Thermal Energy Storage – Electrical Heat Exchangers

Ingenergio

About Ingenergio

- A company established in Bilbao, Spain.
- Core team with high experience in CSP and Storage

Offer to market

- Engineering Services
  - Conceptual
  - Engineering
  - Project Management – Commissioning
  - O&M – Digital Twin
- Solutions
  - Preheating- Melting System
  - Solar Field Quality
  - Autonomous Control System
  - Electrical Heat Exchangers
- Products
  - Receiver HCE tubes
  - Hydraulic Unit
  - Balancing Valves Solar Field
  - HTF

Storage Types

- Unstability LCOE - LCOS
- Storage Types - Maturity
- Storage efficiency – Annual Availability

Unstability – LCOE - LCOS

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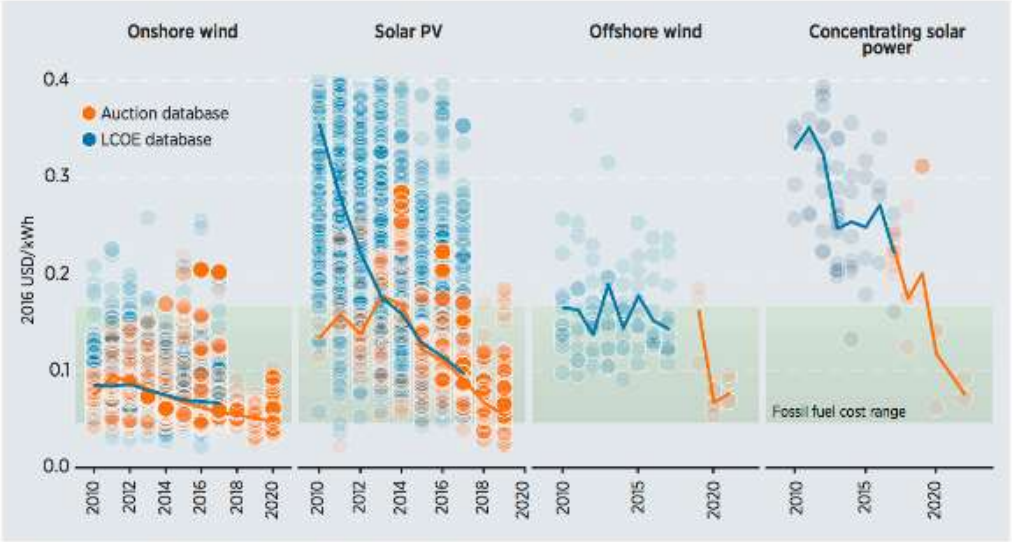
Figure ES.2 The levelised cost of electricity for projects and global weighted average values for CSP, solar PV, onshore and offshore wind, 2010-2022



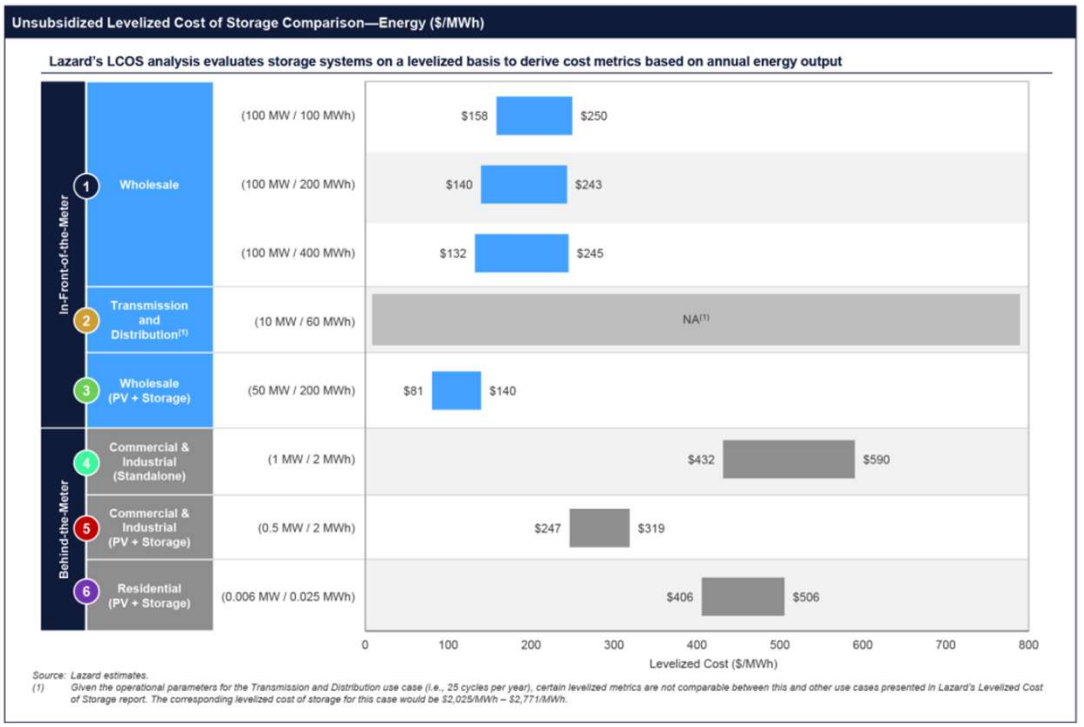
Source: IRENA Renewable Cost Database and Auctions Database.

