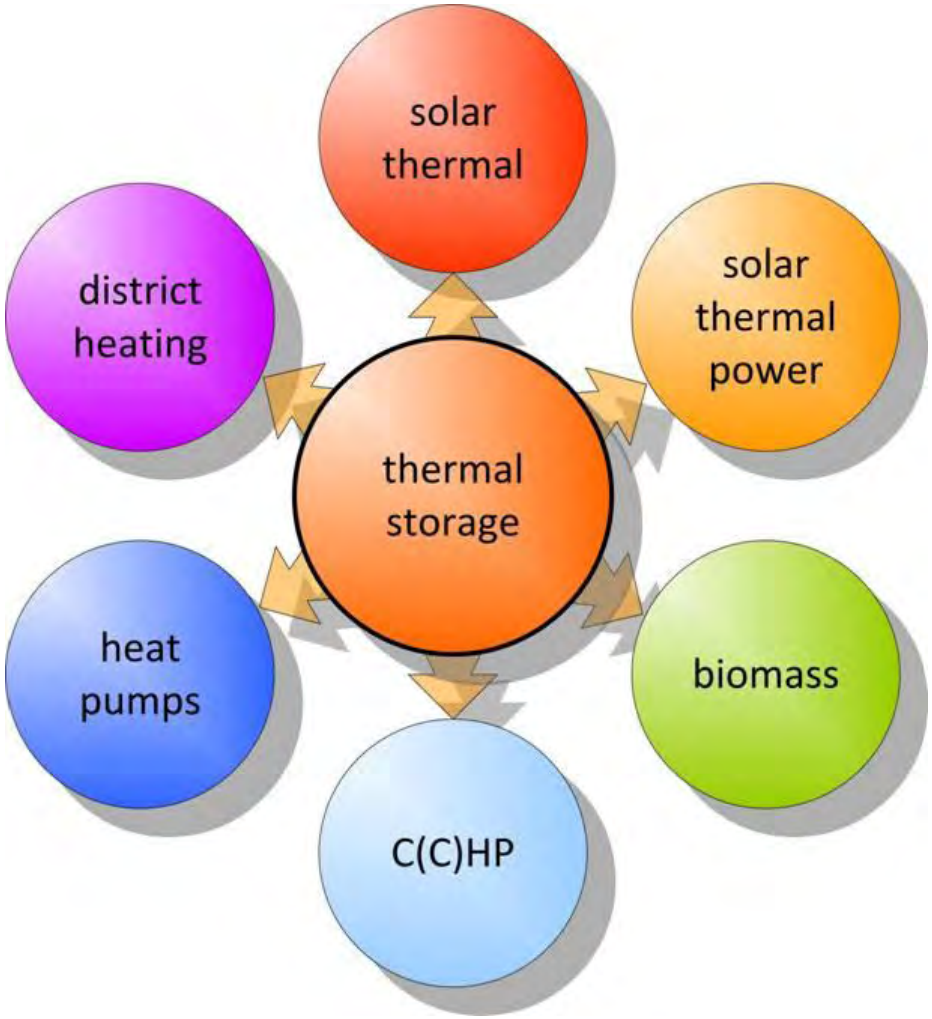
Compact Thermal Storage R&D in IEA T4224 and EU COMTES project

Wim van Helden

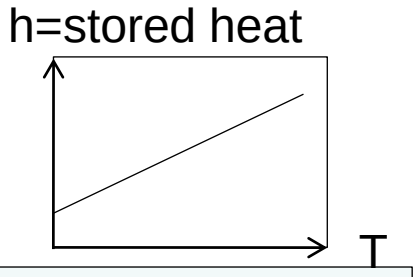
IEA ECES Annex proposal workshop
Paris, France, 18-19 September 2012

Thermal Storage: Key Technology

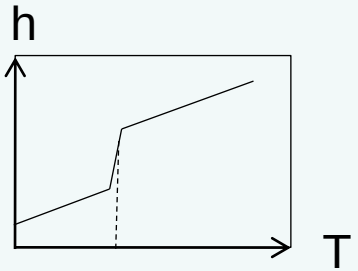


4 principles for Heat Storage

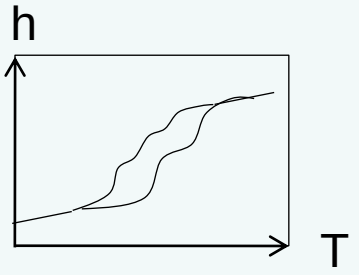
- **Sensible heat**
  - principle: heat capacity
  - reservoirs, aquifers, ground/soil



- **Latent heat**
  - principle: phase change (melting, evaporation)
  - water, organic and inorganic PCMs

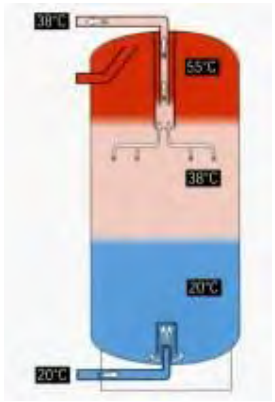


- **Sorption heat** and **Chemical heat**
  - principle: physical (adhesion) or chemical bond (reaction enthalpy)
  - a**d**sorption and a**b**sorption and chemical reactions



Development Stages of TES Technologies

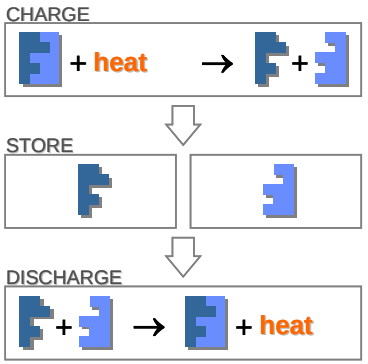
Water (sensible)
Market mature



PCM (latent)
Demonstration

Sorption
Development

TCM (chemical)
Research



IEA SHC/ECES 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:

