



## **Thermal Storage Concept for a 50 MW Trough Power Plant in Spain**

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FLAGSO L

Trough Workshop in Lake Tahoe

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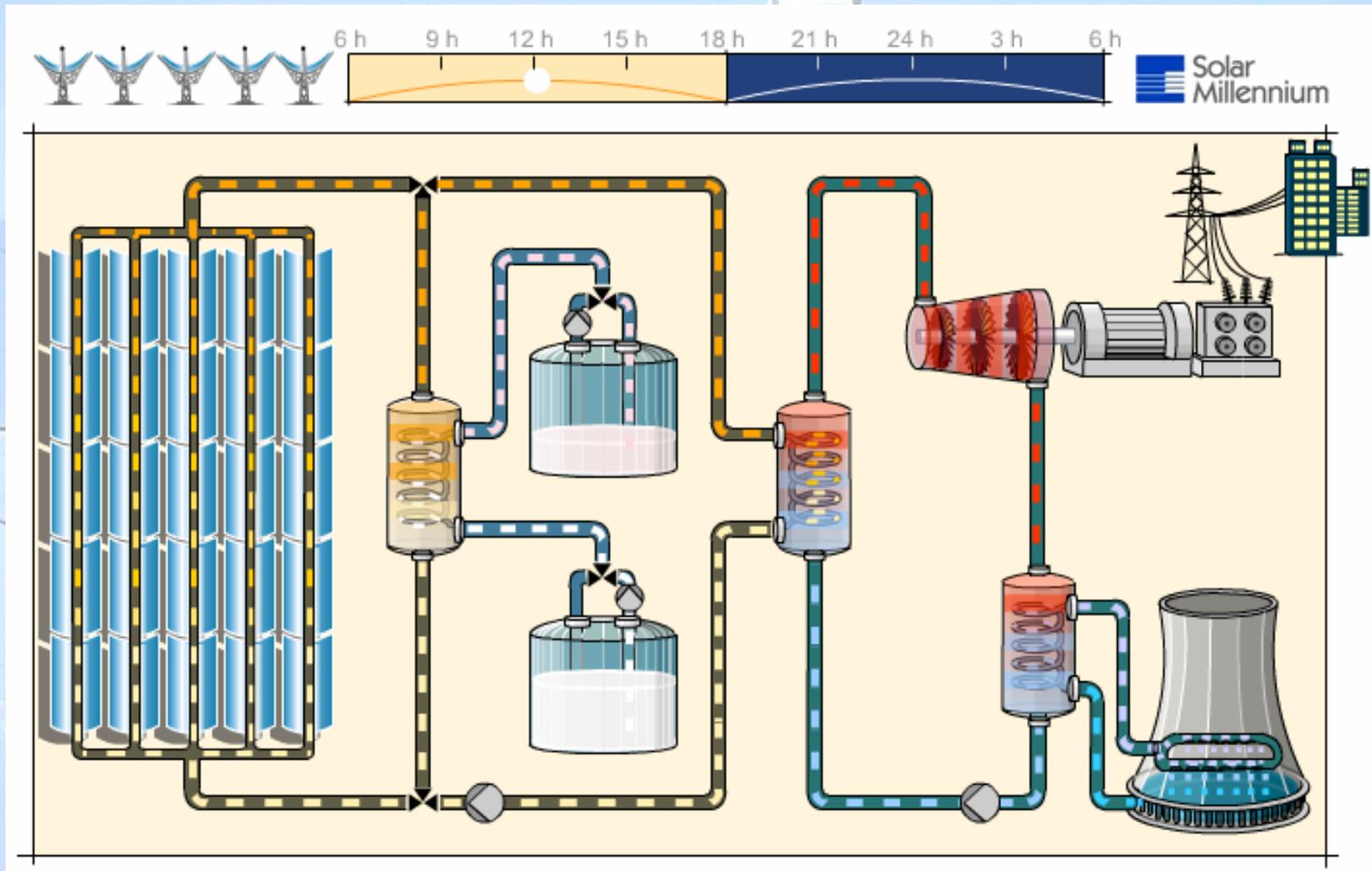
*FLAGSO L GmbH*

# Content

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- 2. Why storage for trough plants?**
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# Storage Concept



**Why storage for trough plants?**

- Increase of annual capacity factor of power plants (more than 4000 hrs of operation per year)

- Buffering during transient weather conditions

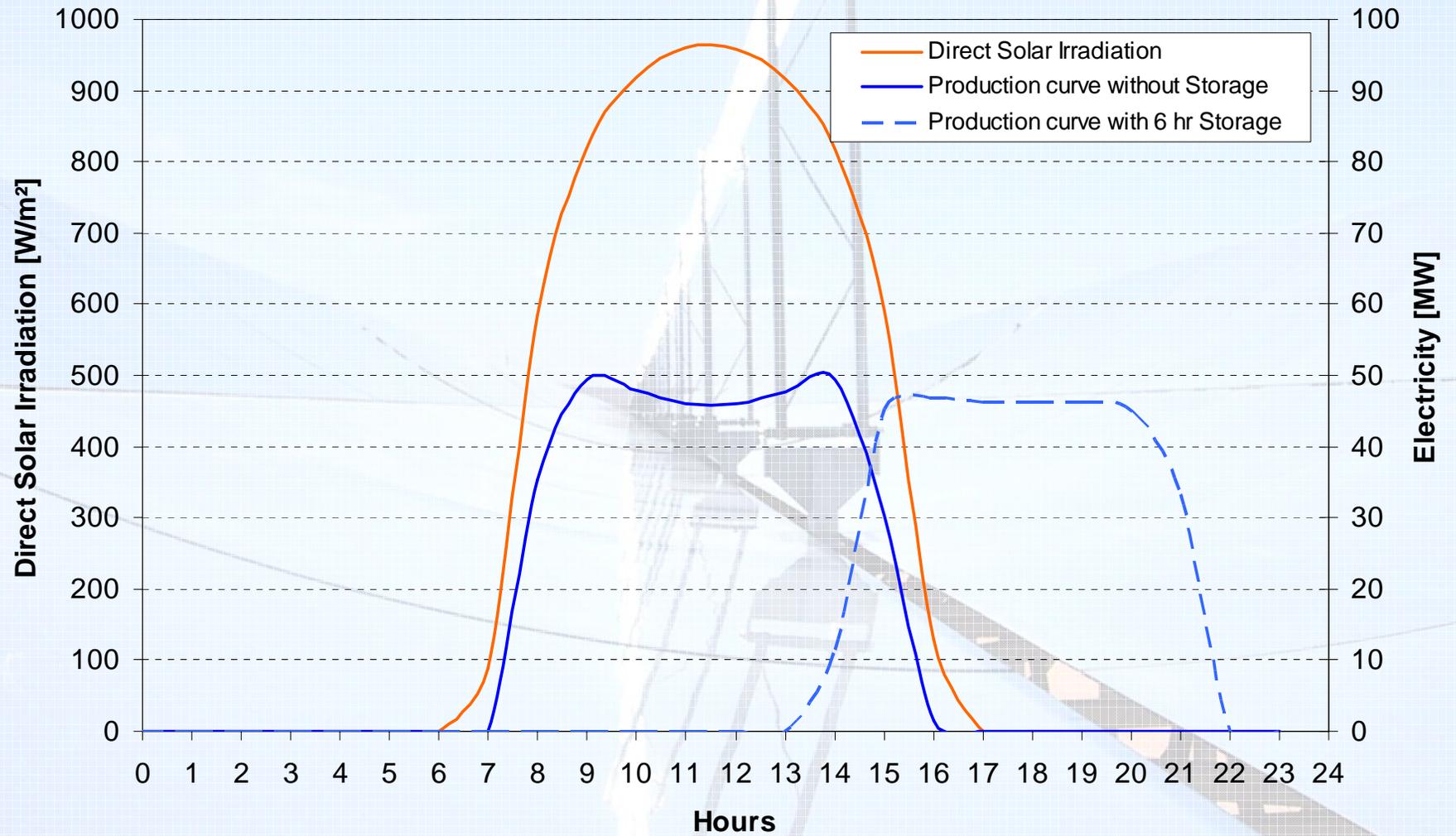
- Time-shifting: decoupling between solar supply and electricity production

