

SUPCON Solar Presentation

ZHE JIANG SUPCON SOLAR TECHNOLOGY CO.,LTD

www.supconsolar.com



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02 PROVEN RECORDS

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04 CSP COST OPTIMIZATION ANALYSIS



01

ABOUT SUPCON SOLAR

Founded in 2010 , focus on CSP Tower

✓ Technologies

✓ Key Equipments

Heliostats, Heliostats Field Control System, Receiver, SGS.....

✓ Project Development

✓ CSP Plant Operation & Maintenance

To provide **low-cost**, **high quality**, and **clean** energy,
for **A Green Future in Sight**

01 BACKGROUND

◆ SUPCON Group :

- ✓ **25 years** leadership in Automation and Control

◆ Hangzhou Boiler Group :

- ✓ **63 years** experience in boiler and thermal equipment, leadership in waste recovery boiler.

◆ Hangzhou Turbine Group :

- ✓ China's biggest industrial steam turbine R&D and manufacture center with **60 years** experience.

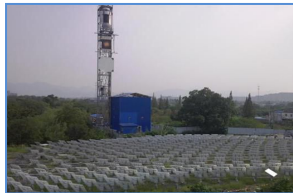


◆ 8 Years Continuous Research in CSP technologies

- ✓ Fully patented technologies : 136 patents, 21 software copyrights
- ✓ The only technology provider from China in IEC Tower CSP Design Standard(PT62862-4-1) drafting committee.

◆ Proven Track Records:

- ✓ Pilots - 10MW DSG - 10MW Molten Salt - 50MW Molten Salt



2011-2012
Pilot Heliostat Field



2012-2013
10MW DSG



2013-2015
Pilot Molten-salt



2015-2016
10MW Molten-salt



2016-2018
50MW Demonstration Project

01 INTEGRATED MANUFACTURING

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Auto Welding



Auto Mirror Adhesion



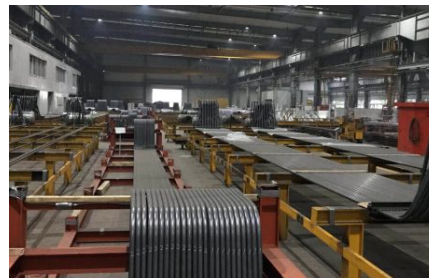
Receiver Welding



Mirror Surface Inspection



Heliostat Assembly



Receiver Assembly

02

PROVEN RECORDS

02 PROJECTS LIST



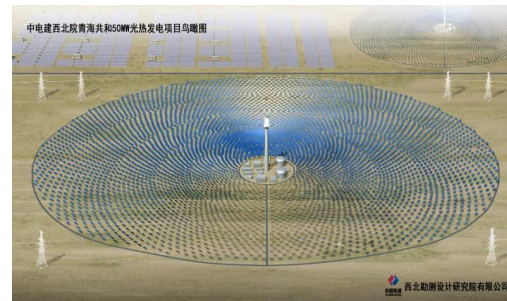
DELINGHA 10MW

Developer, project owner,
EPC, technology provider,
equipment supplier, O&M



DELINGHA 50MW

Developer, project owner,
EPC, technology provider,
equipment supplier, O&M



GONGHE 50MW

Technology provider
Supplier of heliostats field and
MSR receiver
O&M assistance

SUPCON DELINGHA 10MW PILOT PROJECT

China's 1st CSP project

World's 6th CSP tower project and 3rd molten salt based CSP tower project

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02 DELINGHA 10MW: PROFILE

ITEM	VALUE
Installed Capacity	10MW
Storage Time	2 Hours
Total Area	250,000m ²
Reflection Area	63,000m ²
Efficiency	15.9%
Max Temp. of Molten Salt	568°C
Steam Parameter	8.83MPa , 510°C
Commissioning Time of DSG	Jul., 2013
Commissioning Time of Molten Salt	Aug., 2016
Feed-in-Tariff	RMB1.2/kWh

