Panel 3

November 5, 2025

From Storage to Stability: Technologies for Tomorrow's Grid

Moderator Halime Paksoy
Çukurova University, Adana, Turkey

This panel is about

Roles of energy storage and carriers

- For more resilient future energy grids
- In balancing renewable supply/demand
- Green hydrogen – Power2X
- Flexible sector coupling strategies

How flexible is your system ?

Program and Speakers

- Thermal Energy Storage

  Halime Paksoy, Çukurova University, Turkey
- Hydrogen

  *Nathalie Monnerie, DLR, Germa*ny
- Batteries as energy carrier

  Ingo Stadler, TH Köln, Germany
- Grid resilience

  Andreas Hauer, ZAE Bayern, Germany

Thermal Energy Storage

Halime Paksoy

Çukurova University, Adana, Turkey

November 5, 2025 • Fortaleza, Brazil

The Changing Energy Landscape

- Growing share of variable renewables
- Grid instability from mismatch between supply and demand
- Need for **multi-hour to seasonal** storage solutions
- Different energy storages and energy carriers can complement each other

Key Message: Renewable integration challenges require flexible, scalable storage.

The solution is in the nature: Renewable sources

But there is a gap between supply and demand of these sources

Solar Energy

Ground

Air

Water

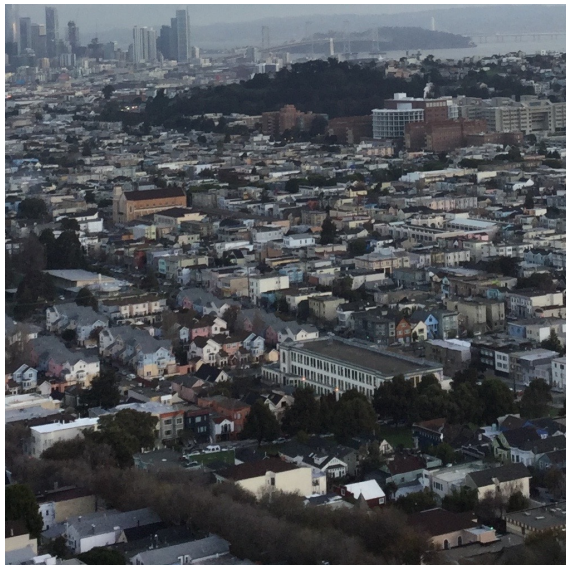
The primary thermal energy source

Artificial thermal energy sources (man-made): Waste heat and cold

Industry

Appliances

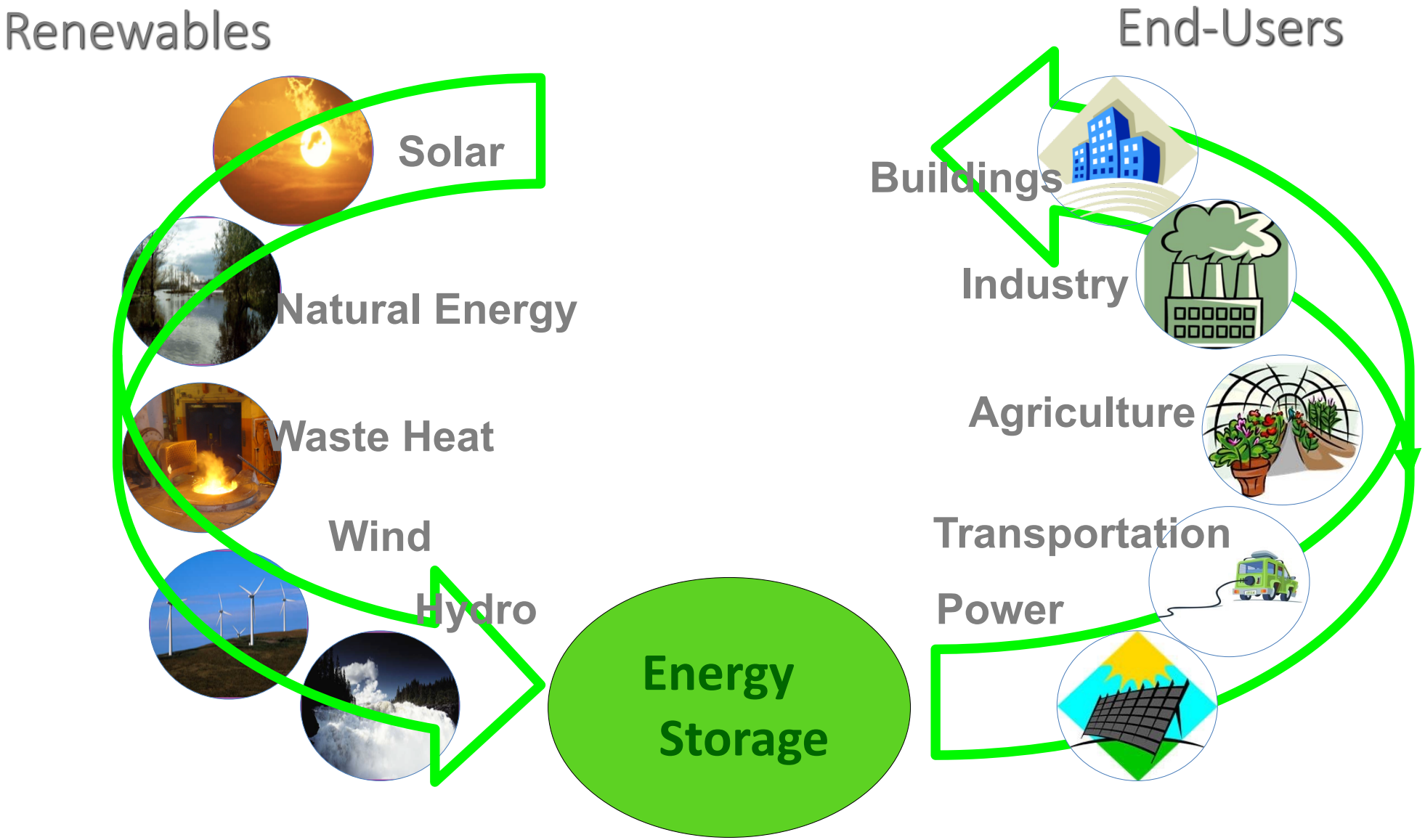
Transportation



Urban Life

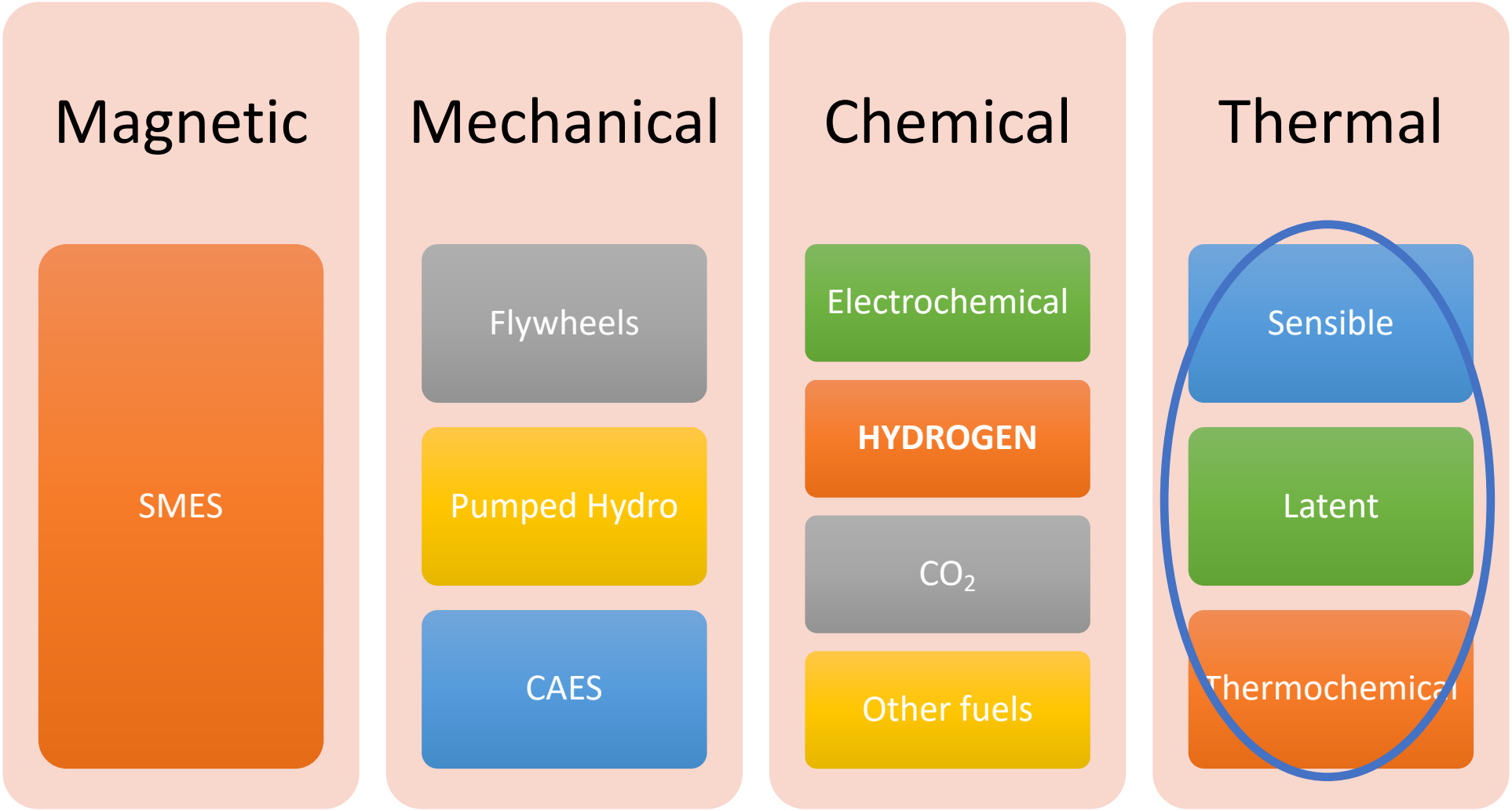
and others….