Note: Each circle represents an individual project or an auction result where there was a single clearing price at auction. The centre of the circle is the value for the cost of each project on the Y axis. The thick lines are the global weighted average LCOE, or auction values, by year. For the LCOE data, the real WACC is 7.5% for OECD countries and China, and 10% for the rest of the world. The band represents the fossil fuel-fired power generation cost range.

LCOE, Levelized cost of energy

- Not consider stability of the grid.
- Not consider back up energy if it is necessary,

LCOS, Levelized cost of energy



- Depends on Energy, PV – Wind, need back – up energy or storage.
- Fossil Fuels and Hydropower, baseload, is used as back – up energy.
- There are renewable energies that can be baseload thanks to storage or maximize,
- Storage solutions can be applicable as baseload, grid stability or self consumption, different technologies

Storage Types - Maturity

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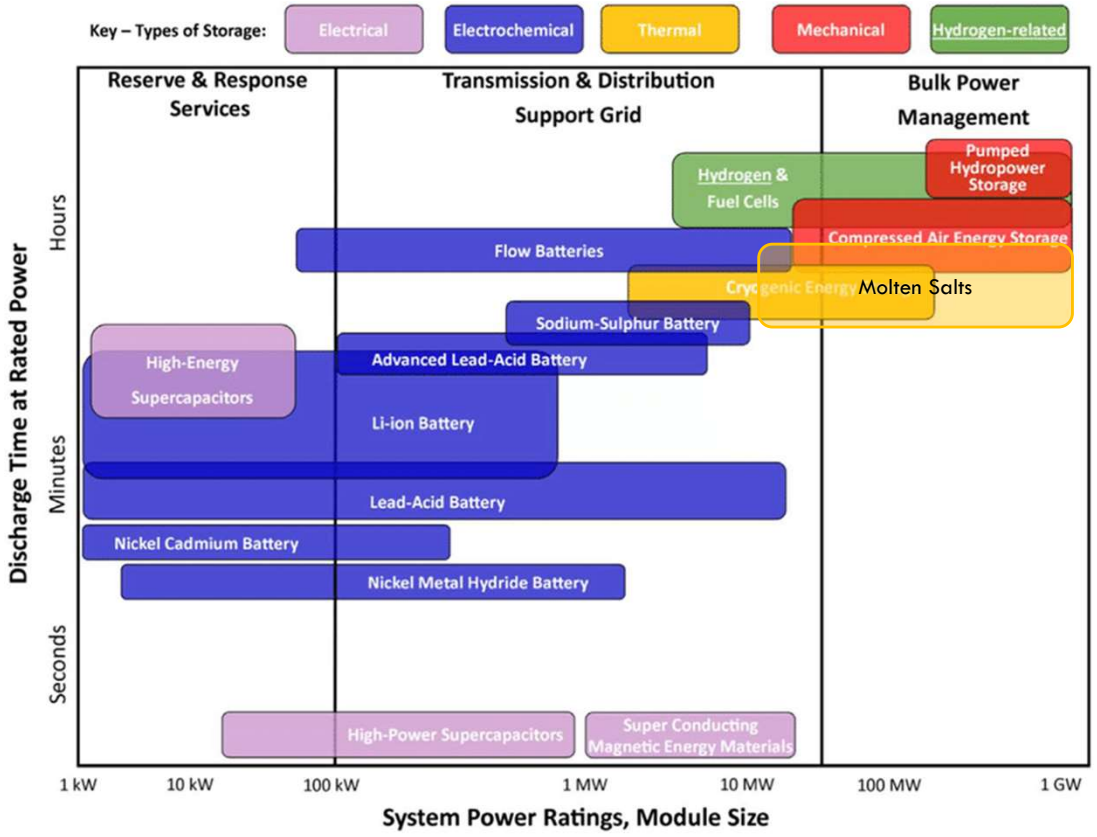
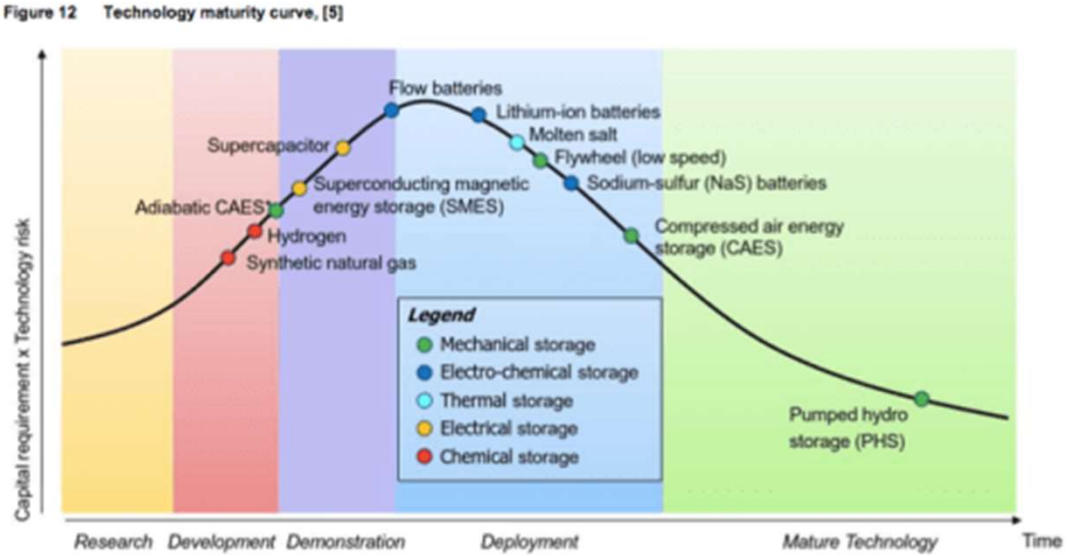
Grid Stability or Baseload necessity it is difficult to define.