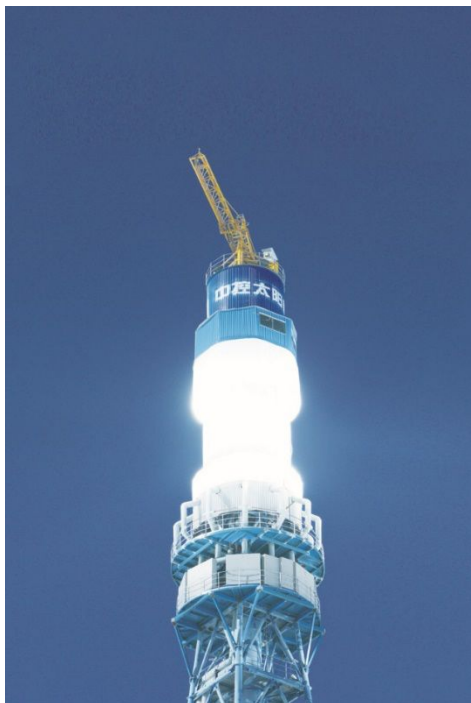


02 DELINGHA 10MW: CORE EQUIPMENT

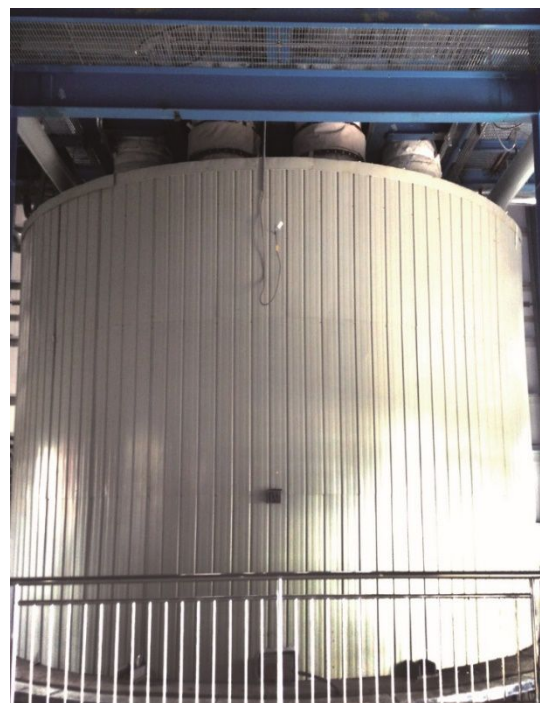
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Heliostats

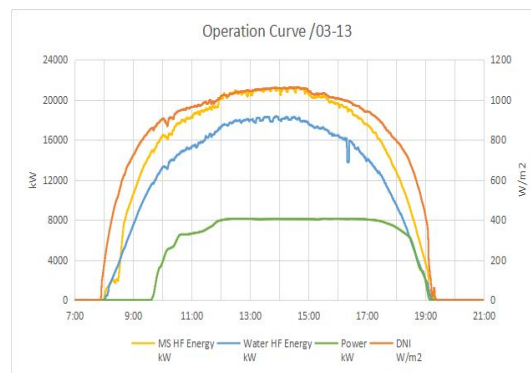
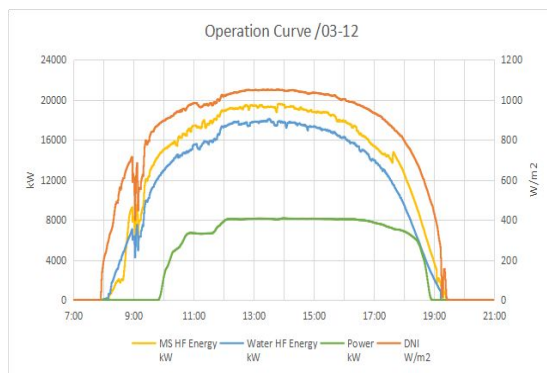
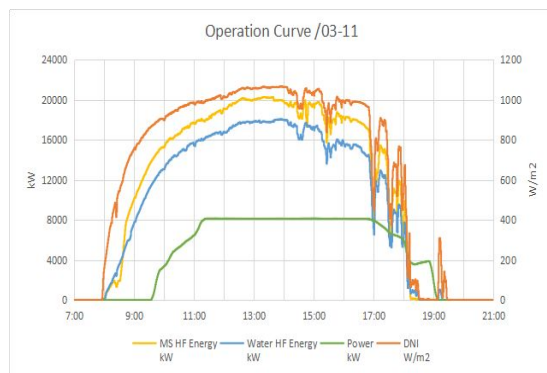
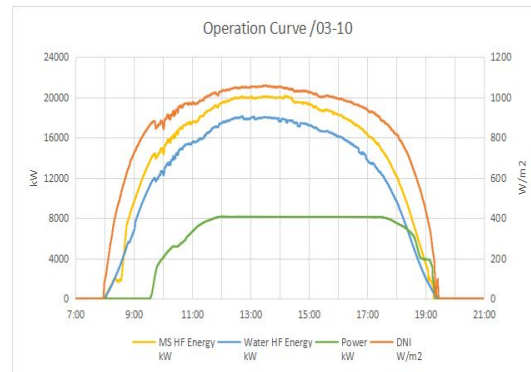
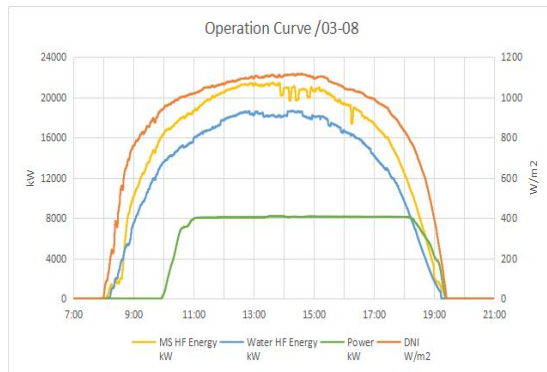
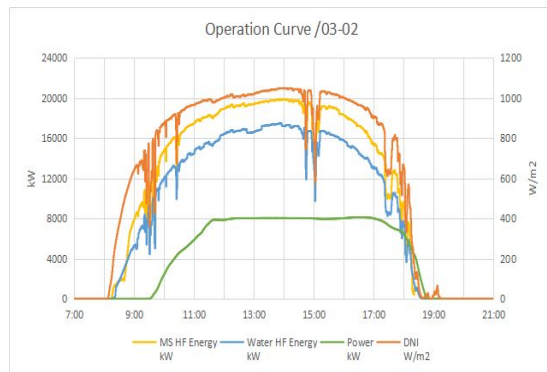


