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ECN

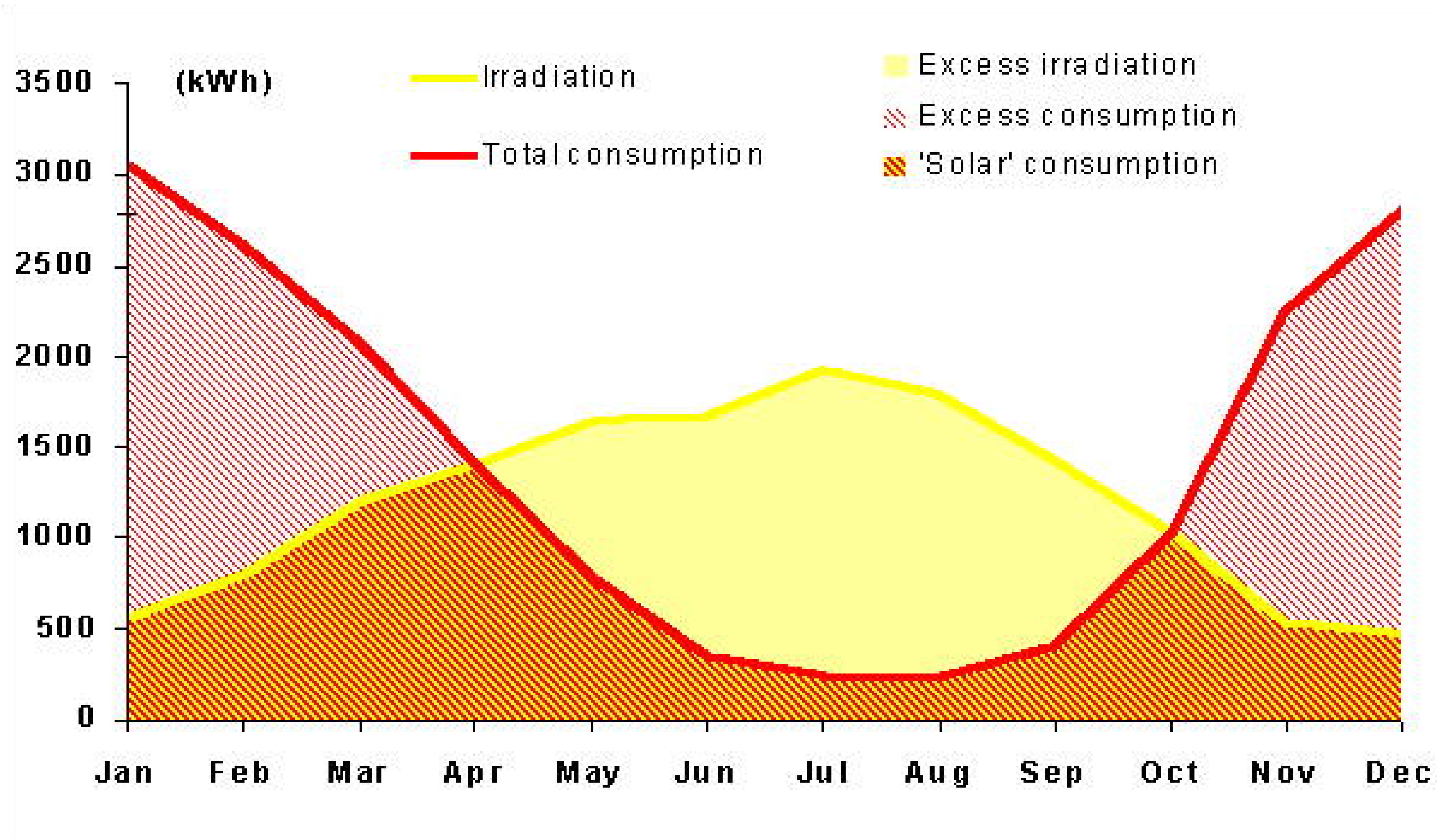
Energy research Centre of the Netherlands

ZAE BAYERN

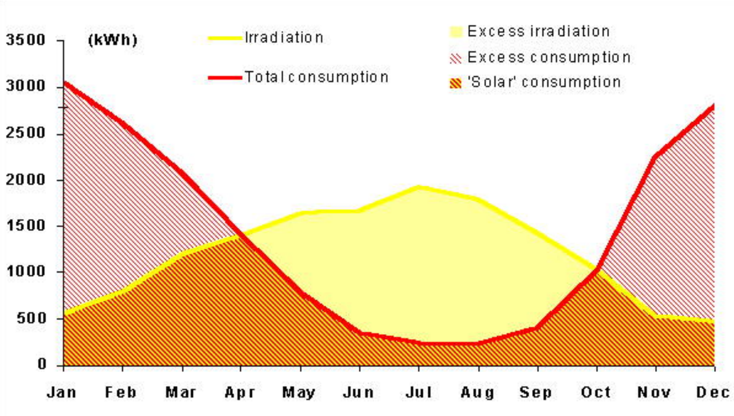
Compact Thermal Energy Storage:
Material Development for System Integration