- More even distribution of electricity production

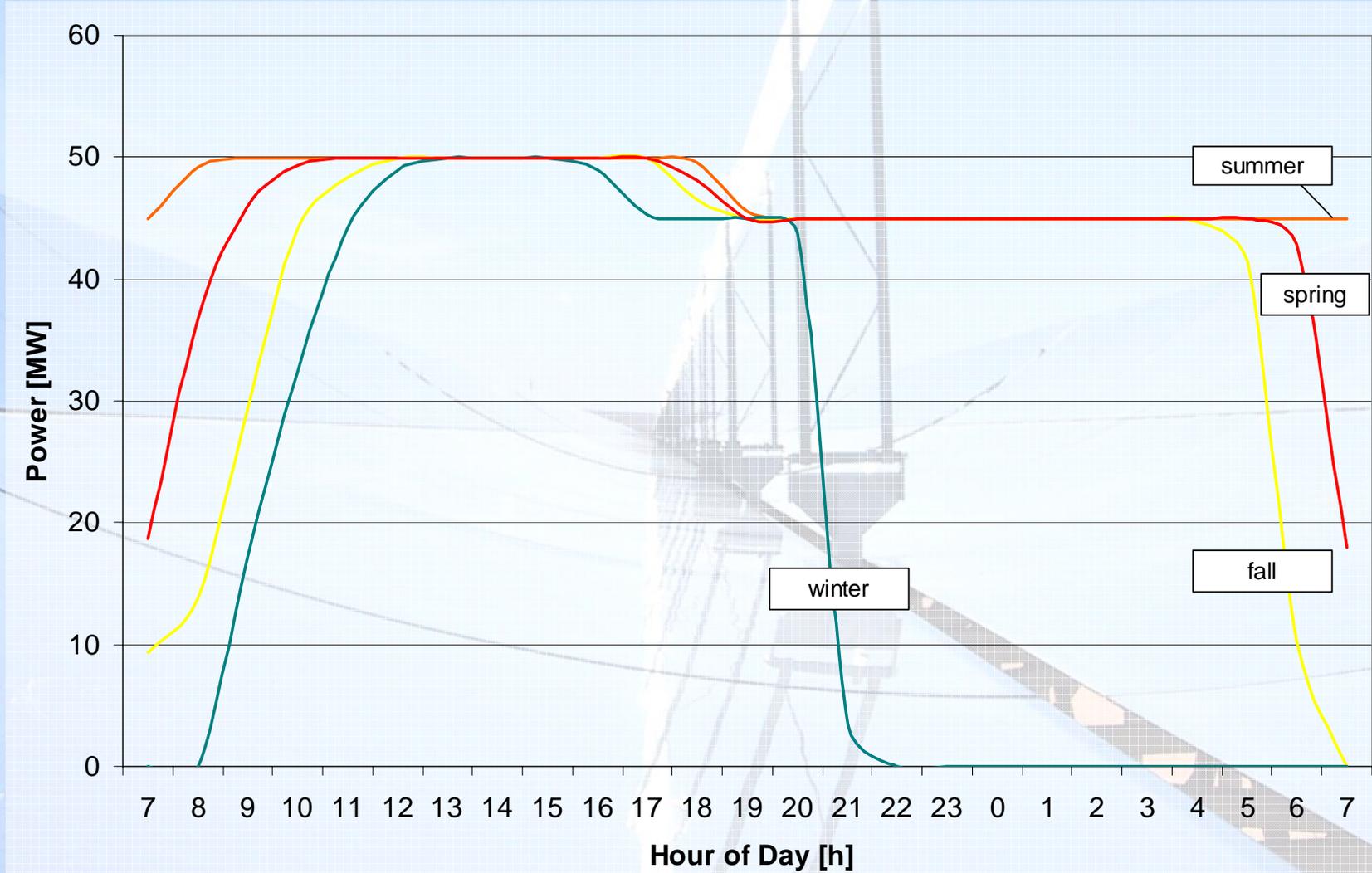
- Achieve full load operation of the steam cycle at high efficiency