MSR



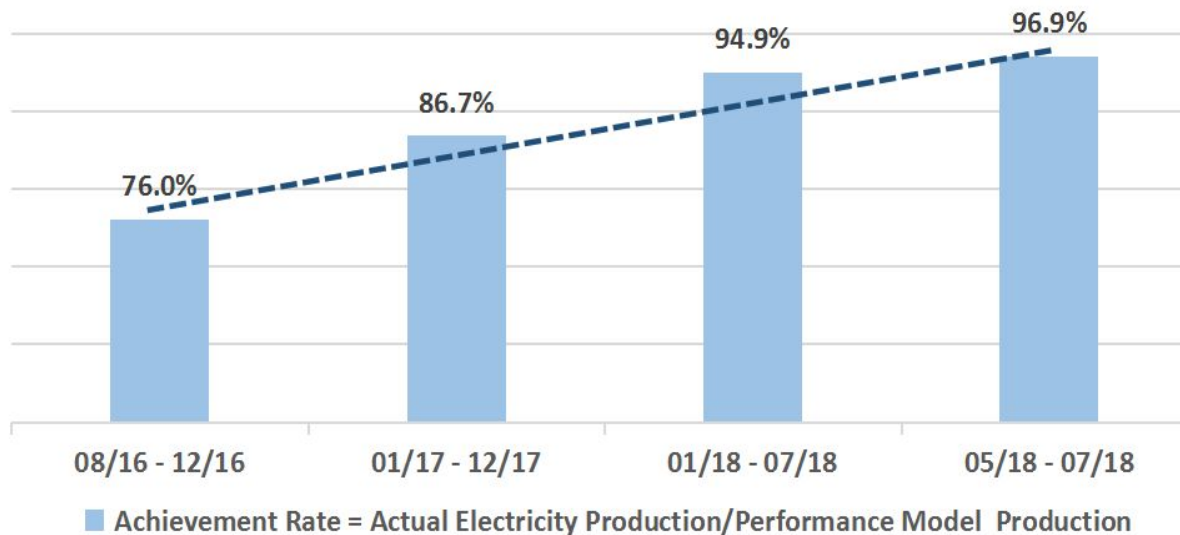
Salt Tank

02 DELINGHA 10MW: OPERATION PERFORMANCE



02 DELINGHA 10MW: OPERATION PERFORMANCE

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- In the last 4 months of 2016, the actual electricity production reached to **76%** of the Performance Model Production
- In the year of 2017, the actual electricity production reached to **86.7%** of the Performance Model Production
- In the first 7 months of 2018, the actual production generated reached to **94.9%** of the Performance Model Production
- In the latest 3 months, the actual electricity production reached to **96.9%** of the Performance Model Production

SUPCON DELINGHA 50MW PROJECT

One of the first 20 demonstration CSP projects of China

Sponsored by Chinese government

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02 DELINGHA 50MW: PROJECT PROFILE