Continue evolution of storage technologies





Storage Efficiency – Annual Availability

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Type	Storage	Use	Efficiency	LCOS - LCOE
Electrochemical	Lithium ion batteries	Reserve & Response Services	85%-90%	130 – 250 $/MWh
		Transmission & Distribution support grid		
Mechanical	Pumped Hydro Energy Storage	Bulk Power Management	70% - 85%	20 – 60 $/MWh
	Liquid air energy storage with heat recovery	Bulk Power Management	21% - 55%	Pilot Phase
	Compressed air energy storage	Bulk Power Management	42% - 54%	Pilot Phase
Thermal	Thermal Energy Storage (alone)	Bulk Power Management	30% - 40%	Pilot Phase
	Thermal Energy Storage hydrid CSP, high hybridization (>60%)	Bulk Power Management	40%	Pilot Phase
	Thermal Energy Storage hydrid CSP, low hybridization (<15%)	Bulk Power Management	80%	100 – 120 $/MWh

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Electrical Heat Exchangers - Hybrid Solution

- **Electrical Heat Exchangers**
- **Hybrid Solution**
  - **Charge Storage**
  - **Charge Storage Booster**
  - **Discharge Storage Booster**

Electrical Heat Exchanger

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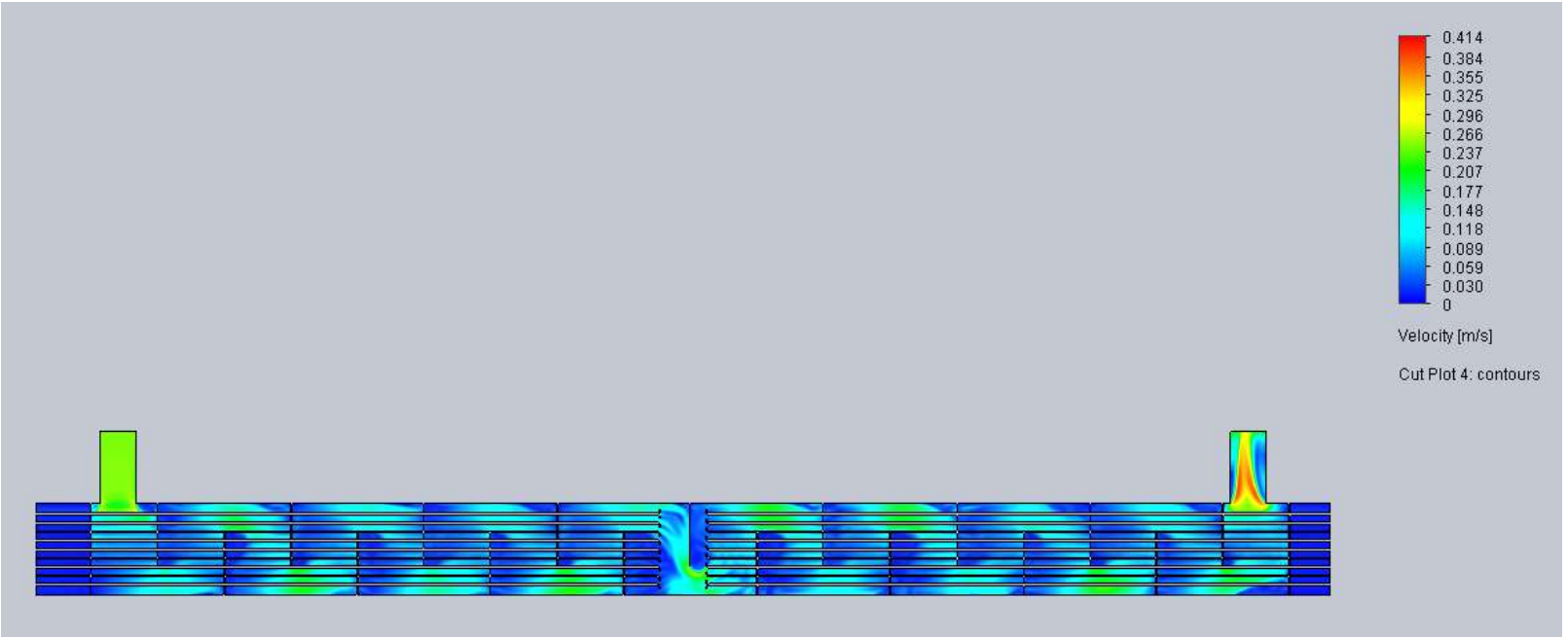
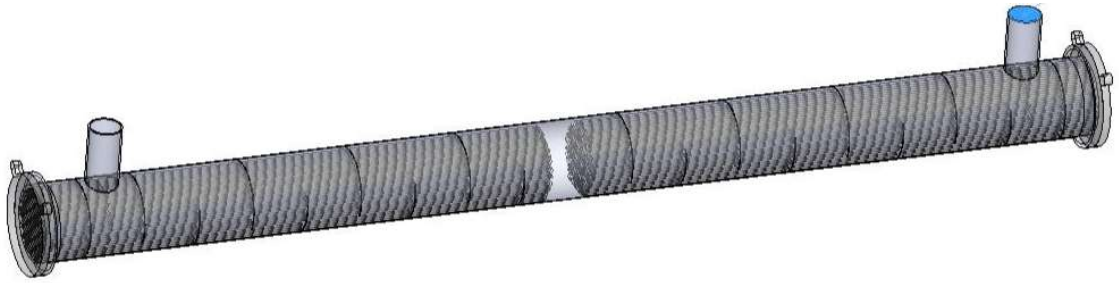
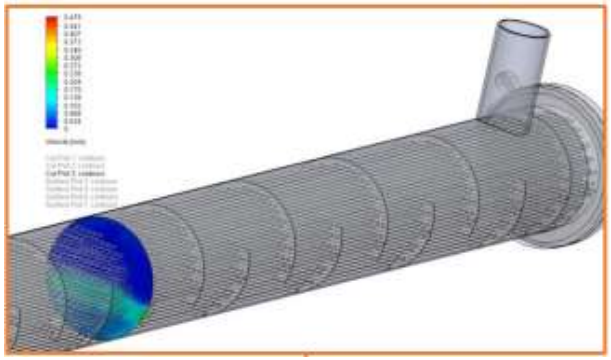
Characteristics

- Outlet Temperature 400ºC to 570ºC
- Flow adjustable
- Feasible to use in Melting Process and Hybridization Solution







Hybrid Solution

Advantages

- Get dump energy at low cost, valley hours preferably.
- In case of mandatory decrease of turbine load, increase self-consumption.
- Increase Efficiency at Partial Loads.
- Increase Efficiency in Peak Hours, using Booster configuration in Steam Turbine.
  - Steam Turbine necessary to be configured for booster configuration.

Dis - advantages

- Medium Voltage area need to be configured properly since basic design phase.
- Detail design with piping, valves, tracing,… of complete solution, not focus only on Electrical Heat Exchangers.
- Electrical Heat Exchangers low experience in market.