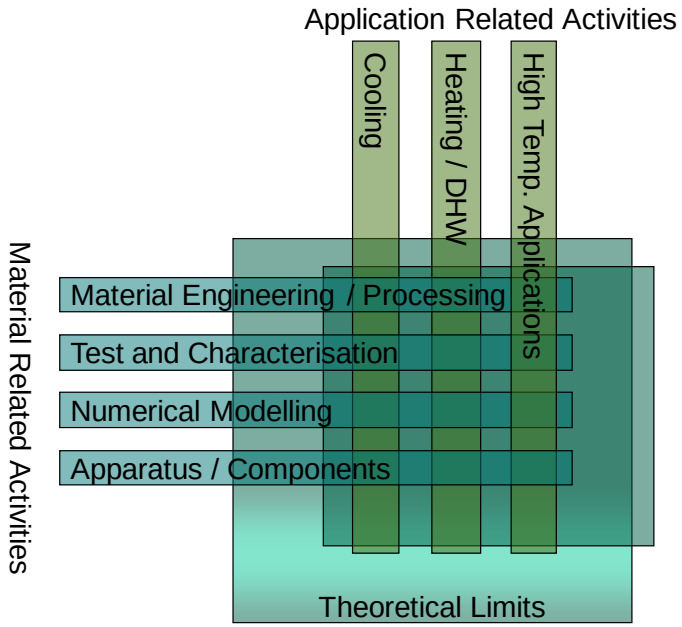
- SHC: Wim van Helden, (NL)
- ECES: Andreas Hauer, ZAE Bayern (DE)

January 2009 – December 2012

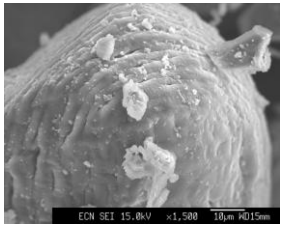
Main added value:
Bring together experts from applications *and* material science

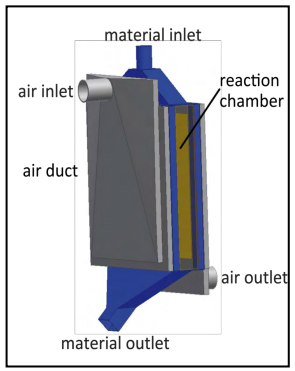
T4224: international collaboration

- More than 50 organisations participating
- From more than 17 countries
- Materials work and application work
- First period of 4 years ends 2012
- Extension period of three years
- www.iea-shc.org/task42
- Next expert meeting: October 18 + 19, hosted by ECN, Petten, NL



Development fields





Materials

- improve performance (capacity, power)
- reduce costs (basic material, production technology)

Components

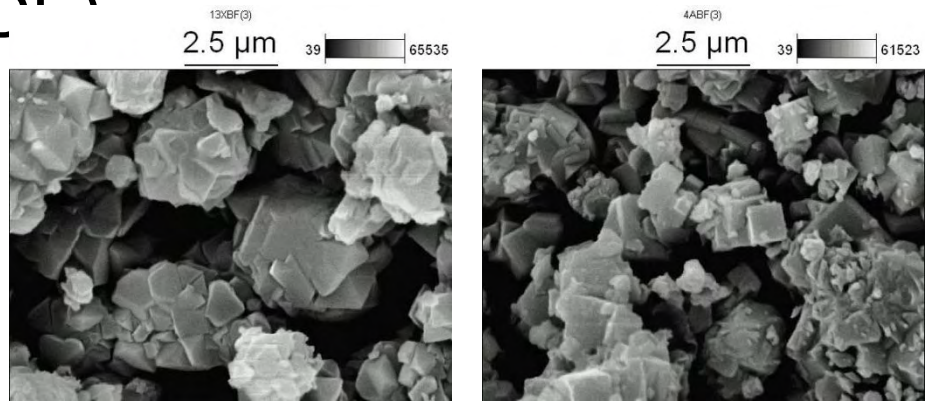
- heat exchangers
- mass transport
- sensoring, control

Systems

- Integration
- control

Materials development: Improving Zeolites

- Replacing the passive binder by an active
- Work by TU Wildau and Chemiewerke Bad Köstriz (D[illegible]

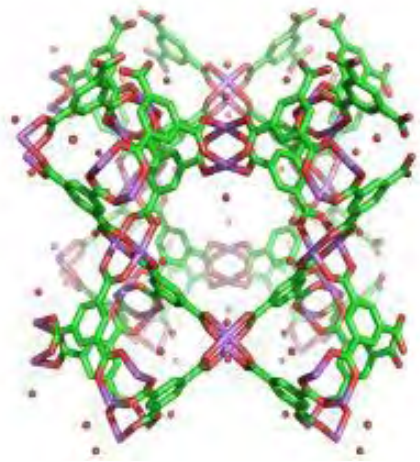


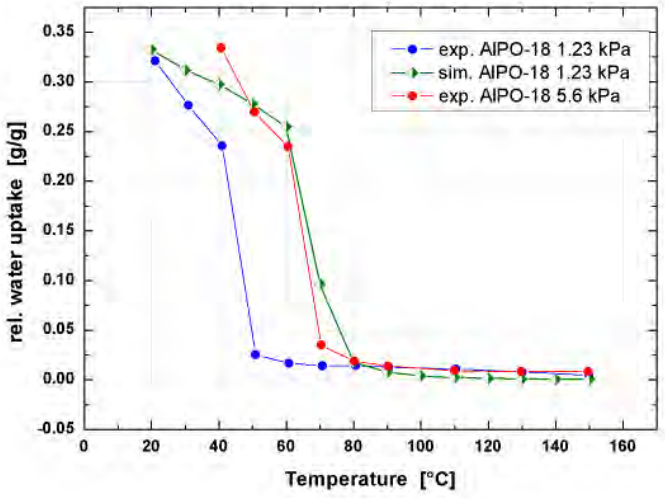
Microscopic images showing a detail of the surface of molecular sieve beads (diameter 1.6-2.5 mm) of 13XBF (left) and 4ABF. Both show an overall zeolitic morphology, without any binder.

