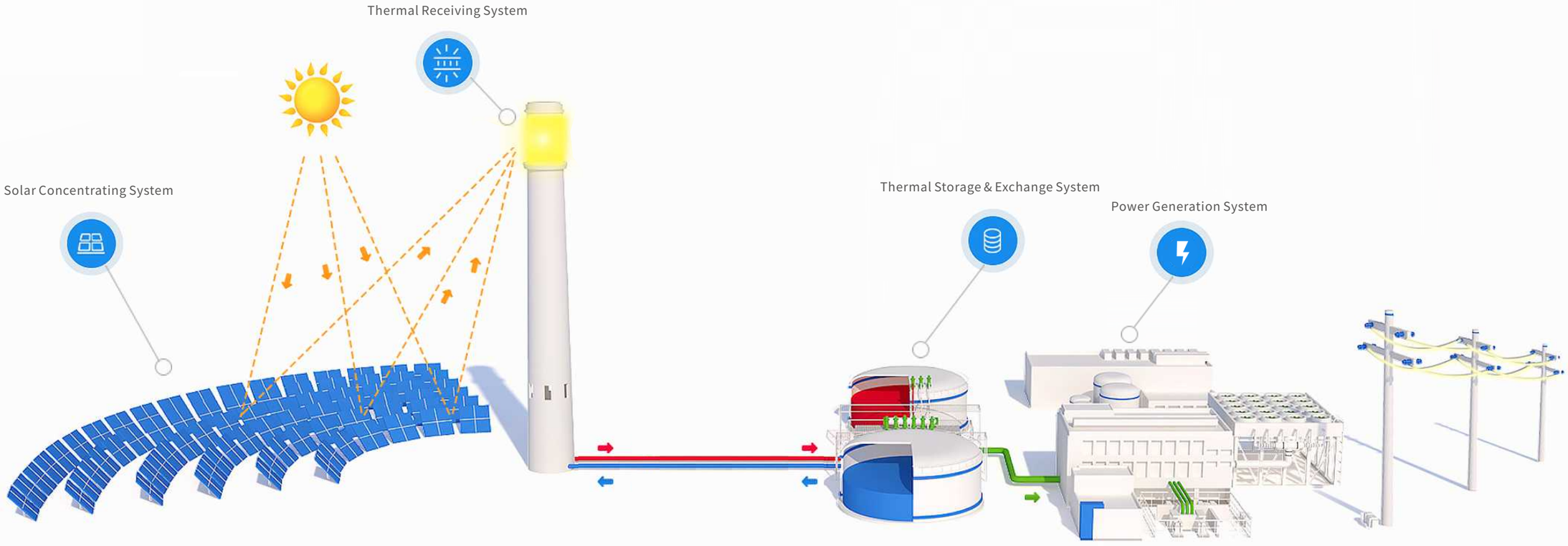
Critical Path Supervision/Winter Construction Measures/Standard Process and Tooling

Operation Optimization

Cloud Forecasting/Auto-cleaning/ Plant On-off Strategy/Emergency Safety Strategy

SOLUTIONS

Total Solution of Molten Salt Tower CSP



Solar Concentrating System

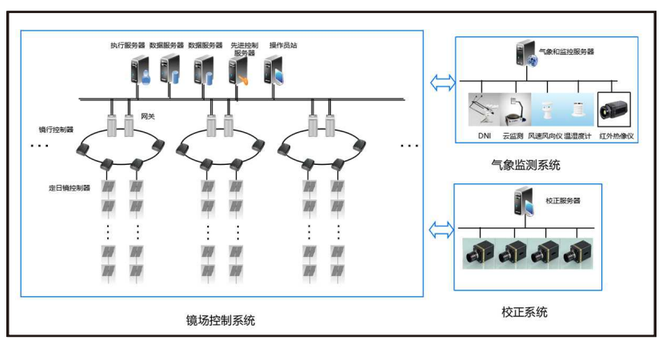
Solar concentrating system consists of large-scale high-precision heliostat field and its control system, which reflects and concentrates direct normal irradiation (DNI) to the tower-top receiver for collecting solar energy.