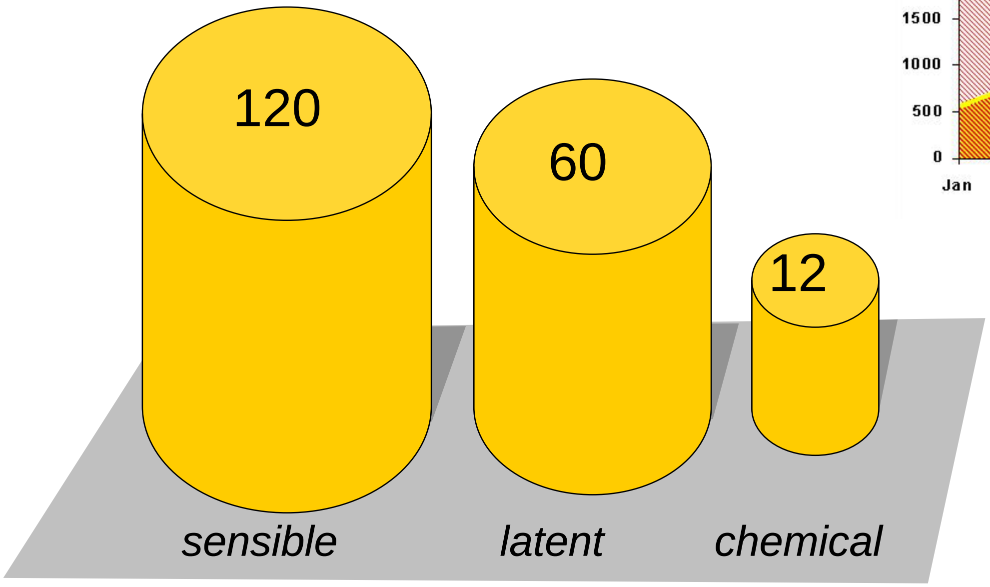
Wim van Helden, Marco Bakker

Seasonal storage of solar heat



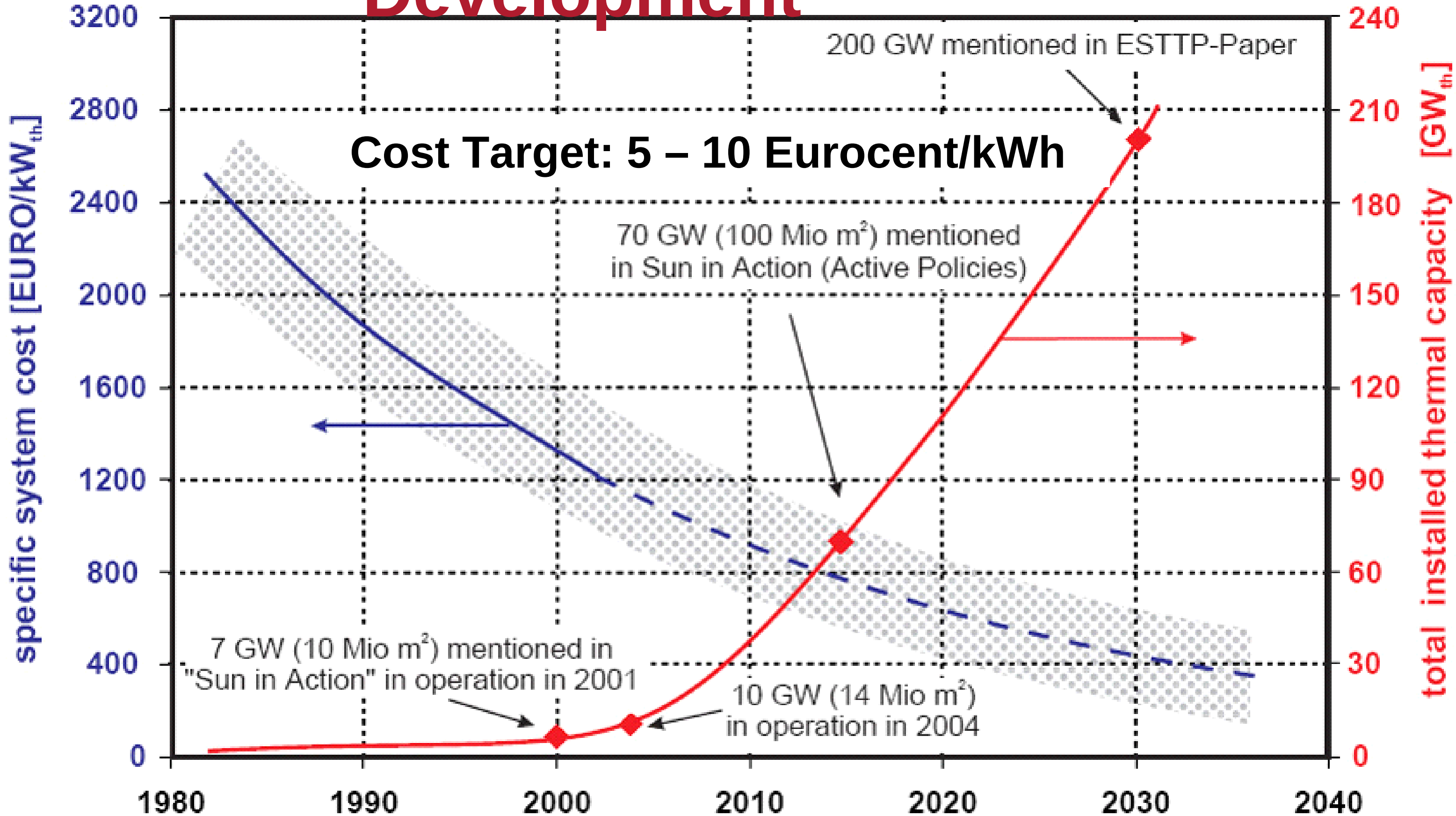
Seasonal storage of solar heat





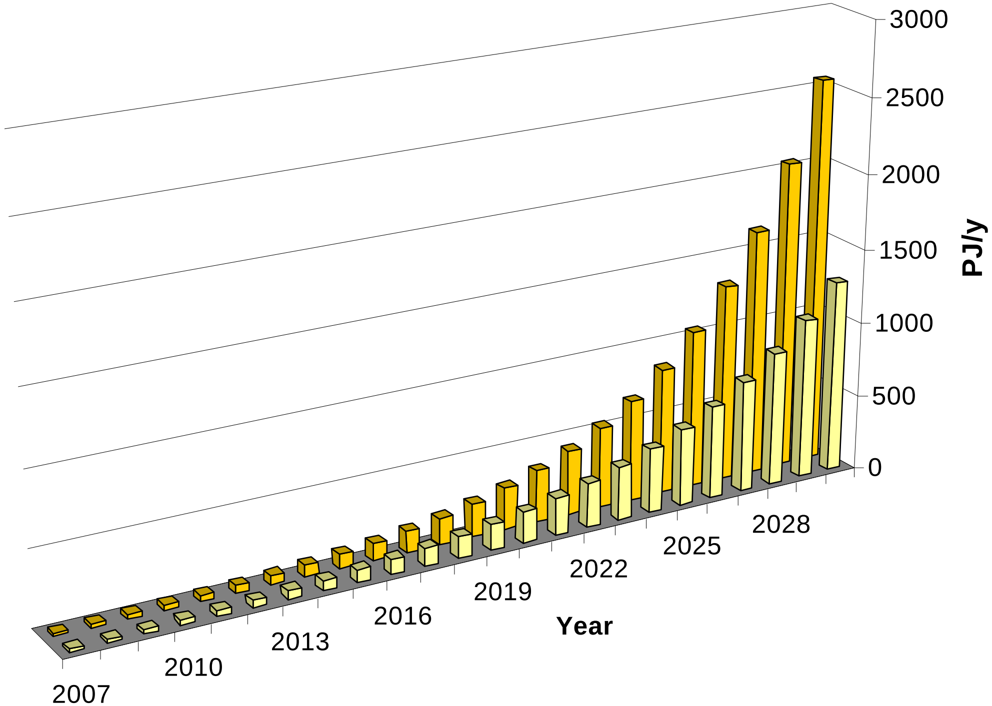
Seasonal storage volume (m³) needed for a very energy efficient household

ESTTP Target: Cost Reduction by Economies of Scale and Technological Development

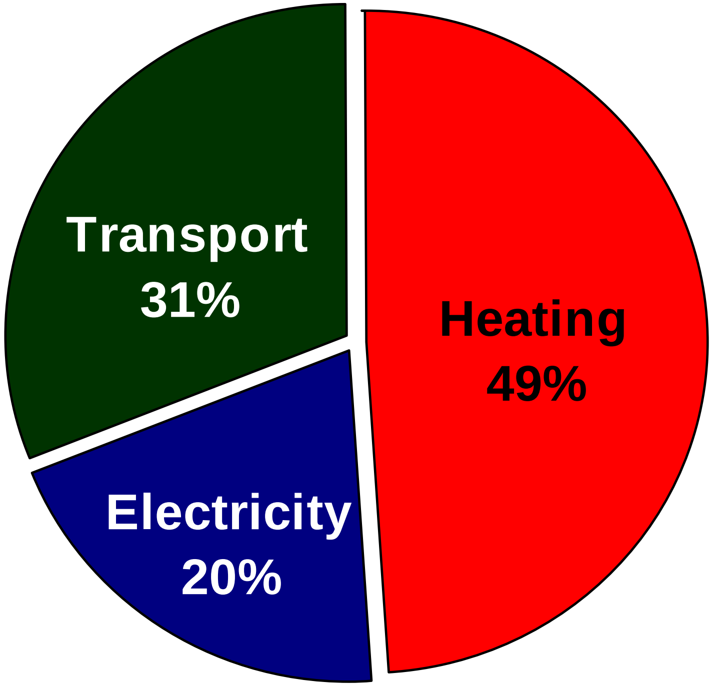


Solar Thermal: Long-term effect of compact heat storage

- Gradual introduction of improved compact storage technologies starting in 2015
- Generated solar thermal energy in EU doubles in 2030



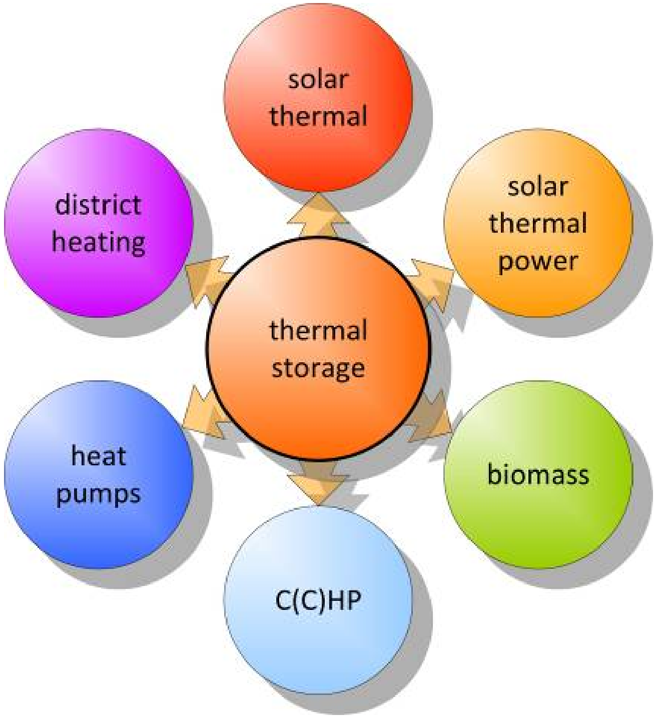
Heating and Cooling: dominant for primary energy consumption



Breakdown of final energy demand in EU25

Starting position for Thermal Energy Storage

- Thermal storage: enabling technology
  - solar thermal
  - concentrated solar power
  - biomass
  - cogeneration
  - heat pumps
  - district heating
  - …



- Main bottleneck: materials research
  - new materials needed
  - large gap between materials and applications experts

Materials and Applications

Two International Energy Agency (IEA) programs:

Energy Conservation through Energy Storage

Solar Heating and Cooling

Task 42/24: Compact Thermal Energy Storage: Material Development for System Integration

Joint Task between Solar Heating and Cooling (SHC) and Energy Conservation through Energy Storage (ECES)

Operating Agents:

- SHC: Wim van Helden, ECN (NL)
- ECES: Andreas Hauer, ZAE Bayern (DE)