Charge Storage

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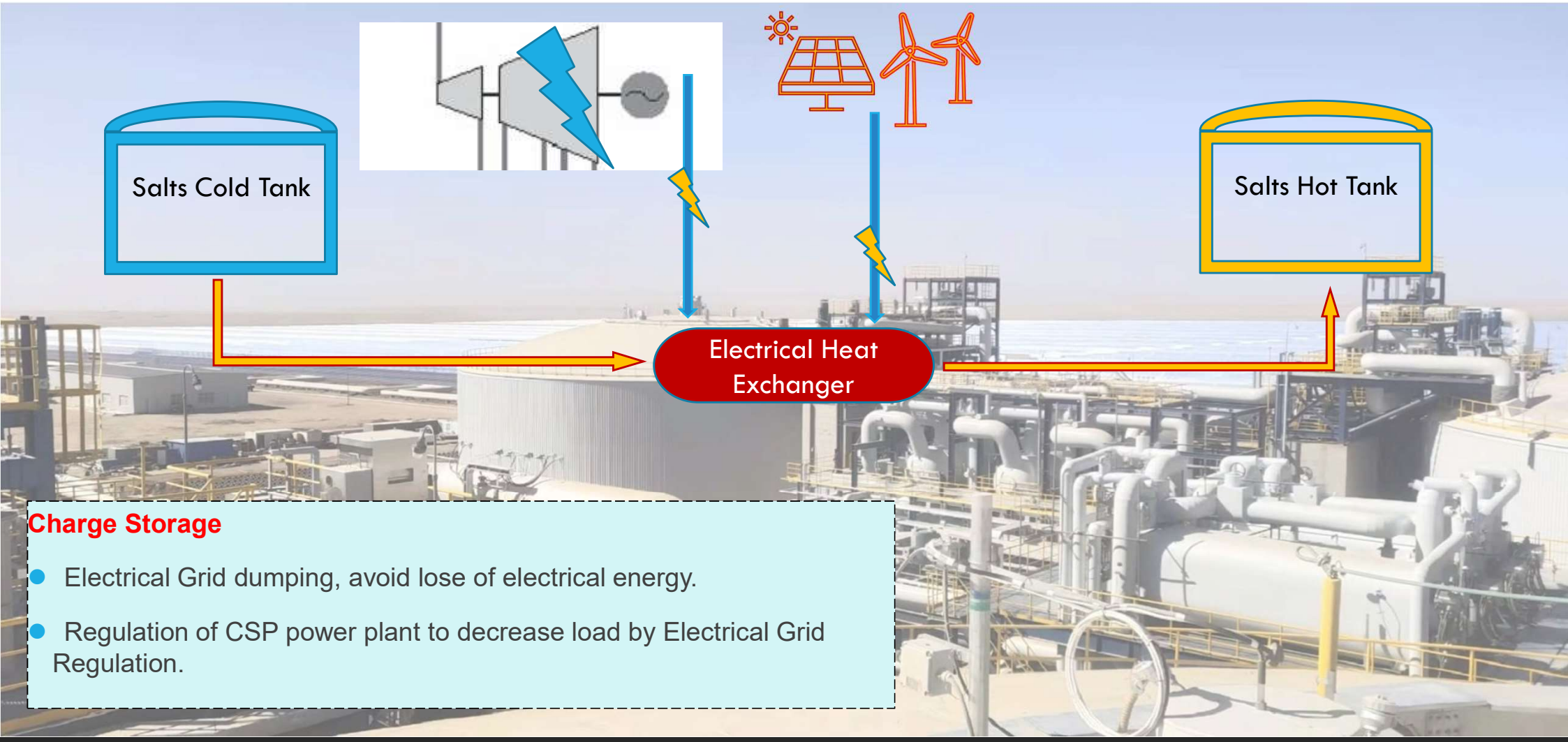

Charge Storage

- Electrical Grid dumping, avoid lose of electrical energy.
