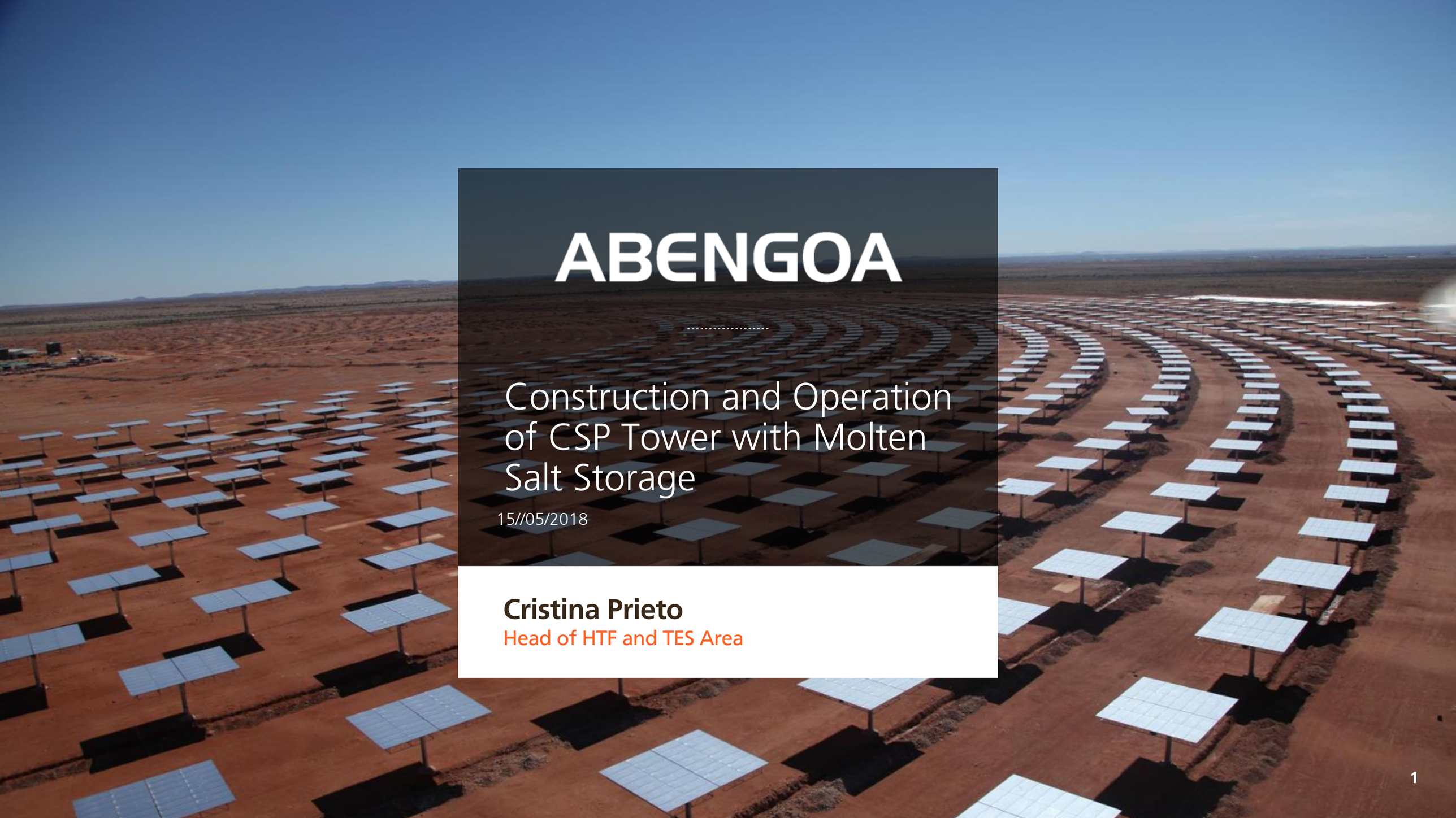

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Construction and Operation of CSP Tower with Molten Salt Storage

15//05/2018

Cristina Prieto
Head of HTF and TES Area

1

Molten Salt Towers

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Molten Salt Towers

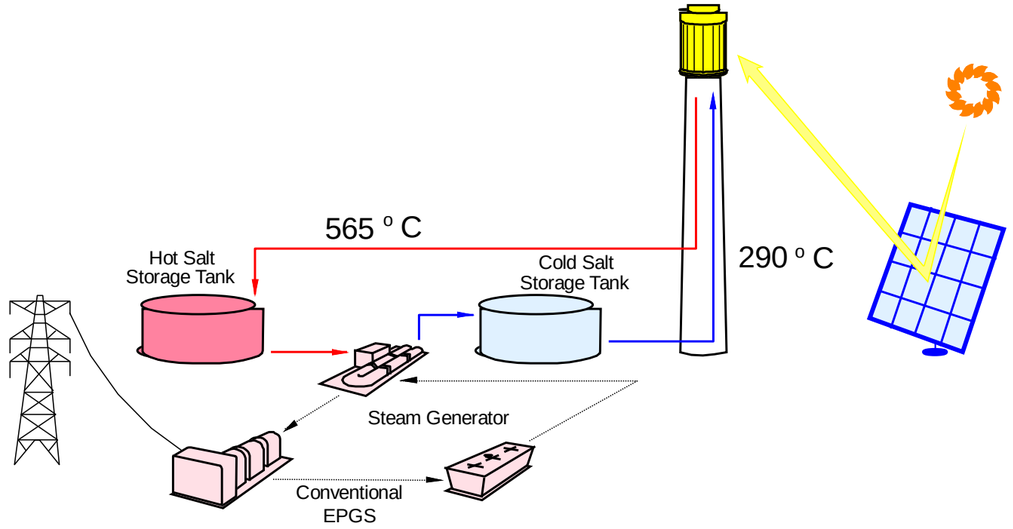
Basic Operation:

