Thermal Energy Storage Today

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February 14, 2013
Energy Storage Technology Roadmap
Stakeholder Engagement Workshop
Discussion Group 2

Thermal Energy Storage (TES)

- Sensible TES

  Water tank, Underground TES

  Storage Capacity ≈ 100 MJ/m³

- Latent TES

  Phase Change Materials PCM

  Storage Capacity ≈ 300 - 500 MJ/m³

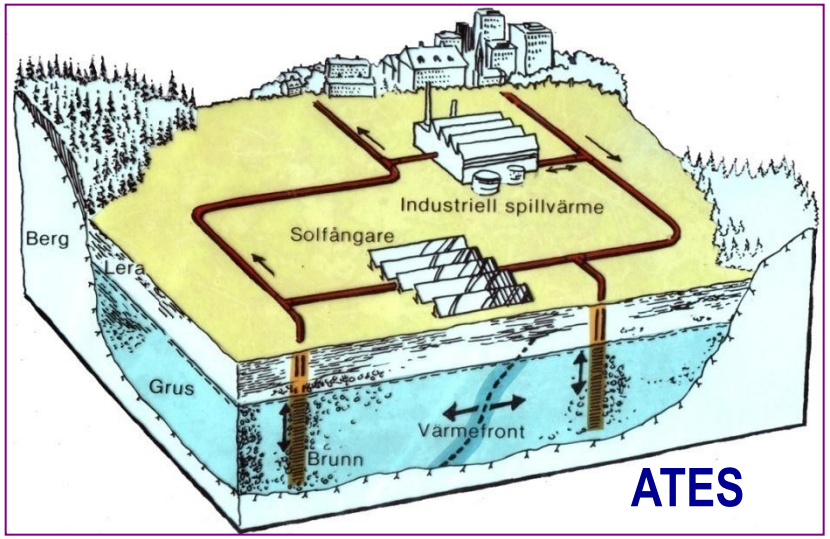
- Thermochemical Reactions

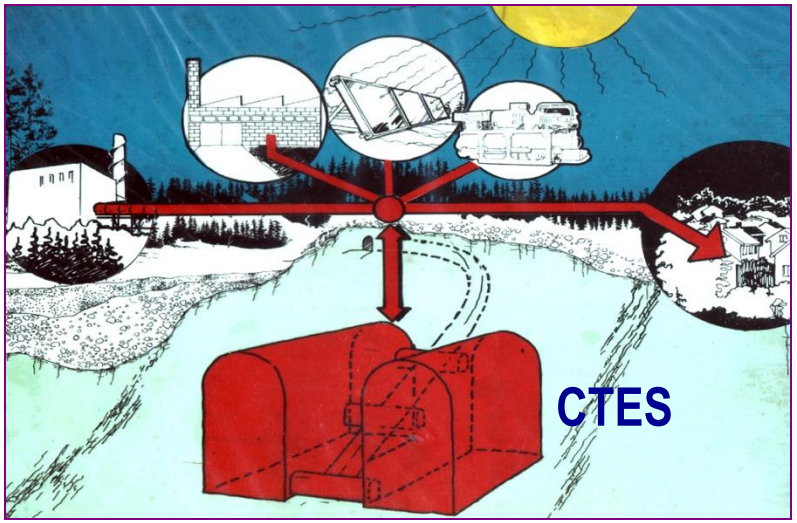
  Absorption, adsorption, chemical reactions

