

# Integrated Energy Solution Based on Molten Salt Energy Storage



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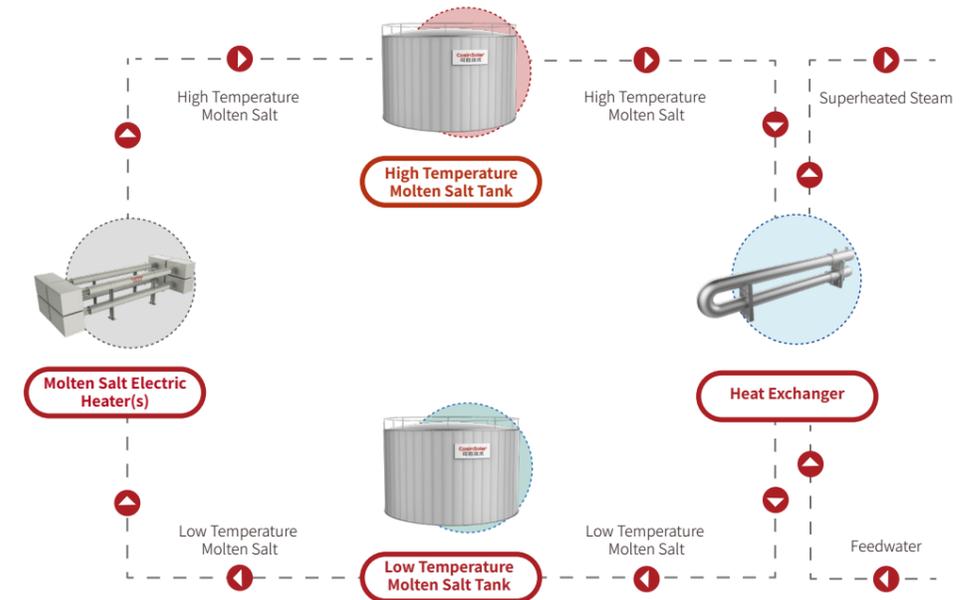
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# Molten Salt Energy Storage

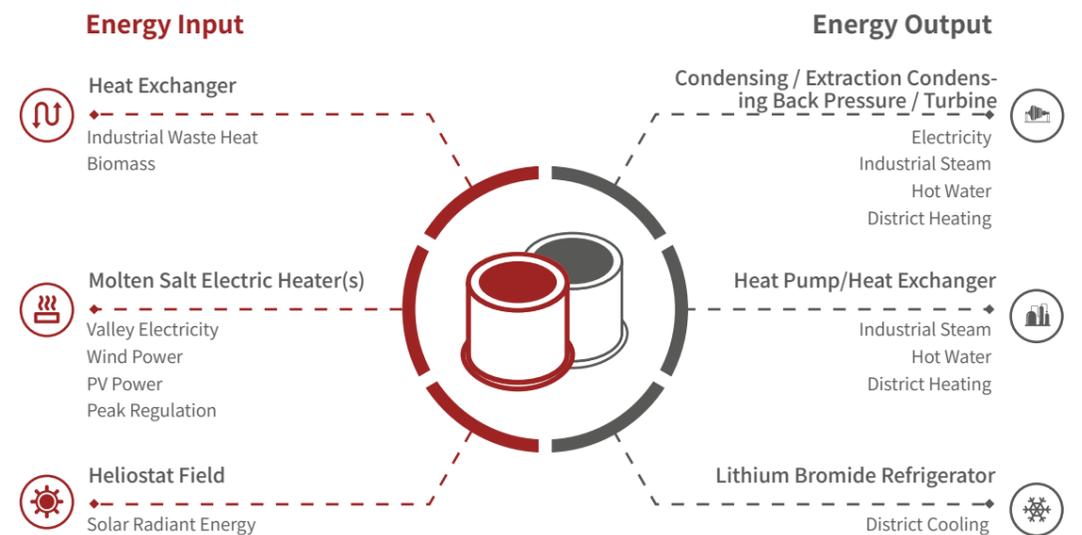


## What is MSES

Molten Salt Energy Storage (MSES) is a low-cost and highly efficient thermal energy storage technology, which absorbs energy at low temperature and release energy at high temperature. It mainly includes molten salt heating system, molten salt heat storage system and steam generation system. Molten salt refers to the molten body of inorganic salt, which appears as a liquid state with good fluidity in the molten salt energy storage system.

