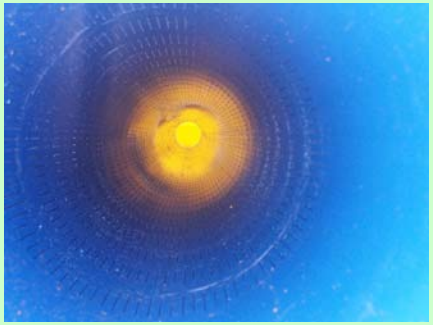
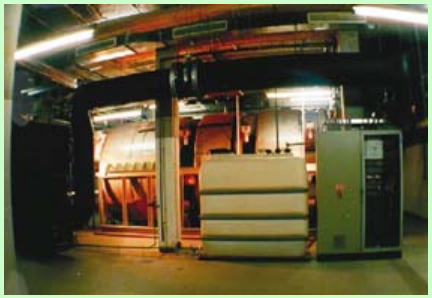
International Energy Agency

Energy Conservation through Energy Storage Programme



Advanced Materials for Thermal Energy Storage



Participating countries and corresponding organizations

The Energy Storage Programme is an R&D Agreement established in 1978

- **Belgium**
- **Canada**
- **Denmark**
- **Finland**
- **France**
- **Germany**
- **Italy**
- **Japan**
- **Korea**
- **Norway**
- **Spain**
- **Sweden**
- **Turkey**
- **United Kingdom**
- **United States of America**
- **IF Technology** (The Netherlands),
- **Institute of Heat Engineering** of the University of Technology Warsaw (Poland

What is the relation between Electricity and Thermal Energy Storage?

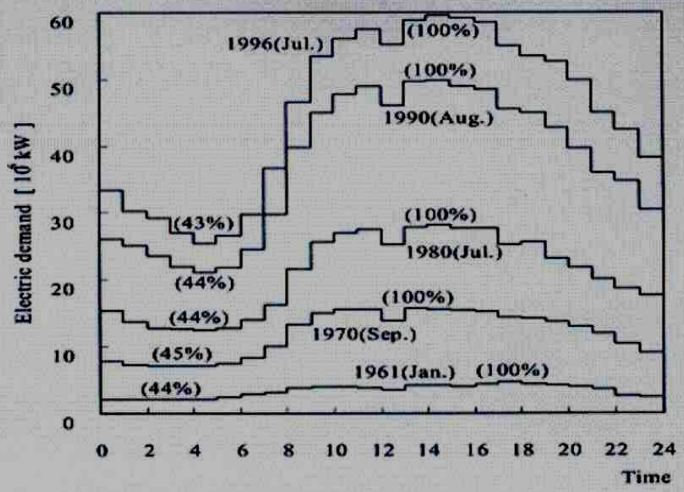


Fig.1 Daily pattern of electric demand in a peak day recorded by Tokyo Electric Power Company

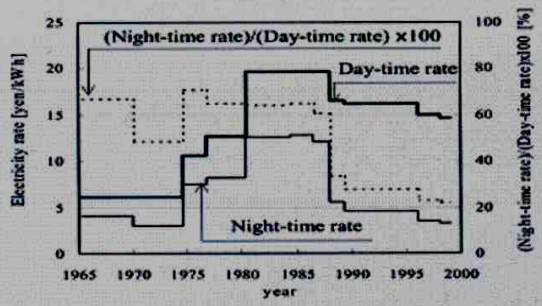


Fig. 2 Electricity rate change from year to year of Tokyo Electric Power Company

The electricity peak can be caused by a thermal demand!