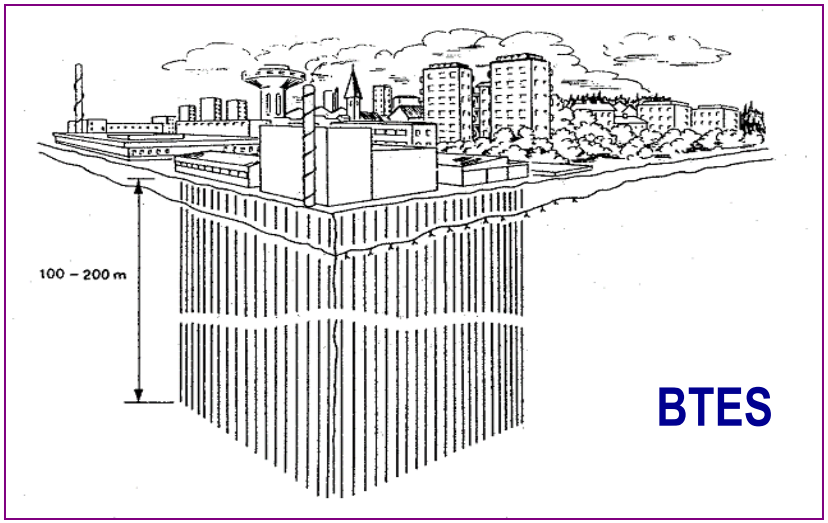
  Storage Capacity ≈ 1000 MJ/m³

Seasonal TES Technologies

- Aquifer Thermal Energy Storage (ATES)
- Borehole Thermal EnergyStorage (BTES)
- Cavern Thermal Energy Storage (CTES)