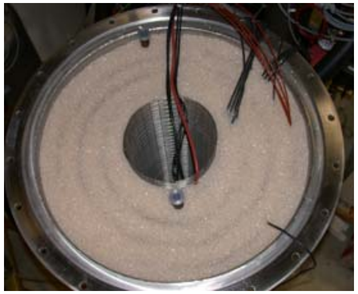
January 2009 – December 2012

Main added value:
Bring together experts from applications *and* material science

Objectives

- Identify, design and develop new materials and composites
- Develop measuring and testing procedures
- Improve performance, stability, and cost-effectiveness
- Develop multi-scale numerical models
- Develop and demonstrate novel storage systems
- Assess the impact of new materials on systems performance
- Disseminate the acquired knowledge and experience
- Create an active and effective research network

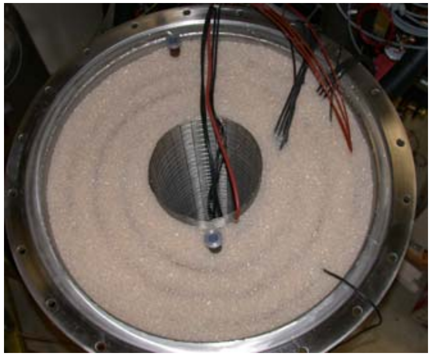





Scope

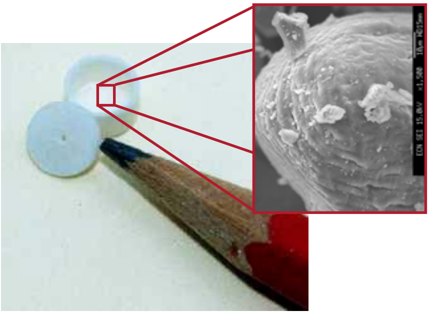
Classes of materials:

- phase change materials
- sorption and thermochemical materials

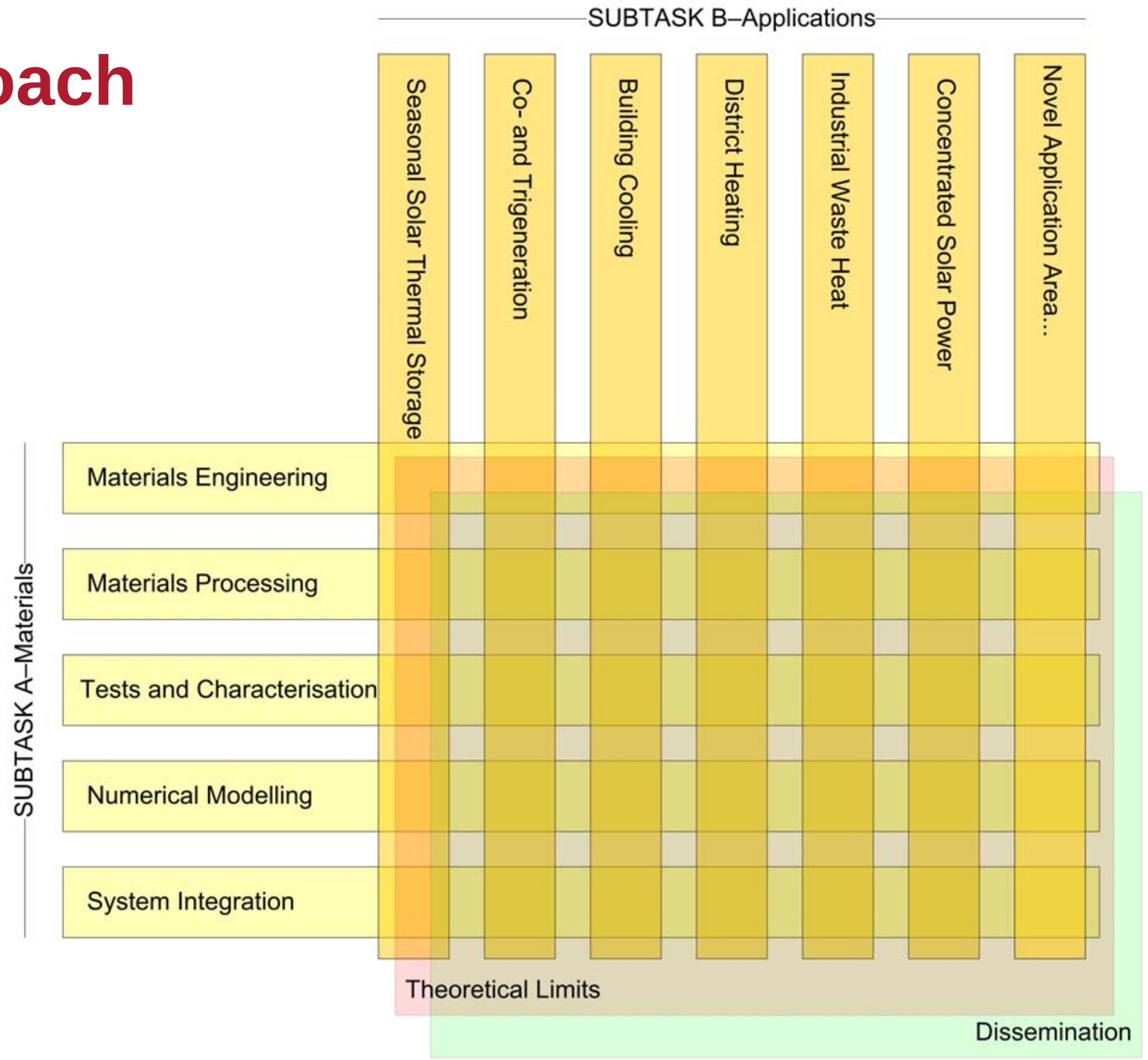


From small to large-scale:

- molecular/particle
  material synthesis, micro-scale mass transport, sorption reactions, …
- bulk
  heat/mass transport, wall-material interactions, reactor design, …
- system
  economical feasibility studies, case studies, system tests, …



Matrix approach



Participation and work

- 9 Countries that have funded participation:
  - AT (2 yr), AU, CH (1 yr), DE, ES, FR, NL, SE, UK
- 16 Organisations
- This number will grow after the start 1 January 2009
- International and national project brought into the Task
- Until now > 850 person months in projects
- Expert meeting + workshop twice per year
- Kick-off: 11-13 February 2009, Bad Tolz, Germany

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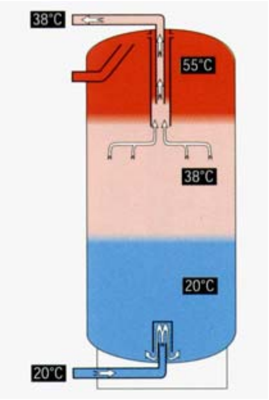
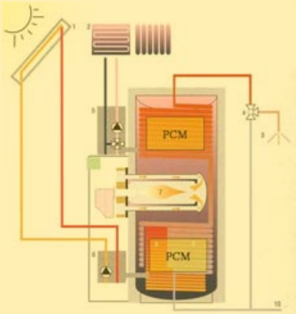
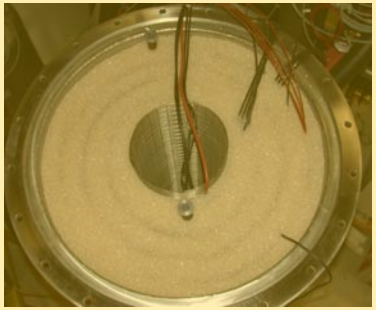
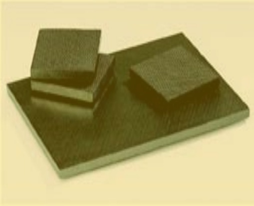
Stage of development of Thermal Energy Storage technologies

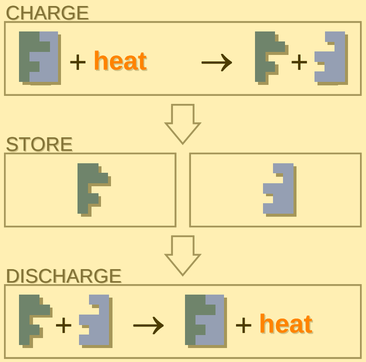
Water (sensible)	PCM (latent)	Sorption (physical)	TCM (chemical)
Mature market	Demonstration	Development	Research

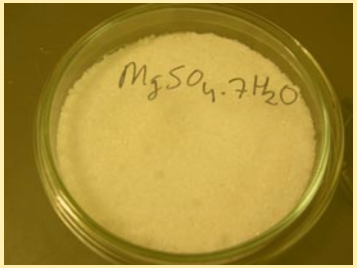








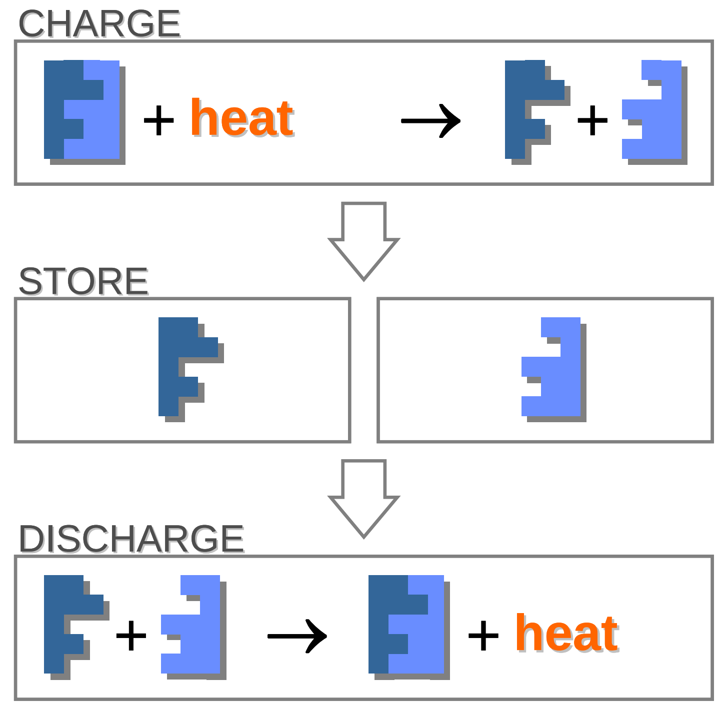




Chemical heat storage

General principle $A + B \Leftrightarrow AB + heat$

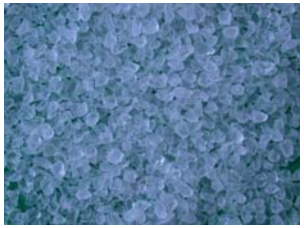
- Components stored sepearately without heat loss
- Long term heat storage
- Charge with temperatures typically higher than 100ºC
- Storage capacity between 250 and 4000 kJ/kg

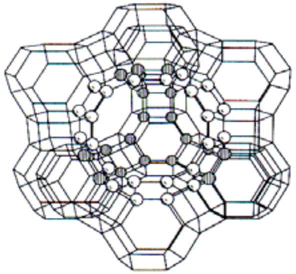


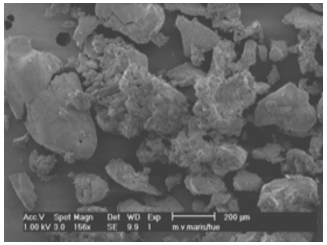
New Materials and Composites

Phase-change, sorption, thermochemical

- Improve active materials (silicagels, zeolites, hydrates)
- Novel materials (phase-change, thermochemical)
- Active material with carrier material (zeolites on aluminum)
- Combination of active materials (zeolites plus hydrates)