- Regulation of CSP power plant to decrease load by Electrical Grid Regulation.

Charge Storage - Booster

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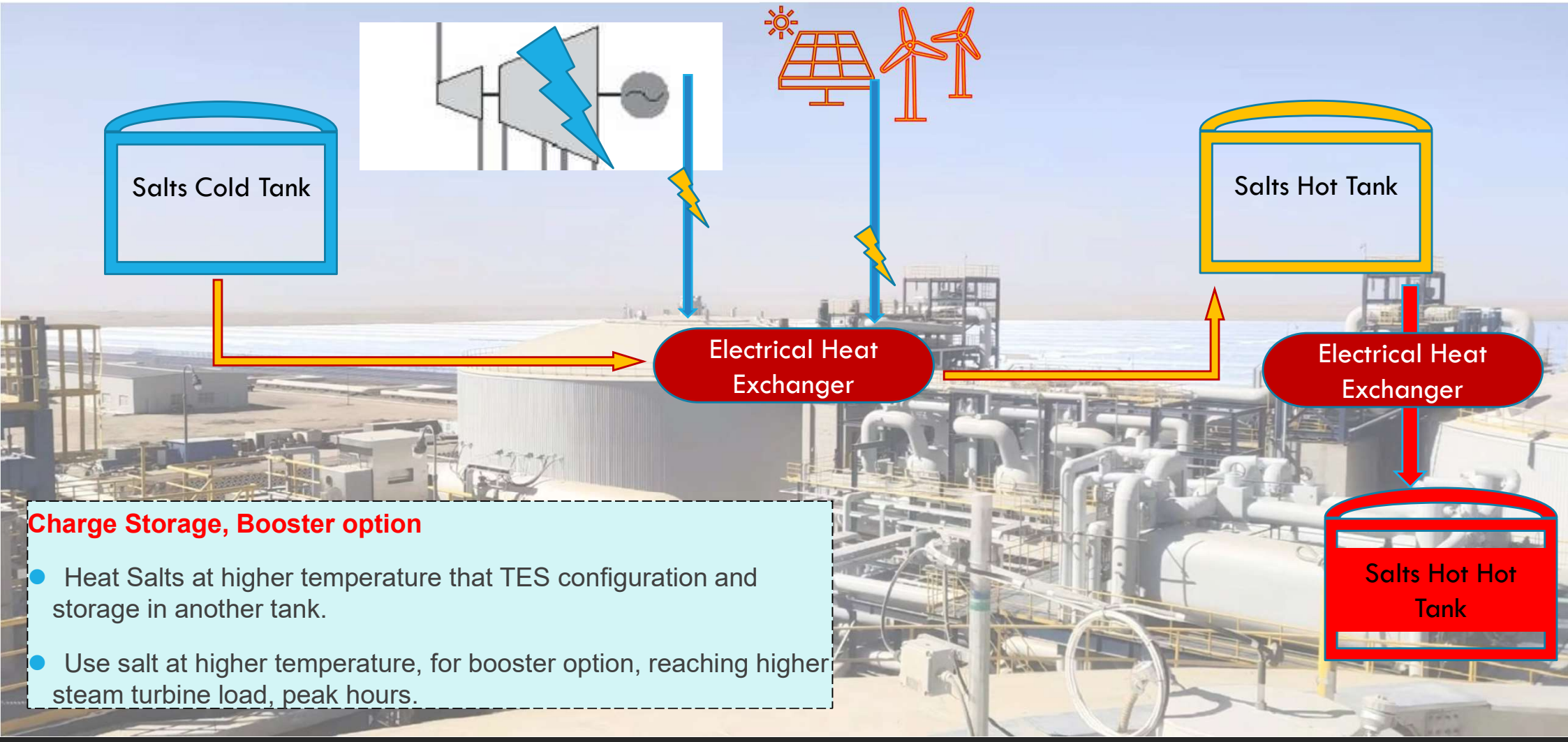