Capacity : 50MW

Storage Time: 7 Hours

Occupied Area : 247ha

Tower Height : 200 m

Total Heliostats Area : 540,000m²

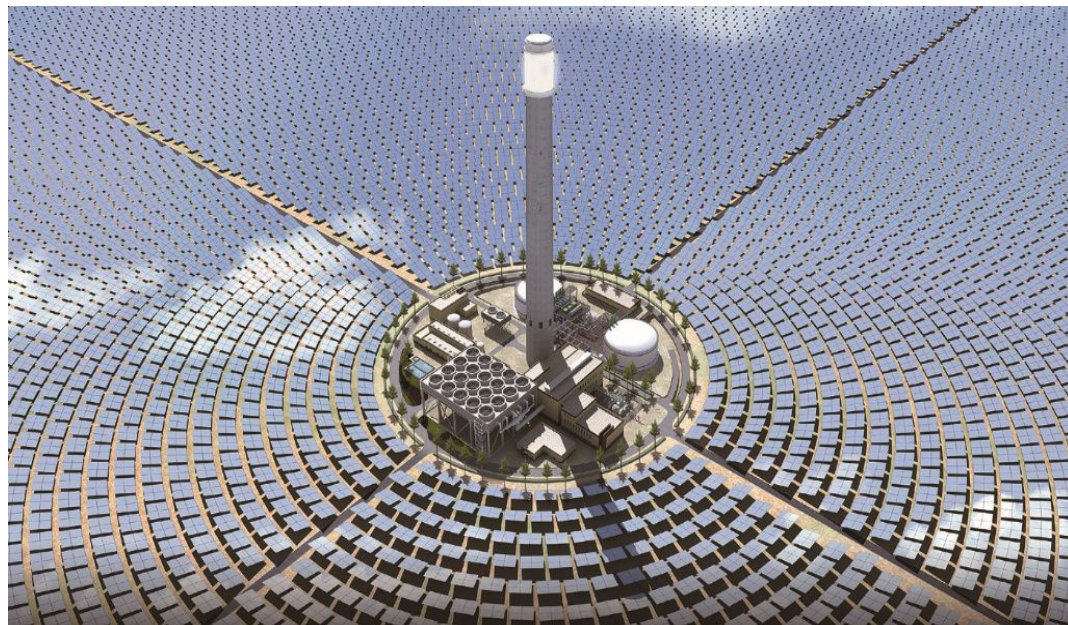
Molten Salt Volume : 10,100 tons

Steam Parameter : 13.2 MPa , 540 °C

Annual Electricity Generation: 146GWh

CAPEX: 159.6 million USD

Planned Commissioned Time: Dec, 2018



02 DELINGHA 50MW TIMELINE



02 DELINGHA 50MW: PROJECT SITE FULL VIEW

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02 DELINGHA 50MW: HELIOSTATS INSTALLATION

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02 DELINGHA 50MW: HELIOSTATS FIELD



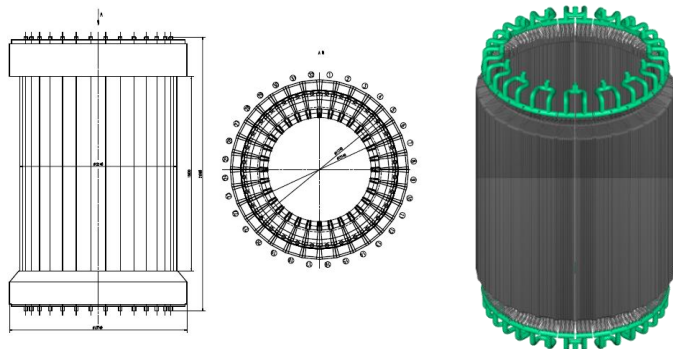
Equipment	Qty.	comment
Heliostat	27135	20m ² , 4*5m ²
Heliostat Control	1	Tracking Accuracy:1.65mrad
Cleaning Vehicle	4	Auto cleaning every week
Cloud Monitor	1	Forecast Range:15min.

02 DELINGHA 50MW: RECEIVER

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02 DELINGHA 50MW: RECEIVER



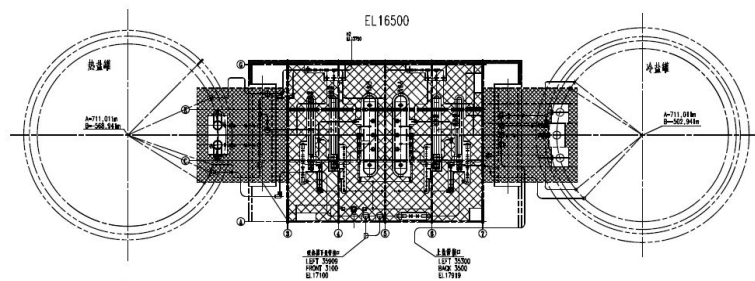
Parameter	Value
Diameter	12.1 m
Height	15.0 m
Thermal Capacity	233 MWt
Flow Rate	1050 m ³ /h
Panel Qty.	32
Material	Inconel alloy 625
Efficiency	90%