Materials Development: Improving AlPo's

Fraunhofer ISE and Karlsruhe University, Germany

- New materials in AluminoPhosphates (AlPo) class
- Reduced aluminum content gives better heat uptake
- Development of numerical models to predict material performance



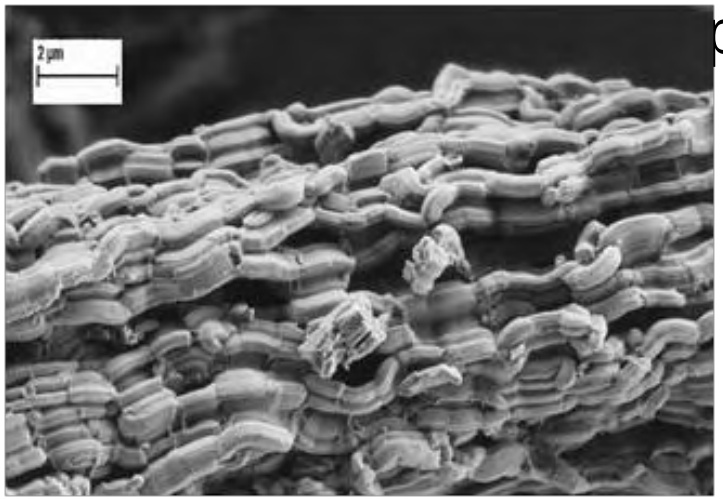


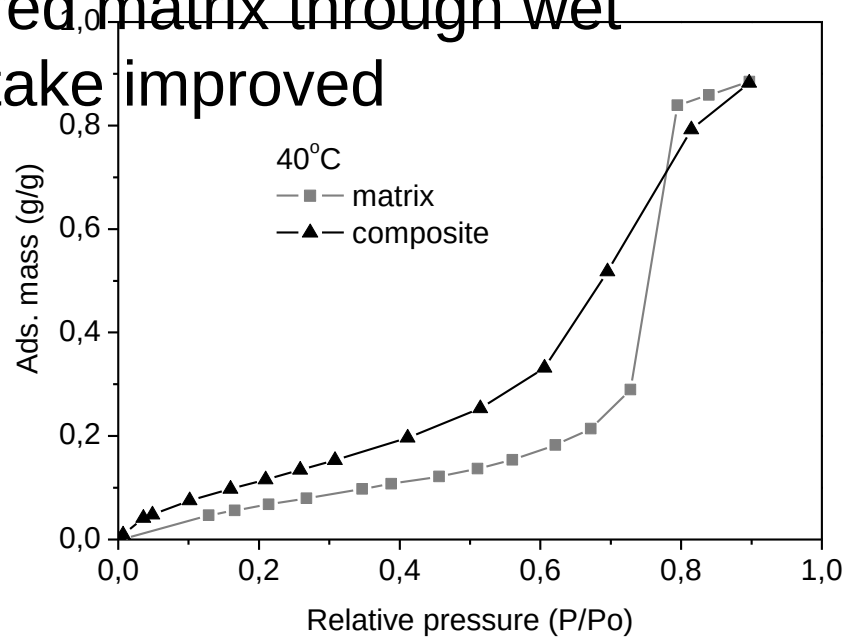
Materials Development: Composites

NIC, National Institute of Chemistry, Slovenia

New composite material made and tested

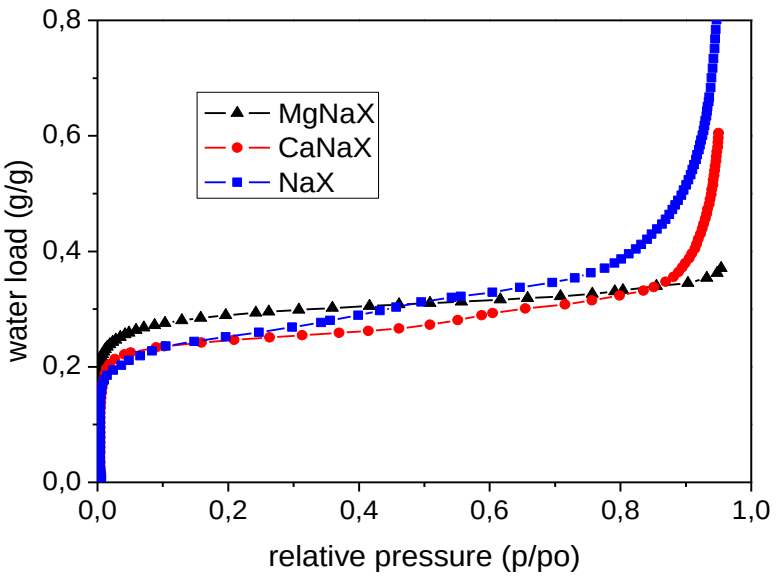
- CaCl in mesoporous ordered matrix through wet
ptake improved