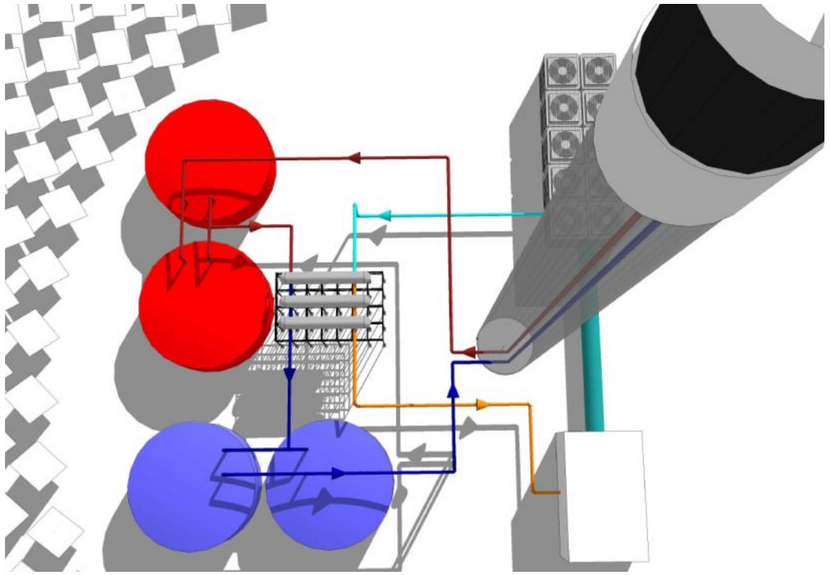
1. Cold Salts are pumped at 290ºC up to the solar receiver.

2. Molten salts flow through the panels of the receiver, reaching 565ºC

3. Hot salt flows back down to the Steam Generation System through the hot salt storage tank

4. The cold salts are directed back to the cold tank, while the superheated steam at 550ºC runs the steam turbine





Advantages:

- Molten salt is heated up to 565ºC in the receiver at very low pressure
- The high temperature salt exchanges thermal energy with water and steam in a steam generator to produce superheated steam at 550ºC
- Possibility of storage, fully dispatchable power, capable for 24h operation

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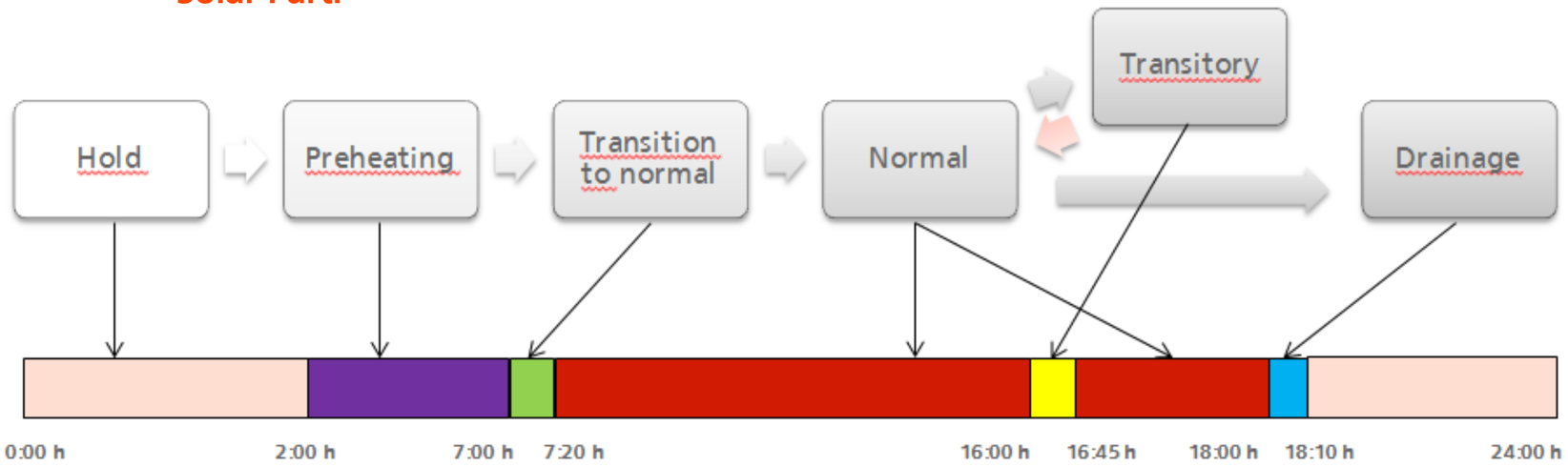
Molten Salt Towers

Solar Part:



Electric Generation Part:

Basic Operation:

- Due to storage system, the plant operation can be divided in solar and electric power generation parts.
- The solar part is formed by the solar field and the solar receiver where the energy is collected and absorbed by the molten salts.
- In Hold mode auxiliary steam is generated.
- The preheating of the SGS needs to be performed carefully.
- Due to the TES, the turbine operation is not directly related with the solar part operation. (TES as buffer).