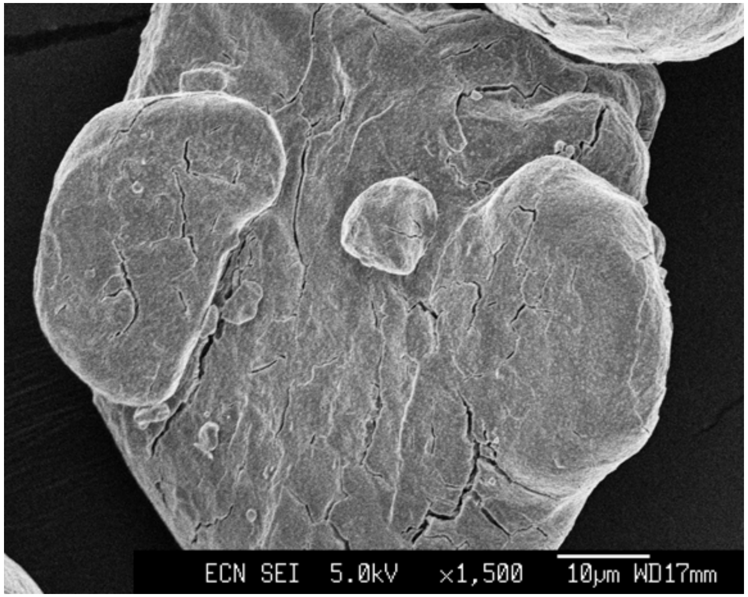


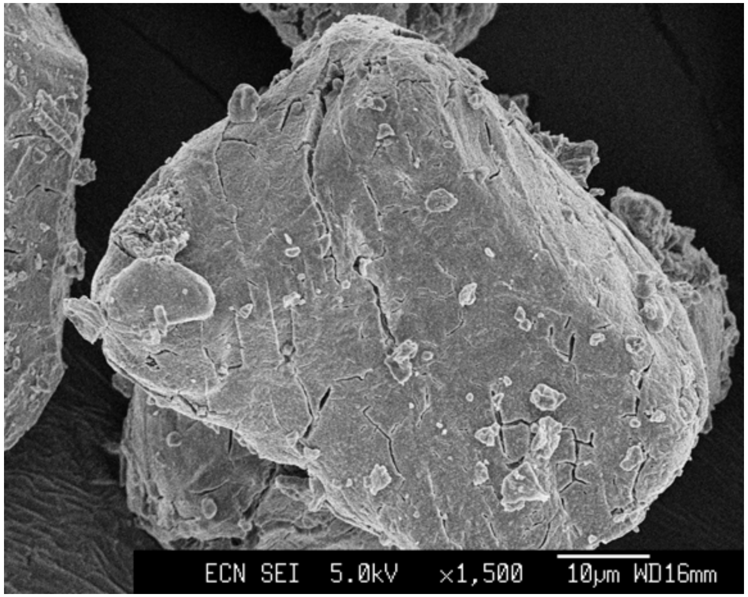




Morphology

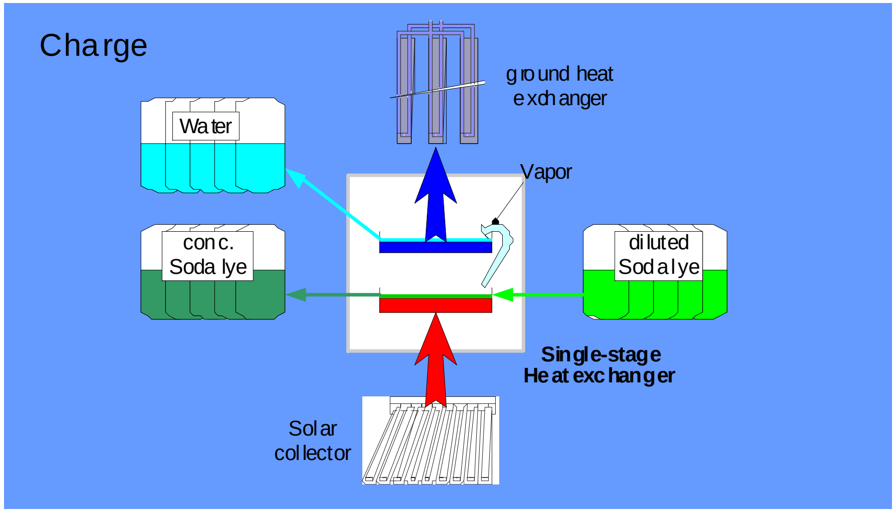
Marked difference found in hydration behaviour of samples of two different suppliers

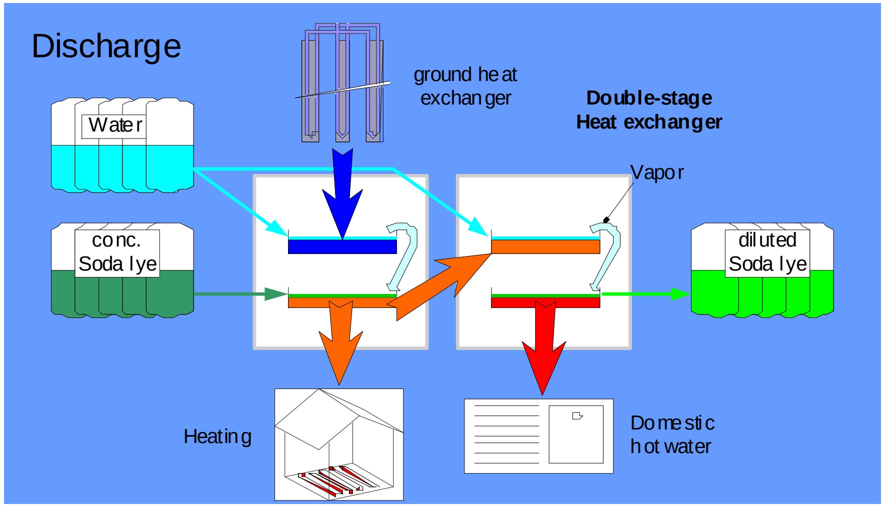




Sodiumhydroxide Storage (EMPA – CH)