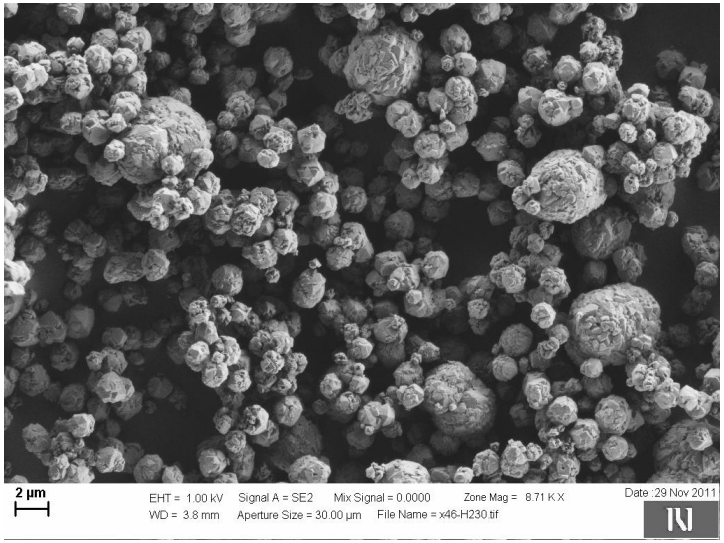


Materials development: Composites

National Institute of Chemistry, Slovenia



Water uptakes of NaX, CaNaX and MgNaX



SEM picture of NaX

Component Development (1)

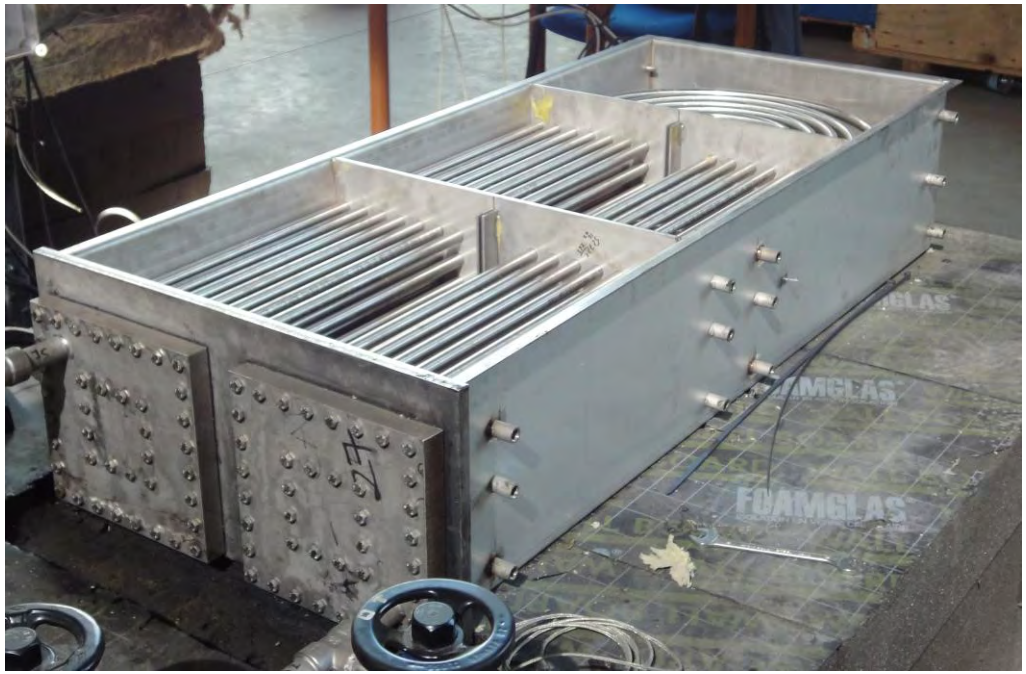
Energy research Centre of the Netherlands, ECN

Reactor for composite material charge and discharge (15 litres)

Component Development (2)

University of Lleida, Spain

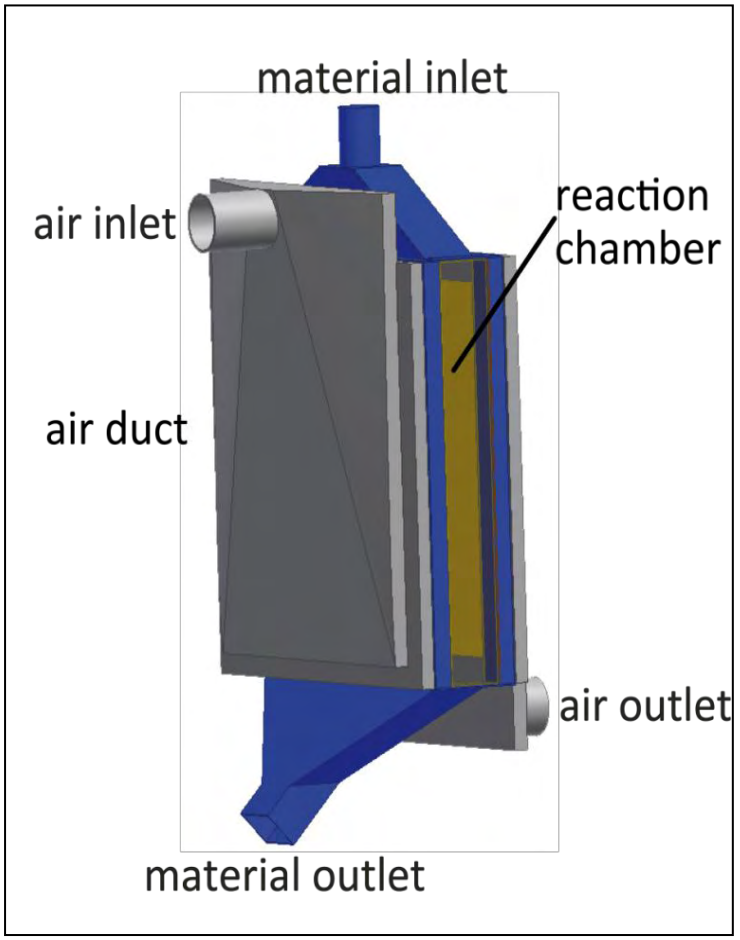
Shell and tube heat exchanger, medium temp. PCM (100 – 250 °C)