Matching Supply and Demand



How to Store Energy

through transformations between different energy forms



What is Thermal Energy Storage (TES)?

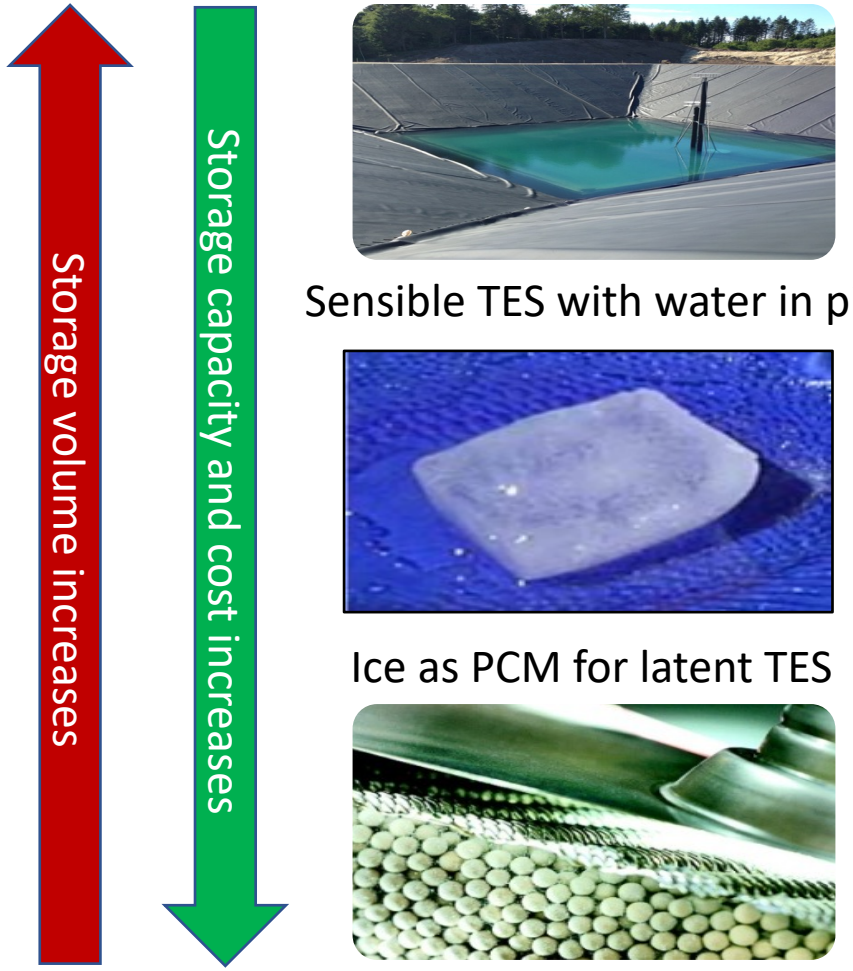
TES = Storing energy as heat or cold for later use

Wide temperature range (–100°C to 1200°C)

