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# STUDY OF HYBRID DRY COOLING SYSTEMS FOR STE PLANTS BASED ON LATENT STORAGE

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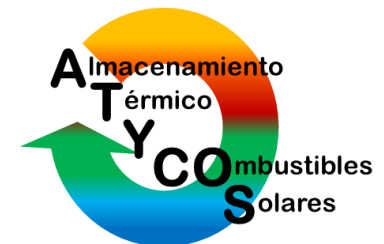


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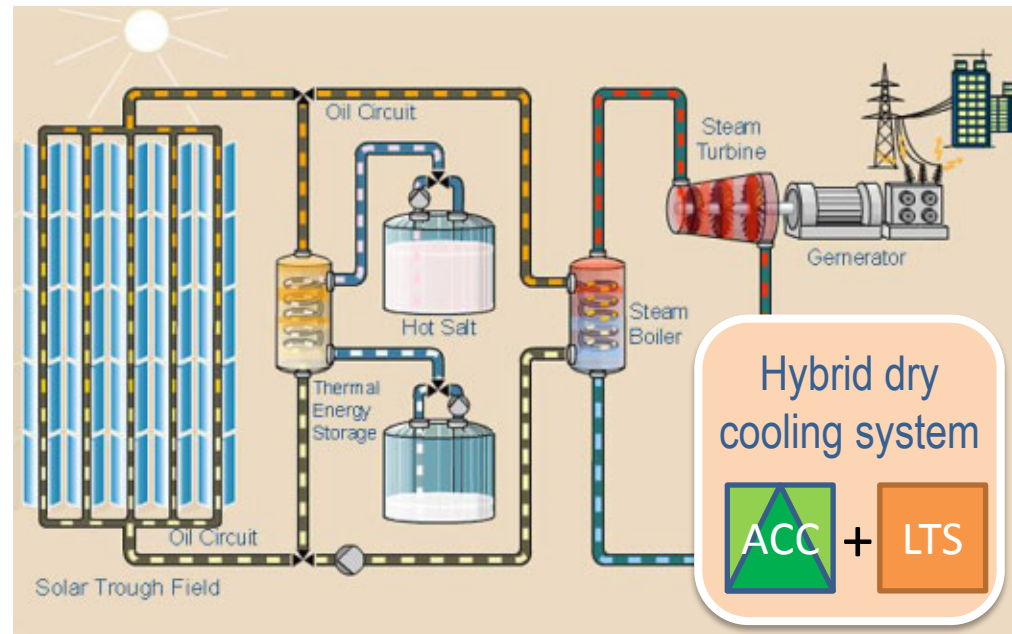
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- ❖ **Aim of the project:** Investigation and implementation of water saving strategies/solutions for **STE** plants located in **deserts** ➔ High solar irradiation but **low water availability**.
- ❖ **One of the solutions:** Substituting the conventional wet cooling system by a **hybrid dry cooling concept** ➔ air-cooled condenser (**ACC**) + latent thermal storage (**LTS**) module containing a phase change material (**PCM**).





If you want to know:

- Why** a hybrid dry cooling system has been chosen
- How** this system works
- Which** PCMs have been tested for the LHS module

**Come to my poster!!**

### STUDY OF HYBRID DRY COOLING SYSTEMS FOR STE PLANTS BASED ON LATENT STORAGE

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#### Introduction

- Thermal power plants require large amounts of water (from 2000 to 3000 m<sup>3</sup>/100M<sub>w</sub>) for CWS.
- In the case of solar thermal electricity (STE) plants about 30% to 50% total water is substituted by power block cooling.
- Most appropriate locations for STE plants may be deserts with high solar irradiation but low water availability → implementation of water saving strategies is a major issue.
- WASCOP project aims to overcome such challenge by offering different solutions.
- One of those solutions consists substituting the conventional wet cooling systems by a hybrid dry cooling concept that combines an air-cooled condenser (ACC) with a latent thermal storage (LTS) module containing a phase change material (PCM).

#### Hybrid dry cooling system

- Exhaust heat from turbine exhaust can be stored in the LTS at day time when  $T_{amb} > T_{acc}$ .
- Heat stored in LTS is substituted ambient at night time when  $T_{amb} < T_{acc}$  and ACC consumes less power ( $W_{acc}$  is low).

##### Day-time

Exhaust heat is delivered to the LTS or to the ACC depending on:

- Time of the day
- $T_{amb}$  value
- LTS state (charge level)

##### Night-time

LTS stored heat is delivered to ambient through the ACC when:

- $T_{amb}$  is below a certain set point and LTS is partially charged
- Turbine is not under operation

#### PCM selection & testing

$T_{TMS}$  from turbine > PCM  $T_{acc}$  > Night-time temperature

$T_{acc} = 25^{\circ}\text{C}$  from 3 AM to 6 AM in June-September

Quartzite (Monaco)

PCMs from Rubitherm<sup>®</sup> with  $T_{acc} = [25^{\circ}\text{C}-40^{\circ}\text{C}]$

Material	Lat	$T_{acc}$ [°C]	$\rho_{PCM}$ [kg/m <sup>3</sup> ]	Cost [€/kg]
Quartzite	100	25	2650	0.15
RT35HC	100	35	1200	1.5
RT42HC	100	42	1200	1.5

#### STE plant simulation

Quartzite MONACO

RT35HC

RT42HC

ACC

#### DSC measurements

Daily melting/freezing cycles of RT35HC

No change in thermal behavior after 20 cycles

Phase change within a narrow temperature interval

#### Conclusions

- 850 MWh gains in net annual electricity production when using ACC-LTS with RT35HC instead of only ACC in Monaco desert.
- Electricity production can be further increased if strategies for plant integration are optimized.
- The cost-effectiveness of the hybrid cooling system strongly depends on electricity prices and PCM costs.

ISEC WASCOP ALCCONES

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