Component Development (3)

ITW, University of Stuttgart

Cross-flow air heat exchanger for falling grains of composite material

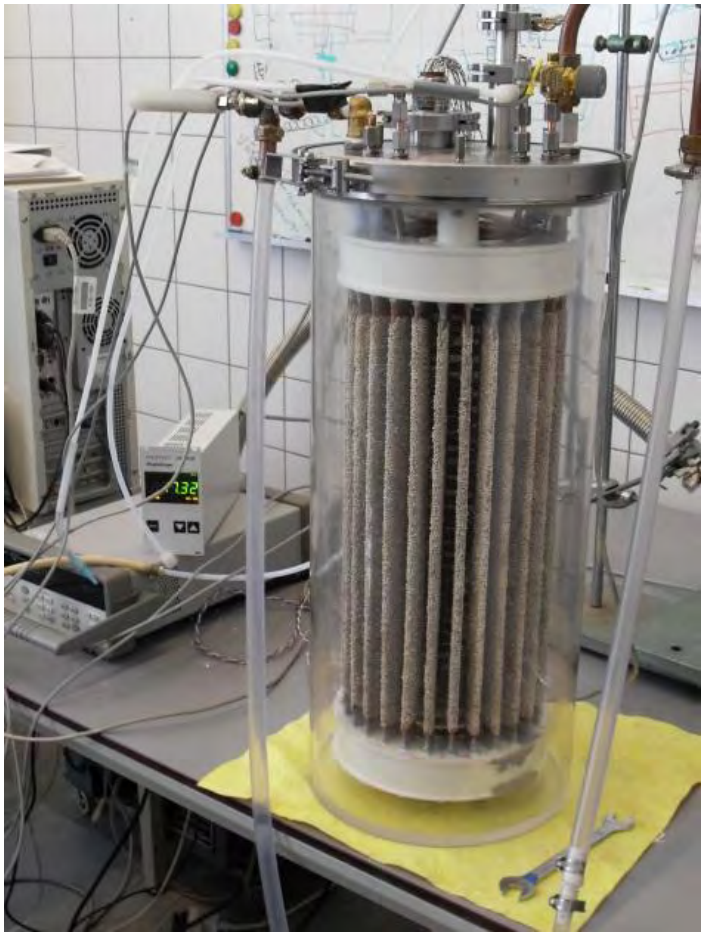


Component Development (4)

TNO, The Netherlands

Reactor for salt hydrate, 20 litres

Zeolite beads glued to



Component Development (5)

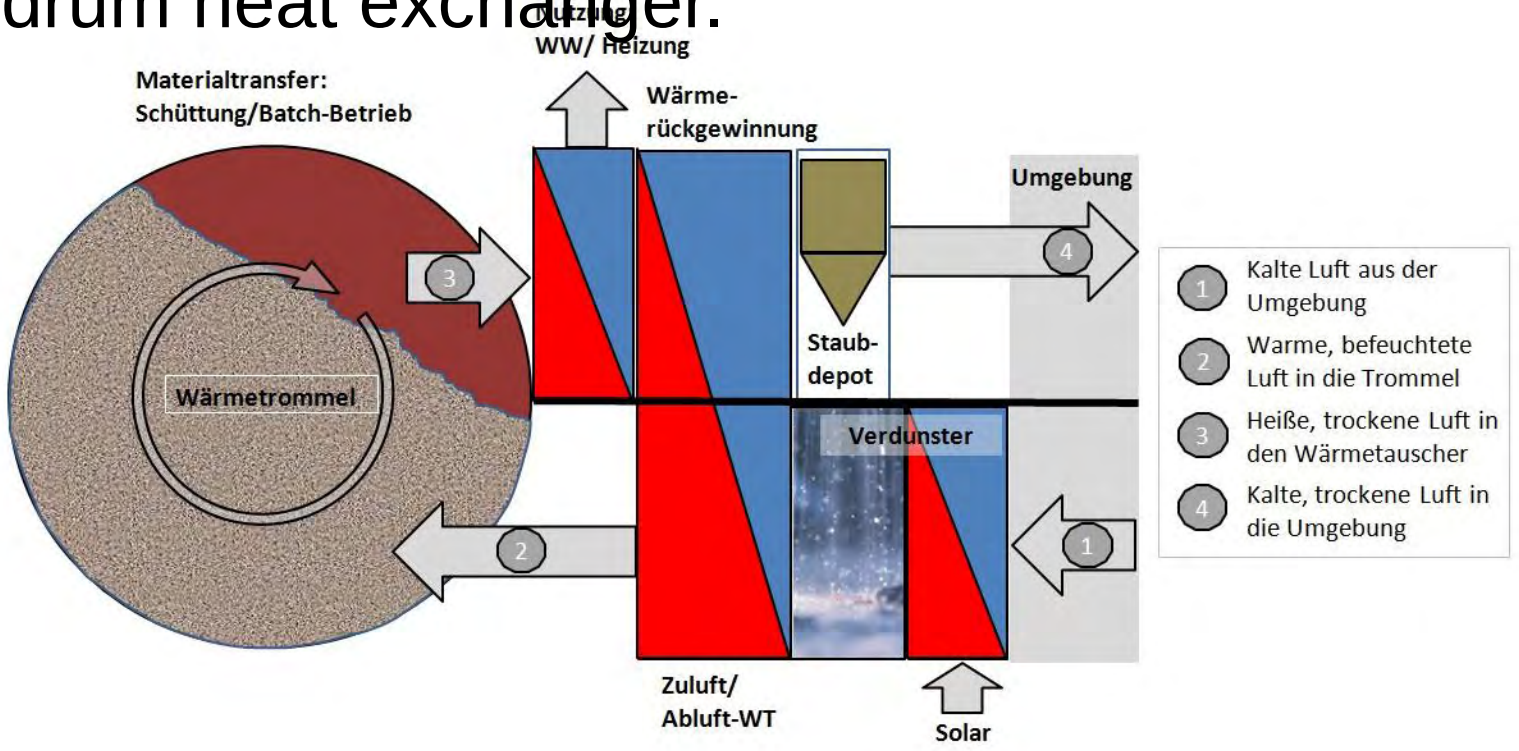
EMPA, Switzerland

Two-stage reactor for liquid (NaOH) sorption material

Component Development (6)

ASIC, Wels, Austria FlowTCS:

optimisation of material use (zeolite) in rotating drum heat exchanger.