Sensible heat: water, molten salts, concrete, metals, others
- Maturity: High
- Temperature range: 20 -1000 (°C)
- Typical application: Heating, CSP

Latent heat: phase change materials (PCMs)
- Maturity: High/Medium
- Temperature range: -100 -1200 (°C)
- Typical application: Heating, Cooling, Thermal management

Thermochemical: reversible chemical reactions, sorption systems
- Maturity: High/Medium/Low
- Temperature range: 100 -1000 (°C)
- Typical application: Heating, Cooling



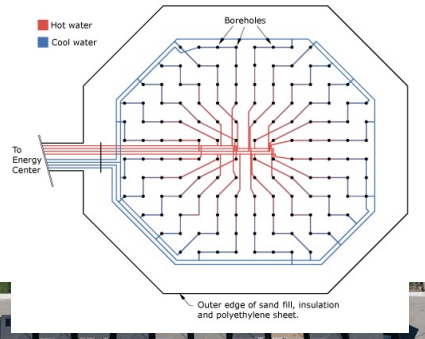
Sensible TES with water in pit

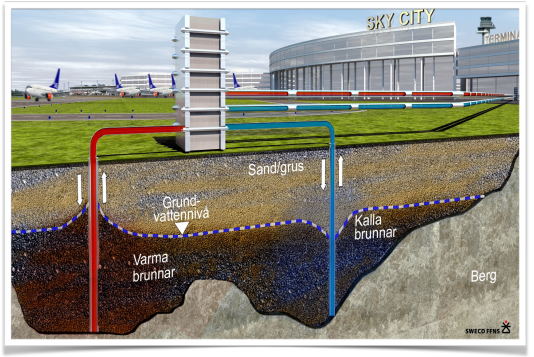
Ice as PCM for latent TES

Zeolite for Thermochemical TES

Application Examples Sensible TES

- Solar heating – DHW and space
- Underground TES (ATES, BTES, PTES)
- Tank TES – HVAC, industry
- Concentrated Solar Power (CSP)
  - molten salt, packed bed

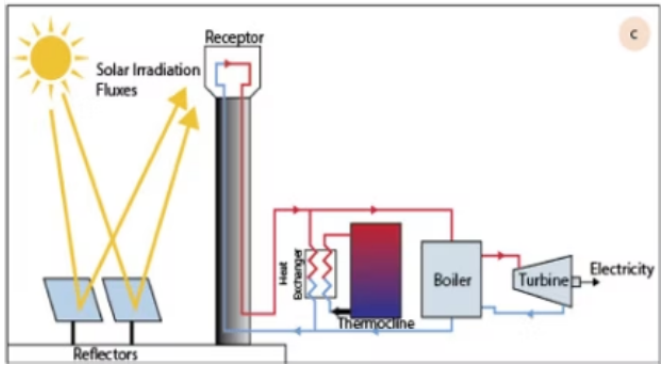




Arlanda airport, Sweden, Andersson, O.

Drake Landing Solar Community, Canada, Cruickshanks, F.

Greenhouse, Turkey, Turgut, B.



CSP with packed bed TES

Chilled water TES in the US
https://www.dntanks.com/projects/raleigh-nc/

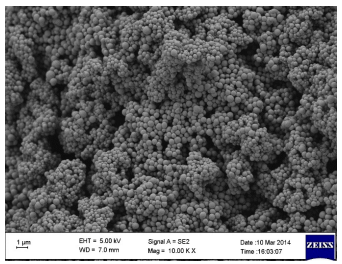
Sand battery, Finland
https://polarnightenergy.fi/sand-battery

Dronninglund, Denmark, PlanEnergi

Applications Examples Latent TES - PCMs

- Active systems
  - Heat pumps, HVAC, industry, PVT, ice storage,…
- Passive systems
  - Building components, materials
  - Thermal management

