

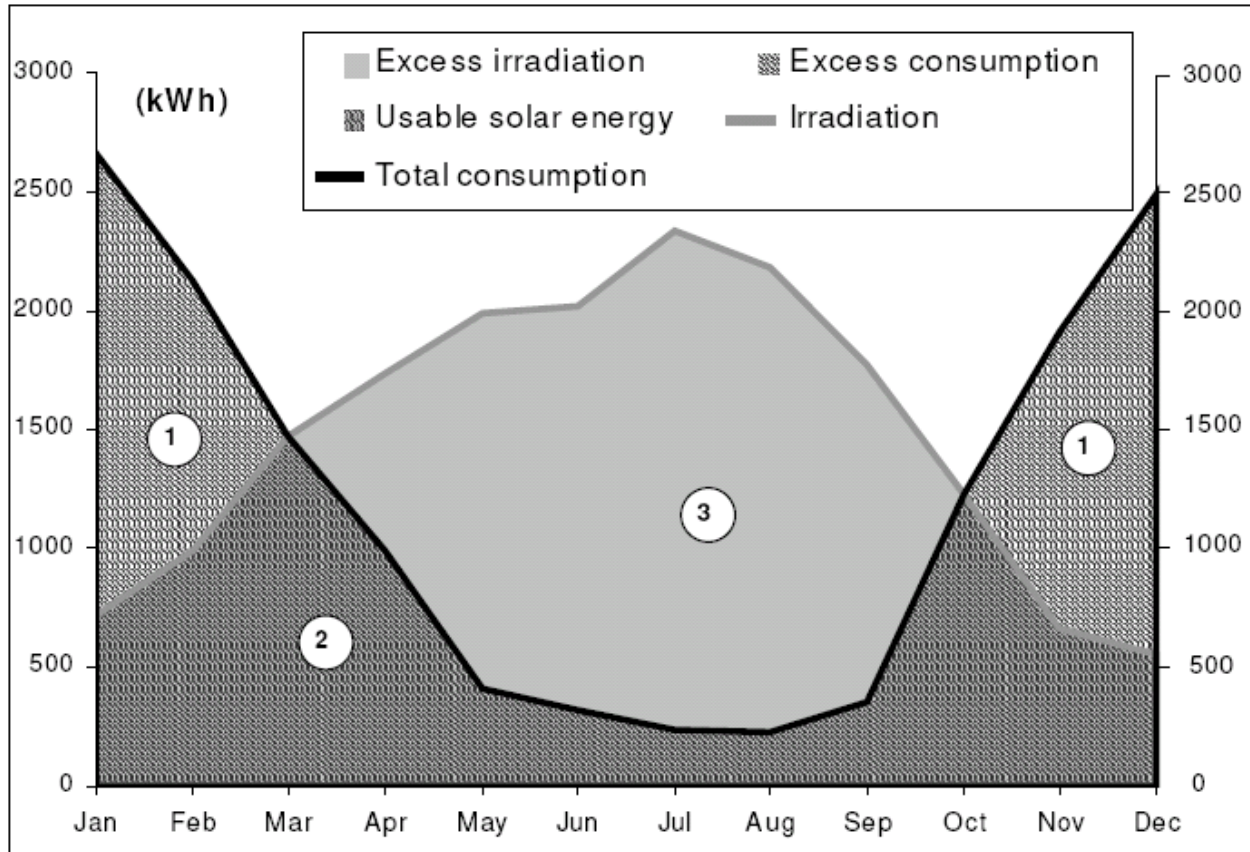
Chemical Storage

Herbert Zondag, Ilse van de Voort, Martijn van Essen, Wim van Helden



Why heat storage?

Bridging time cycles (e.g. annual, diurnal, process-related)



Why chemical heat storage?

Advantage of chemical storage over traditional storage techniques:

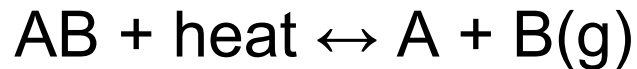
- Loss free storage
- Storage size reduction
 - water typically 0.25 GJ/m^3
 - chemical potentially $1\text{-}4 \text{ GJ/m}^3$

More compact storage adds new markets!