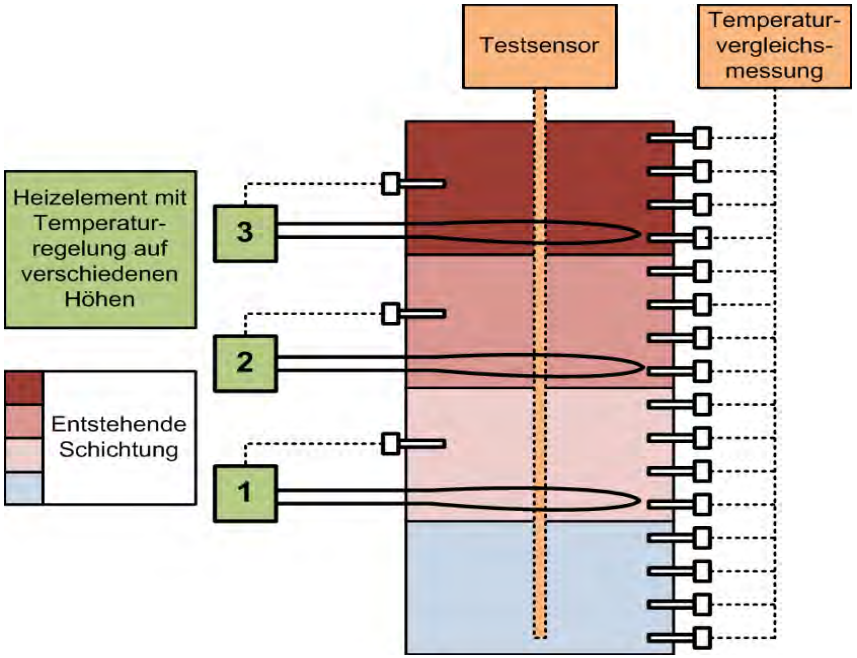
Component Development (7)

ASIC, Wels, Austria

ThermSens: novel sensor technologies for state of charge determination of thermal energy storages.

PCM test storage

For validation of novel sensor



Application in Grids

AIT, Vienna, Austria

- Small scale thermo chemical storage units in district heating Networks
- Modelling of influence of TCS in district heating system in Altenmarkt (Austria)
- Sensitivity analysis
  - various operational strategies
  - storage positions

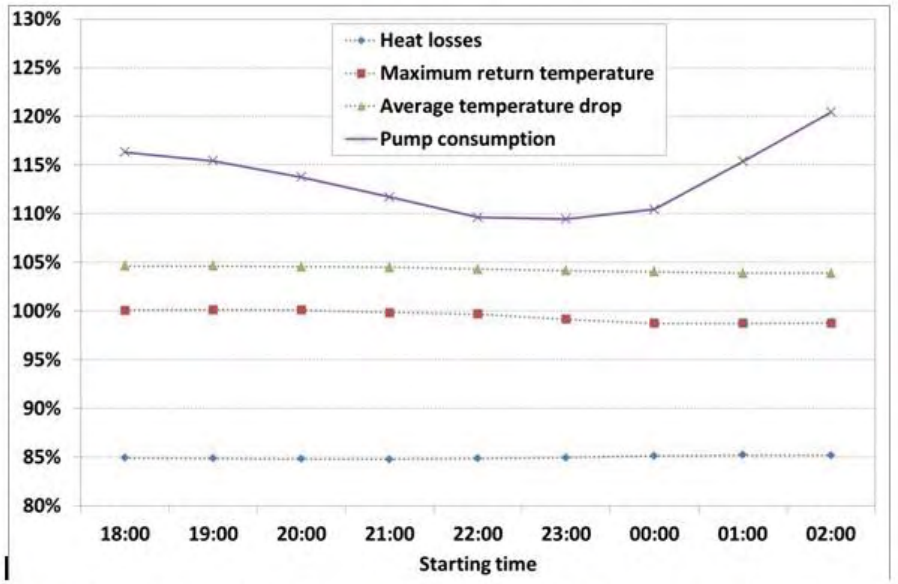


Figure 2: *Assessment of key indicators with respect to the starting time of charging phase*

New Developments

New national projects in DE, AT, FR, ….