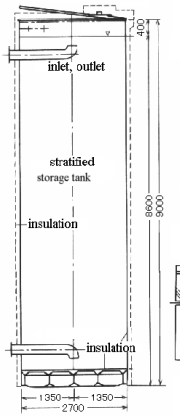


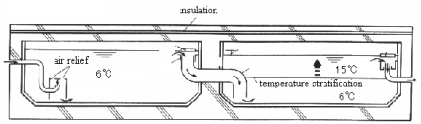


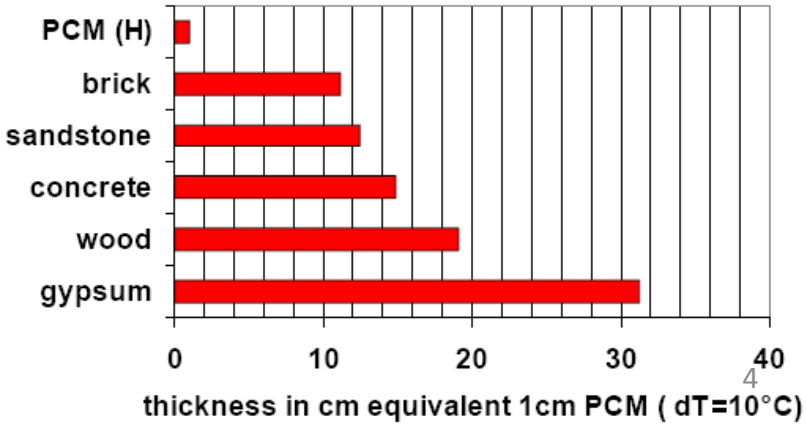
Source: Andersson, 2005

Short-term TES Technologies

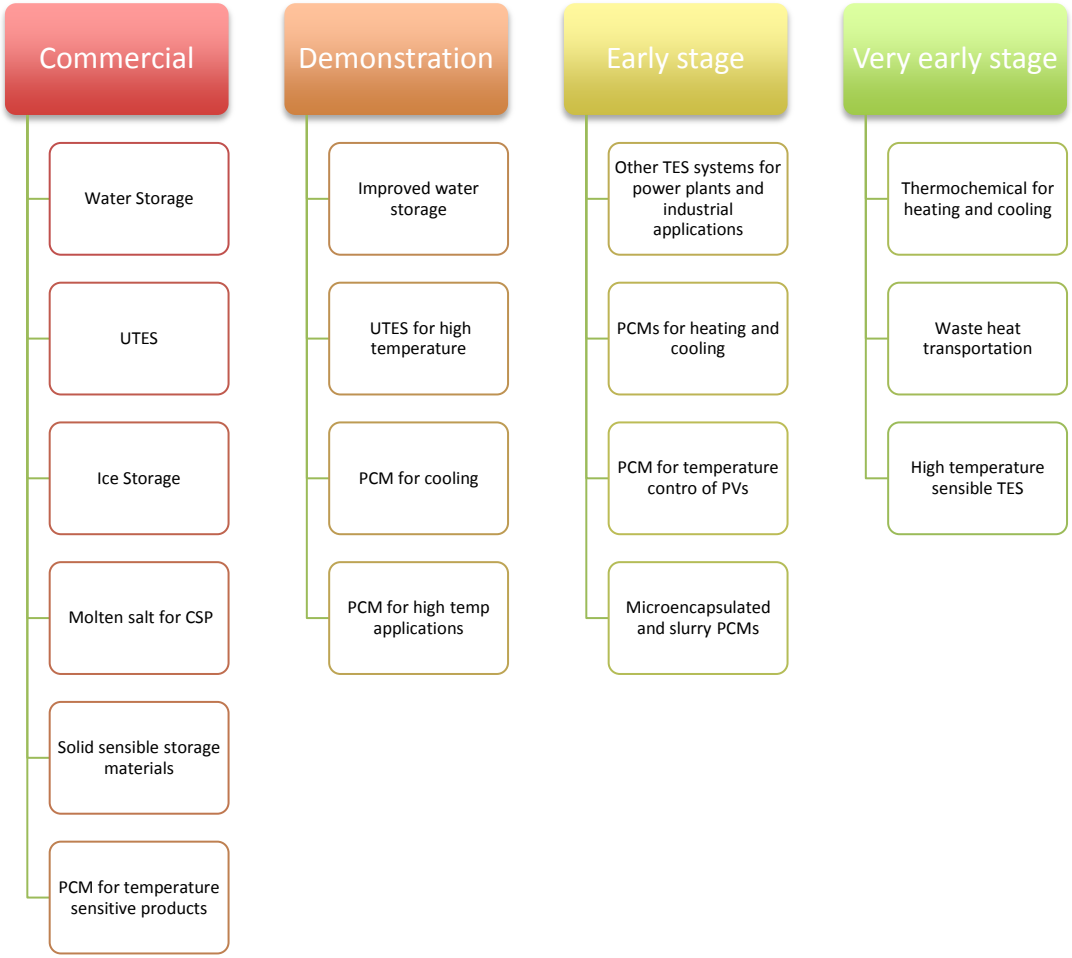
- Water Tanks
- Phase Change Materials (PCM)
  - Water/ice
  - Organics
  - Inorganics
  - Composites
- Thermochemical reactions
  - Absorption/Adsorption
  - Reversible reactions
- Building materials and structures
  - Plaster, concrete mix,etc. + PCM
  - Ceiling + PCM
  - Floor heating + PCM







Technology Readiness Levels of TES*



- Strategic Research Priorities for Cross-Cutting, European Technology Platform for Renewable Heating and Cooling