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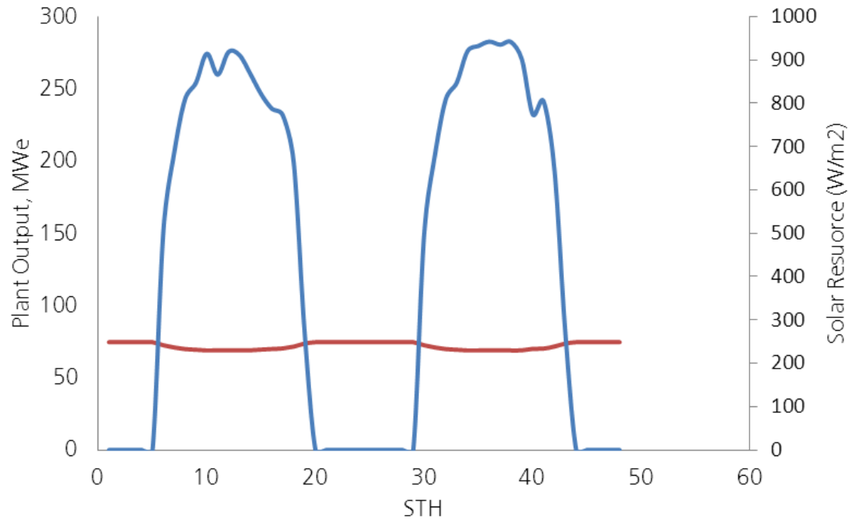
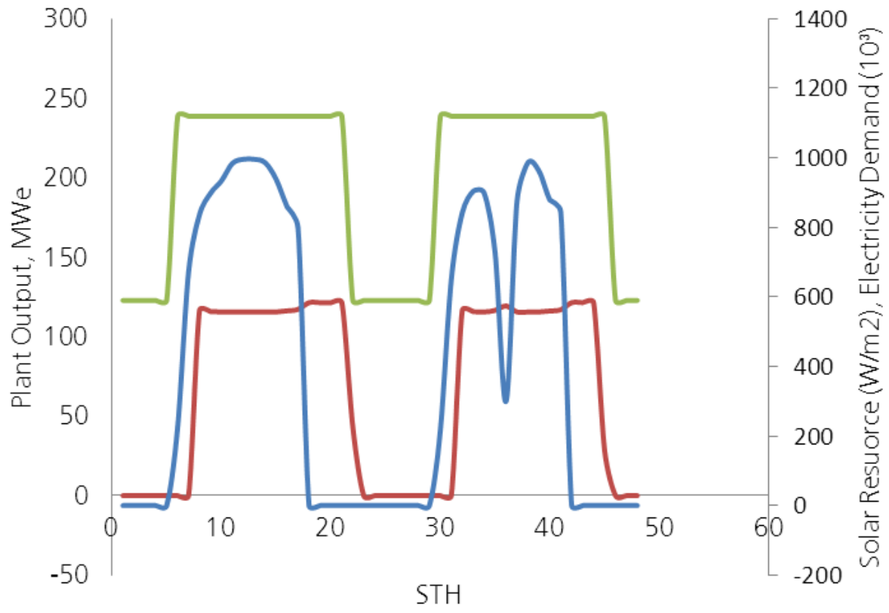
Molten Salt Towers

Conceptual design adapted to electricity demand:

Base Load	Energy Shifter
• Almost 24 hours of production • Large storage	• Production aligned with solar + production in the evening peak • Medium storage
• Molten Salt Tower with 13 hours of molten salt storage	• Molten Salt Tower with 4-6 hours of molten salt storage





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Abengoa Towers know how

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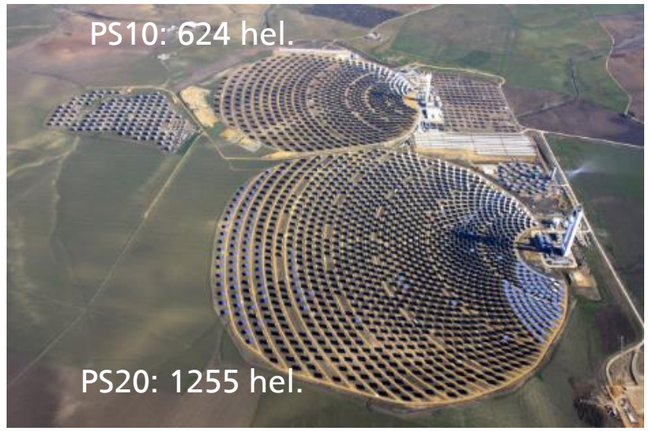
Technology Evolution

