



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

# QUARTERLY UPDATE

Q2 2022

July



# NEWS IN BRIEF

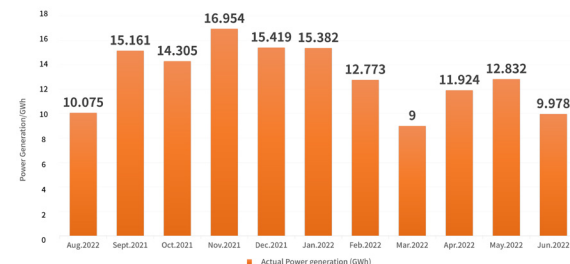
SUPCON SOLAR Delingha 50MW Molten Salt Tower CSP Plant ▶▶



## Project update

Recently, Cosin Solar Technology Co., Ltd. (Cosin Solar for short) announced that SUPCON SOLAR Delingha 50MW Molten Salt Tower CSP Plant has generated 146GWh electricity in the last 11 months, exceeding the designed annual power generation. It has become the first CSP Plant to achieve and exceed designed annual generating capacity in China. Undoubtedly, this is exciting news in the solar thermal industry.

Monthly Performance of Delingha 50MW CSP Plant





## The Story Behind the Successful Operation of Delingha 50MW Molten Salt Tower CSP Plant

### -- Interview with Jin Jianxiang of Cosin Solar

How does this performance influence the development of China's solar thermal industry market? What lessons learned are worth sharing from Cosin Solar?

With these questions, the reporter from China Solar Thermal Alliance interviewed Professor Jin Jianxiang, chairman and chief engineer of Cosin Solar.



Q

Compared with the same type of CSP plant in China and other countries, where is the level of such operation performance?

Tower solar thermal power stations usually have a period of performance improvement & learning curve between 3-5 years after commission of plant and in the commercial operation.

China's solar thermal power generation technology started late compared with other countries. Through the construction of national demonstration projects, 5 utility scale tower CSP plants have been synchronized, and most of them are in the stage of fine tuning and performance rapid improvement stage.

SUPCON SOLAR Delingha 50MW Molten Salt Tower CSP Plant was synchronized on December 30, 2018, and realized full load operation on April 17, 2019. Through half a year of defect remedy and trial operation, it officially entered

the routine operation stage in late July 2019. In the following three years of operation, the equipment malfunctions are solved one by one, and continuously broke operation records for the single day, single month and single year by optimizing the operation strategies. Since the rectification of the steam turbine and pipeline completed on August 5, 2021, the plant has been stably running till now. **The designed annual power generation (146GWh) has been completed within only 11 months, making it the first CSP plant in China with annual designed power generation having been fully reached.**

Based on our prediction, by the 5th August 2022, the power generation of the whole operating year is expected to reach nearly 160GWh, which will exceed the annual designed power generation by 10%. With the excellent operation performance and rich operating experience accumulated, we are confident in the following projects to realize the consecutive 12 month's performance reach the annual design performance within 18 months since COD, to create more value for customers by shortening the CSP plant learning curve.

Q

What are the key technical factors related to the operation performance of the CSP plant? How does the Plant achieve designed generation ahead of schedule? What are the key points and unique features in design and operation?

The operation performance of CSP plant is directly related to the irradiation resources, since it is a non-technical factor, we will ignore to discuss it here. The technical factors mainly include the compatibility in the **system design, the performance and reliability of the equipment, the O&M in the Solar Block, TESS and SGS Block and turbine and generator system.** To achieve the best operation of SUPCON SOLAR Delingha 50MW Molten Salt Tower CSP Plant, substantial jobs are done.