EU funded 4 large projects on Thermal Energy Storage

- SAM.SSA (materials, Univ. of Bordeaux)
  New PCMs (molecular alloys based on sugar alcohols)
- MERITS (systems, TNO, The Netherlands)
  Enhanced TC materials for heating, DHW and cooling.
- SoTherCo (systems, Univ. Mons, Belgium)
  Innovative modular, compact and seasonal thermochemical solar heat storage system.
- COMTES project (AEE INTEC, AT): Combined development of compact thermal energy storage

COMTES Goal

"Technological development and demonstration of novel compact seasonal thermal energy systems"

Main objective:

- Arrive at demonstrated systems
- For seasonal storage of solar thermal energy
- Significantly better than water based systems

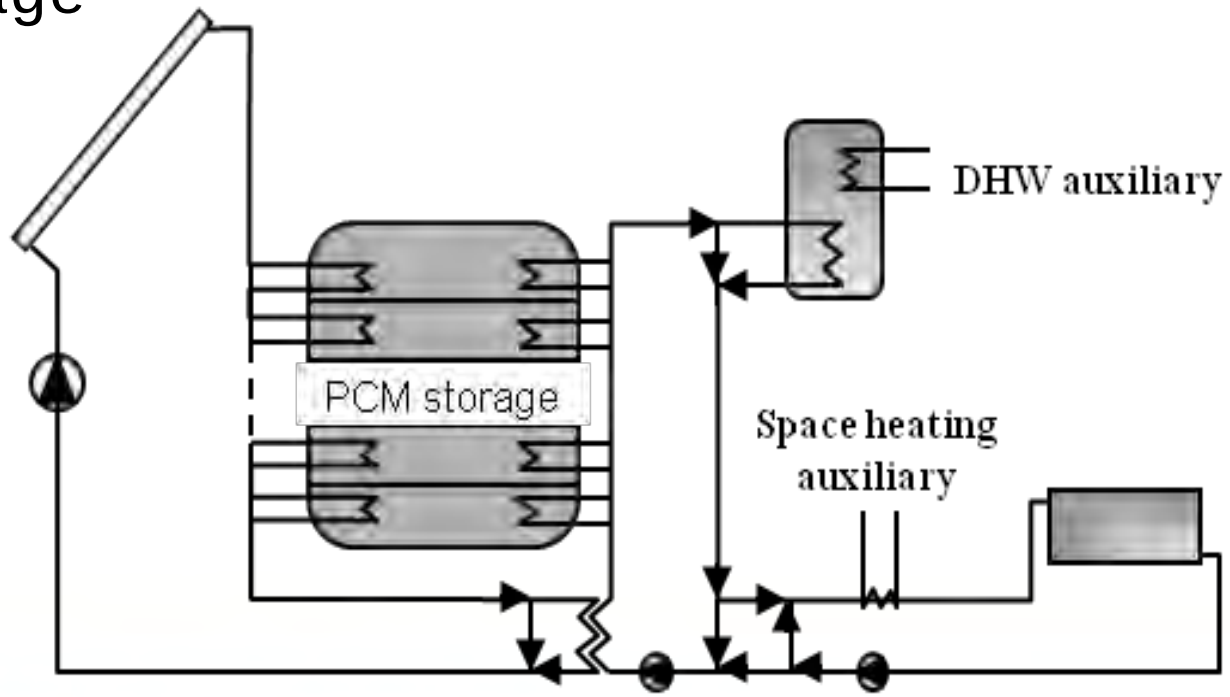
Parallel development of three technologies

- Solid sorption
- Liquid sorption
- Supercooling PCM

Supercooling PCM

DTU (DK), TUGraz (AT), Nilan (DK), Velux (DK)

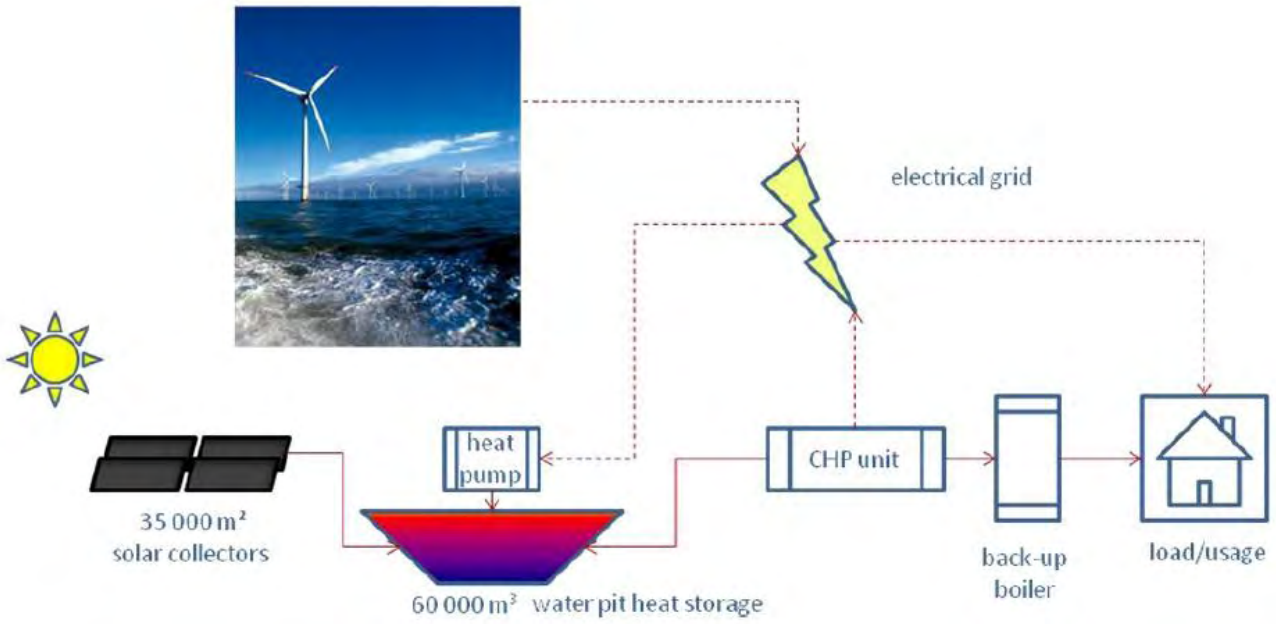
Using the supercooling effect of sodium acetate trihydrate for a modular seasonal storage



DTU system for intelligent grids

Using peak wind power electricity to generate and store heat (DK)