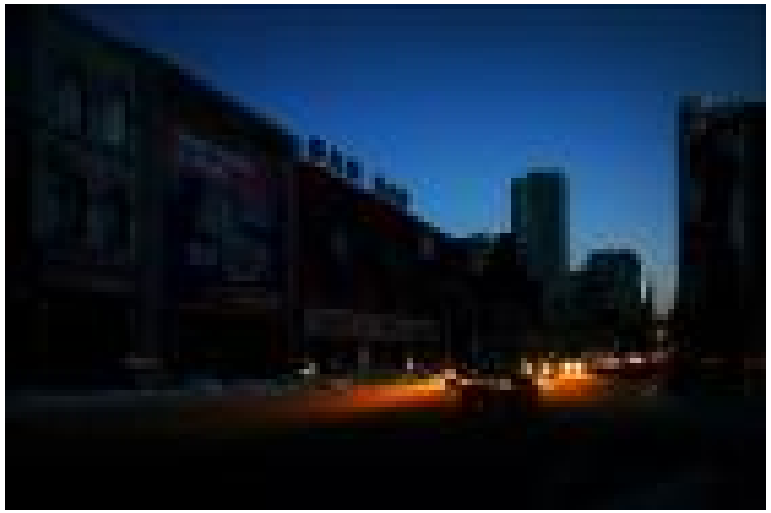
Heating and air conditioning demand can bring electricity grid to its capacity limits!

What can Thermal Energy Storage do for the Electricity Grid?

Thermal energy storage can reduce the maximum power demand

Thermal energy storage can avoid black-outs

…and probably it is the most inexpensive solution



Thermal Energy Storage

Different Thermal Energy Storage (TES) Technologies:

- Sensible TES (Heating/cooling Storage medium)

  Storage Capacity ≈ 100 MJ/m³
  Storage Volume ≈ 10 m³

- Latent TES (Phase Change Materials PCM)

  Storage Capacity ≈ 300 - 500 MJ/m³
  Storage Volume ≈ 2,5 m³

- Thermochemical Reactions (e.g. Sorption storages)

  Storage Capacity ≈ 1000 MJ/m³
  Storage Volume ≈ 1 m³

Thermal Energy Storage

Phase change materials and chemical reactions

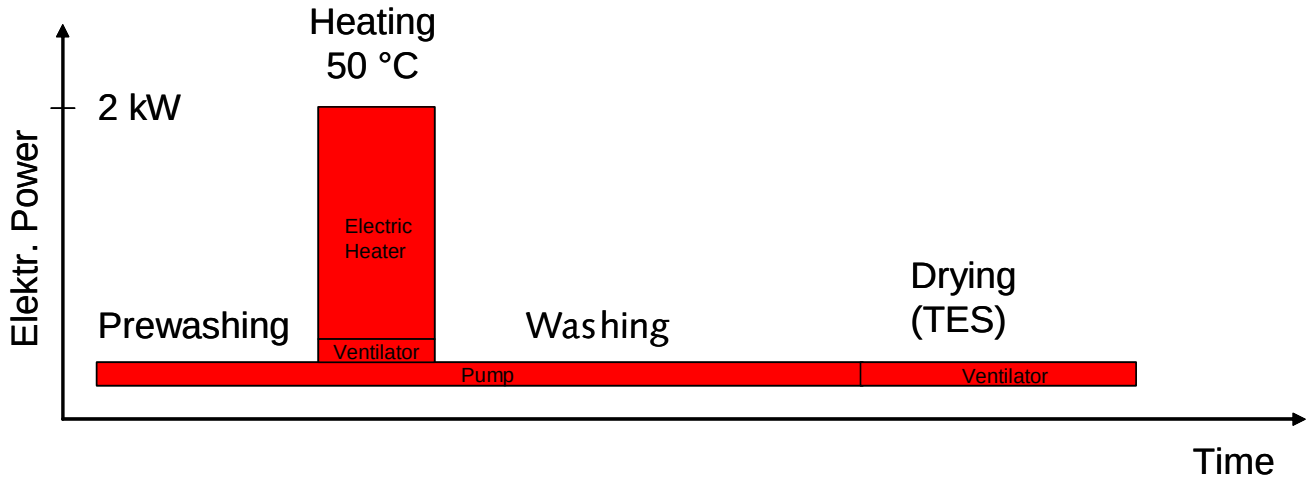
- Advantages
  - Higher energy densities
  - Constant / adjustable discharging temperature
- Phase Change Materials
  - Paraffins, salt hydrates, water / ice
  - Micro / macro capsules, slurries
- Chemical Reactions (Sorption Storages)
  - Solid / liquid sorbent materials
  - Open / closed systems