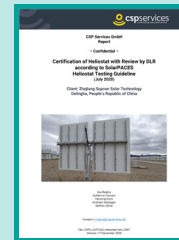
## System Design

First of all, it is a challenge to integrate the Solar Block, TESS and SGS Block, and turbine and generator system by matching all parameters between systems and the reasonable design of interfaces of systems to ensure that the design complies with the characteristics and operation mode of CSP process. **With independently self-developed tower molten salt CSP plant design software and the operation data from SUPCON SOLAR Delingha 10MW Tower CSP Plant(Pilot Project), the optimized solution is fulfilled to improve the overall efficiency of the whole system.**

With regards to the tower CSP, the performance of the Solar Block is the most critical factor to determine the operation performance of the plant. In Solar Block, the concentration precision of the heliostat directly affects the sub-system efficiency, and thus affects the efficiency and power generation of the plant. We improve the concentrating precision mainly from two aspects. First of all, **the mechanical precision of heliostat is guaranteed through structure design and manufacturing.** Meanwhile, it is same important to **maintain the regular calibration of the solar field.** **The automatic calibration based on machine vision methodology is adopted, which is 25 times more efficient than the traditional whiteboard calibration,** which not only greatly reduces the calibration time during commissioning, thus shortens the delivery time, but also maintains the heliostat accuracy at highest level through the life cycle, with frequent real time calibration of the heliostats in operation. The performance of the heliostat field control system also plays an important role in electricity generation. Attributing to our nearly 30 years of accumulation of knowledge in the field of control system, self-developed heliostat field control system could be used to realize large-scale cluster of heliostat field control, and coupling with the thermal

receiver control system, the safe and stable operation of solar block is ensured, and solar resources utilization is enhanced, thus to improve the generation of the plant.

Cosin Solar's achievements in such related domain is remarkable. As early as 2019, **German Aerospace Center (DLR) and CSP Services as an independent third-party has inspected and certificated on our heliostats, which received "Excellent" as the highest rating by DLR.** Our ability and level of knowledge on Solar Block has been widely recognized by the industry. We lead to draft the IEC international standard for the solar-thermal power stations heliostat field control system, and two National standards of Technical Requirements of Thermal Receiving Systems of Tower CSP, and Technical Requirements for Heliostats of Tower CSP.



Certification report of heliostat by CSP Services and DLR



## Reliability of Equipment

The reliability of equipment is very critical, as well. The main equipment of tower CSP plant include heliostat field, molten salt receiver, molten salt



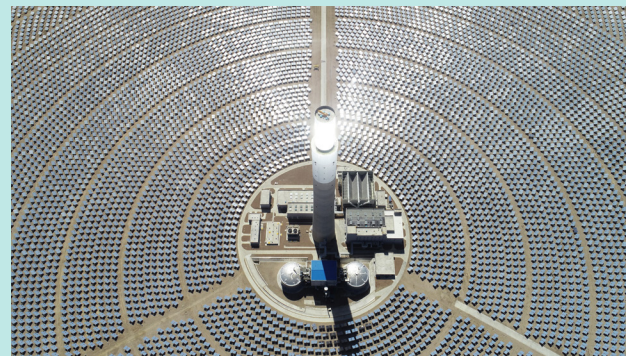
storage tank, molten salt pump, molten salt valves, steam turbine generator set, etc. The reliability of plant equipment is the primary factor that directly affects the performance and power generation. We designed and developed CSP tower core equipment/components that operate stably under extremely harsh conditions on the plateau, such as heliostats, thermal receiver etc, and solved the technical challenges such as electronics control at high altitude, high efficiency transmission design at low temperature, sealing as low air pressure, etc..

All above mentioned equipment/design solutions have been long term verified at SUPCON SOLAR Delingha 10MW Tower CSP Plant (COD in July 2013, Operation for 9 years), SUPCON SOLAR Delingha 50MW Molten Salt Tower CSP Plant (COD in December 2018) and POWERCHINA Gonghe 50MW Molten Salt Tower CSP Plant (COD in September 2019). At the same time, Cosin solar cooperates with international and domestic leading suppliers and engineering companies, conquering a series of technical challenges such as the **material selection, flexible structure design and operation process of Receiver, structure design and welding quality control of Storage Tank, height of Tank), wear resistance design at high temperature of molten salt pump, joint design of molten salt pump with pipeline and platform, the sealing of molten salt valves. All these key features have been mastered, the complete design and quality control process has guaranteed the reliable operation of the key equipment.**