02 DELINGHA 50MW: MOLTEN SALT SYSTEM

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02 DELINGHA 50MW: MOLTEN SALT SYSTEM



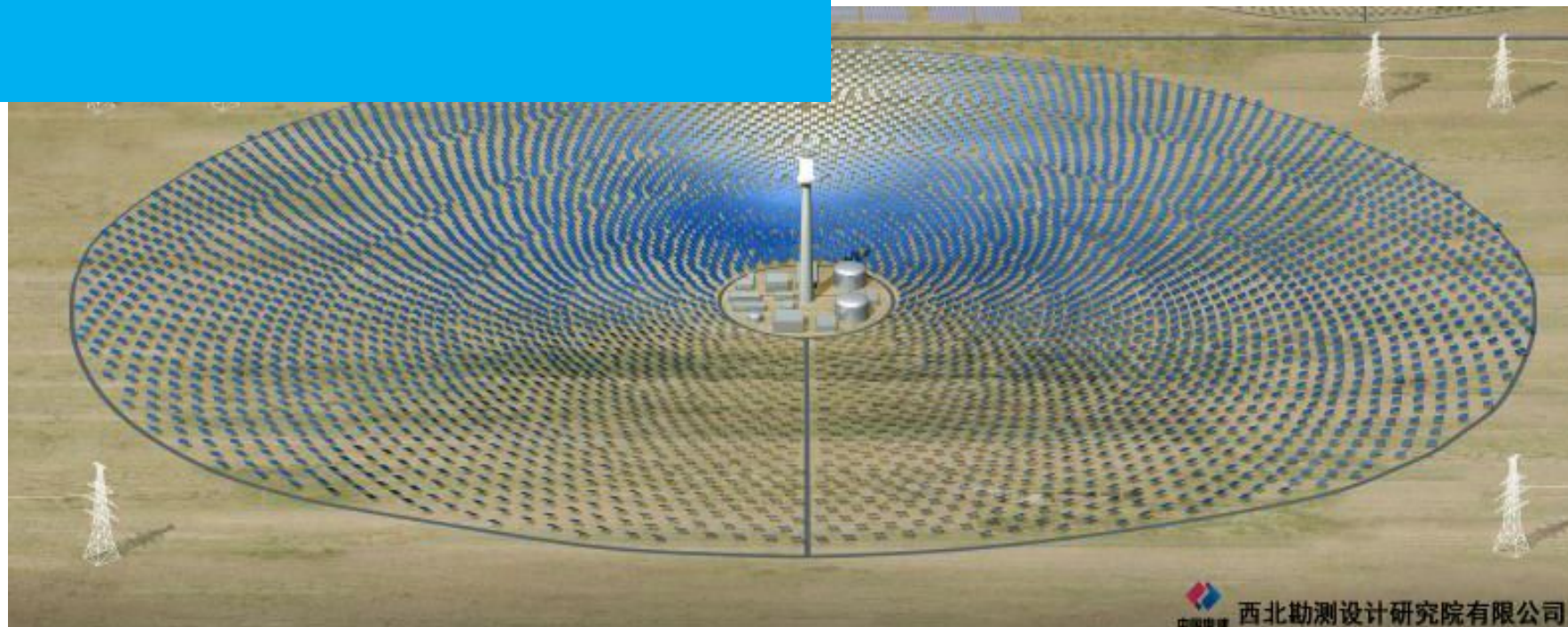
Equipment	Parameter
Cold Tank	D:24.0m, H:12m, Material:Q345R, Temp: 290°C
Hot Tank	D:25.2m, H:12m, Material:347H, Temp: 565°C
SGS	Super-heated Steam: 15.8MPa, 550°C Flowrate: 146.4 t/h
Molten Salt Quantity	10093 tons
Low-temp. MS Pump	2 sets, 321m, 1050m³/h
High-temp. MS Pump	2 sets, 81m, 630m³/h