High-precision Intelligent Heliostat

- **High-precision:** 1.65mrad tracing accuracy to ensure efficient energy utilization
- **Intelligence:** Automatic accuracy check / Periodical auto-calibration
- **Easy maintenance:** 30-year maintenance-free heliostats / No lubricant replacement needed
- Thanks to its outstanding advantages of high surface and tracking accuracy, awarded the top evaluation grade of “Excellent” in the quality inspection conducted by the international third-party authoritative, CSP services of Germany and Deutsches Zentrum für Luft- und Raumfahrt (DLR).

Large scale heliostats control system

- **Large scale control ability:** Over 10,000 sets of heliostats/ 2km reflecting distance /
- **Safety and reliability:** Redundant power-supply and communication/ Working temperature range: -40℃ to 65℃/ Working wind speed: up to 24m/s/ Survival wind speed: up to 40m/s



Thermal Receiving System

Receiver is the core equipment of thermal receiving system, which absorbs solar energy and converts it into thermal energy by heat transfer media. Considering Molten Salt Receiver works in corrosive, frequent and sharp temperature fluctuation conditions, Cosin Solar has optimized the design of receiver with safety strategies to assure its performance in the harsh conditions.

Key Technologies

- **Receiver Material Selection:** High-nickel alloy with Heat-resistant/Anti-corrosion /Thermal stress & fatigue resistance
- **Flexible structure:** Minimum impact of thermal stress & fatigue
- **Safe operation process:** Anti-freezing/ Real-time Temperature monitoring interlock with solar field dispatching

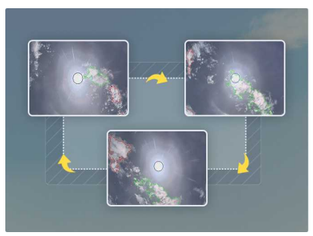
Thermal Energy Storage & Exchange System

Thermal energy storage & exchange system consists of hot and cold salt tanks, heat exchanger, tubes, instruments, electric tracing, heat preserver and other auxiliary systems. The salt tank can store high-temperature molten salt which exchanges with water through heat exchanger to produce superheated steam for high-quality power generation. Cosin Solar can provide not only integrated thermal energy storage & exchange equipment and solutions, which have been proved on utility-scale projects, but also thermal process package customized as per technical requirement of the client, including Equipment Specifications, Platform & Pipes Layout, System Process Flow, Test Point and Control Plan.

Key Technologies

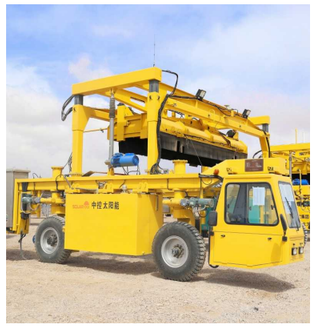
- Safe and reliable process flow: Anti-Freezing, Leak Proof/Intermittent Operation, Frequent On-Off/Coordination Control of Energy Variation
- Customized equipment: Frequent On-Off/High Tolerance Of Thermal Stress and Fatigue/Heat-Resistance, Corrosion Resistance
- Molten salt tank features: Customized material and thickness design/Expansion and Thermal Stress Analysis/Foundation Heat Dissipation (<50℃) and Heat Preservation Optimization/Reliable Welding Process, Repairing And Maintenance Plan
- Optimized Heat-exchanger design for load change: Wide and quick load change ability/ Engineering of Preheater, Evaporator, Steam Drum, Superheater, Reheater/Natural Circulation or Forced Circulation engineering /Single train or Double train engineering

Whole-Process Intelligent Management System



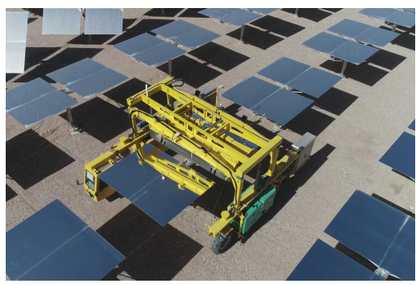
Cloud Forecasting System

Cosin Solar Cloud Forecasting System, based on all-sky imager and satellite cloud image, can track the cloud motion path within 5 hours and accurately predict its impact on the operation of the system. With this system, the operation strategy for CSP Tower Plant can be well optimized in advance to ensure the safe and stable operation and maximize use of solar resources.