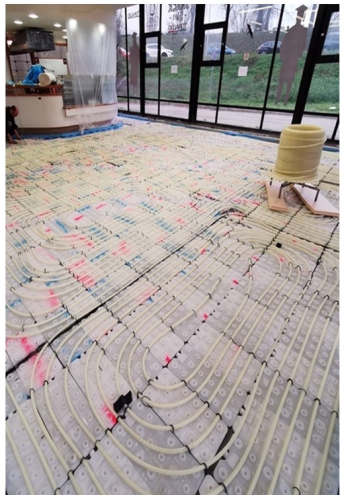
Macroencapsulated PCMs



Micro-nano encapsulated PCMs

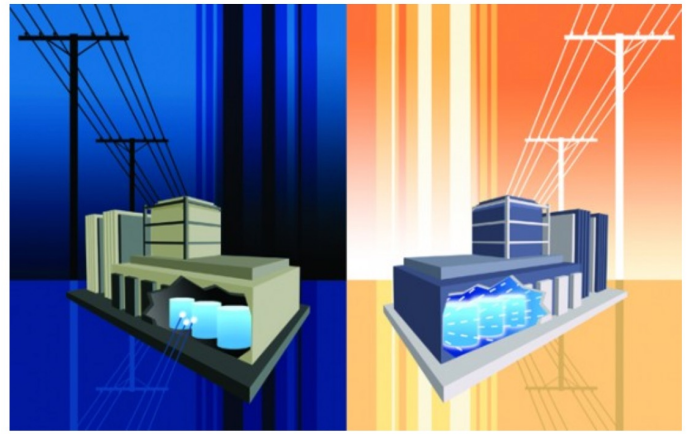
Shading with PCMs, Mehling, 2022

Chilled ceiling
www.climator.com

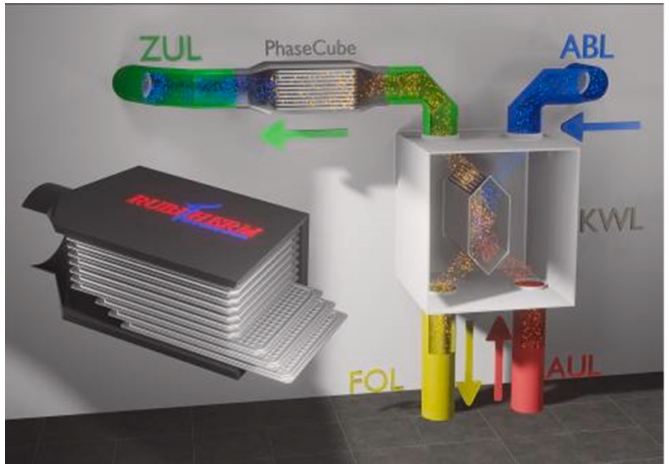


Floor heating with PCM
Cesari et al.,2024

PCM heat exchanger,
Paksoy, 2025



Ice storage, www.calmac.com

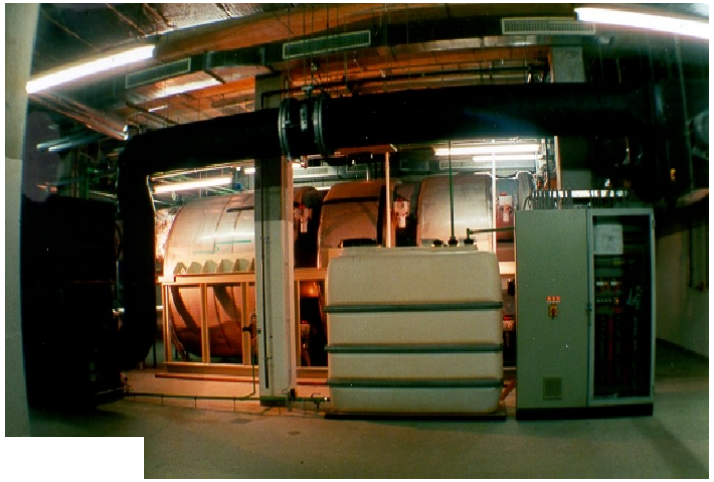


PCM plates in air ducts, Mehling, 2022

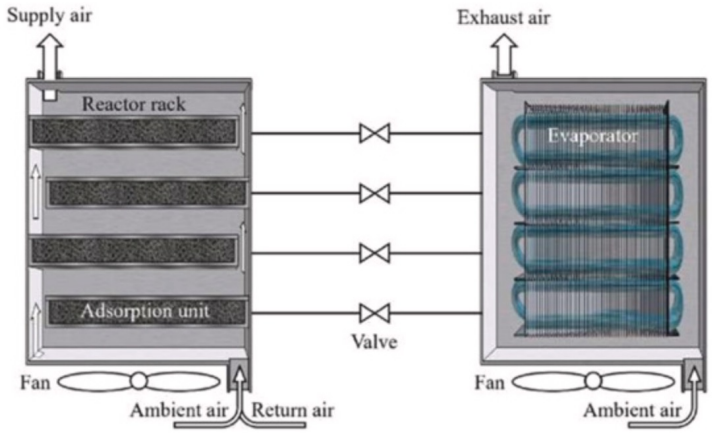
Applications Examples Thermochemical TES