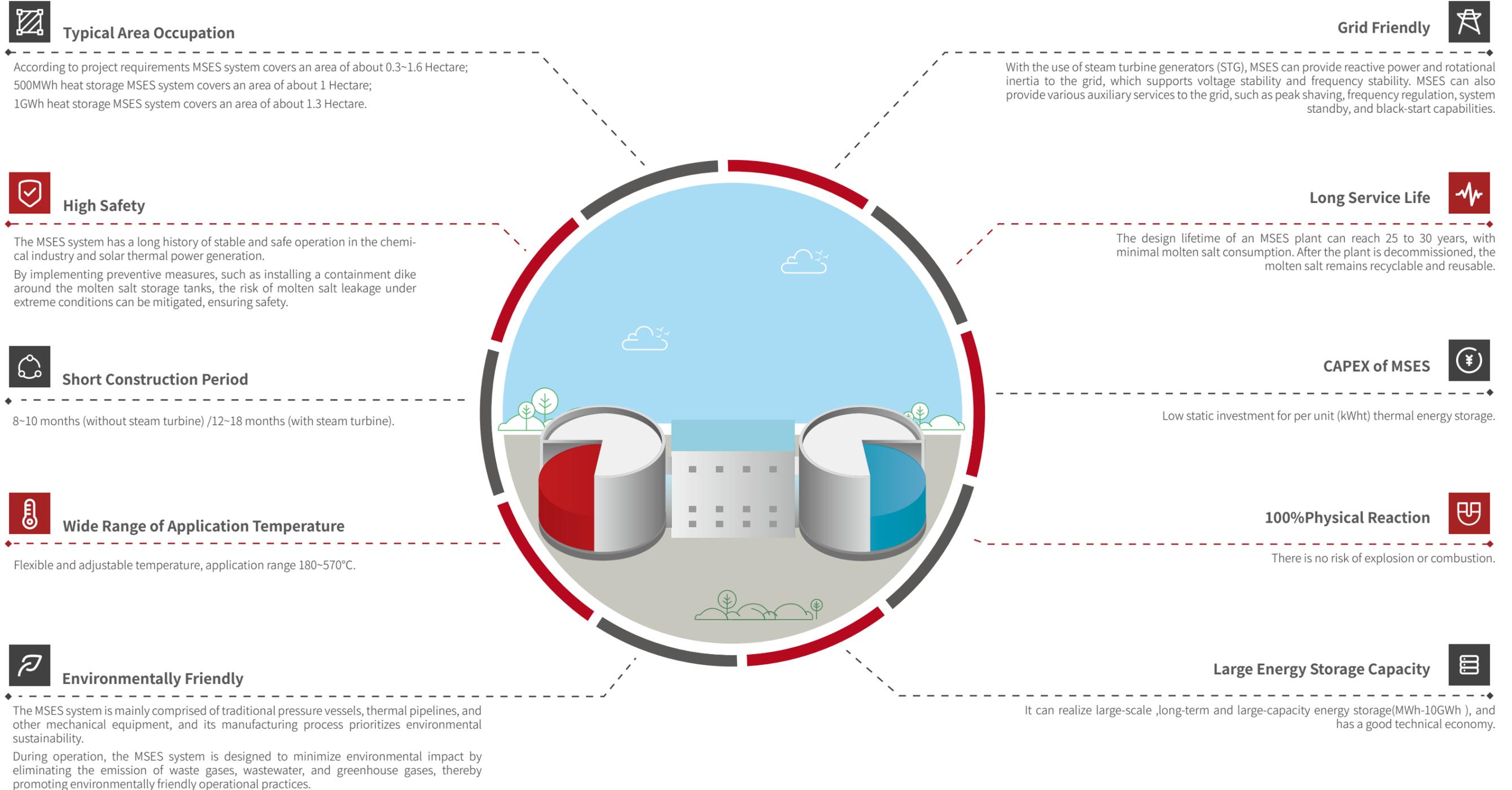


There are many application scenarios for Molten Salt Energy Storage (MSES). It can absorb low-cost electricity, wind power, photovoltaic (PV) power, industrial waste heat, natural gas, coal gas, and solar radiation energy. After storing and shifting the thermal energy over time, it can deliver electrical energy (especially during high-price periods), high-parameter steam, hot water, and district heating.