# Example for Time Shifting (6 hr Storage)



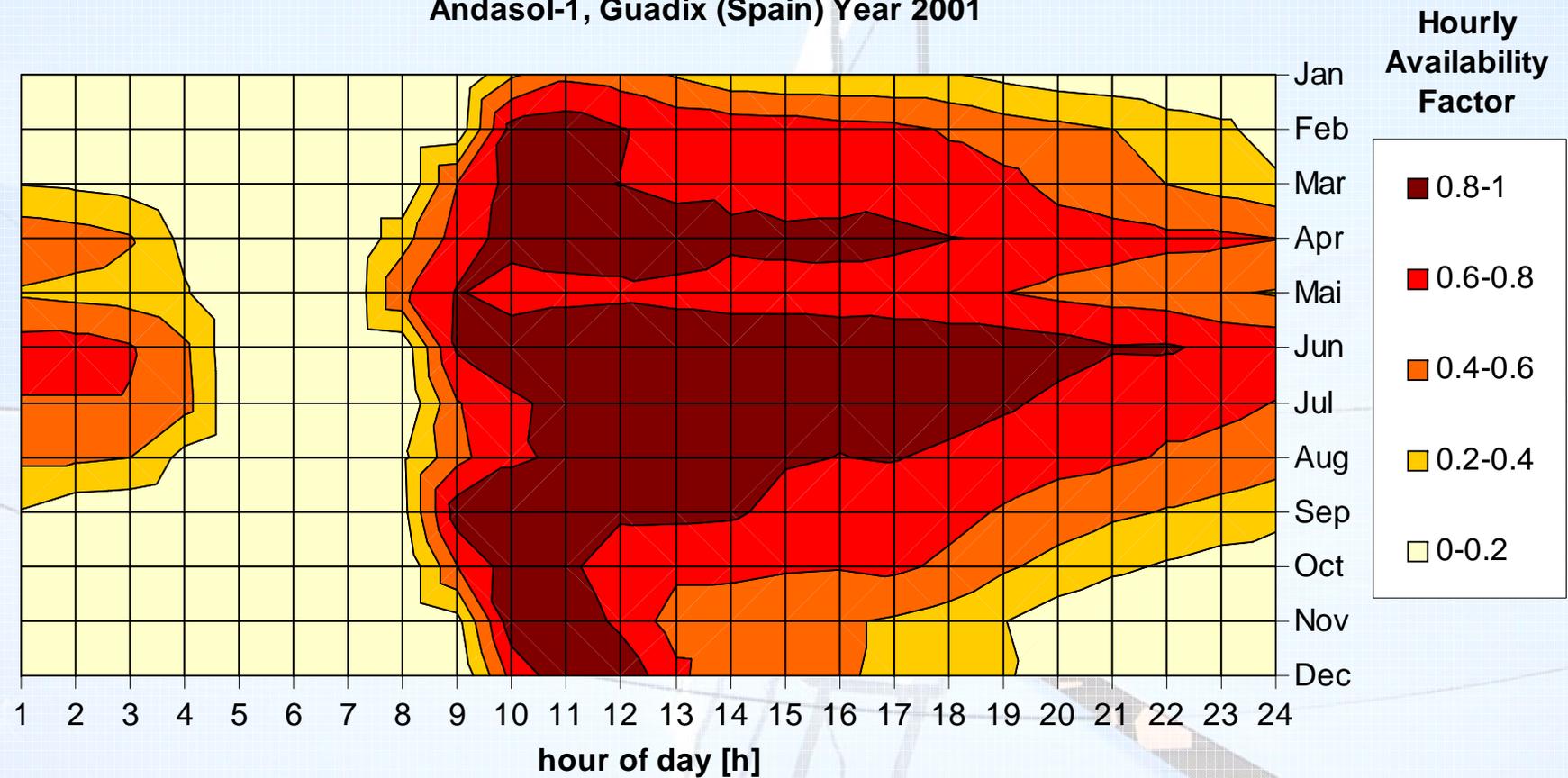
# Example for Increase of Operating Periods (12 hr Storage)





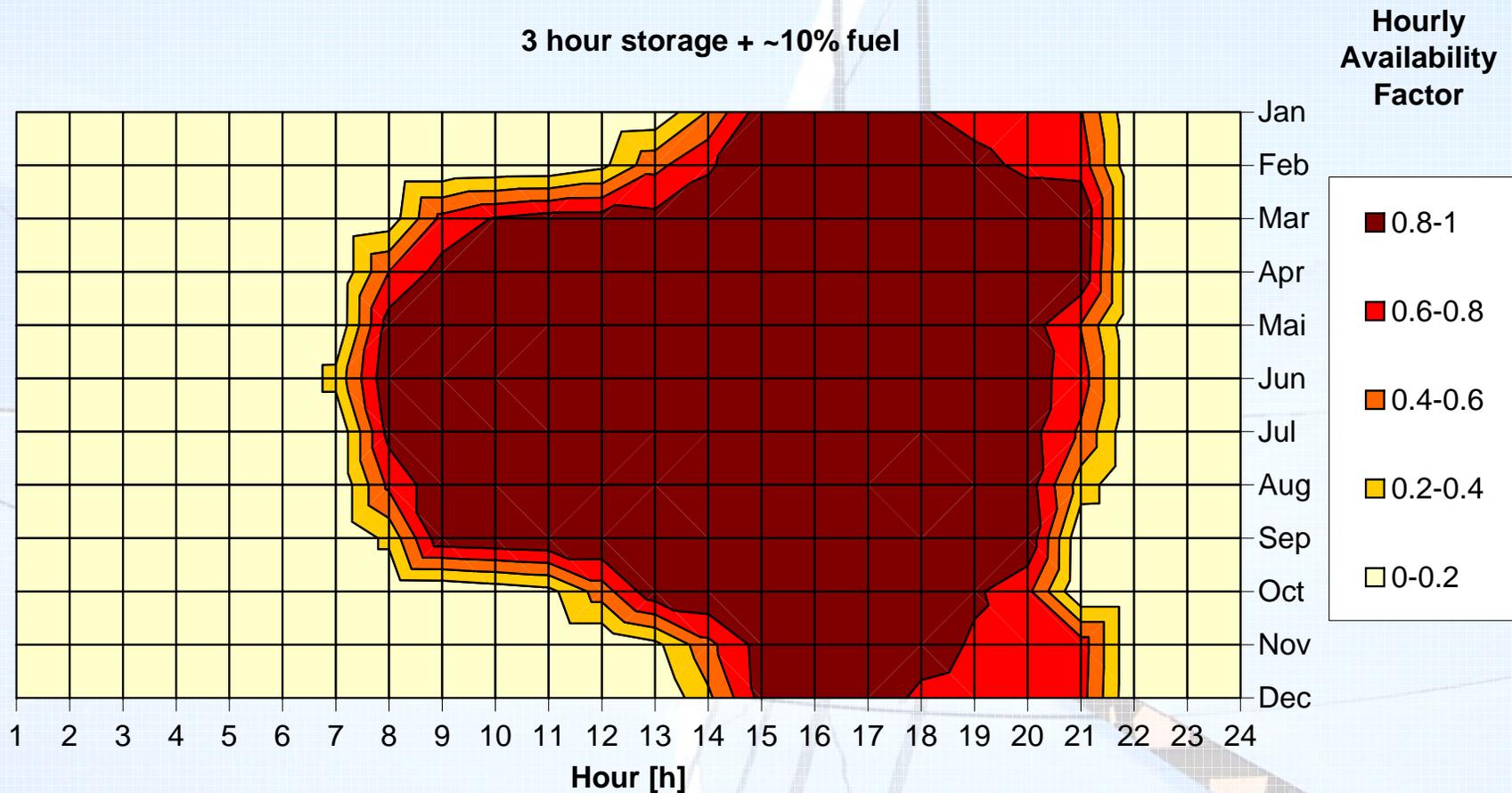
# Availability of Solar Plant with Storage **FLAGSOL**