GONGHE 50MW PROJECT

One of the first 20 demonstration CSP projects of China

Technology provider and solar field supplier

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西北勘测设计研究院有限公司

02 GONGHE 50MW: PROJECT PROFILE



- ✓ Project Location: Gonghe, Qinghai Province
- ✓ Project Owner: Power China
- ✓ EPC: Northwest Engineering Corporation Limited, Power China
- ✓ Installed Capacity: 50MW
- ✓ Storage: 6 hours by molten salt
- ✓ SUPCON SOLAR Supply Scope: Integrated Heliostats Field, including Heliostats, Control System, Receiver.....
- ✓ Heliostats: 600,320 m²(30016 sets, 20m² each)
- ✓ Planned Commissioned Date: 30th Jun 2019

02 GONGHE 50MW: UNDER CONSTRUCTION

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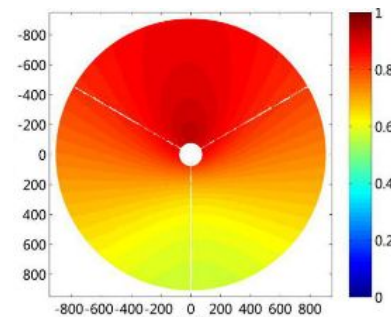
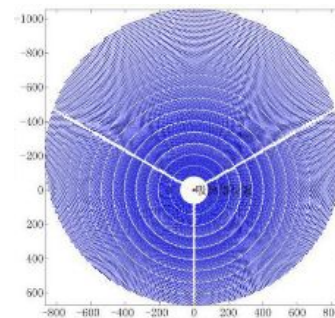
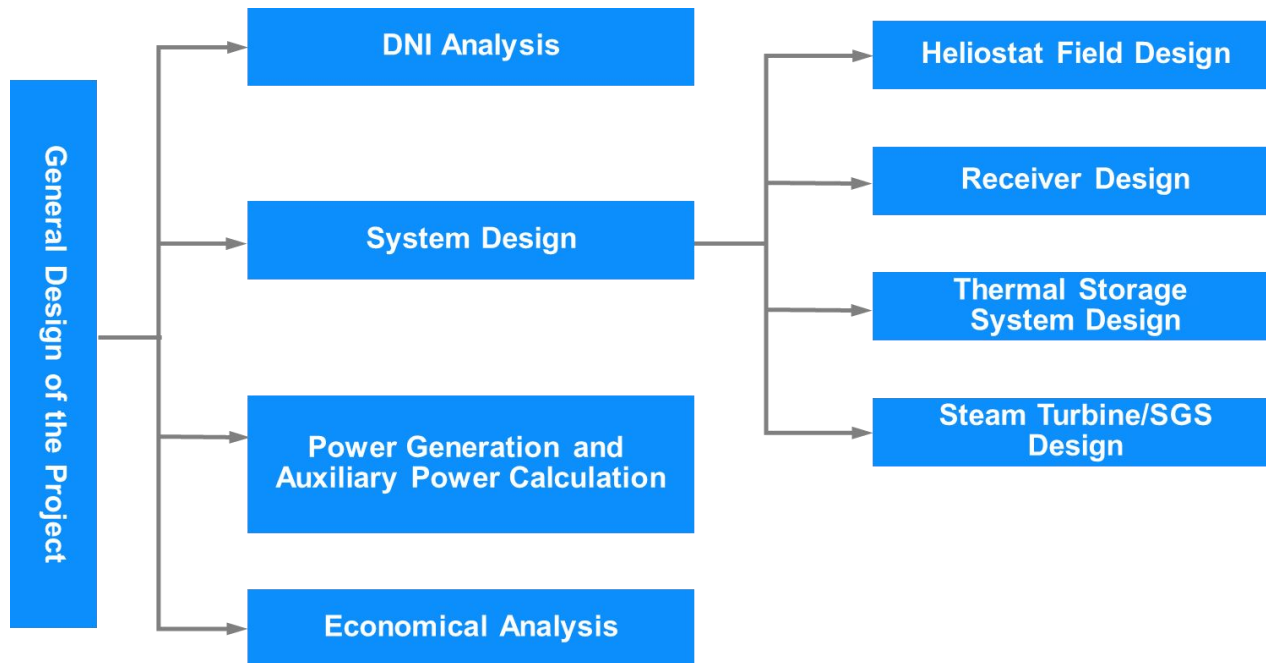


02 PROJECT OVERVIEW



03

INNOVATIVE TECHNOLOGIES



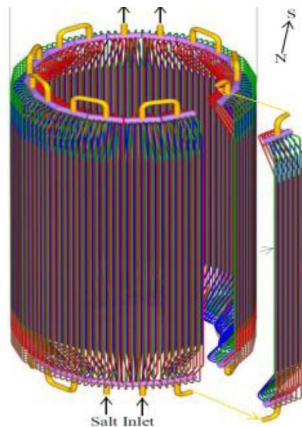
03 HELIOSTAT

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Feature

Working Wind Speed	24m/s
Survival Wind Speed	40m/s
Ambient Temperature	-40℃~65℃
Protection	IP65
Altitude	5000m
Reflectivity	94%
Accuracy	1.65 mrad
Annual Failure Rate	0.5‰
Maintenance	No Lubricant Replacement Needed
Function	Auto-Concentrating Auto-Dispatching Auto-Calibration Self Diagnosis