## Advantages of MSES

Molten Salt Energy Storage (MSES) technology offers several advantages, including high safety, environmental friendliness, grid compatibility, wide range of applicability, low investment, large storage capacity, long service life, simple site selection, small land footprint, and short construction period. It can be applied not only in Concentrated Solar Power (CSP) plants but also in industrial waste heat utilization, green heat supply/combined heat and power (CHP) in industrial and commercial parks, Carnot Battery of coal-fired power plants, and energy storage configuration in PV & Wind Power plants.

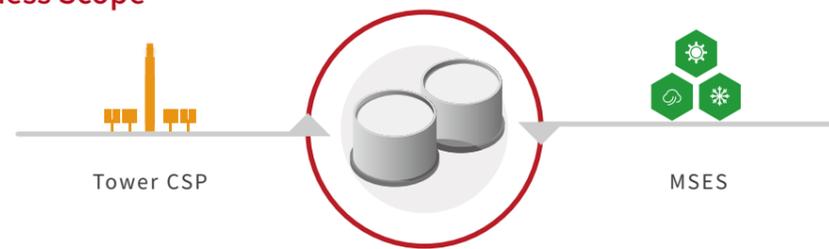


# About Cosin Solar

## About Cosin Solar

Cosin Solar Technology Co., Ltd. (Cosin Solar) was previously known as Zhejiang Supcon Solar Technology Co., Ltd. The company was established in 2010 and is a reliable provider of Molten Salt Tower CSP. Cosin Solar focuses on the research and development, equipment, and engineering of Tower CSP and MSES. The company is deeply committed to the Tower CSP/-Multi-Energy Power plant with CSP and MSES application business. Cosin Solar aims to provide high-quality and low-cost clean energy solutions.

## Business Scope



## Research & Development



**15** Years' dedication in Tower CSP technology R&D



**6** Provincial and municipal-level scientific and Technology Progress Award



**443** Patents  
**314** Patent for Invention  
**117** Patent for MSES



**42** International, national, industry, and organizational standards  
**9** Standards for MSES



**31** National Level Scientific Research Program  
**20** Research Program for MSES



**International Certification**  
Design technology of tower molten salt energy storage solar thermal power plants and core equipment developed through independent research and development