Andasol-1, Guadix (Spain) Year 2001



# Availability of Solar Plant with Storage + **FLAGSOL** Fuel

3 hour storage + ~10% fuel





# Why this storage concept?

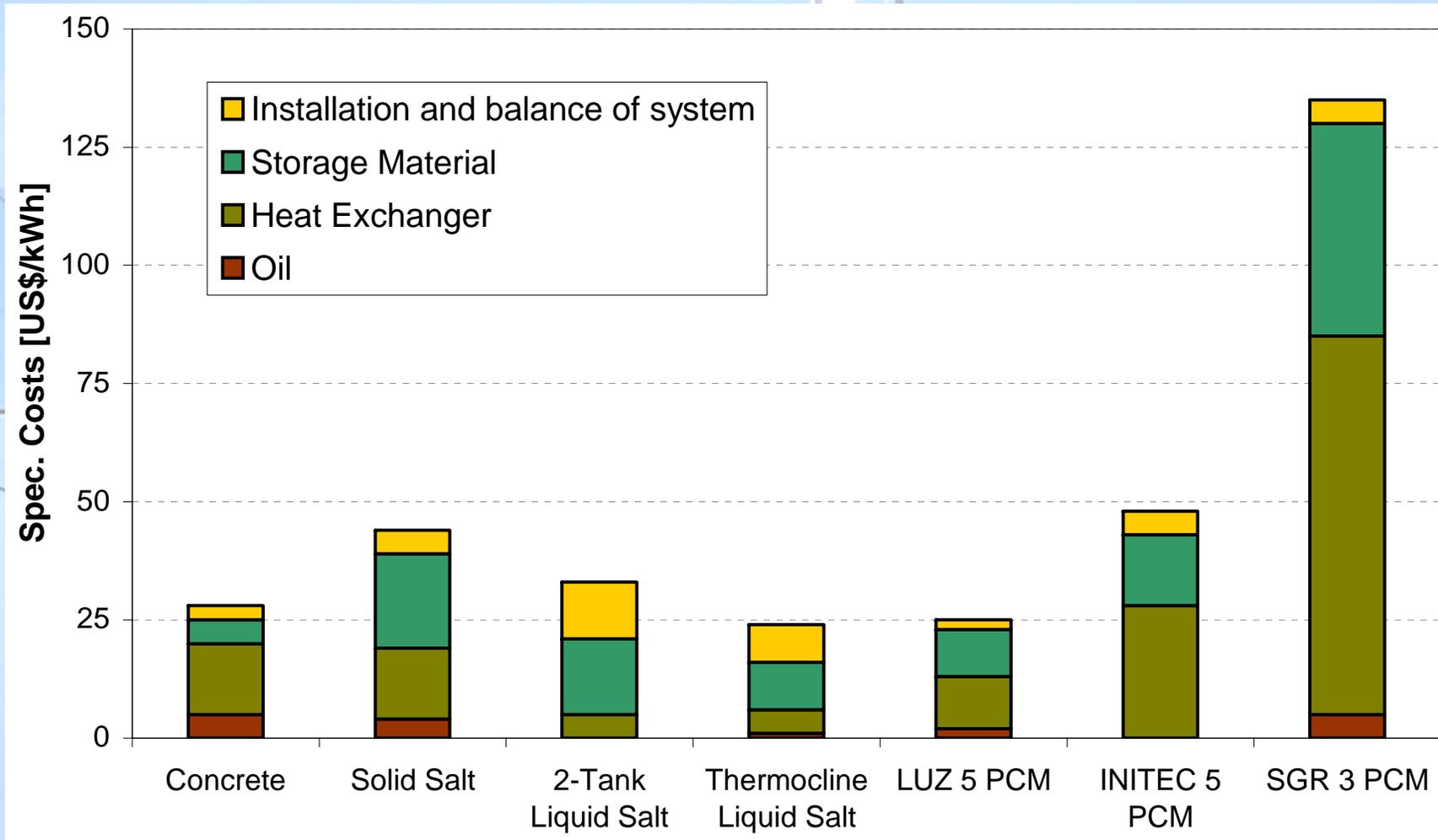
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**1. Relatively low cost**

**2. Salt Technology is the most proven technology**

# Specific Cost of Different Storage Concepts



# Proven at Solar Two



# Widely used in Process Industry



a) Molten Salt system with an output of 14 MW at 430°C, England

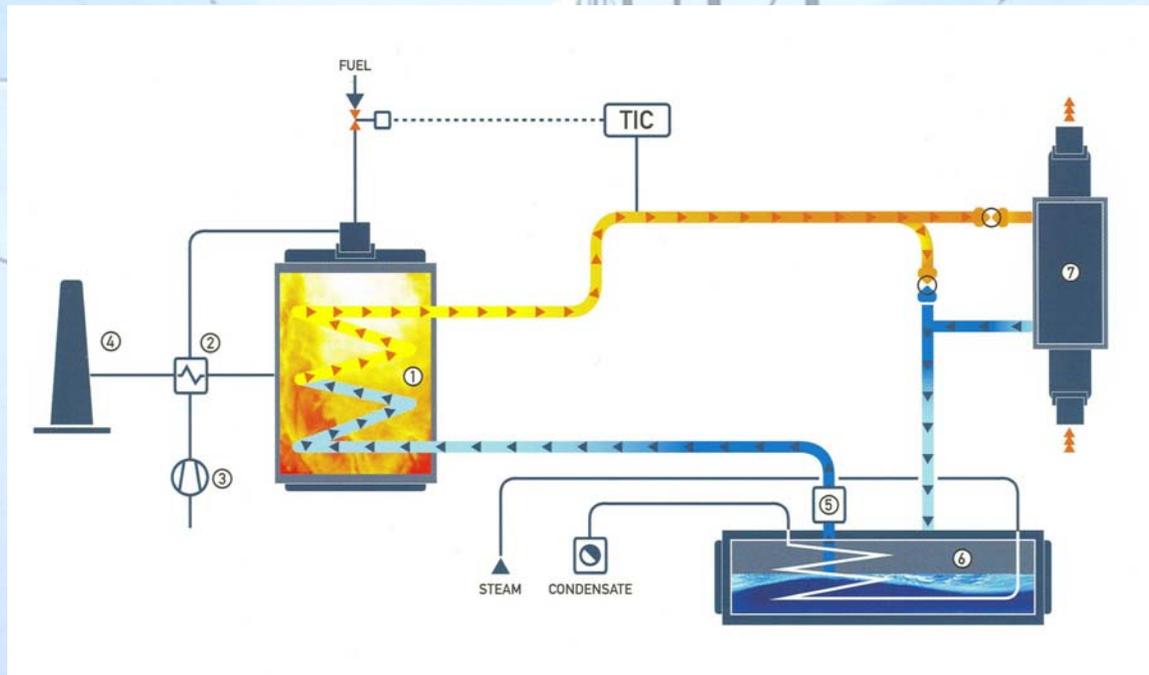


b) Molten Salt system with an output of 88 MW at 400°C, Bauxite digestion plant in Germany