Heliostat Field Auto-cleaning System

Cosin Solar Heliostat Field Auto-cleaning System is able to carry out periodical cleaning during operation of the plant. The system automatically monitors the cleaning process and can switch between Manned or Unmanned driving mode, Wet cleaning or Dry cleaning model to tackle with extremely low temperature and sandy conditions. Taking SUPCON SOLAR Delingha 50MW project for instance, 6 unmanned auto-cleaning vehicles which can work in day time and also at night, could clean the whole heliostat field in 7 days with two shifts every day, saving 200K USD labor cost and adding 180K USD incomes per year.



Molten Salt Tower CSP Simulation Software

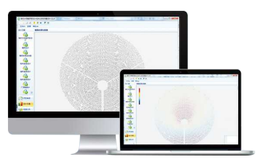
Through the mathematical modeling of the whole process of CSP plant production, Operation and Maintenance of the plant owns the following tools:

Operation Simulation: Plant Operation and On-Off Simulation, Operation Data Output, Simulation Platform Acceleration & Suspension.

Failure Simulation: Simulation of equipment failure and its corresponding corrective operation and interlock protection.

Design optimization: Verification and Optimization of Process Flow, Equipment Selection and Control Strategy.

Training: Demo of plant process flow, Operating personnel training and KPI monitoring.

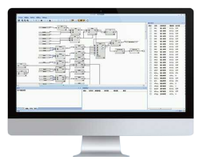


Molten Salt Tower CSP Design Software

With necessary project input data, Cosin Solar CSP design software can realize overall design of the project. Detailed technical documents, including solar resource analysis, parameter of heliostat field, receiver, salt tank, heat exchanger, steam turbine, amount of electricity production & auxiliary services power, as well as economic analysis, can be generated from the CSP design software and further used for feasibility study, investment decision-making and preliminary project design of the project.

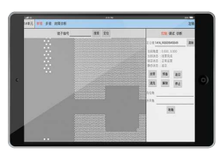
Plant Performance Measurement Software

Through analysis of meteorological data, main equipment parameters, power operation mode and other detailed plant data, Cosin Solar Performance Model can calculate the theoretical power generation of CSP plant and display the outcome by chart. The Performance model has been proved to well support Economic Evaluation during the project early design stage and Generation Achievement Rate Assessment in the operation stage.



Operation Optimization Software

Cosin Solar operation optimization software is well designed based on mathematical modeling, big data analysis and machine learning, with functions of System Operation Analysis & Evaluation, Expert Diagnosis of Major Equipment and Operation KPI Assessment, which is able to continuously improve the standardization, automation and intelligence, power generation rate and economy return of CSP Plant.



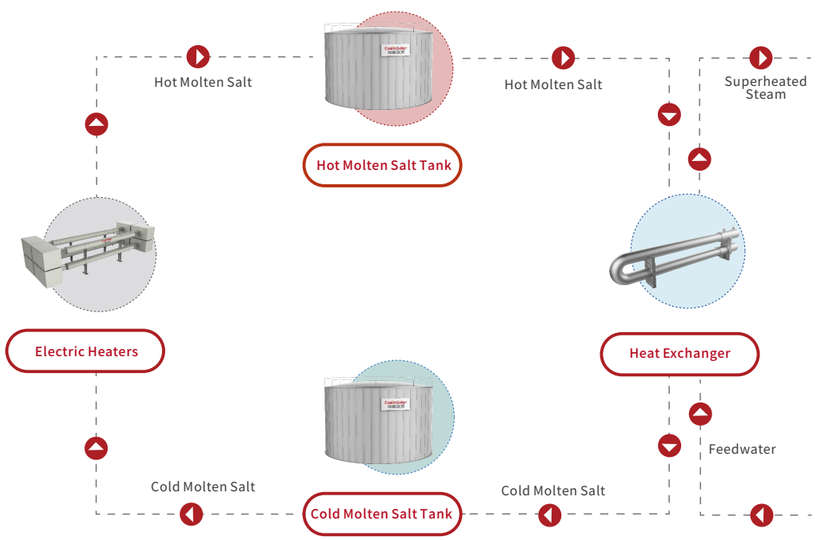
Commissioning & Maintenance Mobile Platform

This platform can be installed on android-powered cellphones and tablets to conduct commissioning, maintenance and failure correction of heliostat, as well as historical data interaction. It can dramatically improve work efficiency during commissioning and maintenance of heliostat field.