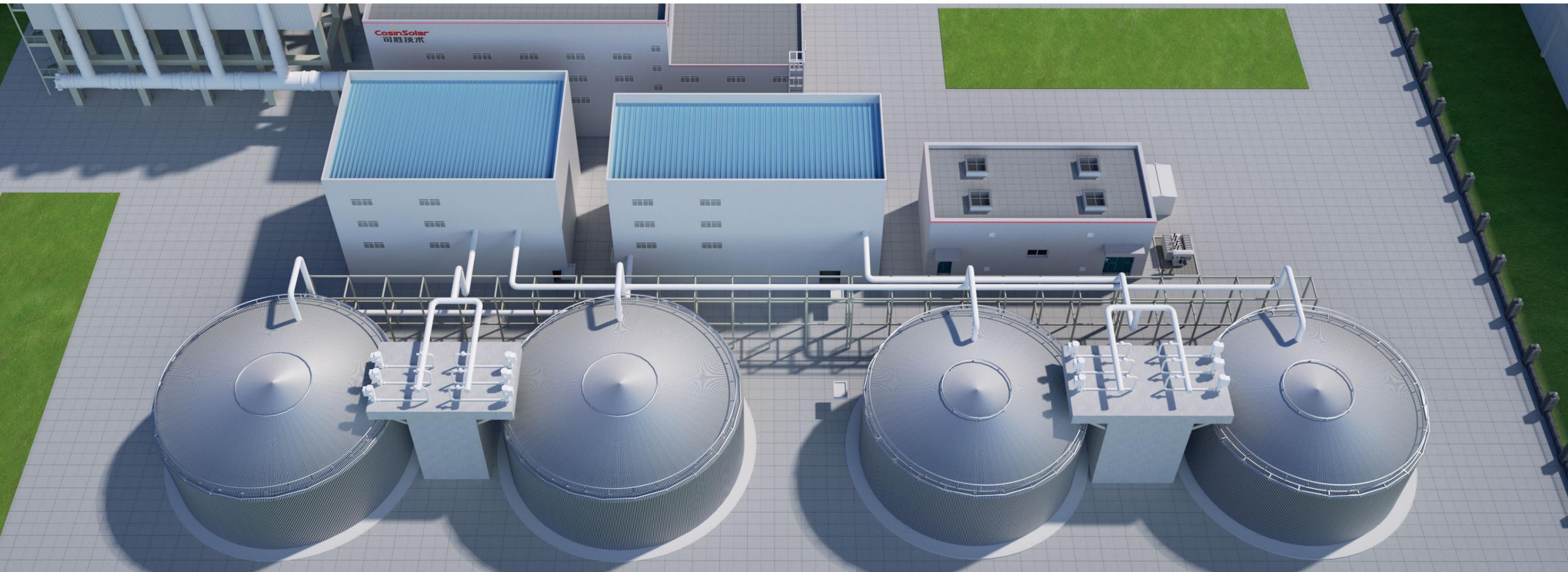


## CORE COMPETENCE

After more than ten years of technical research and engineering practice, Cosin Solar has developed a comprehensive set of solutions based on large-scale wide-temperature MSES. These solutions cover MSES technology, independent design of key system equipment, system equipment integration and supply, etc. Cosin Solar has also cultivated a technical personnel team that integrates technology research and development, engineering design, construction management, energy storage debugging, and operation and maintenance. The company can provide high-reliability products and technical services for molten salt energy storage projects.

- **Large Capacity High Temperature MSES System:** Cosin Solar has developed a special MSES system with a large capacity, designed for high temperatures. This system is safe, reliable, and cost-effective, and is capable of storing high-grade energy. It allows for rapid start-up and shutdown, as well as quick load changes across a wide range. The MSES system operates with a high level of automation, greatly reducing problems caused by improper operation, such as freezing, overheating, leakage, and load instability. This enhances the overall operational reliability of the system.
- **System Equipment Integration and Supply:** A complete supply chain system has been set up to facilitate the integrated supply of MS tanks, MS heating equipment, steam generation system equipment, auxiliary and supporting equipment of MS system and other core components, allowing for the optimal configuration of the overall system and equipment. Our aim is to provide customers with high-quality and cost-effective system solutions.

- **System Key Equipment Independent Design:** Cosin Solar has developed advanced design technology for the highly reliable MS tank. This includes the ability to simulate and analyze temperature and pressure variations during processes such as tank preheating, salt intake, and liquid level changes. Additionally, the company can design and optimize the foundation heat dissipation and insulation structure of the storage tank, as well as key structures and parameters for critical equipment like the MS heat exchanger, MS pump, MS valve, and MS electric heat tracing. This includes optimizing heat exchange efficiency, reducing flow resistance, and designing structures for rapid load changes in the heat exchanger, as well as designing large flow and high head MS pump structures. The company also offers comprehensive solutions for sealing surface, seal, and packing selection to prevent internal and external leakage of molten salt valves, and enhances the reliability of electric heat tracing design and intelligent control strategy. They also collaborate with high-quality suppliers for manufacturing on a long-term basis.
- **Customized Operation Control Strategy:** The development of customized control strategies for various application scenarios can address energy storage needs from different sources such as wind and PV power, high-temperature waste heat, etc. The start-stop control strategy, which is based on equipment characteristics and user requirements, is designed to ensure safety, high efficiency, and rapid response to load changes, meeting diverse energy needs and adapting to frequent changes in energy requirements. Furthermore, a customized system interlock and protection strategy is implemented to prevent abnormal conditions such as molten salt freezing, overtemperature, and pipe rupture.