Saturated Steam



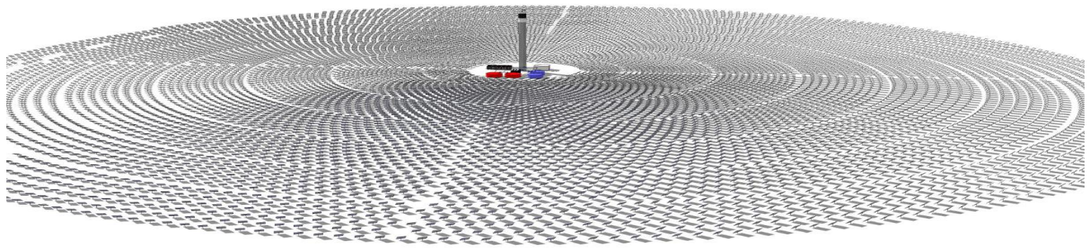
Eureka Pilot Plant

Superheated Steam: !Khi Solar One

CRS Sales Pilot Plant

	PS10	PS20	!Khi Solar One	CSP Atacama 1
Number of heliostats	624	1255	4120	10600
Tower height (m)	115	165	200	250
Nominal turbine power (MWe)	10	20	50	110
Mean net yearly production (GWhe/y)	20	40	200	800
Steam pressure (bar)	40	40	115	130
Steam cycle efficiency (%)	<30%	<30%	Around 38%	Around 43%
Thermal Storage Capacity (h)	<1 h	<1 h	<3 h	17,5 h

Molten Salts: CSP Atacama 1



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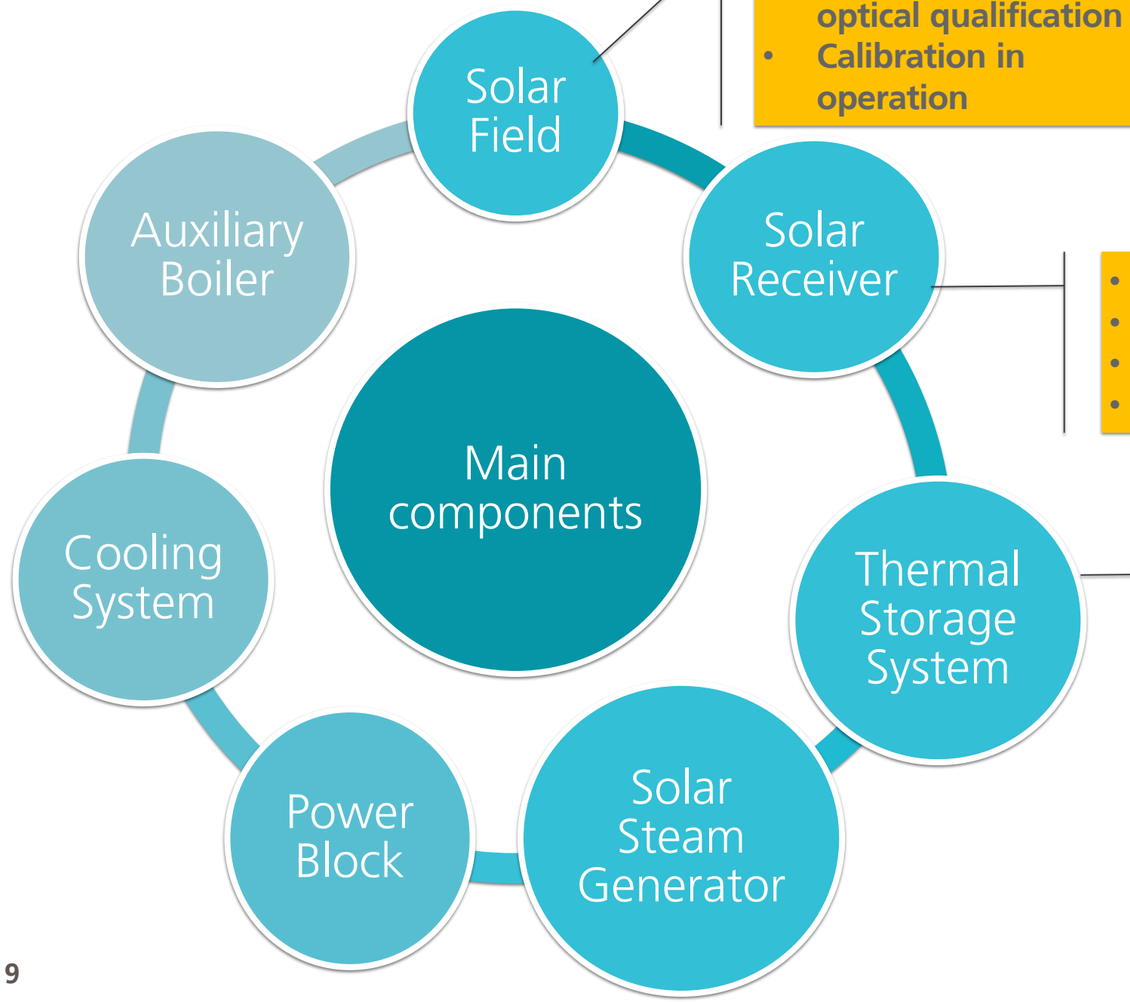
2

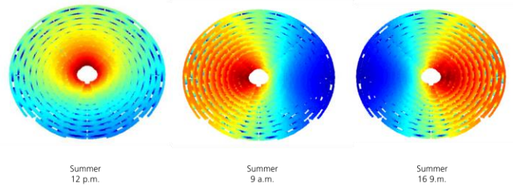
Main components. Design and construction