- Sorption systems
  - HVAC, industry, waste heat transportation
  - Solar absorption cooling
- Chemical reactions
  - Space heating and cooling, industry,
  - Transportation

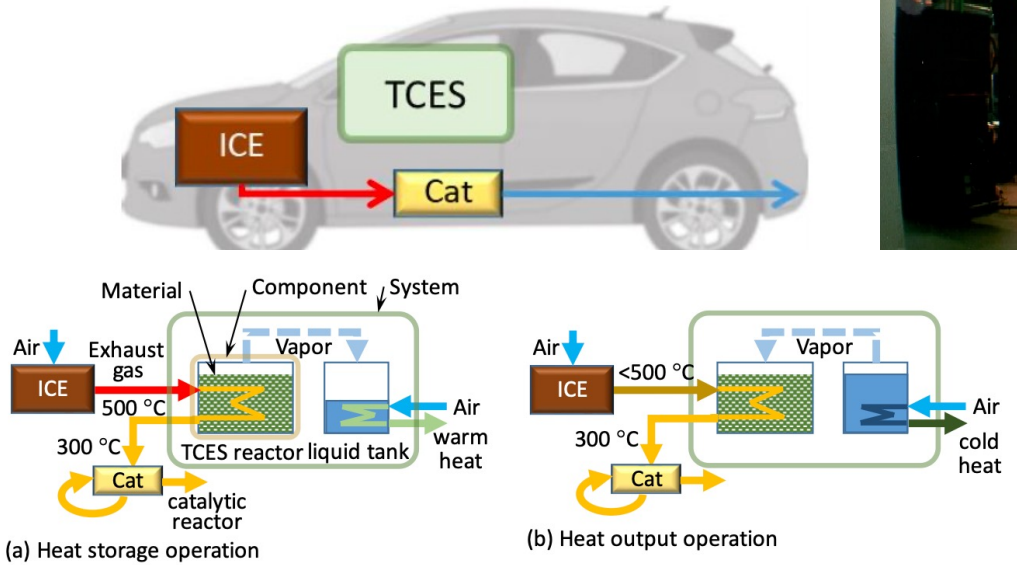
Adorption TES for waste heat transportation, Hauer, A.



Adorption TES for HVAC, Hauer, A.



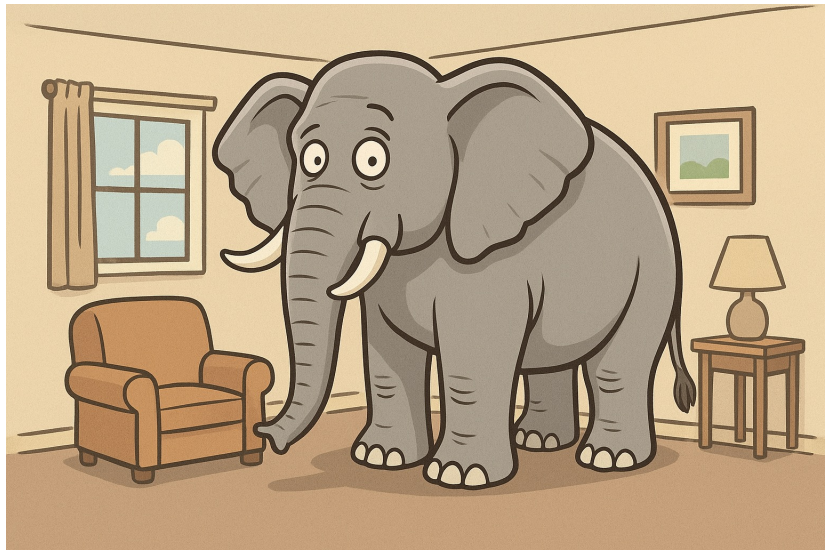
EV car cabin heating, Wilks et al.2023



MgO/H2O TCES for automobile catalyst heating, Kato, 2018

Outlook: From Storage to Stability

- TES as **a cornerstone of flexible, resilient grids**
- Crucial for **sector integration and decarbonization**
- Next steps: demonstration → scale-up → integration
- “Heat is the hidden dimension of the energy transition.”



Heat: Elephant in the room

Thank you

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For more information on energy storage you can check webpage of

International Energy Agency Energy Storage Technology Collaboration Programme (IEA ES TCP)

https://iea-es.org

iea-es.org