### Operation Optimization

In terms of operation optimization, the core is how to take into account the safe and stable operation of the receiver and improve the utilization rate of solar resources in cloudy weather condition. According to statistics, Delingha

project site suffers more than 200 days of cloudy weather in a year, and the cloud from time to time has a great impact on the operation of the CSP plant. We are aware that sunshine blocked by cloud will not be concentrated by part of the heliostat field, which will endanger the safe operation of the receiver due to the drastic temperature change in its surface. Normally, during cloud movement, it is standard practice to shut down the solar field (defocusing of heliostats) and drain the molten salt is the most secure operation. But this operation will cause enormous waste of solar resources. At the same time, when the solar field is put into operation again, it takes time to preheat the receiver system and the pipeline. Thus the power generation of the CSP plant will be decreased.



However, with Cosin Solar's high-precision solar field control system, **it can quickly dispatch the whole heliostat field in the fastest way, so that energy is evenly distributed on receiver surface in cloudy condition to avoid the drastic change of the surface temperature of receiver.** Therefore,

there is no need to shut down the field and drain the molten salt from the receiver system to make best use of the solar resource. In addition, the duration of cloud may also influence operation strategies, which in turn affects the power generation. For example, when the heliostat field is covered by the cloud, the plant needs to choose the optimal operation strategy according to the duration of the cloud over the solar field. If the duration of the cloud is very short, the projected energy from the heliostat field and the flow of molten salt should be adjusted to avoid the shutdown of heliostat field, so as to ensure that the normal operation state can be restored quickly after the cloud passes the heliostat field. If the duration of the cloud is judged to be very long, the heliostat field should be shut down(defocusing), and the receiver system should be drained. The core to adopt the optimal strategy depends on the accurate forecast of the cloud movement and trend. **Cosin Solar independently develops the cloud forecast system to identify and track the cloud movement, to achieve the DNI forecast 30 minutes in advance.** Through seamless coupling with heliostat field control system, the operators are enabled to choose the optimal running strategies of CSP plant to reduce the frequency of startup and shutdown of the receiver system and improve the utilization of solar resources significantly.

Meanwhile, in order to improve the operation stability and power generation, and reduce the risk of equipment operation failure and lowered system efficiency caused by human factors, **the automatic operation software of the Solar Block is developed to realize the automatic operation under different scenarios.** Moreover, based on the experience on running SUPCON SOLAR Delingha 50MW Molten Salt Tower CSP Plant, **the software of equipment expert diagnosis system and operation analysis system is developed to realize the early failure warning on key equipment of the plant to facilitate operators** to continuously improve the operation strategies and

and greatly reduce the troubleshooting time of the plant.

In addition, in view of the influence of sandstorms on the solar field, **the automatic cleaning vehicle has been developed for the first time around the world, which features automatic navigation and water/dry cleaning functions to greatly improve the cleaning efficiency of heliostat field and ensure the power generation efficiency and reduce the opex at the same time.** The automatic cleaning vehicle has won the SolarPACES 2020 Technology Innovation Award.



**Q** Could you please elaborate the main problems encountered so far to run this CSP plant? What lessons are there for your peers to learn from your experience?

Since SUPCON SOLAR Delingha 50MW Molten Salt Tower CSP Plant completed COD, **we have mainly solved the problems of cold salt pump vibration, receiver tube froze and steam turbine static and static friction.** Among them, it took about a year to solve the problems of vibration of cold salt

pump and frozen tube of receiver, even though it did not have a great impact on the power generation performance. The recurrence of such event of the components can be completely avoided as long as lessons are learned in the future. However, the problem of steam turbine is relatively serious. The turbine has been overhauled three times between July 2020 to July 2021. The steam turbine was returned to factory workshop for inspection & maintenance and the turbine foundation was reinforced to strengthen the bearing capacity of the main steam pipes. The last time for the rectification of the steam turbine involves both returning to factory workshop for major maintenance and comprehensive rectification on main steam pipe with support of NWEPI CEEC during July to August in 2021 to significantly reduce the thrust of the steam pipe on the turbine, which provided the basis for excellent performance over the last 11 months of non-trouble smooth operation.