E&C on main Components for MST

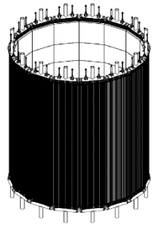


- Tools for design, construction and optical qualification
- Calibration in operation

Solar Field Efficiency



- Design Optimization
- Control configuration
- Aging know how
- Tools for control



- Optimization of MS Components
  - Tanks
  - Heat exchangers
  - Pumps
  - Materials

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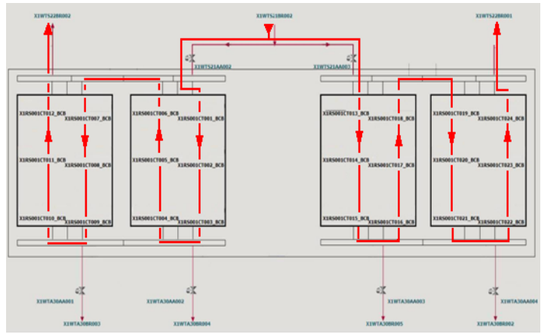
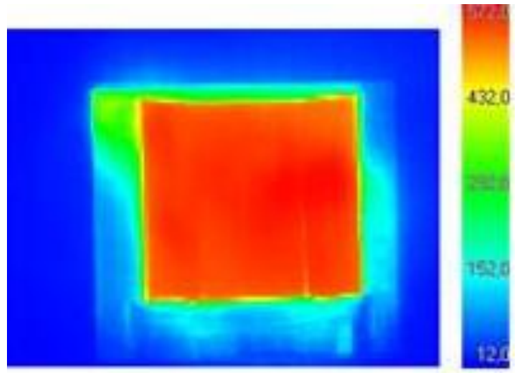
CRS Demo Plant (Study case): Molten Salt Pilot Plant





Main features:

- 5 MW th Molten Salt receiver, engineered by Abengoa
- Operation in real temperatures: 290 to 565ºC
- Solar field: 88 electro-mechanical heliostats Sanlucar120; 60 m tower height
- Demonstration of continuous operation, evaluation of performance and efficiency.
- More than 3600 hours of successful operation from 2012 to 2014

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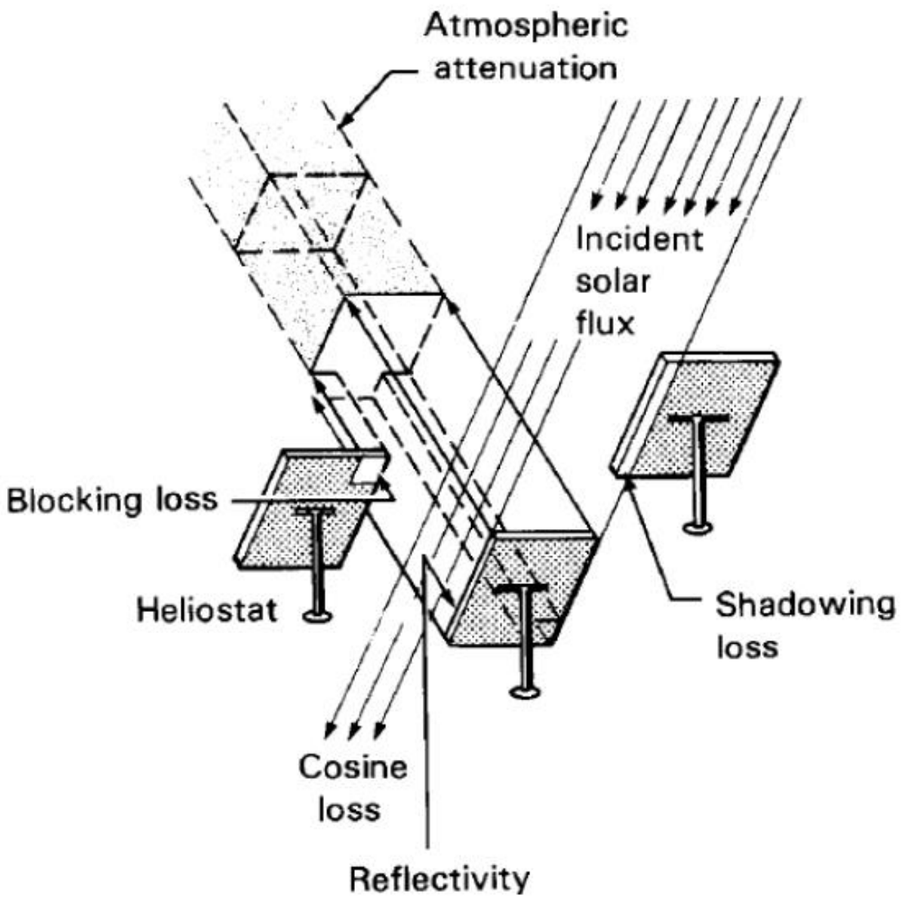
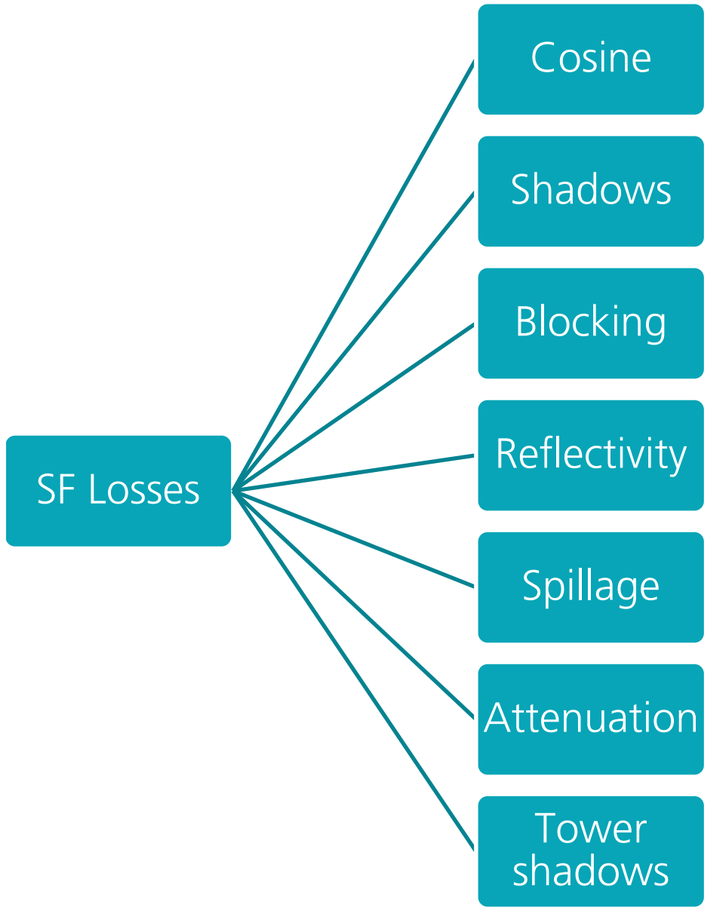
Solar Field