Charge Storage, Booster option

- Heat Salts at higher temperature that TES configuration and storage in another tank.
- Use salt at higher temperature, for booster option, reaching higher steam turbine load, peak hours.

Discharge Storage - Booster

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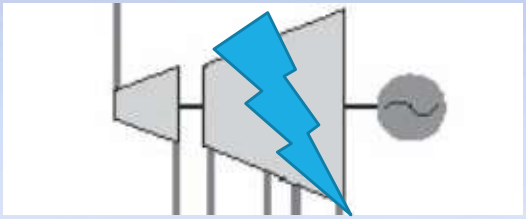


Salts Cold Tank

Salts Hot Tank

Molten Salt – HTF HX

Molten Salt – Steam Superheater HX

Salts Hot Hot Tank

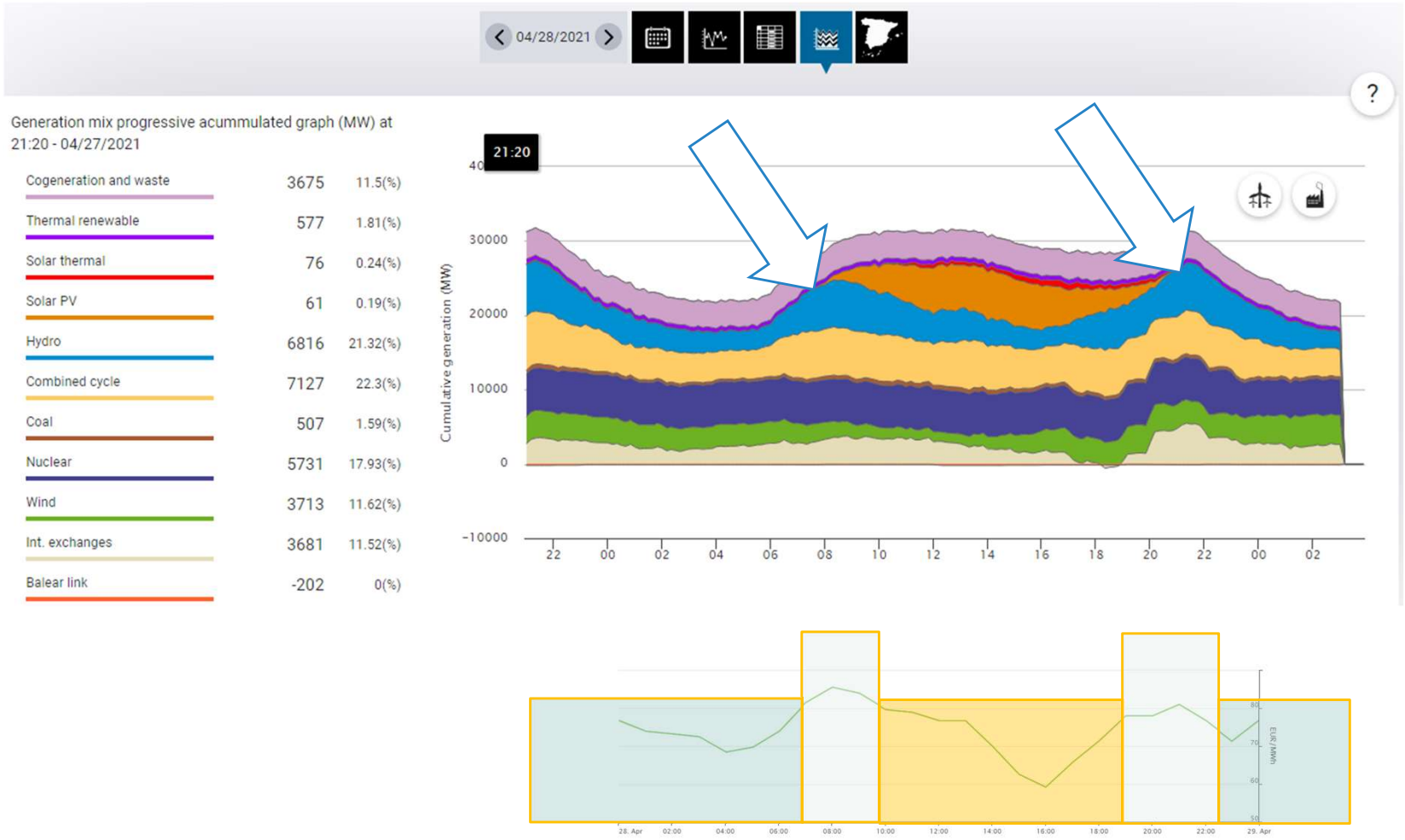
Discharge Storage, Booster

- Steam Turbine Booster Option, increase electrical output & efficiency, preferred in peak hours during afternoon.
- Steam Turbine can operate in both modes.

Case Analysis – Stability

- **April**
- **June**
- **September**
- **November**

Case Analysis – Stability, April



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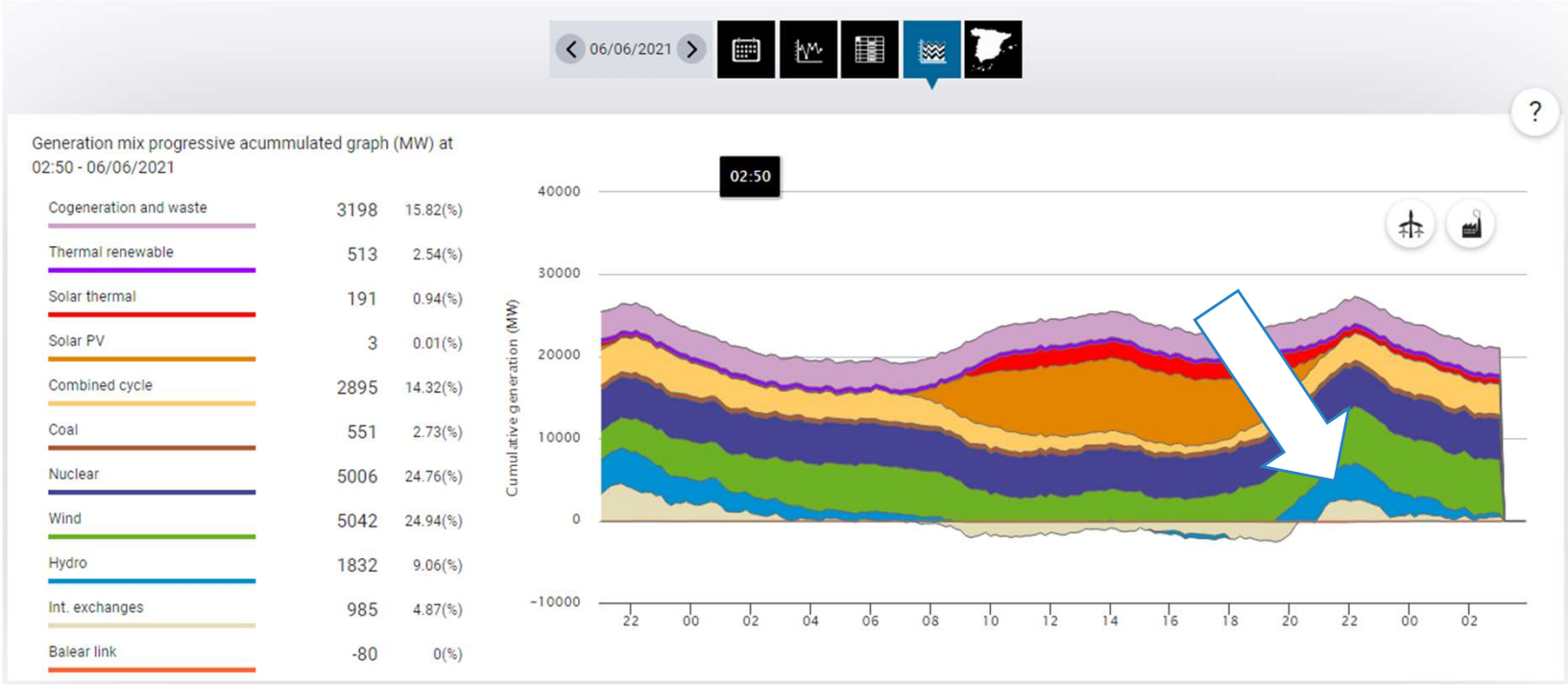
Discharge TES Booster Operation