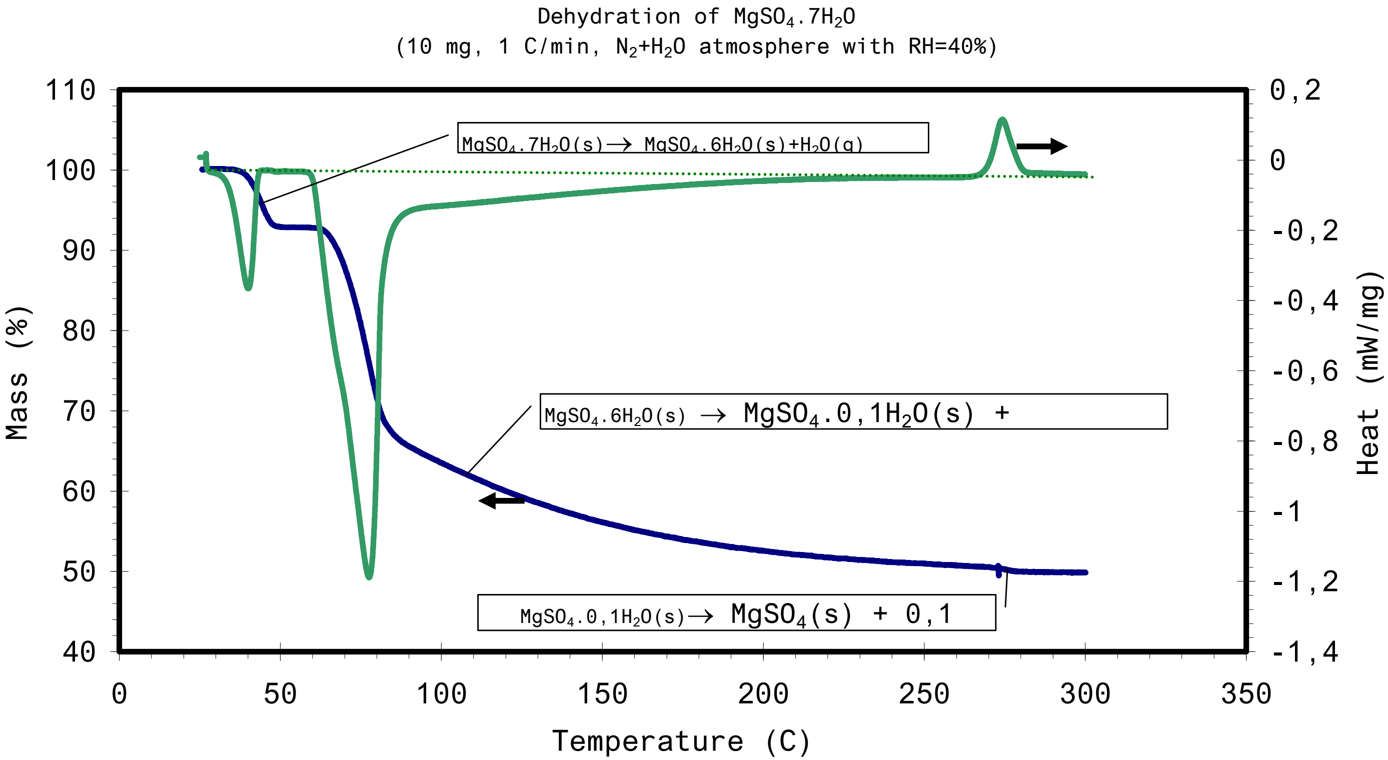
$$2NaOH \Leftrightarrow Na_2O + H_2O$$

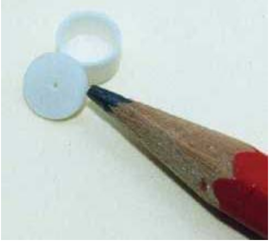




Thermochemical material – $MgSO_4x7H_2O$

Reaction: $MgSO_4xnH_2O$ + heat $\rightarrow$ $MgSO_4$ + nH_2O

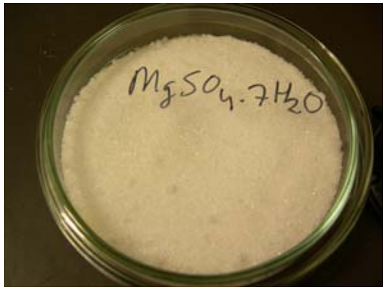


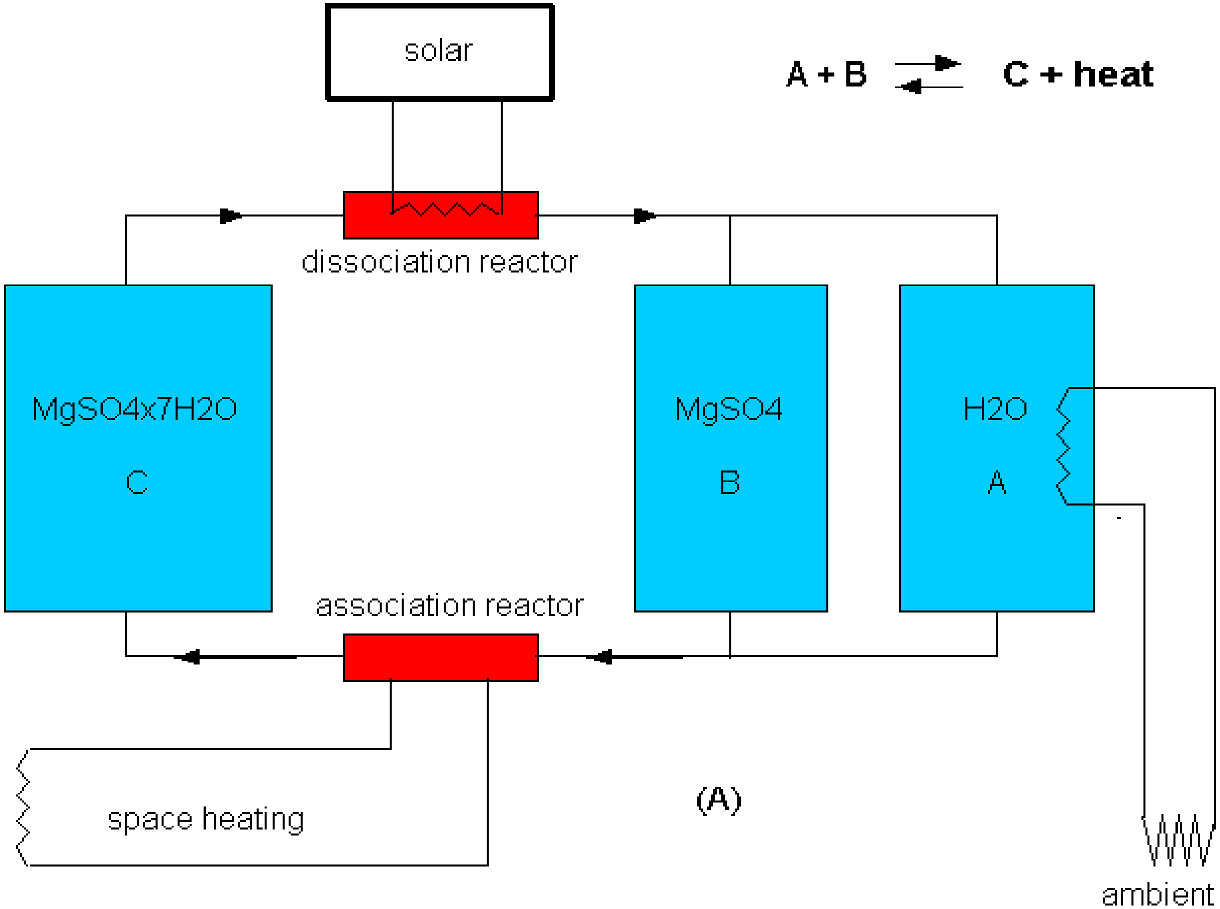


Sample mass decreases at increasing temperature

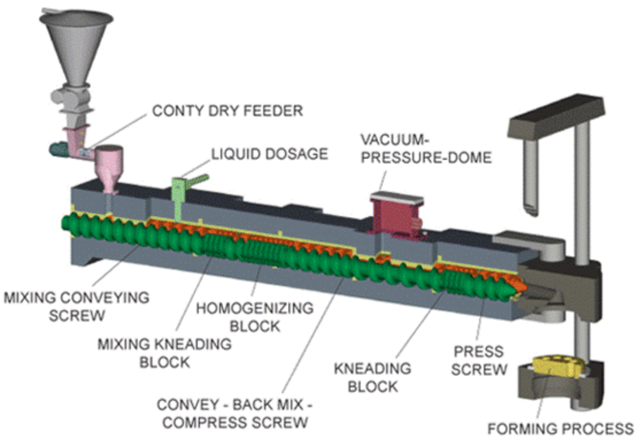
Magnesiumsulphate (ECN –NL)

Separate reactor concept