Solar Field Efficiency



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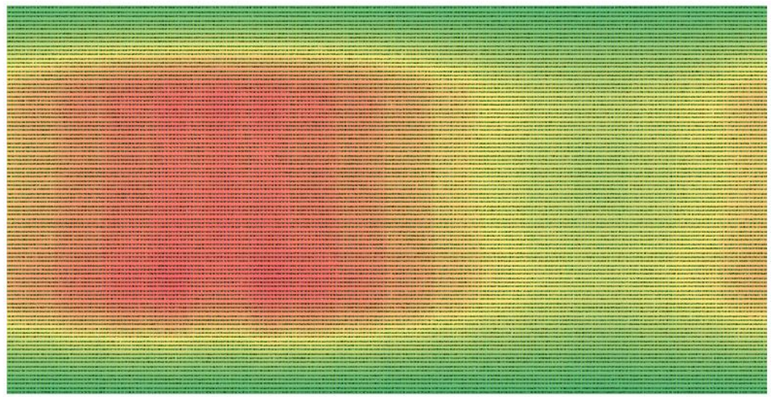
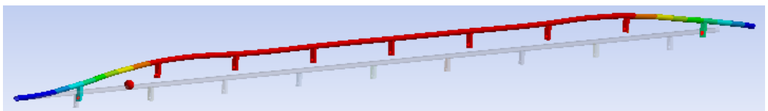
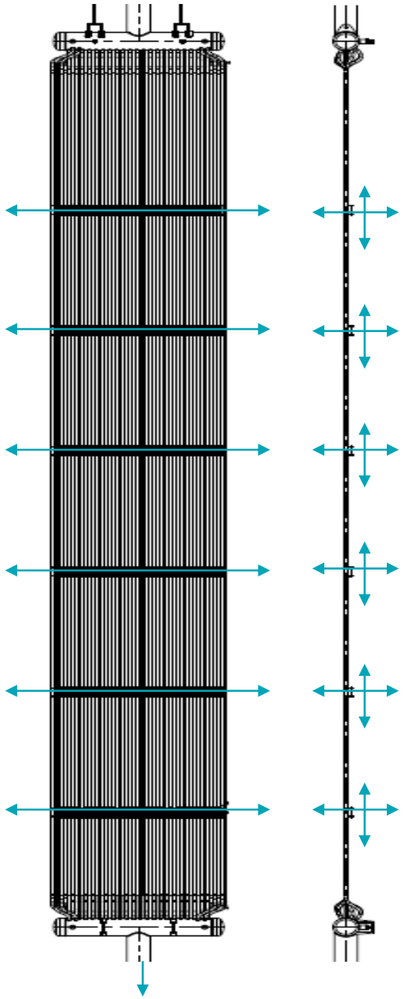
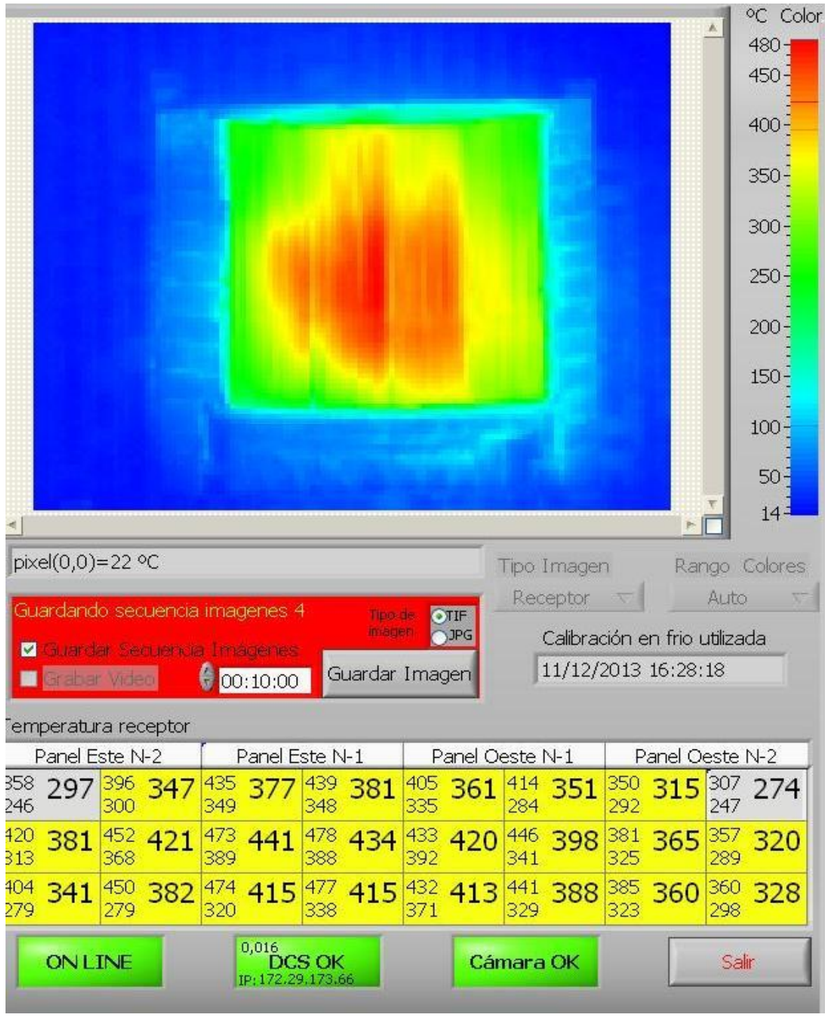
Molten Salt Solar Receiver