Integrated Energy Services Solution Based on Molten Salt Energy Storage

What is MSES

Molten Salt Energy Storage (MSES) is a low-cost and high-efficiency thermal energy storage technology, which uses sensible heat media to absorb energy at low temperature and release energy at high temperature. MSES is highly safe and friendly to the environment and power grid, with advantages of low investment and operating cost, long life time and less land occupation. MSES can be well applied not only to CSP plant, but also to Coal-Fired Power Plant Flexibility Upgrade and CCHP(Combined Cooling, Heating and Power).

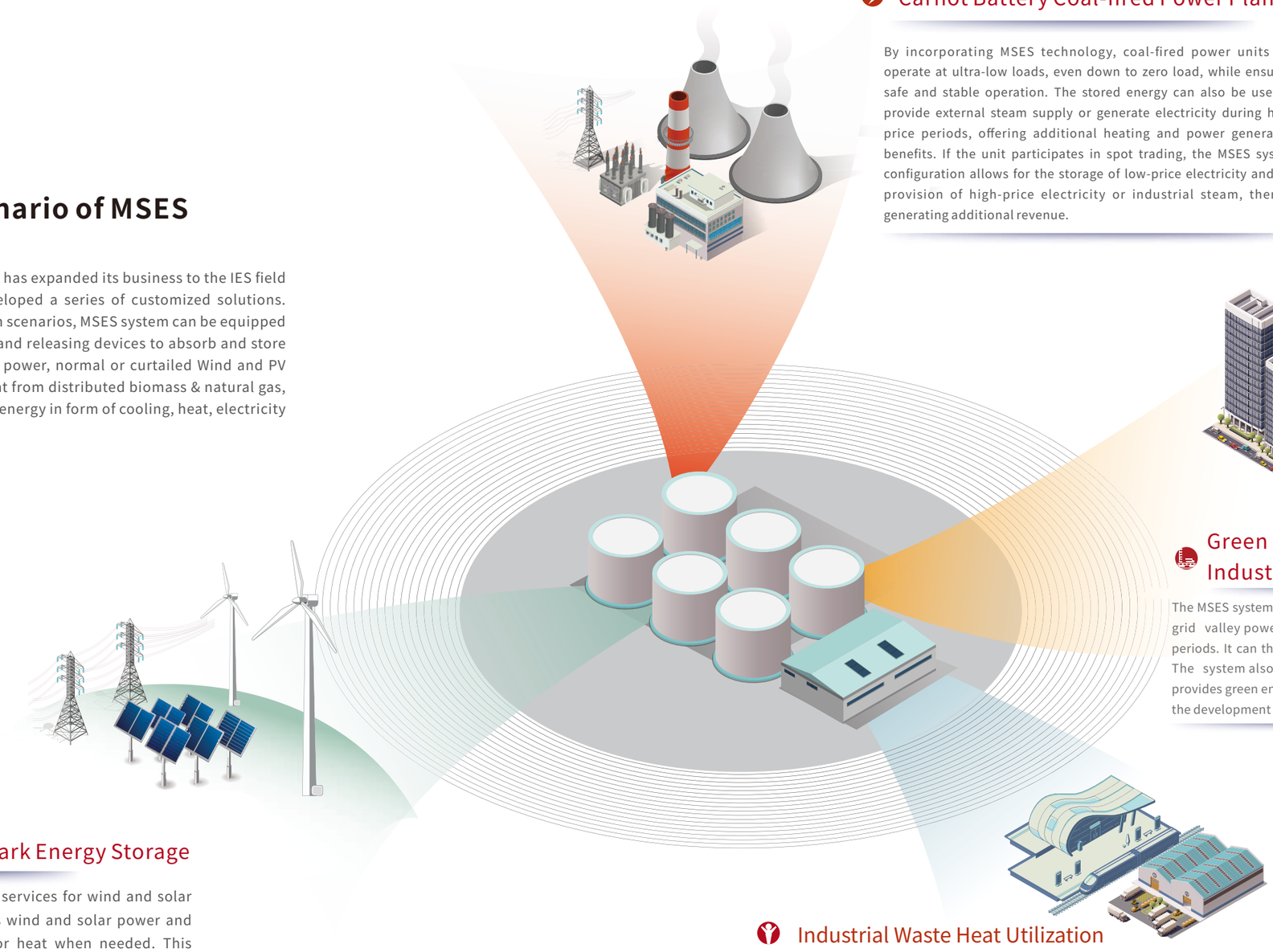


Advantages of MSES

- **Wide application range:** flexible and adjustable temperature, application range 80 ~ 600 ℃;
- **Long service life:** up to 25 ~ 30 years. Molten salt can continue to be used after decommissioning of CSP plant;
- **Large energy storage capacity:** 10MWh-10GWh large-scale and large-capacity energy storage;
- **Low thermal storage cost:** 24-40 USD / KWh;
- **Short construction period:** 8-10 months (excluding steam turbine) / 12-18 months (including steam turbine);
- **Efficient land use:** 0.3-1.6 Hectare/GWh;
- **High safety:** 100% physical change without risk of explosion and combustion in the whole process. Well proved long-term stable and safe operation in chemical industry. The tank cofferdam can minimize personnel injury and property loss in case of high-temperature molten salt leakage;
- **Environment friendly:** No pollution during manufacturing and operation;
- **Grid friendly:** With steam turbine generator, can provide reactive power and rotary inertia to power grid, support voltage stability and frequency stability of the grid, provide peak shaving, frequency regulation, voltage regulation, system standby and black start services to power grid.

Application scenario of MSES

Based on R&D of CSP, Cosin Solar has expanded its business to the IES field with MSES technology and developed a series of customized solutions. According to different application scenarios, MSES system can be equipped with different energy absorbing and releasing devices to absorb and store several types of energy(off-peak power, normal or curtailed Wind and PV power, industrial waste heat, heat from distributed biomass & natural gas, solar radiant energy) and supply energy in form of cooling, heat, electricity or steam to the end user.