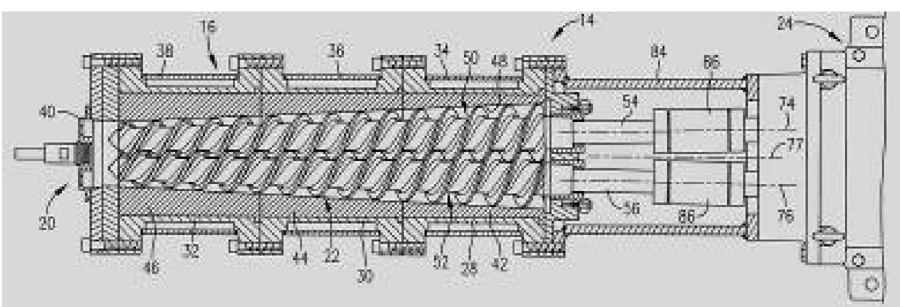


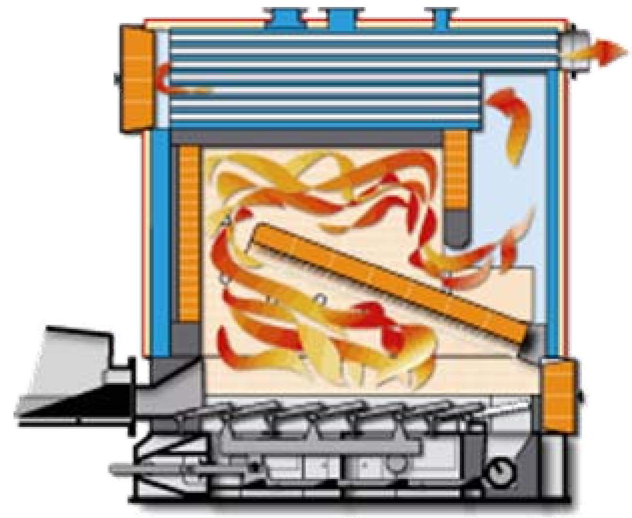


Reactor concepts



Hot screw dryer,extruder





Moving grate dryer

What You Can Do For Compact TES

- Do materials research
- Do applications research
- Find connected fields
- Incorporate it into your strategy
- Convince policy makers
- Support a programmed international effort
- Spread the word

- Contact us: www.iea-shc.org/task42

The First Thing You Can Do

Memorise the number