- Distributed solar flux not to overheat the receiver.
- Tubes subjected to thermomechanical requirements
- High alloy Steel chosen due to better stability at high T.
- IR Cameras installed to operate the receiver within allowable limits.

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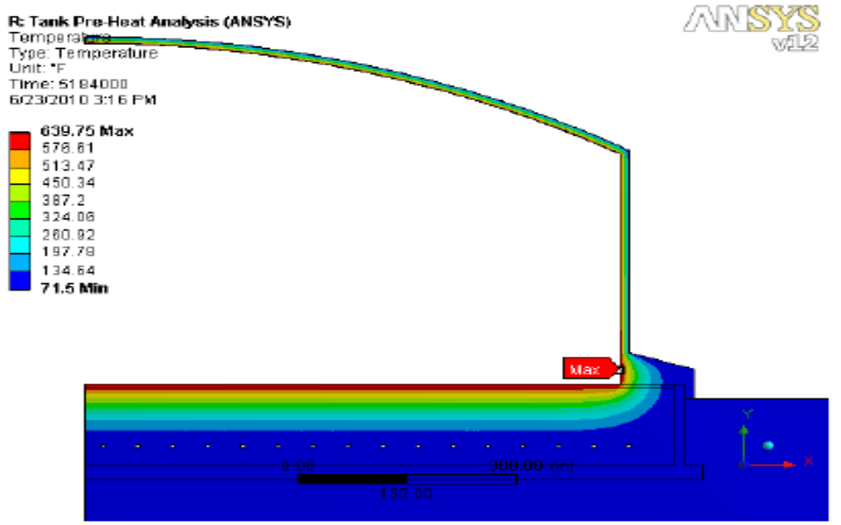
Molten Salt Systems-Tanks

Figure 65: Temperature Distribution in the Tank & Foundation at the End 60 Days



- Carbon Steel (Cold salts) and stainless steel (Hot salts) atmospheric tanks.
- Same concept that Solana, Kaxu and Xina.
- Designed following the American Petroleum Institute standards (API 650) and checked with ASME code..
- Thermal losses evaluation