Carnot Battery Coal-fired Power Plants

By incorporating MSES technology, coal-fired power units can operate at ultra-low loads, even down to zero load, while ensuring safe and stable operation. The stored energy can also be used to provide external steam supply or generate electricity during high-price periods, offering additional heating and power generation benefits. If the unit participates in spot trading, the MSES system configuration allows for the storage of low-price electricity and the provision of high-price electricity or industrial steam, thereby generating additional revenue.

Green Heat Supply/CHP Supply in Industrial and Commercial Parks

The MSES system configuration can store clean energy, including grid valley power, wind power, and PV power during low-price periods. It can then supply electricity during high-price periods. The system also meets the stable heating demand of the park, provides green energy for the entire industrial park, and supports the development of a clean energy industrial park.

PV/Wind Power Park Energy Storage

MSES can offer energy storage services for wind and solar power plants by storing excess wind and solar power and converting it into electricity or heat when needed. This helps solve the problem of wasted wind and solar power in large renewable energy facilities.

Industrial Waste Heat Utilization

For steelmaking, coking, industrial silicon, chemical, and other industries, utilizing the residual heat MS heat exchange device enables the absorption and large-scale storage of high-temperature industrial waste heat and other waste heat. Through MSES, it achieves large-scale thermal energy storage, releasing the energy of the heat during high tariff periods, which can generate electricity and supply various parameters of industrial steam. This reduces energy consumption, high-price period energy use costs, and improves energy efficiency. The configuration of the MSES system for high energy users can increase self-sufficiency during high-price periods and ensure stable production.

SUPCON SOLAR Delingha 50MW Molten Salt Tower CSP Plant

One of China's first batch of CSP Demonstration Projects, entitled as National Strategic and Emerging Industry Key Project by NDRC (Chinese National Development and Reform Commission).