# SOLUTIONS

## Application Scenarios of MSES

Cosin Solar has expanded its business from CSP research and development to MSES system. They have developed customized solutions for various application scenarios. The MSES system can store different types of energy such as valley electricity, wind/PV power, curtailed wind/PV power, wasted heat, heat from industrial waste heat, natural gas, coal gas, and solar radiant energy. It can supply energy in the form of electricity, steam, or heat to the end user.

### 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, while also fulfilling the policy mandates for energy storage and peak regulation in renewable energy initiatives.

### Carnot Battery Coal-fired Power Plants

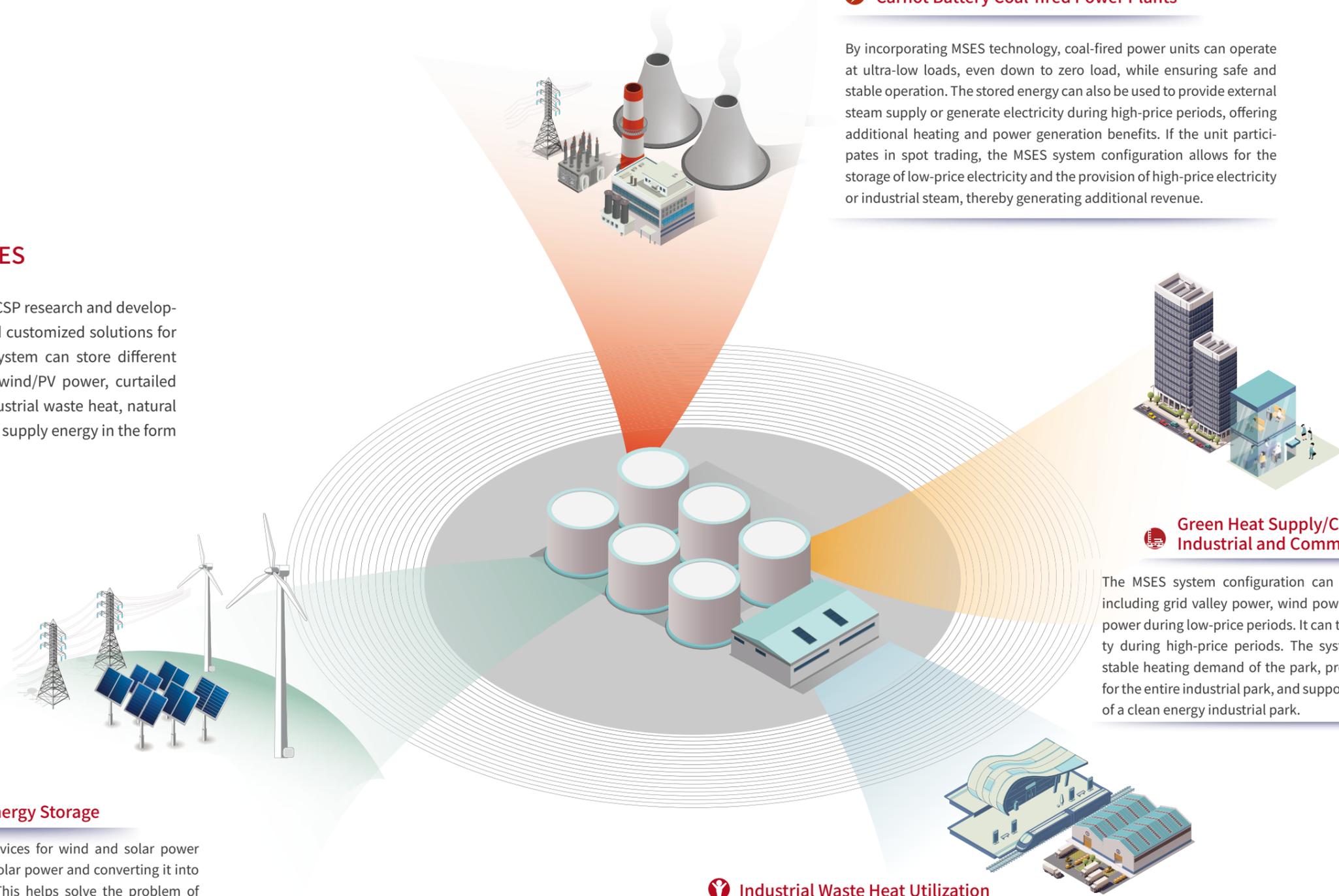
By incorporating MSES technology, coal-fired power units can operate at ultra-low loads, even down to zero load, while ensuring safe and stable operation. The stored energy can also be used to provide external steam supply or generate electricity during high-price periods, offering additional heating 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 photovoltaic 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.

