Solar power, latent heat storage and CHP

Sustainable energy and how to use it efficiently…

Solar Power

Solar Collectors
Windows
SG elements

PV

Chlorophyll

Biomass

Heat

Electricity

Steam
Stirling
Energy converter cells
(Werner Henze, Pat No. DE102005025028A1)

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Solar power

Electricity

Scotland is good for solar power!

Different kinds of PV cells available:

- Monocrystalline (expensive, 15% efficiency)
- Polycrystalline (less expensive, 12% efficiency)
- Amorphous (cheap, only 8% efficiency, but work better with diffuse light)

PV Cells

UK average: 1 Wp provides approx 1kWh/a

- **Prices dropped from £15/Wp (1980) to £3/Wp (still falling)**
- **Warranty: 26 years on output (SOLARA)**
- **New developments with higher efficiency**
- **≤ 5 years of "Carbon debt" (≤ 10 years with storage batteries)**

PV Cells

Energy storage

- **Batteries**
- **Centrifugal power storage**
  (like the Nova sports car in the background)
- **Grid**

PV Cells

Energy storage: Grid

Example "100,000 Dächer-Programm"

- **Started in 1999 in order to give PV a push**
- **300MW of solar power**
- **45.7 cent/kWh guaranteed**
- **Cheap KfW*) loans (1.9% over 10 years)**
- **Up to 13,500DM per installed kWp**

***) "Kreditanstalt fuer Wiederaufbau" – a group of banks working with the government**

PV Cells

Energy storage: Grid

Example "100,000 Dächer-Programm"

- **Within 1 year 50% increase on the solar market**
- **PV panel prices lowered**
- **1.1 billion Euros invested (& jobs created)**
- **Approx 100 times more PV in Germany than in the UK**

PV Cells

Energy storage: Grid

Example "100,000 Dächer-Programm"

- **Finished sooner than expected in 2003**
- **Subsidising continues:**
  ≤30kWp: 57.4 cent/kWh
  30-100kWp: 54.6 cent/kWh
  ≥100kWp: 54 cent/kWh (+5% on façade installations)
- **UK: 8p/kWh (plus £400 to pay for export meter)**

PV vs Nuclear Power

CO2 emissions of PV (after manufacture):

0 g/kWh

CO2 emissions of a Nuclear power plant (after manufacture):

≤ 159g/kWh

(any gas-fired power plant can do better than that…)

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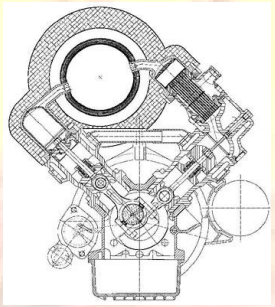
PV energy costs

- In 1995, a kWh supplied to the customer cost 2.6p… But that was not the real cost: It was subsidised with 4p/kWh.
- Now we are over 10p/kWh and prices are rising… and we are still blowing out CO2.
- PV sits at 20p/kWh and still falling – with no CO2 emissions…
- This doesn't even consider the "independence side of things"…

Solar Power

Heat

Steam production
Stirling engines



DHW & Heating
via solar collectors

Hot air systems
(Heating & airing)