Located in Delingha, Qinghai Province, is a molten salt tower CSP plant configured with 27,135 sets of 20m^2 heliostat. The designed electricity output is 146 GWh/year, which meets power demand of 80,000 households, saves 46,000 tons standard coal and reduces 121,000 tons CO_2 emission every year.

The plant started construction in Mar. 2017, was synchronized to the grid on Dec. 30,2018 and reached full-load operation on April 17, 2019.

Installed Capacity	50MW
Storage	7Hours with Molten Salt
Occupied Land	2.47km^2
Heliostats	542,700m^2
Receiver Center Heigh	200m
Molten Salt Volume	10,093tons
Steam Parameter	13.2MPa，540.0℃
Electricity Output	146GWh/Year

After the plant was put into operation, its performance steadily improved and repeatedly broke records in terms of non-stop operation hours, daily, monthly, and annual performance. In 2022, the plant's cumulative actual power generation reached 146.4GWh, i.e. 100.26% of the designed annual power generation(146GWh), setting the highest operation record among the tower CSP plants in China. The total annual accumulative actual power generation of the Plant in 2023 was 152.4GWh, i.e. 104.38% of the designed value (146GWh), exceeding the target in a second year.

Meanwhile, the plant has passed the complete technical assessment of Fichtner, a German independent engineering consultancy company. Fichtner considers the design of the plant corresponds to state-of-the-art design of similar plants in the world, the self-developed heliostat and control system and other core equipment are of high quality, and the plant has good operation performance and advanced quality with the level of other international peers.

POWERCHINA Gonghe 50MW Molten Salt Tower CSP Plant

One of China's first batch of CSP Demonstration Projects. Cosin Solar is technology provider and equipment supplier of solar-thermal collecting system and also conducted commissioning of the plant.

Located in Gonghe County, Qinghai Province. Molten salt tower CSP plant configured with 30,016 sets of 20m² heliostat to generate 156.9 GWh electricity annually, which can save 51,200 tons standard coal and reduce 154,000 tons CO_2 emission.

The plant started construction in May 2018, was synchronized to the grid on Sep. 19, 2019, and reached full load operation on Nov. 6, 2020.

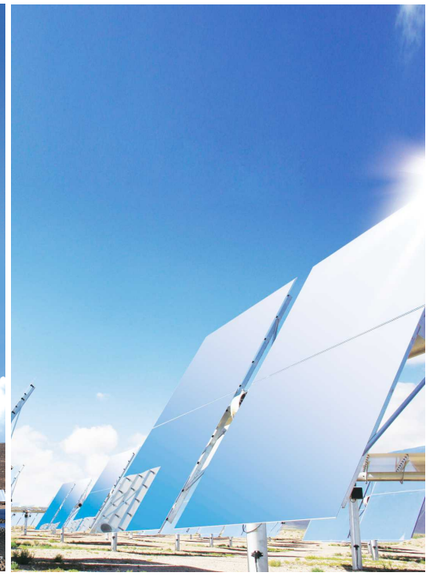
Installed Capacity	50MW
Storage	6 Hours with Molten Salt
Occupied Land	2.13km²
Heliostats	600,320m²
Receiver Center Height	210m
Steam Parameter	13.2MPa，540.0℃
Electricity Output	156.9GWh/year

SUPCON SOLAR Delingha 10MW Molten Salt Tower CSP Plant

- China's 1st commercially operated Tower CSP plant (since July,2013)
- China's 1st Molten Salt Tower CSP plant (since August, 2016)
- China's 1st CSP plant awarded with Feed-in Tariff (1.2 RMB /kWh)

Located in Delingha, Qinghai Province. The plant is featured with DSG(Direct Steam Generation) and MS(Molten Salt) twin receivers, combined solar field with 21,500 sets of $2m^2$ heliostats and 1,000 sets of $20m^2$ heliostats.

Installed Capacity	10MW
Storage	2 Hours with Molten Salt
Occupied Land	250,000m^2
Heliostats	63,000m^2
Efficiency at Design Point	15.90%
Steam Parameter	8.83MPa/510°C



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