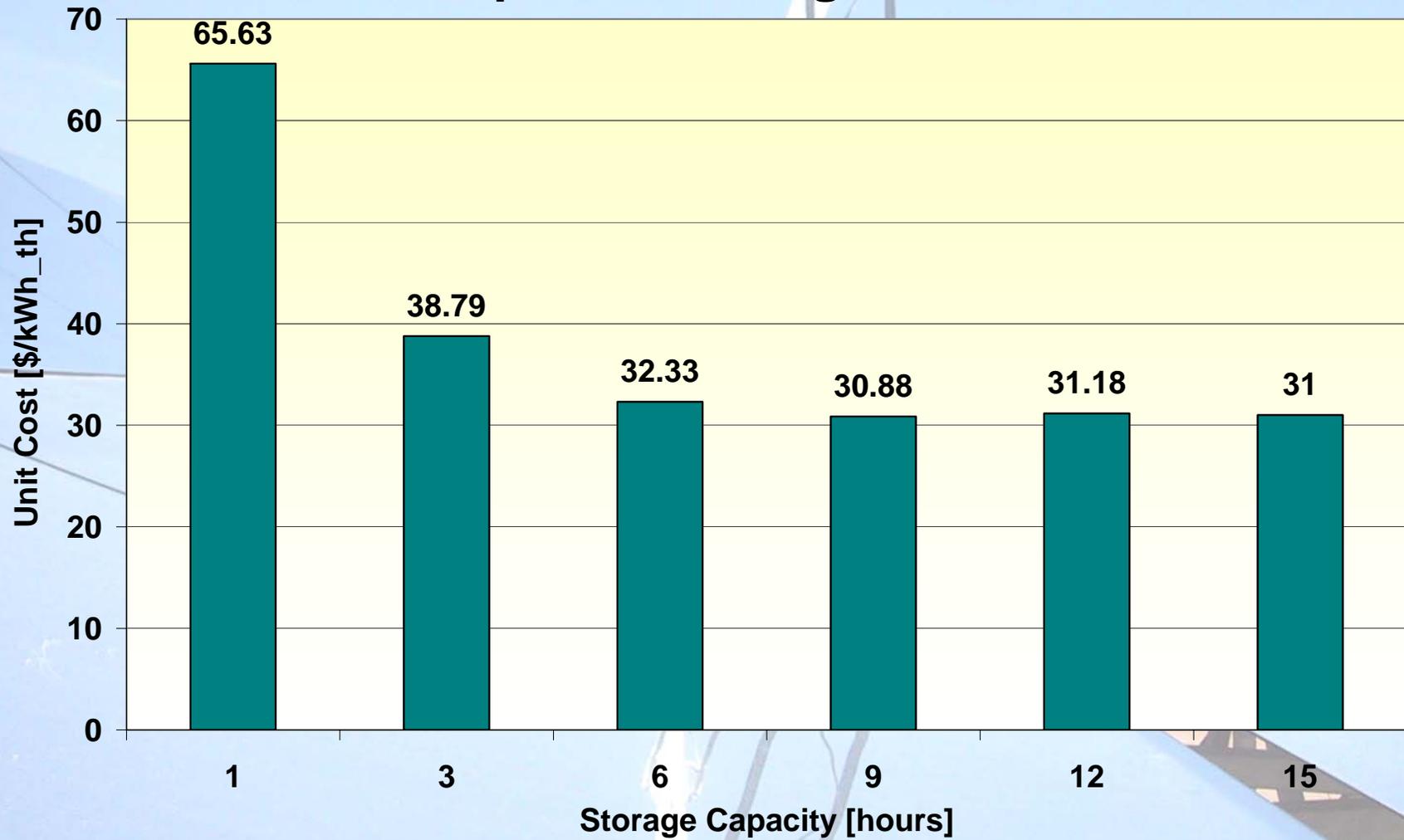
b) Molten Salt system with an output of 7.7 MW at 470°C, melamine plant in Germany

Heat Transfer plants. All photographs by Bertrams Heatec Ltd.