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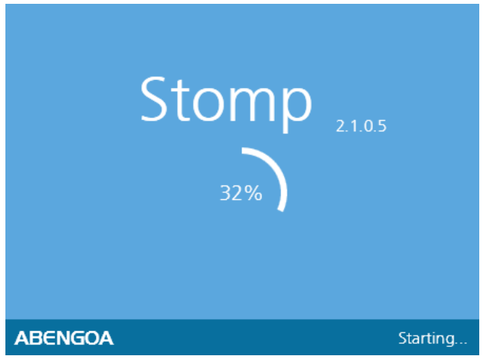
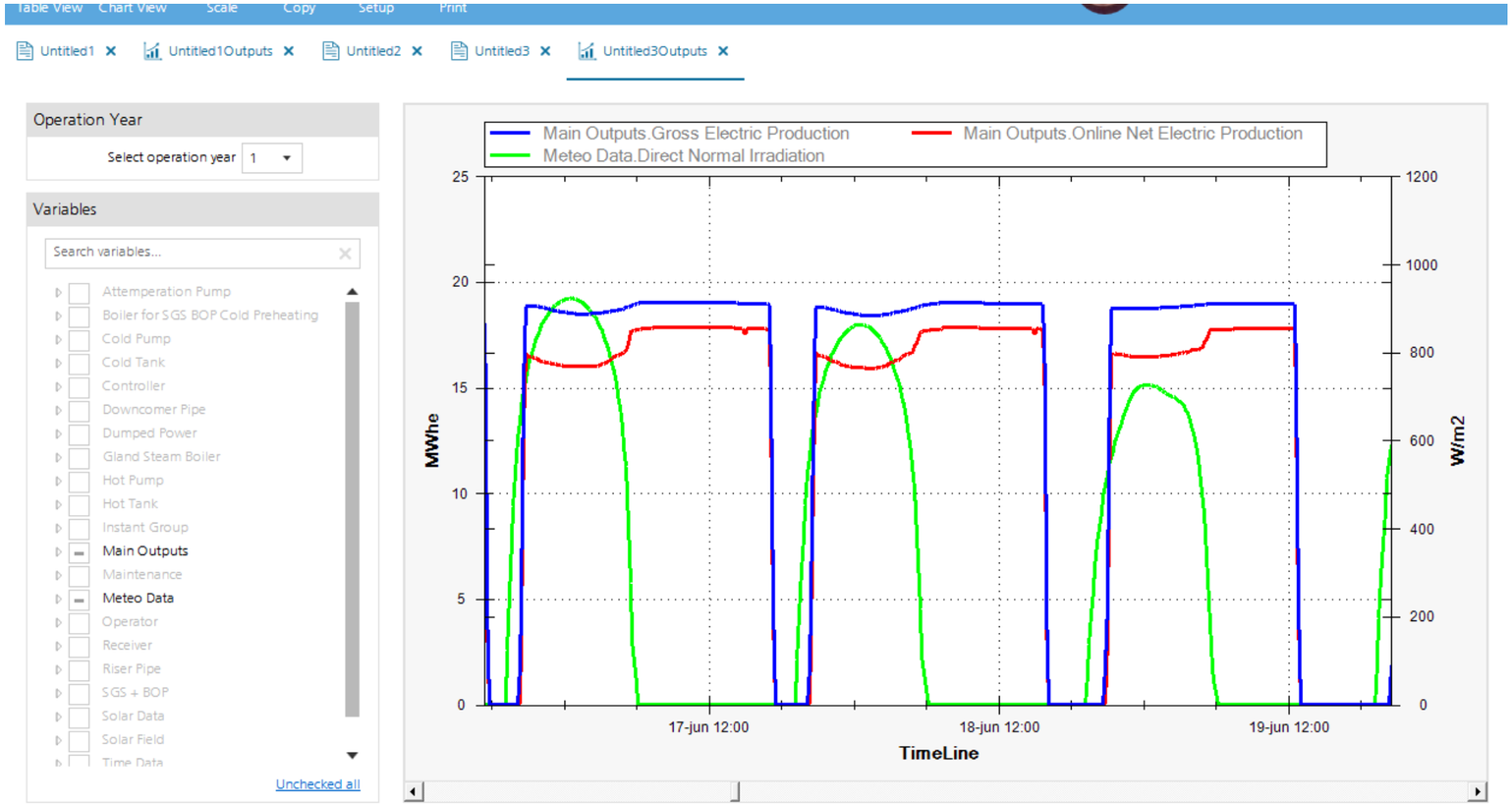
Performance Model: STOMP





- In-house Performance Model capable of optimizing and calculating all STE Technologies electric production with detail
- Verified with real data and audited by many LTA
- Internal optimizer for the design process with different operation strategies.

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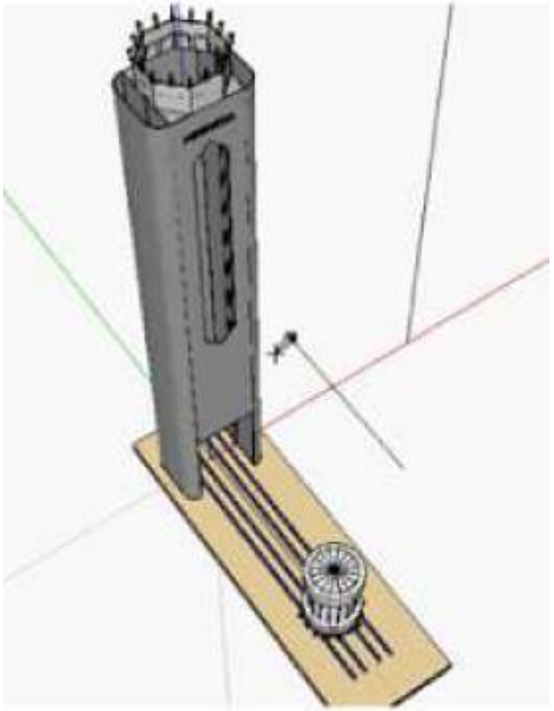
Tower



- Tower designed to assemble the receiver at ground level.
- Continuous construction of the concrete tower

CSP Atacama 1

CSP Atacama 1

Status:

- Under construction

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Thank you

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