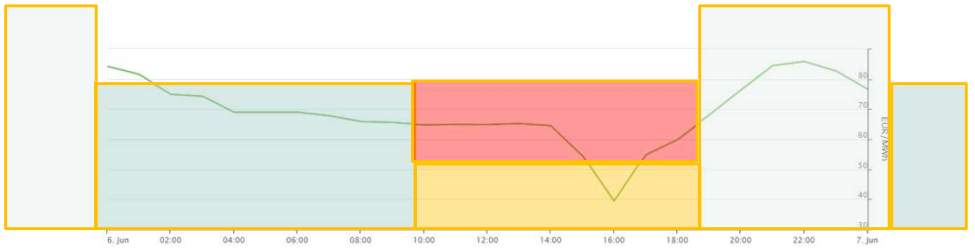
Discharge TES

Electrical Generation + Charge TES

Charge TES – Hydrid Operation

Case Analysis – Stability, June





Discharge TES Booster Operation

Discharge TES

Electrical Generation + Charge TES

Charge TES – Hydrid Operation

Case Analysis – Stability, September

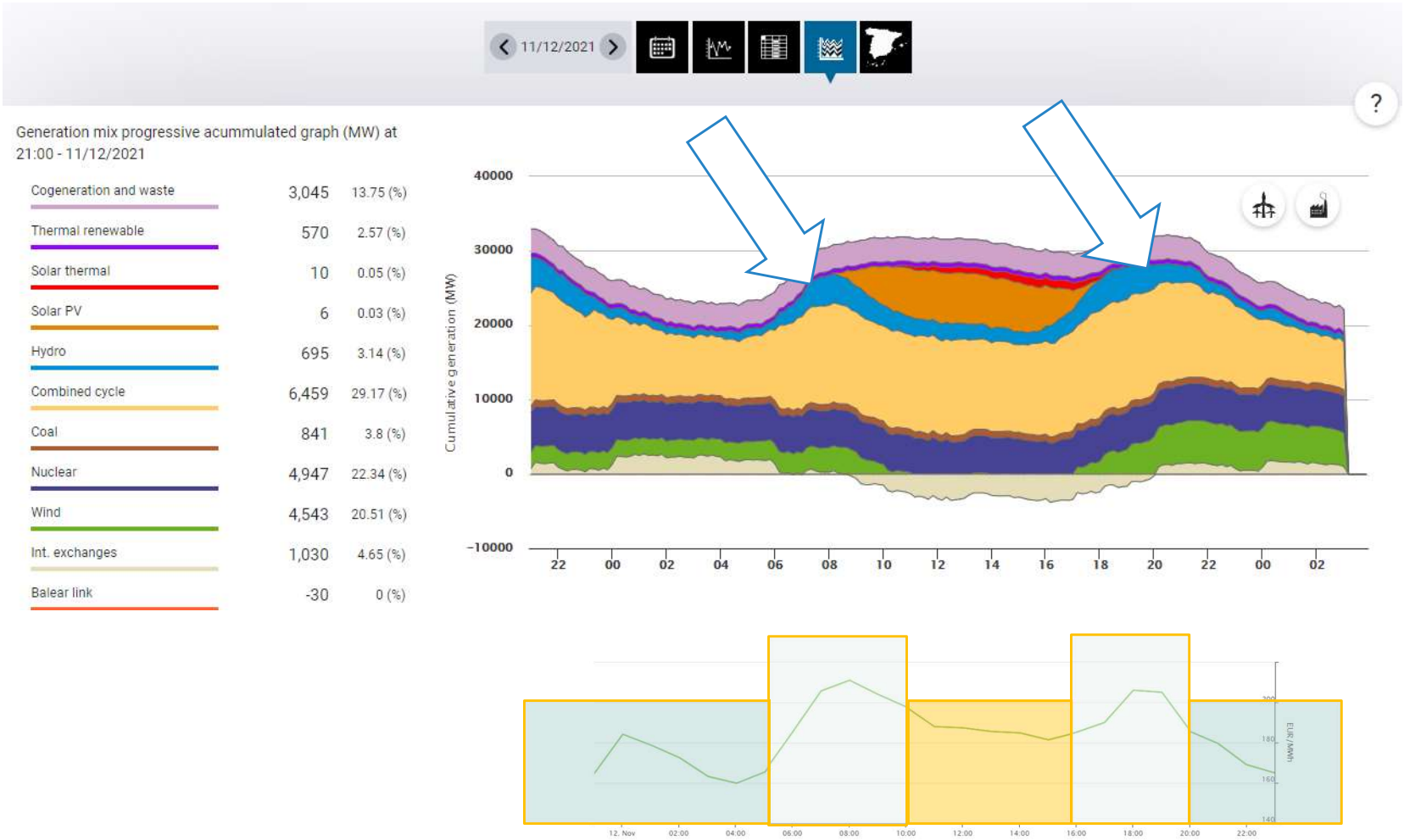
Discharge TES Booster Operation

Discharge TES

Electrical Generation + Charge TES

Charge TES – Hydrid Operation

Case Analysis – Stability, November



Discharge TES Booster Operation

Discharge TES

Electrical Generation + Charge TES

Charge TES – Hydrid Operation

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QUESTIONS?
THANK YOU

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