How does it work? - 1

Storage with reversible chemical vapour-absorption reaction

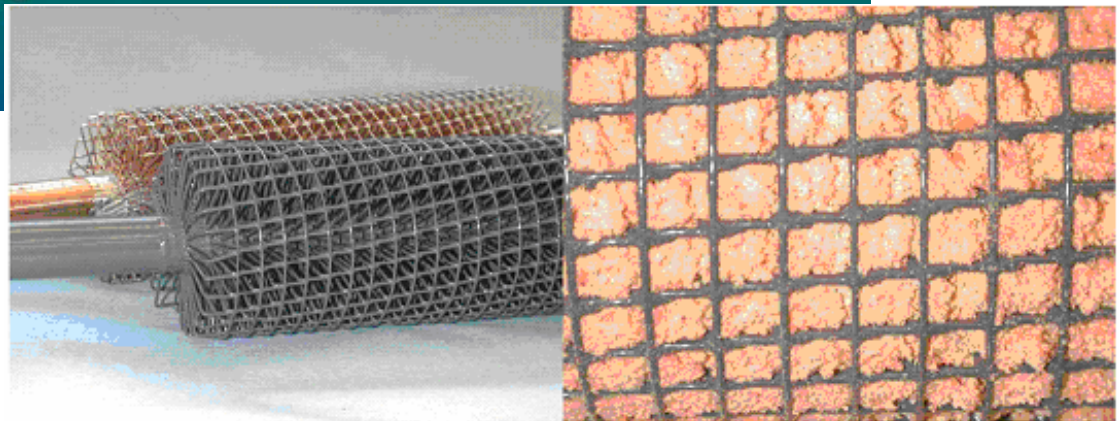
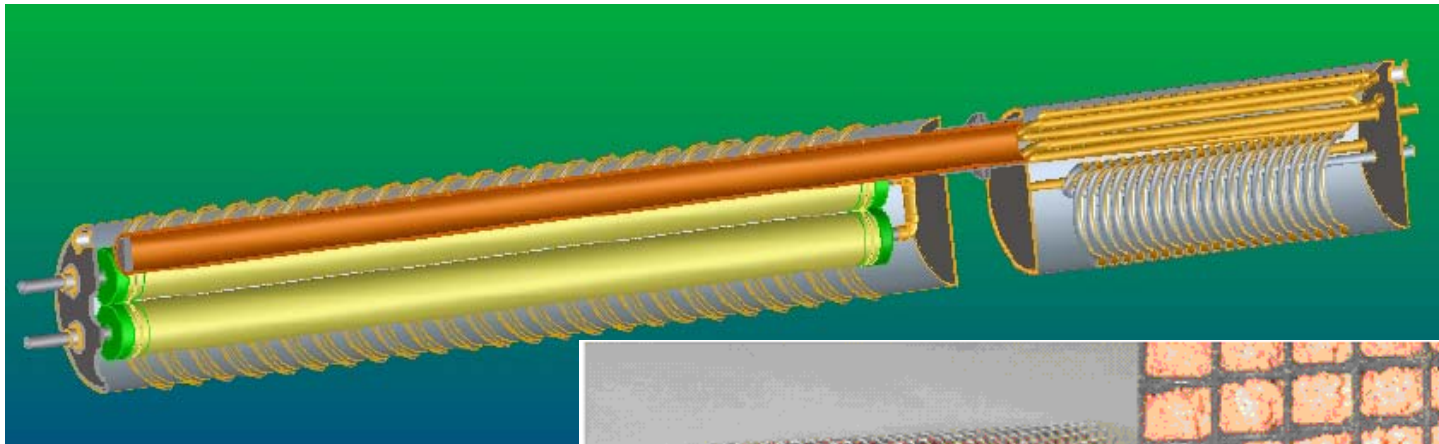
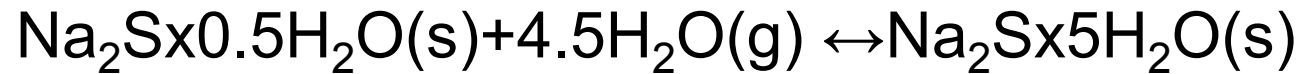


- Charge: $AB + \text{heat} \rightarrow A + B(g)$
- Discharge: $A + B(g) \rightarrow AB + \text{heat}$