### 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.





## Industrial Waste Heat Utilization

- Traditional industrial waste heat power generation projects have a consistent power generation capacity, which only partially meets the energy consumption needs of the park. The park needs to purchase the rest of the energy from the grid, leading to a high average energy consumption cost.
- By setting up the MSES system, we can store the heat of high-temperature industrial waste heat in high-temperature MS tanks during the low-price period. This allows us to achieve high-grade heat storage and release the heat during the high-price period, effectively transferring energy from the low-price period to the high-price period to meet the energy consumption demand of the park. This significantly reduces the cost of electricity purchased from the grid during the high-price period, lowers the average energy consumption cost of users, and enhances the value of energy utilization.

### Energy Input

 Heat exchanger  
Wasted Heat  
Industrial Heat



### Energy Output

 Steam Turbine  
Electricity  
Industrial Steam  
Hot Water

 Steam Generation System  
Industrial Steam  
Hot Water



## Green Heat Supply/CHP Supply in Industrial and Commercial Parks

- During the low-price period, store relatively inexpensive energy from sources like wind/PV power, electricity, and distributed PV power. Then, during the high-price period, use this stored energy to generate electricity. This electricity can also meet the heating needs of the park, helping to reduce the overall energy costs for the park.
- Improve utilization of renewable energy.
- Ensure a steady and uninterrupted supply of heating and electricity for business parks and other users.

### Energy Input



#### Electric Heater

Valley Electricity  
Wind Power  
PV Power  
Wind and PV Curtailment



### Energy Output

#### Steam Turbine

Electricity  
Industrial Steam  
Hot Water



#### Steam Generation System

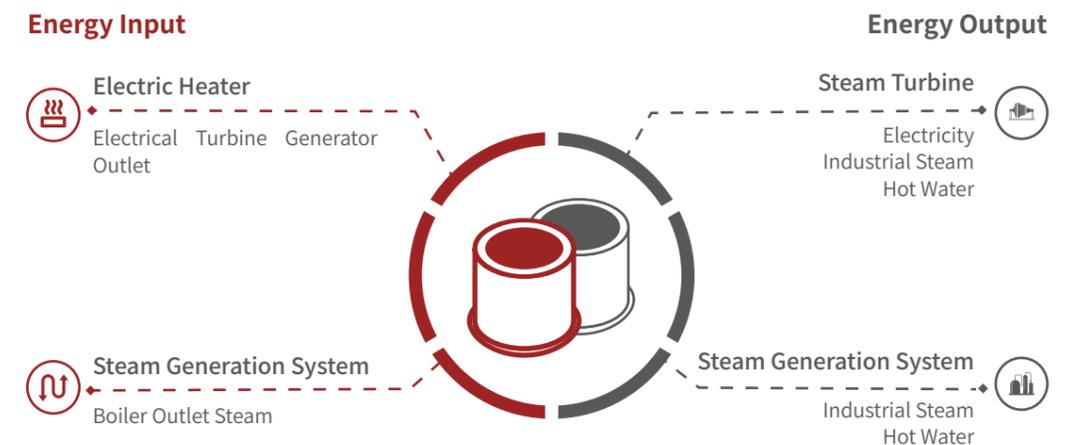
Industrial Steam  
Hot Water





## Carnot Battery Application for Coal-fired Power Plants

- Using electric heating, steam heating, and other forms, the energy generator output or boiler steam is stored in MS, maximizing the ability of the unit to connect to the grid at low loads and even achieving zero load grid connection for the unit. It also improves the peaking depth and operational flexibility of thermal power units, and the heat stored in MS heat can be converted into electrical or heat output according to the users' demand.
- Ensure safe, stable, and environment-friendly operation of the boiler and turbine unit when it operates at a low load, it can also replace the starting boiler and has the ability of emergency backup.
- The flexible startup-stop/load change of electric heater or steam molten salt heat exchange equipment can replace the slow load change process of the boiler, greatly improving the frequency regulation capability of the whole plant.
- For the thermoelectric unit, the MSSES system can solve the issue of “power determined by heat” by precisely controlling the thermal and electrical output separately.