In retrospect, these problems were mainly caused by the lack of experience of the parties, and could be completely avoidable as long as adequate

adequate attention is paid during the design, manufacturing, and later operation stages of CSP plant. For example, the vibration of molten salt pump could be avoided, if the foundation of the pump should be optimized and joint calculation and dynamic analysis should be carried out for the pump platform and pipeline in the design; the frozen of the receiver tube can be solved by simply adjusting the structure of inside connection pipes in the design, the problems of steam turbine can be effectively avoided by paying attention to the design and selection of steam turbine and the optimization of pipeline in view of the characteristics of frequent on/off and variable load operation in CSP plant.

We can conclude that the Solar Block and TESS and SGS system has been running stably as of now. This indicates that these core technologies and equipment are mature for the future application. However, relatively more problems exist in the conventional steam turbine generator system and BOP Systems with more optimal design needed, which calls for the special attention in future projects. **Generally there are no lethal problems as to the main equipment of the CSP plant.** The next goal is to promote the localization of imported equipment and materials such as molten salt pumps and receiver tube materials, and continuously optimization in system and equipment to improve system efficiency and the economics of CSP.

Q

What positive significance does the successful operation of the Plant have for the development of the CSP industry?

First of all, SUPCON SOLAR Delingha 50MW Molten Salt Tower CSP Plant took the lead in exceeding the designed annual power generation estimation, **which is fully verified that the tower CSP plant can be built and successfully operated in the harsh environment like high altitude, low tempera-**

ture, windy and sandy area on earth.

Secondly, the real operation data of the plant also indicates that our independent R&D of the tower CSP technology is mature, and the core equipment such as the receiver system and thermal storage and exchange system are also reliable & robust. Through out the construction and operation of this project, valuable unforeseen experience has been recorded & accumulated for the whole CSP industry, as reference for future projects. A number of CSP industry supplier/service provider supply chain data base with strong competitiveness have been cultivated by Cosin Soar, which has laid a solid foundation for the large-scale promotion and application of CSP in the next stage in China and world.



The winter operation performance of tower molten salt CSP plant shows that it is very necessary to build tower CSP plant in northwest China. At present, tower and parabolic trough are the main technologies that have been

commercialized among several other CSP Technology available in the market. Among the large CSP plants built in China, the tower accounts for about 60%, the parabolic troughs technology for about 28%, and the linear Fresnel technology for about 12%.

Most of the regions with high DNI in China are located in middle and high latitudes. In these areas, the solar altitude angle is small in winter. The parabolic trough adopts the form of single-axis tracking, and the cosine efficiency of its solar field will drop significantly. The solar field efficiency of the winter solstice is only about 30% of that of the summer solstice. The tower heliostat adopts the dual-axis tracking form, which can well reduce the loss of cosine efficiency caused by the reduction of the sun's altitude angle. There is little difference between the efficiency of the plant in winter and summer. Moreover due to the less rainfall in winter, the power generation in winter often exceeds that in summer.

As hydropower generally enters the dry season in winter, and the power grid peaking resources are seriously insufficient, the tower CSP station can supplement with production in winter, which can secure power supply of the grid.