Typical vapours: water vapour, ammonia vapour etc

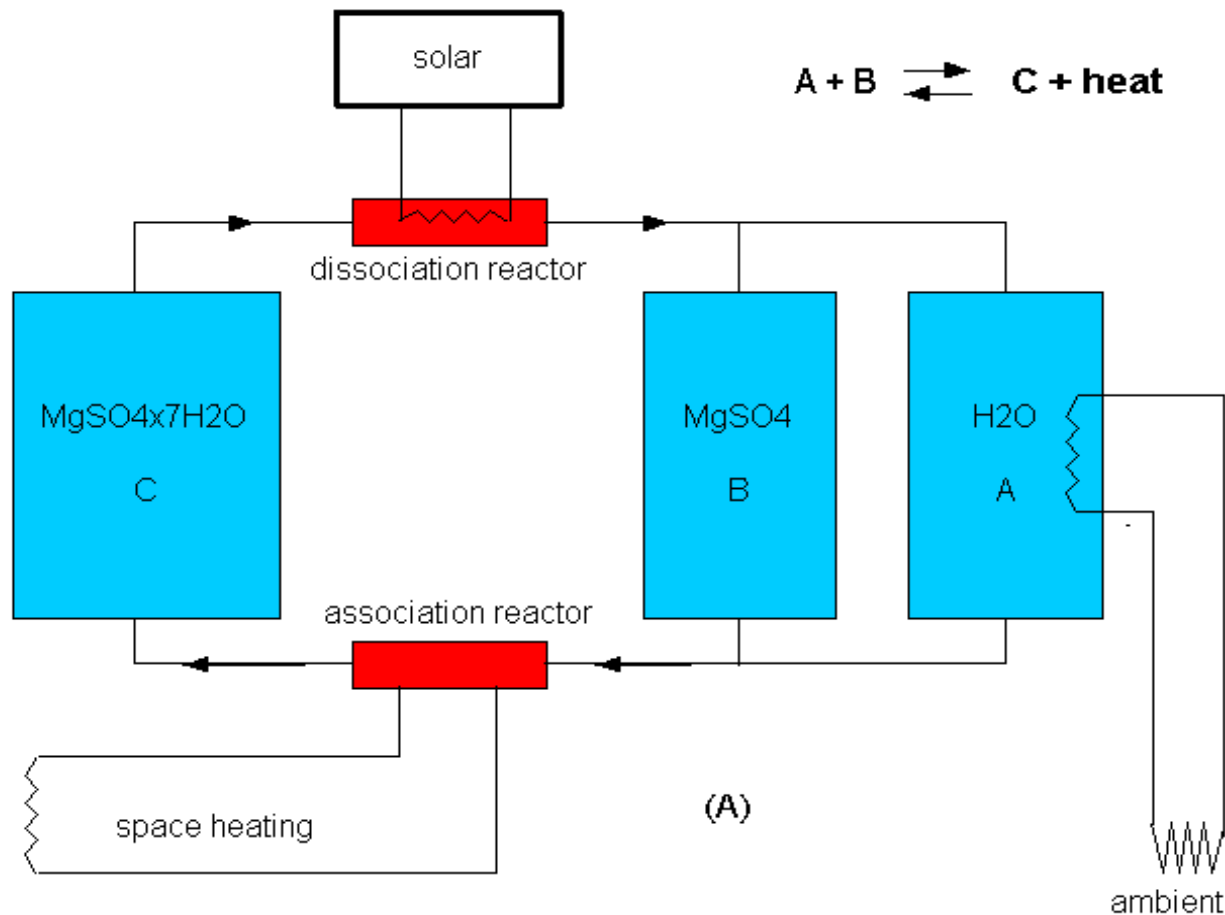
How does it work? - 2

Typical case: SWEAT heat pump (ECN – EEI)



How does it work? - 3

Separate reactor concept



Requirements for storage materials

- Good energy density and temperature level
- Low-cost
- Good cyclability
- Low corrosivity
- Environmentally benign

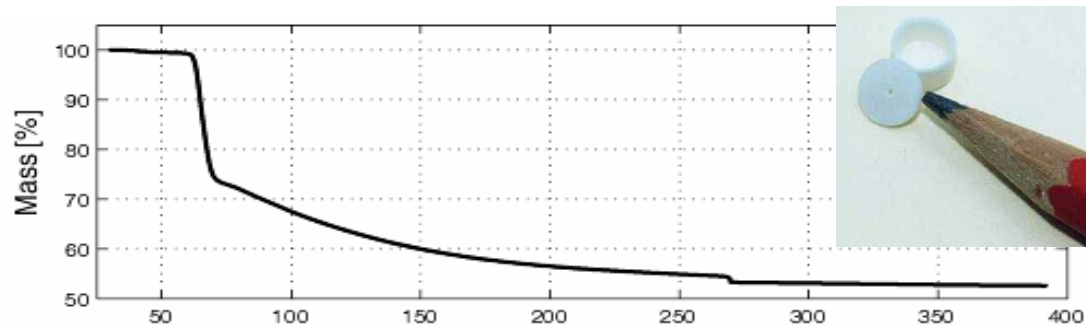
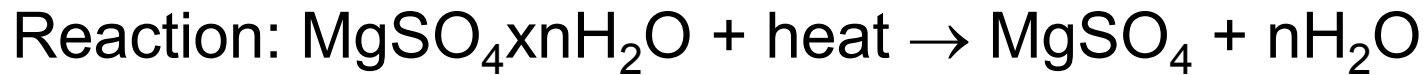
Requirements for storage design