## Energy Storage Services for Wind/PV

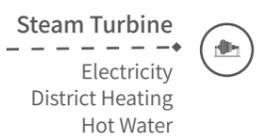
Renewable energy sources like wind and solar power have natural characteristics of instability, intermittency, and non-dispatchability. However, Multi-Energy Storage System (MSES) facilities offer a solution by storing excess or curtailed wind and solar power for peak demand periods or for generating revenue through heat supply. This setup also aligns with the policy requirements for energy storage systems connected to the grid in various regions.

- During morning and evening peak hours, thermal energy previously stored in MS could be converted into electricity or heat by STG or heat exchanger.
- With MSES, the generation curve can be smoother and the stable operation ability of power system can be improved.
- Compared with other energy storage system, MSES has lower investment, higher safety, and nearly zero loss of molten salt.

### Energy Input



### Energy Output





**PROJECTS CASES**

**SUPCON SOLAR Delingha 50MW Molten Salt Tower CSP Plant**

As one of China's first concentrated solar power (CSP) demonstration projects, it is awarded as National Strategic and Emerging Industry Key Project by NDRC (Chinese National Development and Reform Commission).

The project located in Delingha, Qinghai Province, is a Molten Salt tower CSP plant configured with 7-hour MSES. The amount of MS is 10,093 tons, and the designed annual electricity output is 146 GWh/year, which is enough to supply power for 80,000 households. It can save 46,000 t/ce and reduce 121,000 tons CO<sub>2</sub> 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 Apr.17, 2019, it has been running stably for 5 years.

Solar salt (binary salt) is used in this project's molten salt storage and heat exchange system. The total amount of molten salt is 10,093 tons. It has two tanks for cold and hot storage, achieving an effective energy storage capacity of 820MWh /350MWh. The parameter of SGS is 13.2MPa, 540°C, 146.7t/h.

Meanwhile, the plant has passed the complete technical assessment by Fichtner, an independent German engineering consultancy company, which considers the design of the plant corresponds to state-of-the-art design of similar plants in the world. The main equipment is operating in good condition and features several design highlights, such as the minimized design of the number of molten salt pumps, which can reduce costs and its own power consumption while maintaining high reliability and availability. In addition, the steam cycle system design can improve the operational flexibility of the power station.

Location	Delingha, Qinghai Province
STG Capacity	50MW
Storage Capacity (Hours)	7 Hours with MS
Energy Storage Capacity	820MWh /350MWh
MSES (Core island) Area	28,338m <sup>2</sup> /2.8 Hectare
MS Quantity	10,093tons
Steam Parameters	13.2MPa/540°C, 146.7t/h
Designed Electricity Output	146 GWh/Year