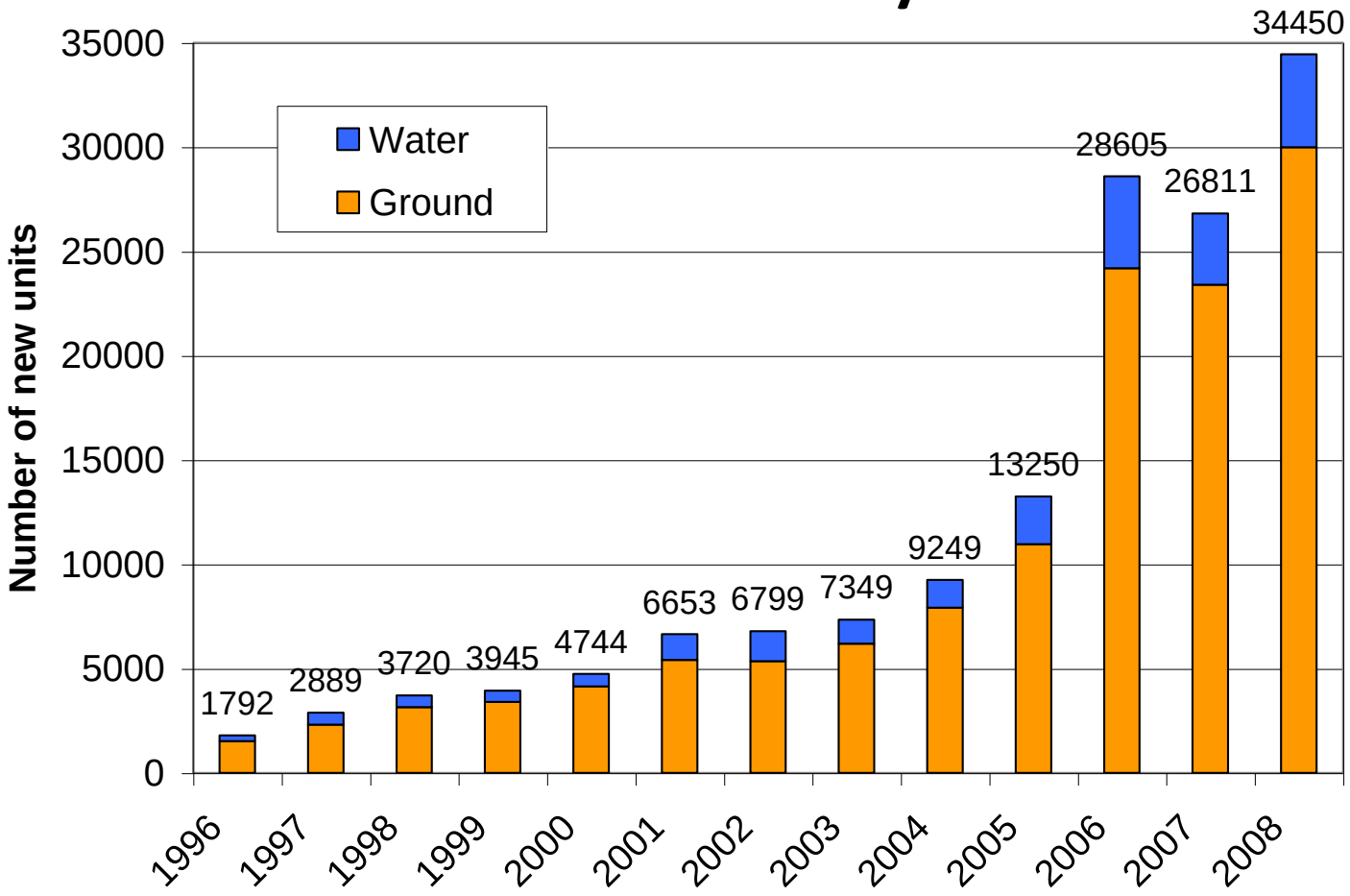
Status Countries

Sweden UTES Statistics

- Ground source heat pumps (GSHP)in general (close to half a million units): Heat from the underground (shallow geothermal), At least 12 TWh/year
- UTES in general (approx. 500 units): Stored and recovered heat: Approx. 450 GWh of heat and 400 GWh of cold annually

- Source: Geotec 2012: Geoenergi i samhället - En viktig del i en hållbar energiförsörjning (Geoenergy in the society - An important part of a sustainable supply of energy), Svensk Geoenergi, Report 2012:1.