System from IEA SHC Task45



Liquid Sorption

EMPA (CH), SPF (CH), Kingspan (UK)

Sorption and desorption

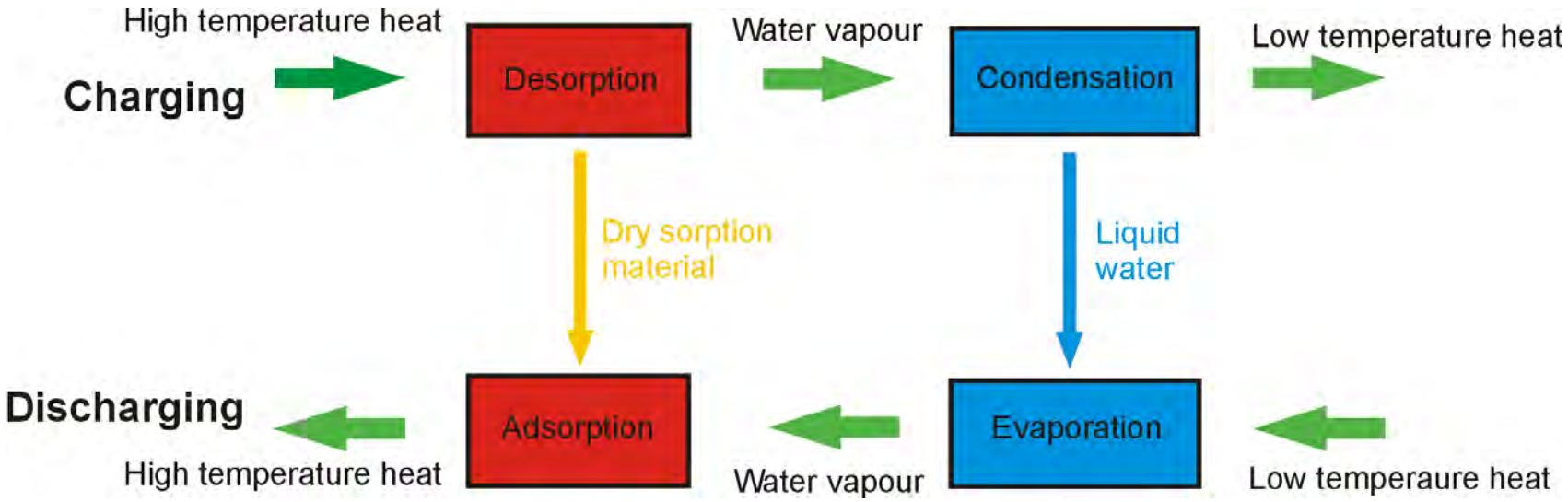
of liquid NaOH

in two-stage reactor.

Solid sorption

AEE INTEC (AT), ITW (DE), TH Wildau (DE), Vaillant (DE)

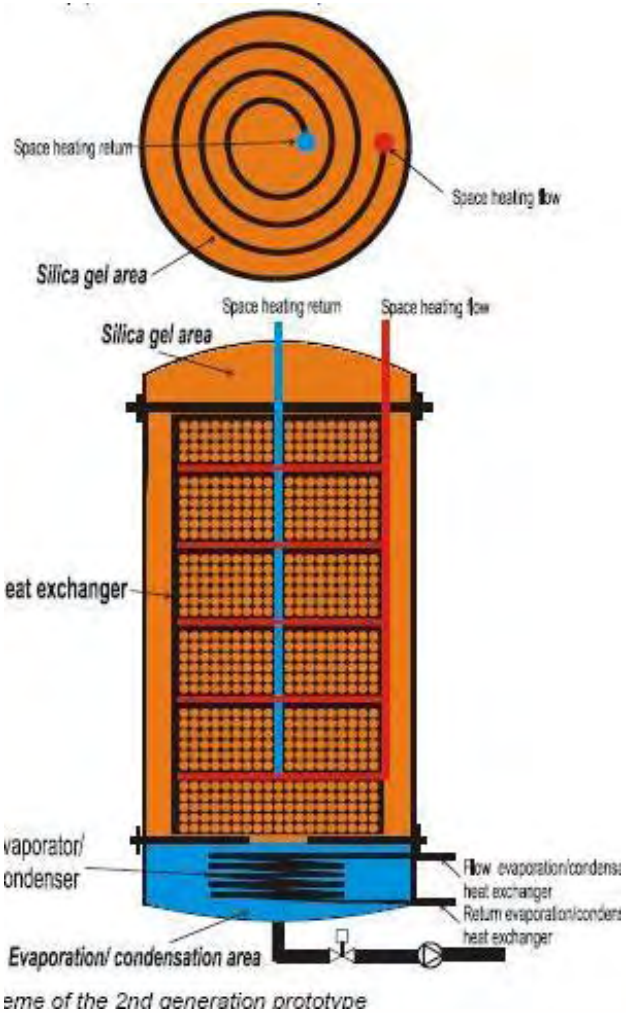
Using solid sorption material in a closed system



Solid sorption technology

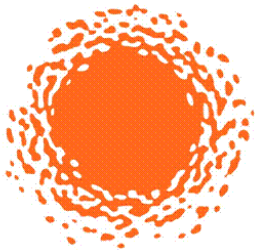
Closed system

Based on Modestore technology



eme of the 2nd generation prototype

Conclusions



Increasing R&D on compact thermal storage

Materials and applications research

Task4224: some projects targeted at Distributed Thermal Energy Storage

Seasonal storage technologies: low losses, modular, scaleable; suited for DTES

7th International Renewable Energy Storage Conference and Exhibition (IRES 2012)

November 12 – 14, 2012
bcc Berliner Congress Center, Berlin / Germany

- Electricity and Thermal Storage and Hybrid solutions
- Technology and Policy
- www.eurosolar.de