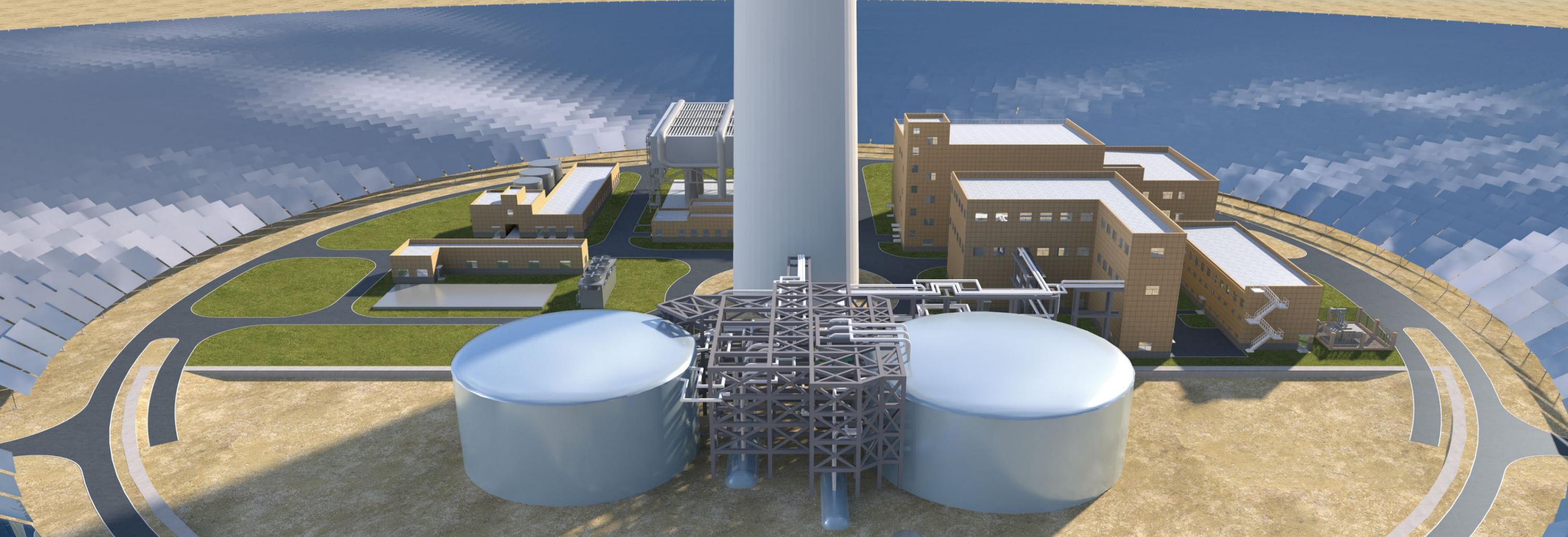
## SUPCON SOLAR Delingha 10MW Molten Salt Tower CSP Plant

Located in Delingha, Qinghai Province. The plant is featured with DSG(Direct Steam Generation) and MS(Molten Salt) twin receivers, with a 2-hour MS storage system.

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

Location	Delingha, Qinghai Province
STG Capacity	10MW
Storage Capacity (Hours)	2 Hours with MS
MS Temperature	565°C
Steam Parameters	8.83MPa/510°C
Commencement Date (MS)	Dec. 2014
Completion Date (MS)	Aug. 2016





## Jinta ZhongGuang Solar "CSP + PV" Hybrid Pilot Project 100MW CSP Project

Jinta ZhongGuang Solar "CSP + PV" hybrid pilot project, is one of the China's 2nd batch of national large-scale scenic base projects focusing on deserts, Gobi and deserts, located in Jinta County, Jiuquan City, Baishui Spring photoelectric industry zone. This project has a total installed capacity of 700MW and is developed and constructed by Jinta ZhongGuang Solar Power Generation Co., Ltd. It consists of a 100MW concentrated solar power (CSP) and 600MW photovoltaic (PV) elements. The 100MW CSP project, with an 8-hour MSES, uses solar thermal tower technology fully developed by Cosin Solar. Its designed annual production is 1580GWh and will save 480,000 tons of standard coal and reduce 1,310,000 tons of CO<sub>2</sub> emissions per year after operation.

STG Capacity	100MW
Storage Capacity (Hours)	8 Hours with MS
Electric Heater	6.3kV/20MW/Reserve 30MW
Energy Storage Capacity	1983MWh
MS Quantity	20,517tons
Steam Parameters	14MPa, 550°C
Designed Electricity Output	209GWh/Year

\*Item Parameter of CT CSP

The molten salt storage and heat exchange system of this project employs solar salt (binary salt) with a total amount of 20,517 tons of molten salt, achieving an effective storage capacity of 1983MWh/800MWh. The parameter of SGS is 14MPa, 550°C. The power station is equipped with a 20MW/6.3kV molten salt electric heater that serves the dual purpose of consuming discarded curtailed PV power and facilitating salt dissolution, thereby reducing investment in salt dissolution equipment for the power station. Furthermore, the cold tank of this project adopts an innovative "short-shaft pump" design, which effectively minimizes the amount of unusable salt, shortens the shaft length of the cold salt pump, enhances the operational reliability of the cold salt pump, and reduces the cost of the molten salt storage and heat exchange system.



**CosinSolar**