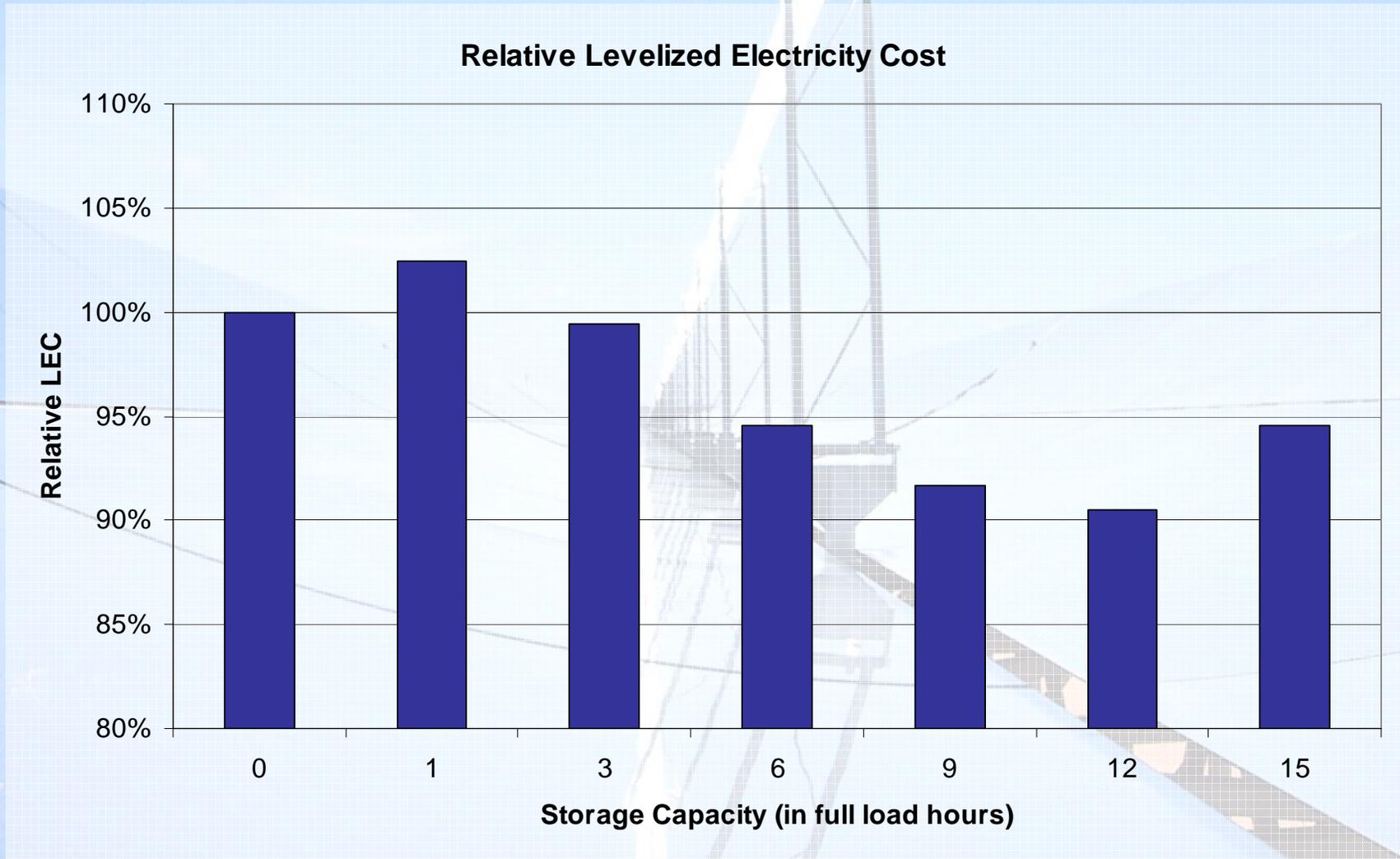


# Why this storage size?

## Specific Storage Cost



# Selection of Storage Size



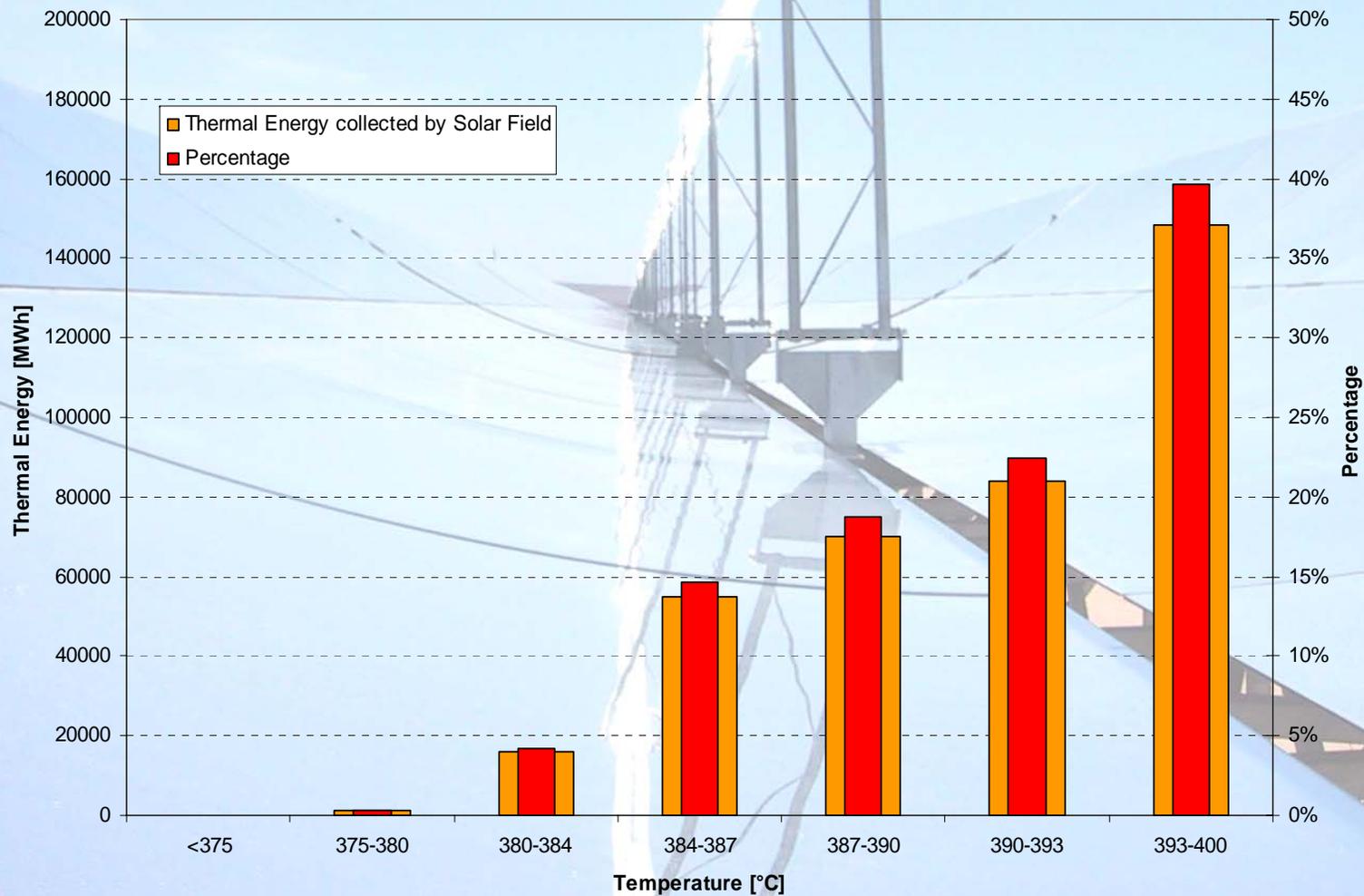
## Technical Parameter

- **Type:** 2-Tank Molten Salt Storage
- **Storage Fluid:** Nitrate salt mixture  
(60% NaNO<sub>3</sub> and 40% KNO<sub>3</sub>)
- **Melting Point of Fluid:** 223°C
- **Storage Capacity:** 1010 MWh (~7.5 hrs full operation) load
- **Storage Tank Size:** 14 m height  
37 m diameter
- **Salt Mass:** 27 500 tons
- **Flow Rate:** 953 kg/s
- **Cold Tank Temperature:** 292°C
- **Hot Tank Temperature:** 386°C

# Solar Field outlet temperature (1)

Overall thermal energy collected by the solar field at different solar field outlet temperatures (Case 1: loop control, only storage operation)

Case 1: Valve Control (Weighted average temperature = 390°C)