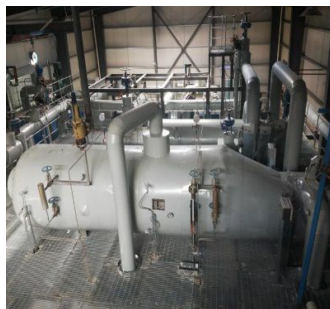
Key Technologies

- Material: Hi-Temp Resistant, Anti-Corrosion, Thermal Fatigue Resistant;
- Flexible Design: Thermal Stress, Thermal Fatigue;
- Safe Operation: Anti-frozen, Energy Dispatch, Temperature Monitor

Items	Parameter
Technology	External/Cavity
Material	Inconel Alloy 625 / Haynes Alloy 230
Coating	Black Pyromark Coating 2500 Series
Absorptivity	$\geq 94\%$
Efficiency	$\geq 90\%$
Surface Flux	1200kW/m^2

- **Safe and reliable process**

- Anti-freezing, anti-leakage
- Intermittent operation, frequent on-off
- Coordination control of load variation



- **Highly-reliable customized equipment**

- Frequent on-off
- Sustain strong thermal stress and fatigue
- Highly heat-resistant, anti-corrosion

TESS

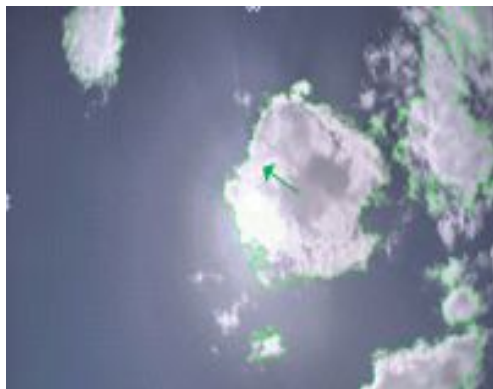
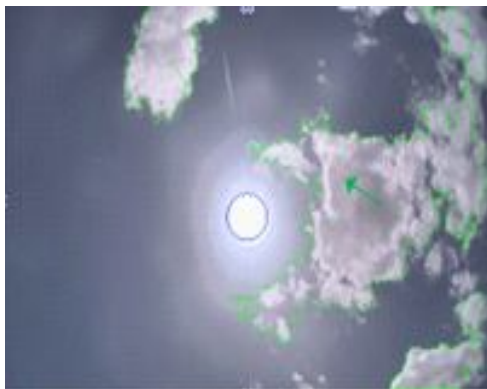
- Material selection
- Thermal Stress Calculation
- Foundation ventilation, insulation
- NDT on all weld seam

SGS

- Adaptable for load variation
- Preheater, Evaporator, Steam Drum, Superheater, Reheater
- Natural/Forced circulation
- Single/Double Array

03 CLOUD FORECAST SYSTEM

- Forecast in 2 minutes ahead, error within 10 seconds

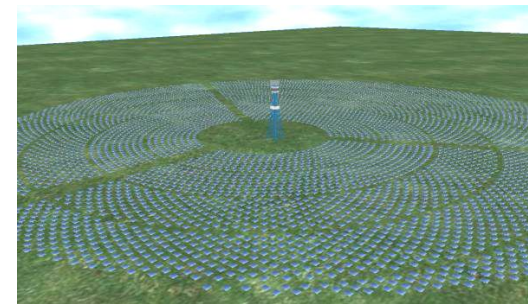
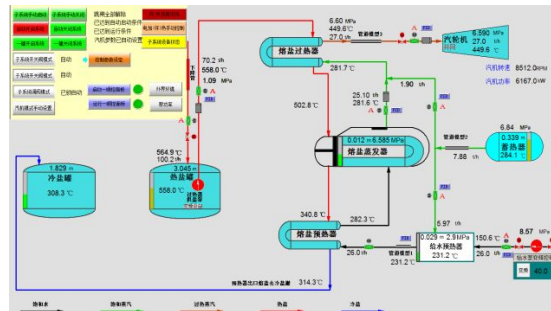
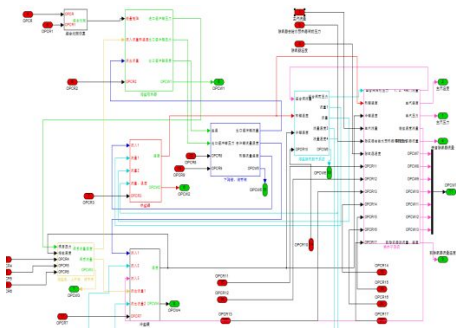