- Sufficient power (heat- and vapour transport)

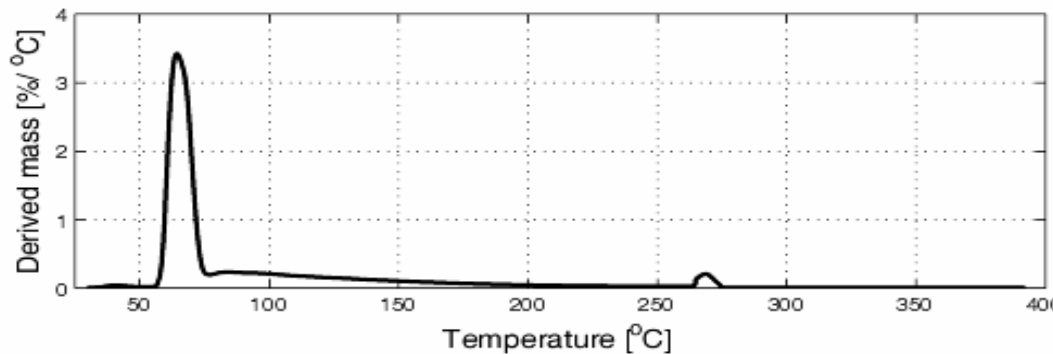
Options for chemical heat storage

- Adsorption reactions at high surface area materials (zeolites, silicagel, etc.)
presentation Schmidt
- Absorption of vapour in liquid
presentation Weber on $\text{NaOH} \times n\text{H}_2\text{O}(\text{l})$
- Absorption of vapour in solid
present presentation e.g. $\text{MgSO}_4(\text{s})$

Types of materials – $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$



Sample mass decreases at high temperature

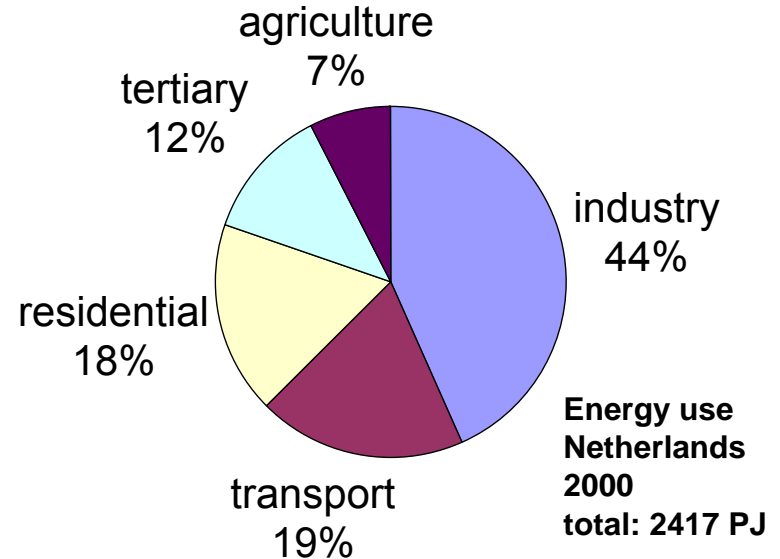


Vapour production (a.u.)

Market potential

- Residential heating & cooling
- Offices & other tertiary sector heating & cooling
- Upgrade industrial waste heat
(mainly heat pump, limited storage required)

⇒ Very large future potential
for chemical heat storage



Required future activities

- Chemical materials research
 - Materials selection & characterisation
 - Integration in support matrices
- Optimised reactor design
 - Heat- and vapour transport
 - Corrosion
- System design
 - Optimised system design
 - Optimised control strategy

ECN activities

- R&D on salt hydrates and other materials
 - WAELS project (Buildings as energy provider)
- R&D programming
 - National
 - International: Strategic Research Agenda ESTTP



Further information: vanhelden@ecn.nl