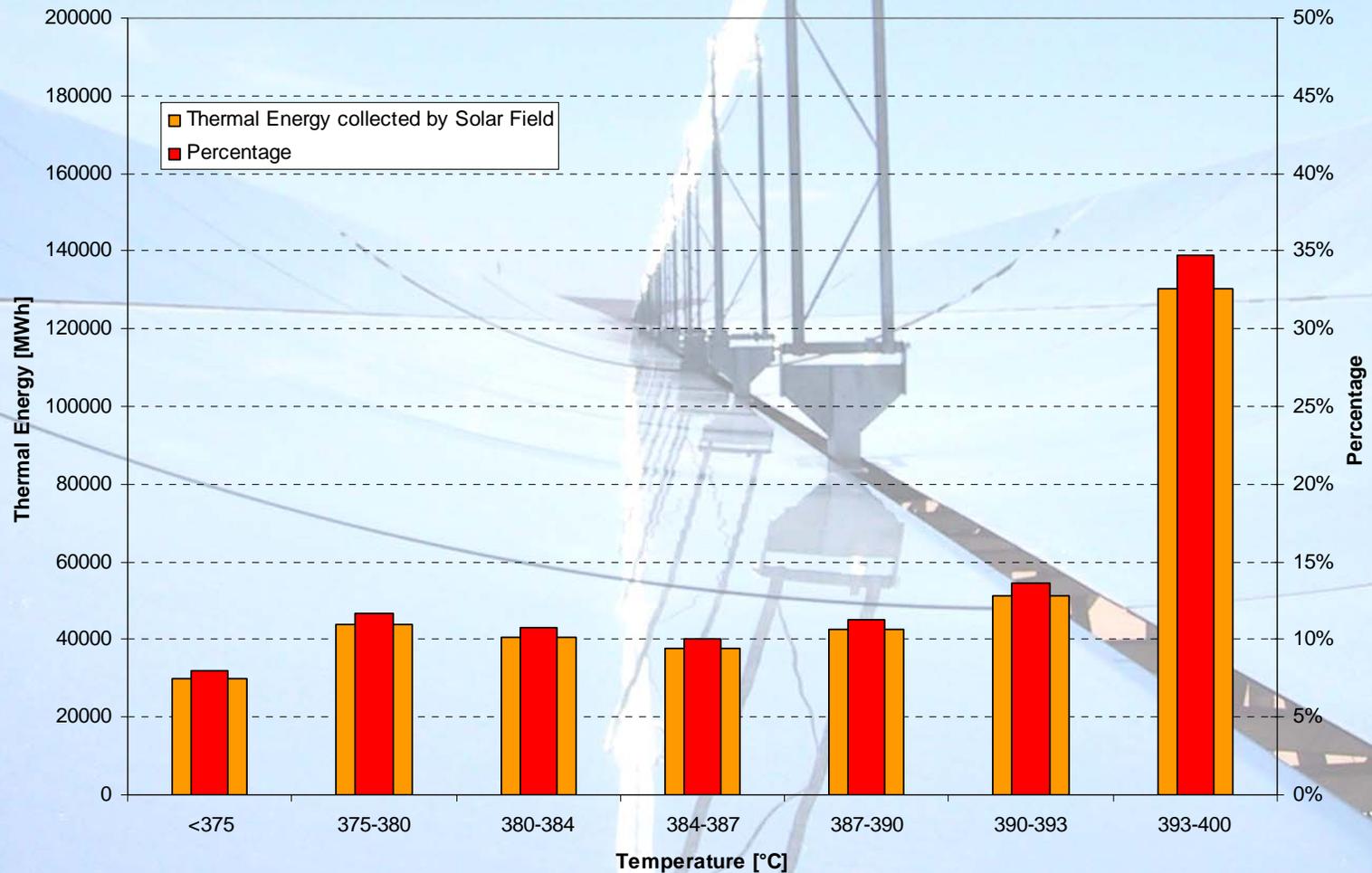


# Solar Field outlet temperature (2)

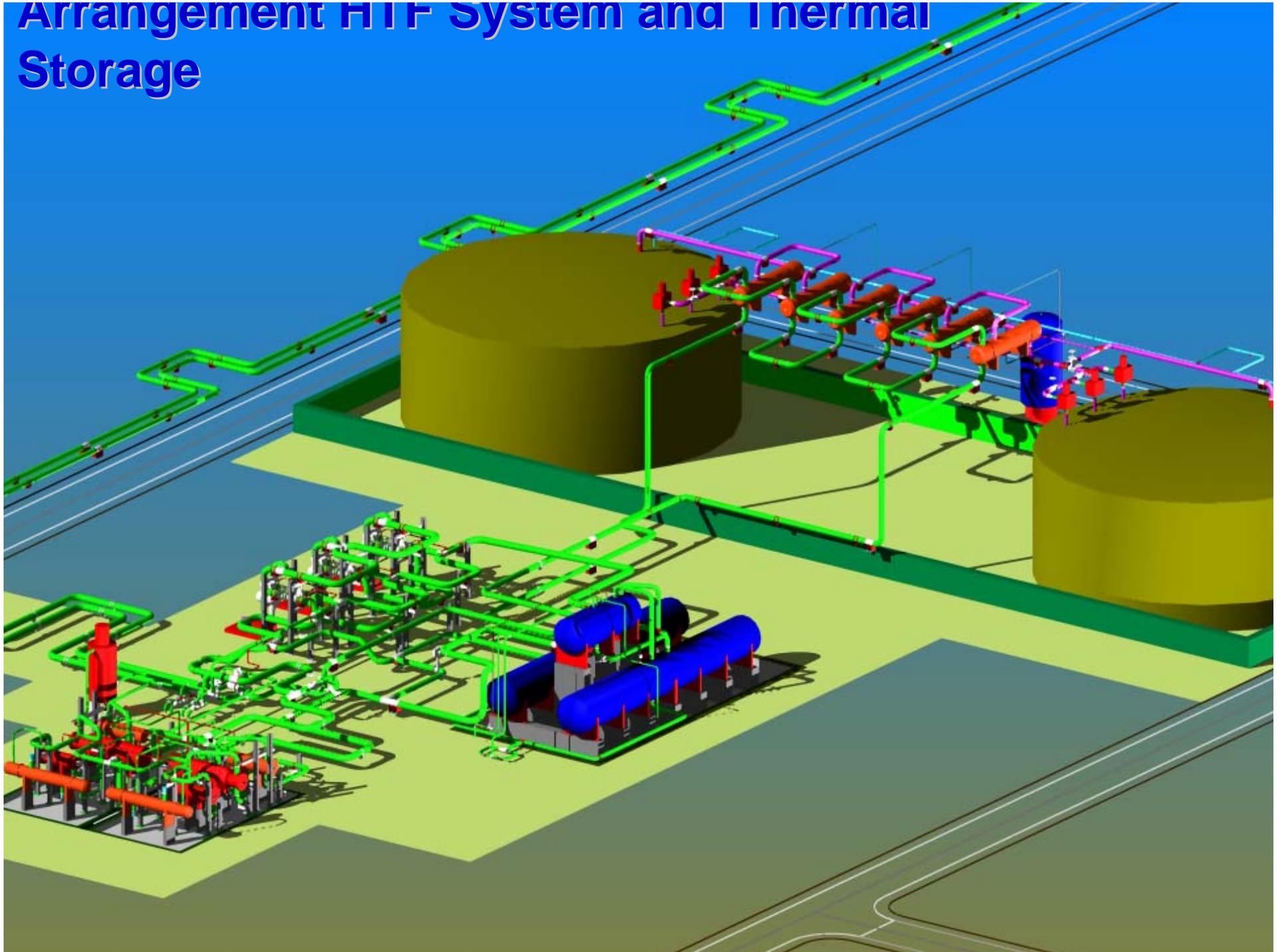


Overall thermal energy collected by the solar field at different solar field outlet temperatures (Case 2: without loop control, only storage operation)