No.	Forecast time	Forecast Duration		Actual Duration		Forecast in advance	Error	Failure
		Enter	Leave	Enter	Leave			
1	09:27:59	09:29:35	09:33:29	09:29:29	09:33:09	1'30"	6"	1
2	13:27:40	13:28:40	13:32:15	13:28:30	13:34:30	50"	10"	0
3	14:22:04	14:23:59	14:24:19	14:24:04	14:34:25	2'	5"	0
4	15:06:56	15:12:31	15:14:21	15:11:57	15:13:02	5'1"	34"	0
5	17:00:40	17:06:21	17:13:44	17:08:34	17:16:10	7'54"	2'23"	0

03 CLEANING VEHICLE

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■ Operation Simulation

- Startup, Run, Shutdown Simulation
- Operation Data Output
- Speed-up Simulation

■ Design Optimization

- Process Optimization
- Equipment Selection Optimization
- Operation Strategy Optimization

■ Fault Simulation

- Equipment Status in Accident
- Operation and Interlock in Accident

■ Demonstration

- CSP Plant Running Demonstration
- Operator Training

04

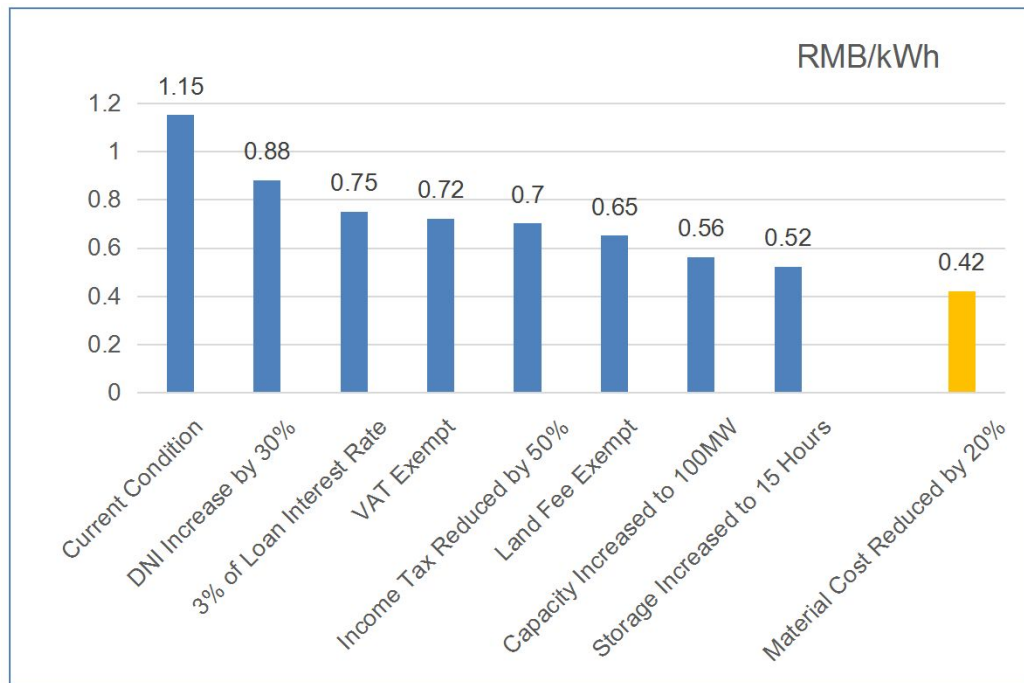
CSP COST OPTIMIZATION ANALYSIS

04 ANALYSIS OF THE LCOE OPTIMIZATION

Delingha 50MW Facts :

Item	Value
Capacity	50MW
Storage	7h
Annual Generation	146GWh
CAPEX	159.6million \$
Unit kW Cost	3,191 \$/kW
FIT	RMB1.15 (\$ 0.17)/kWh
Annual DNI	2,000 kWh/m2
VAT	16%
Enterprize Income Tax	25%
Land Cost	7.35 million \$
Loan Interest Rate	6%
IRR	10%

Ways to reduce LCOE



THANK YOU!

SUPCON SOLAR, A GREEN FUTURE INSIGHT

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