Annexes: 5, 10, 14, 17, 18 and 19

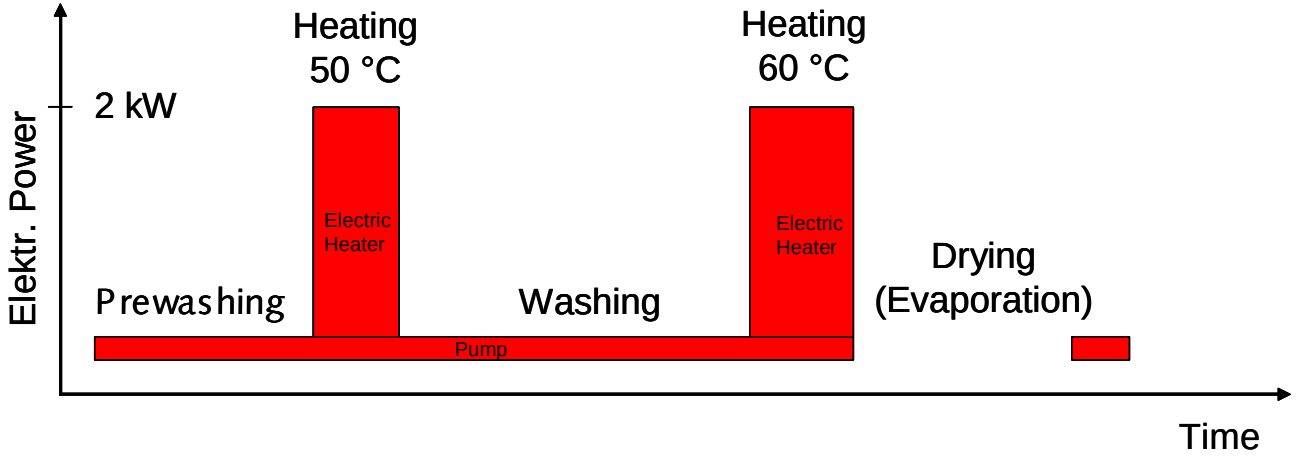



Example: TES in a Dishwasher

Dishwasher with TES



Conventional Dishwasher



Example: TES in a Dishwasher

Experiment TES

Example: TES in a Dishwasher

Energy Consumption:

Conventional Dishwasher	1.05 kWh
Dishwasher with TES	0.80 kWh
Energy Saving (about 25 %)	0.25 kWh

Conditions:

Washing per year	250
Liftime	10 years
Dishwasher produced per year	1.8 Mio.

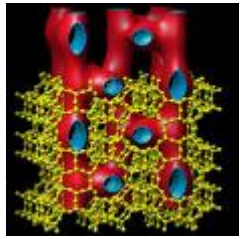
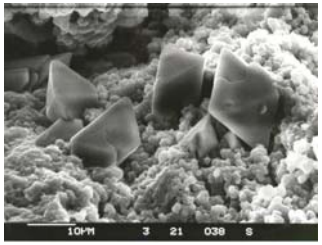
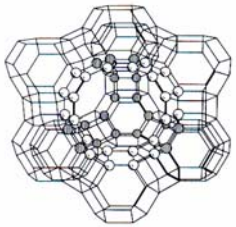
1kWh = 0,5kg CO_2 (EU-Energymix)

Energy Savings per year	**112.5 GWh**
Energy Savings after 10 years	**1.125 TWh**
CO2 emission reduction	**562,500 t**

Example: TES in a Dishwasher

Material Requirements:

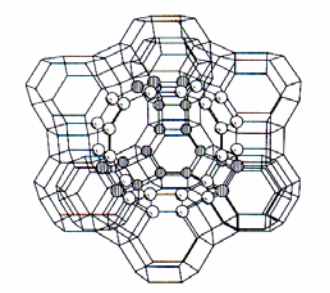
• High Storage Capacity	about 250 kWh/m³
• High Thermal Power	fast drying
• High Stability	3500 cycles
• Low Price	below 3 €/kg

Special Conditions:
Charging at high temperature (300 °C) and high humidity (dewpoint of 70 °C) → Hydrothermal Stability!!

From Materials to Applications

Material | **System** | **Application**



Basic Science
e.g. Universities

Applied R&D
e.g. Research
Insititutes

Product
Development
e.g. Industry

Three different languages!