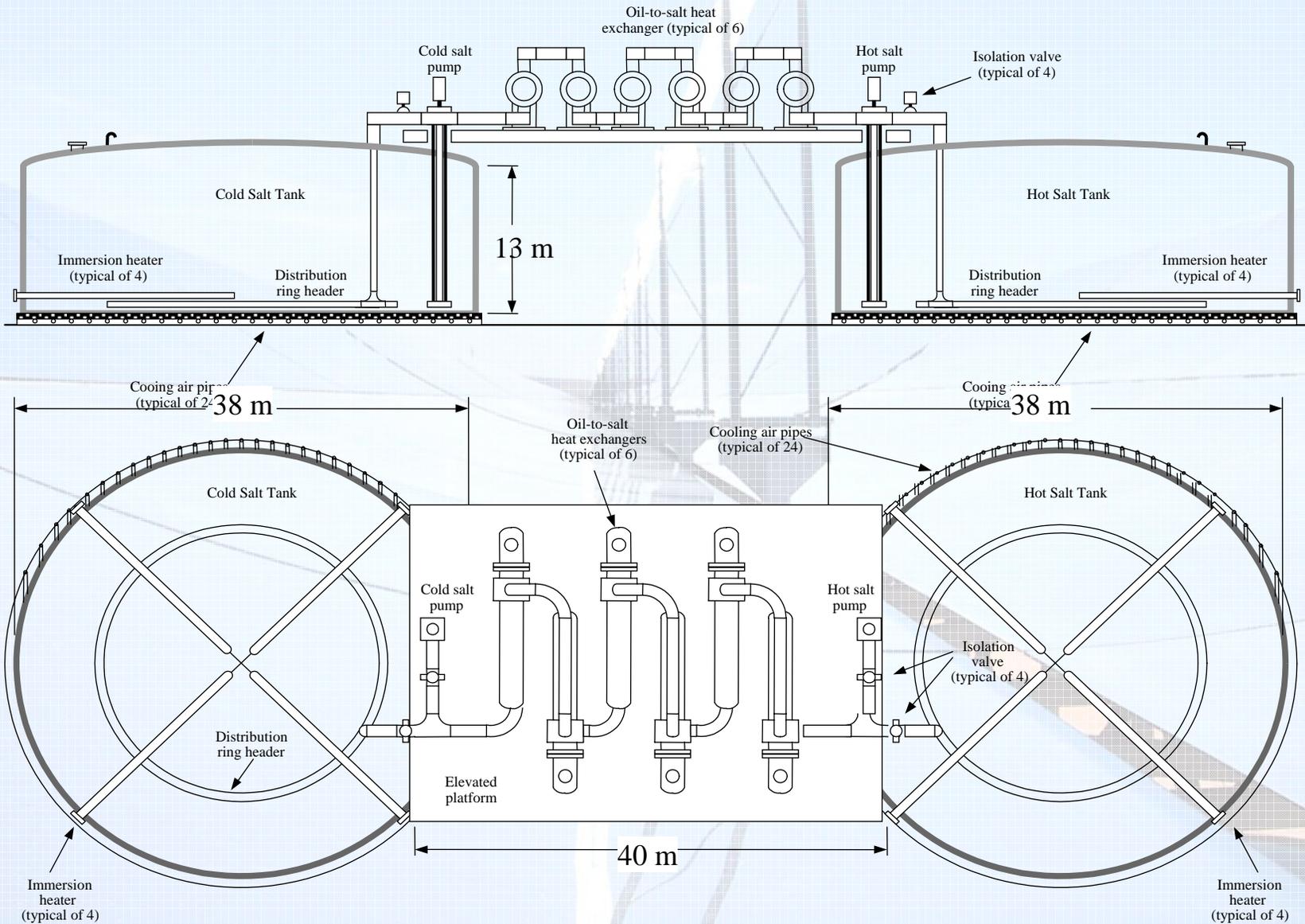
Case 2: No Valve Control (Weighted average temperature = 387°C)



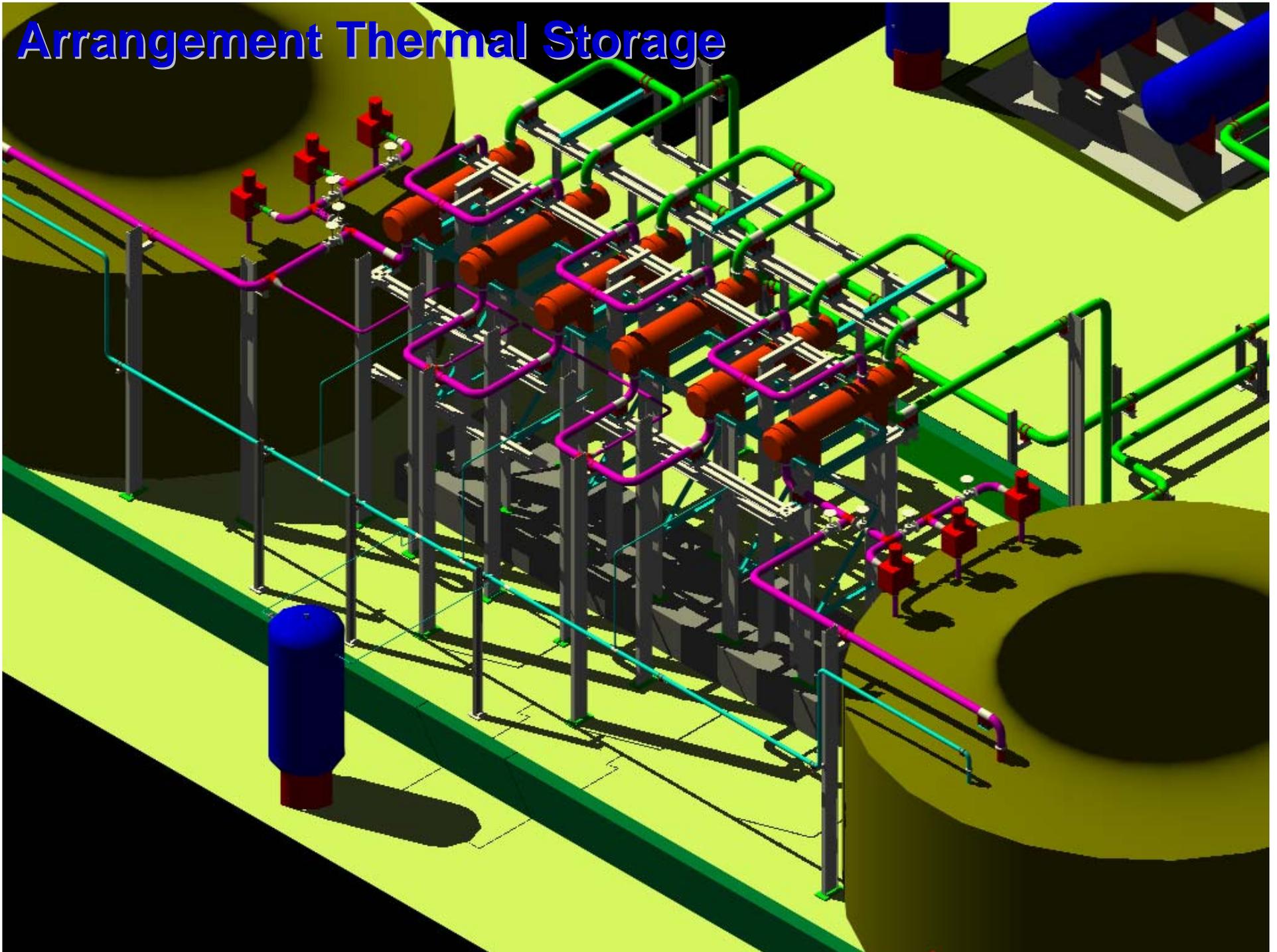
# Arrangement HIF System and Thermal Storage



# General Arrangement Storage System



# Arrangement Thermal Storage



## Summary

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- **Storage helps to improve economics of solar thermal power plants**
- **Storage helps to increase availability and plant capacity factor and improves system flexibility**
- **Molten salt technology is a proven technology in the process industry**
- **Economic storage capacity is in the range of 3 – 15 full load hours**
- **The Andasol plants in Spain will have ~7.5 hrs (1010 MWh) storage capacity**