Status Countries Germany



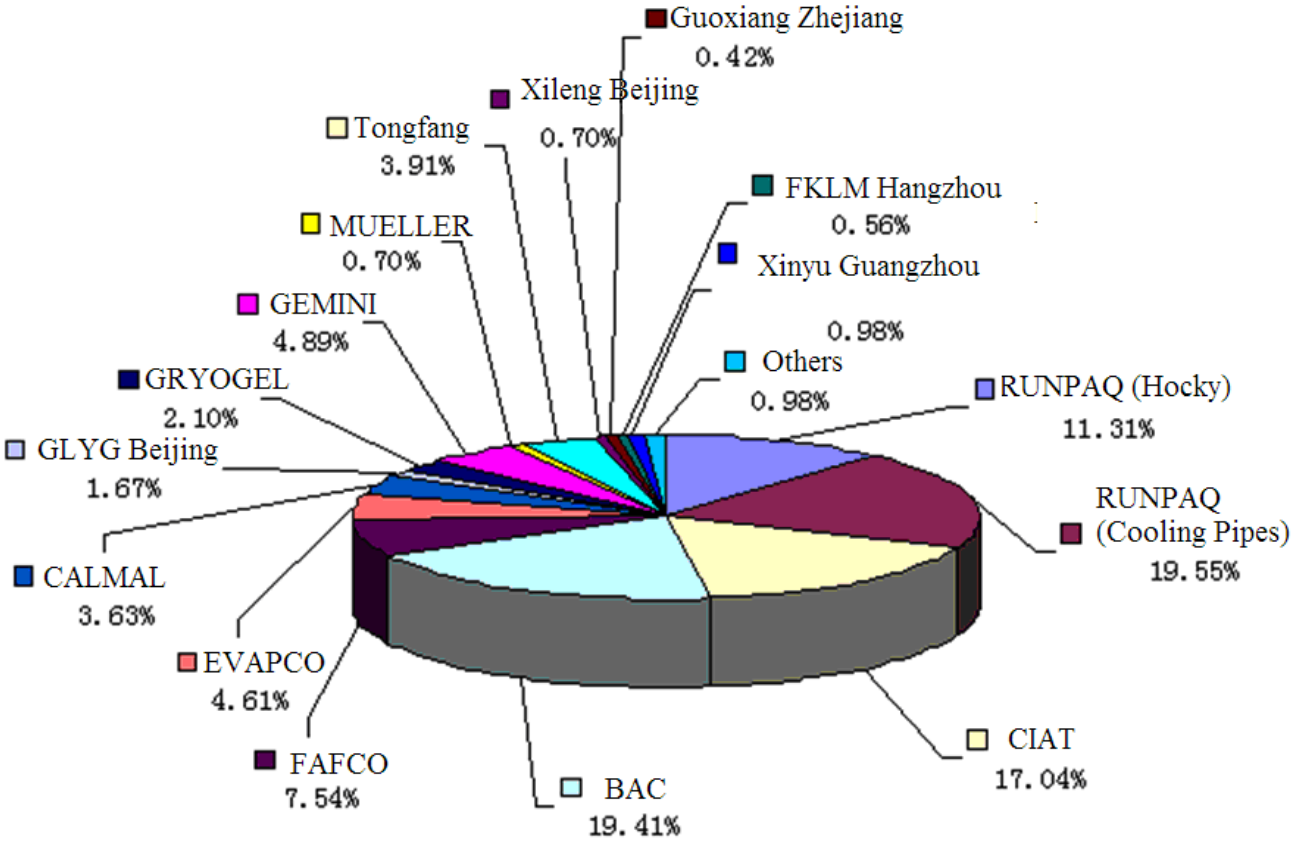
Sales numbers of GSHP in Germany

(after data from BWP)

Status Countries

Water and ice storage in China

- Started in 1990s
- About 833 projects in 4 municipalities and 22 provinces



Ice and water storage companies

Status Countries

Norway

- 3 TWh energy from UTES including ATES and BTES
- GSHP continues to grow
- Large scale BTES systems installed every year

Status of R&D in TES

- 15 countries cooperating
  - OECD NA, OECD EU, OECD Asia, China
- Some of the current R&D topics
  - Quality assurance of BTES systems
  - Novel compact material development
  - Methods for characterization of materials
  - TES for distributed energy systems
- 77 working teams (Sum of participants in on going annexes)
  - Total number of person months:1085*
  - Estimated annual budget: 8.04 MEuro*

* Based on Task2442 “Compact thermal energy storage” activities only

Case Studies
UTES

- Arlanda Airport, Sweden

  ATES, 10 MW and the turnover some 10GWh/year

- IKEA Stores in Sweden

  5 BTES, 1 ATES, store size varies between 25 and 35 000 m^2 and have an equal heating and cooling load demand of 1 000-1 300 kW.

- Xylem Emmaboda, Sweden

  HT BTES for waste heat from industry, 800 kW capacity

- Richard Stockton College, USA

  ATES, Thermal Energy stored: 2,025 MWh/year

- Nydalen Industrial Park, Norway

  BTES, heat output 6.0 MW, cooling capacity: 9.5 MW

- Post terminal building, Norway

  BTES, 4 MW capacity, area of building 100,000 m^2

Case Studies
Ice/Water Storage

- Harumi DHC, Japan

  Water storage 19000 m^3, Building area : 456,000m2

  Employed Population : 20,000

- China Pavilion for Shanghai World Expo 2010

  Building area 160100m^2, total refrigerating capacity 8.7 GW

- China Petrochemical Corporation Research

  Building area is 175000m^2, total refrigerating capacity 10.5GW

Conclusions

What do we need for the storage roadmap?

- Determine maturity of TES technologies
  - UTES
    - High penetration in some countries
    - Legal framework readiness
  - Ice/water storage
    - Favorable electricity tariffs
    - Peak shaving for high cooling loads
- Identify breakthroughs needed
  - PCMs
  - Thermochemicals
- Vision for deployment of TES 2050??
  - Consider needs for future energy systems
  - Milestones??