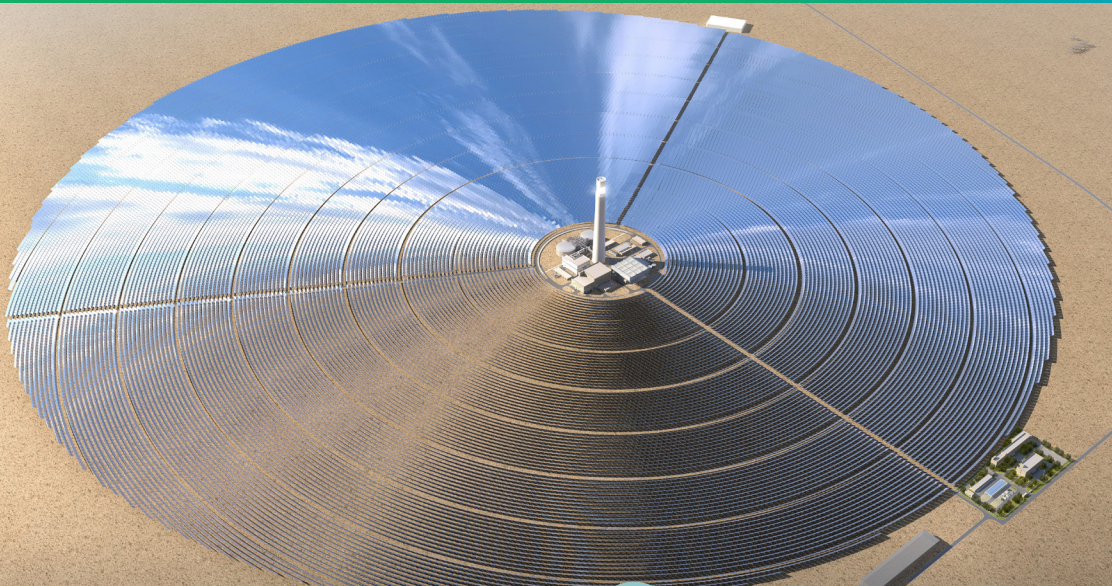
As illustrated from the power generation data of SUPCON SOLAR Delingha 50MW Molten Salt Tower CSP Plant in the past 11 months, the power generation of the plant is stable month by month with little variations between seasons. Especially during the four-month winter from October 2021 to January this year, the winter operation performance is more prominent, with the average monthly power generation as high as 15.515 GWh, higher than the designed monthly average (12.167 GWh), fully reflecting the advantages of the tower CSP technology in the application of high latitude regions in China.



# TOP NEWS

Jinta ZhongGuang Solar “100MW CSP + 600MW PV” Project ▶▶▶

## Project Profile



The project is developed and constructed by Jinta ZhongGuang Solar Power Generation Co., Ltd., with a total installed capacity of 700MW. It adopts the configuration mode of "CSP +", including CSP of 100MW and PV of 600MW. The 100MW CSP project adopts the molten salt tower CSP technology independently developed by Cosin Solar, with a 9-hour molten salt thermal storage system. The design electricity production is 1370 GWh/year, can save 480,000 tons of standard coal and reduce 1,310,000 tons of CO<sub>2</sub> emission per year.

The project started construction on Mar. 25, 2022, will be connected to the grid at full capacity before the end of December 2023.



## 01 The Project site leveling works officially started

On March 25, Jinta ZhongGuang Solar "100MW Tower CSP + 600MW PV" project site leveling works started, which marked the full-scale construction phase of the project.



## 02 The Project Main Works Officially Started

On April 29, excavation of the receiving tower foundation of Jinta ZhongGuang Solar "100MW CSP + 600MW PV" project commenced, which marked the official start of the main works of the project.

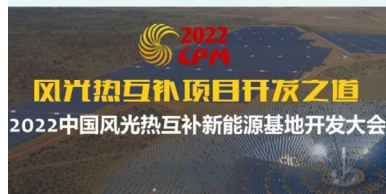


## 03 Tower Foundation Pouring of the Project Initiated

On June 17, the tower of Jinta ZhongGuang Solar "100MW CSP + 600MW PV" project started foundation concrete pouring.



# UPCOMING EVENTS



## Multi-Energy Complementation Development Conference in China



July 27th-28th, 2022



Xian, China



Cosin Solar is attending this event



## China Solar Thermal Electricity Conference 2022



August 29th-31st, 2022



Gansu, China



Cosin Solar is attending this event



### A Global Leading Provider for Molten Salt Tower CSP

- The former SUPCON SOLAR, officially renamed in July 2021 into Cosin Solar Technology Co., Ltd. (Cosin Solar for short)
- Founded in 2010, focus on Tower CSP and Energy Storage technology
- Independent R&D with fully patented technology and homebred equipment
- Technology consultancy, Equipment integration, Engineering services
- Development, Investment, Construction, Operation of projects



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