ECES Activities

International Symposium on Material Development for Thermal Energy Storage

Phase Change Materials and Chemical Reactions

4.-6. Juni 2008, Bad Tölz, Germany

Participation of about 15 Universities & Reserach Institutes from 9 countries and over 12 Companies (6 Material Provider and 7 System Producer)

Supported by the Executive Committee of the ECES IA and the IEA AHGSET

More Information
http://www.zae-bayern.de/

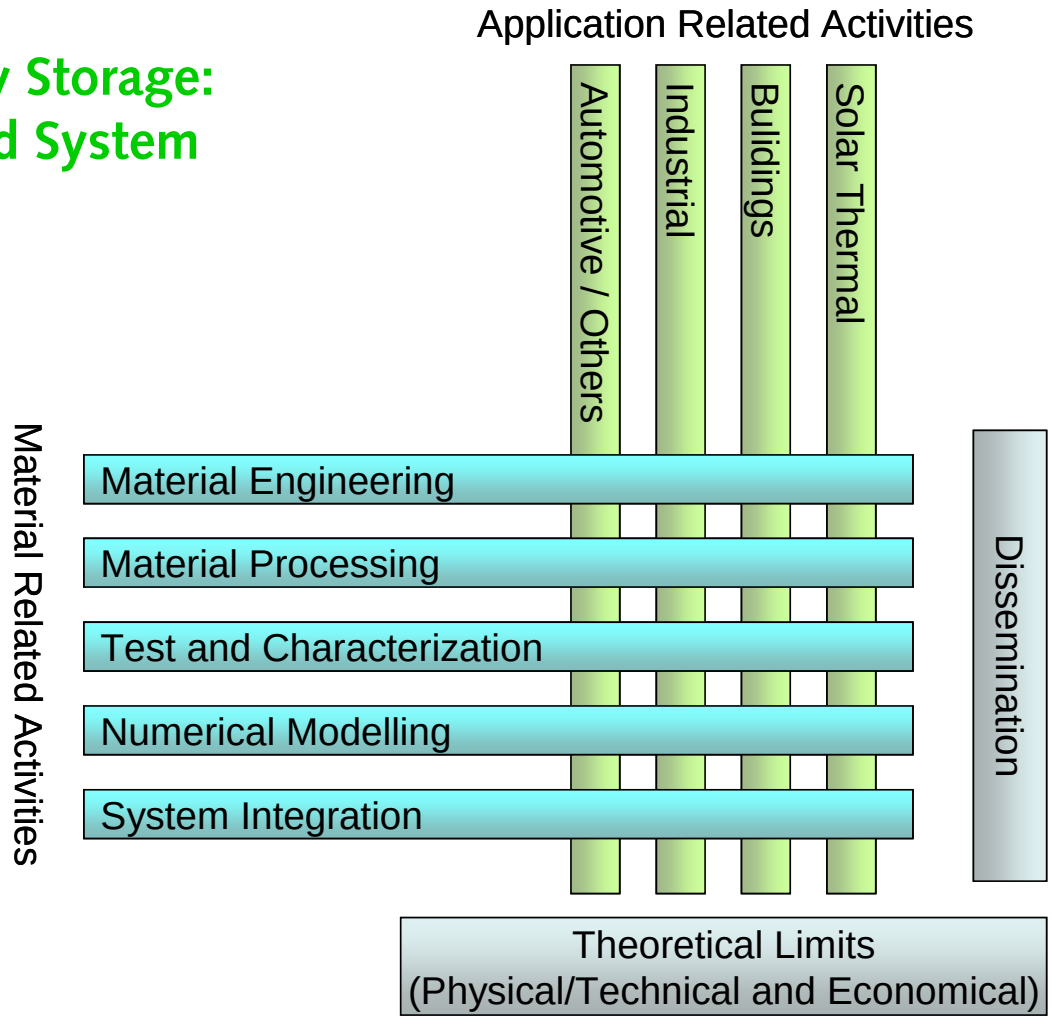
ECES Activities

New Joint Activity ECES / SHC planned

„Compact Thermal Energy Storage: Material Development and System Integration“

Annex 24 / Task 42

Start: 2009



Thank you very much for your attention!

Is that all you saved from last summer? Energy Storage helps to conserve Energy and to protect the environment!