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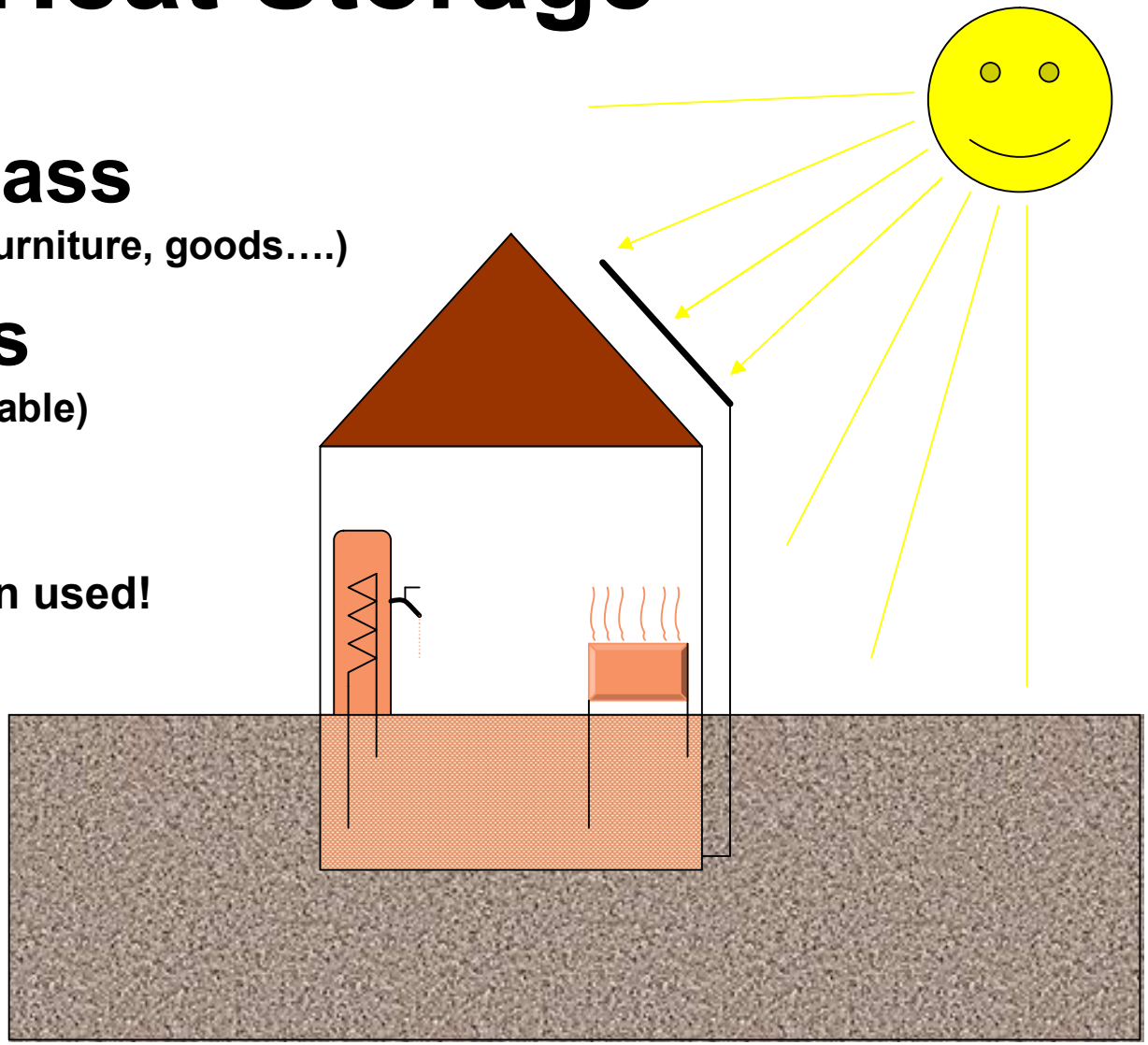
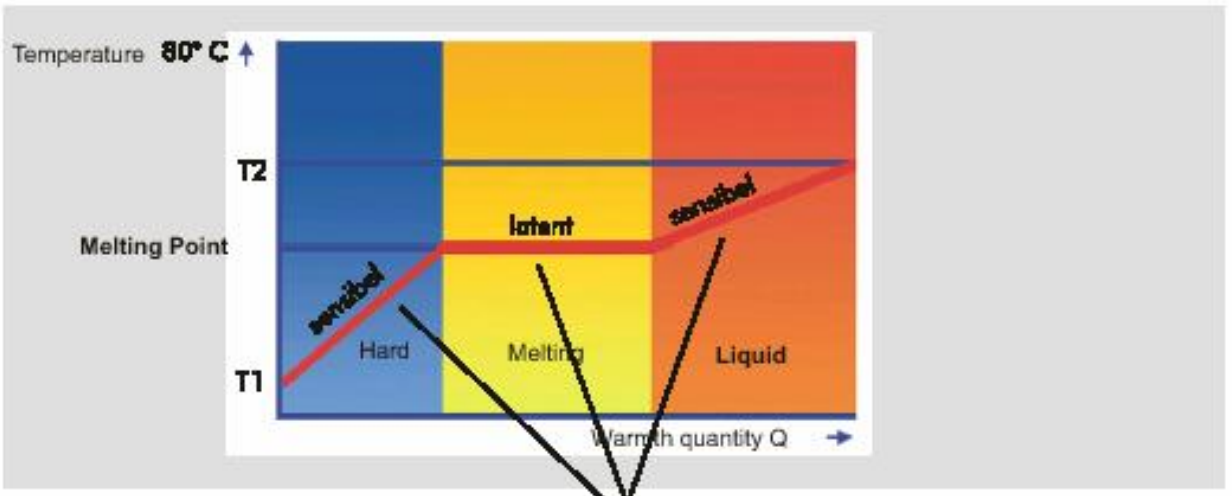
Heat Storage

- **Thermal mass**
  (Building structure, furniture, goods….)
- **Heat stores**
  (dedicated & controllable)

Up to now big water reservoirs have been used!



Latent Heat Storage

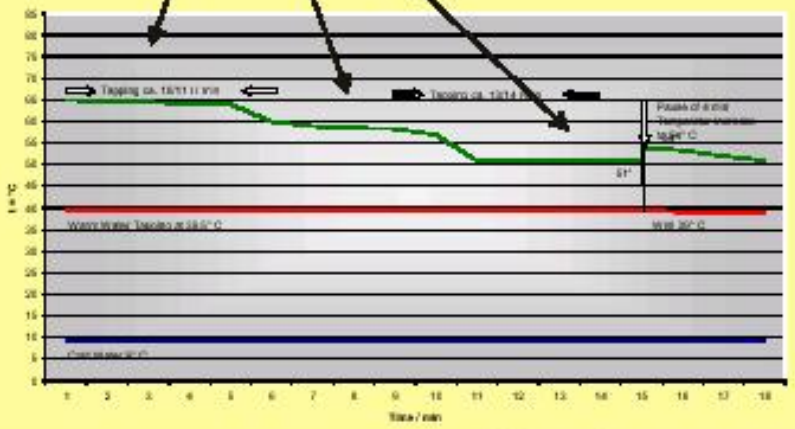


Discharge curve:

This curve clearly shows the latent crystallization process during the discharge.

Conditions:
LPT-6-360
Ambient temperature:: 17 °C
PCM_melting temperature: 60/62° C
Insulation: 150 mm PSE
Filling: pebble stones
Water temperature cold: 9°C
Water temperature warm: 39.5°/39° C

Result without energy supply:
Total discharge: 240 l
Time: 18 min.
Temperature after discharge: 51° C
delta T 55° / kW capacity of heat exchanger



(Subject to change, errors excepted)

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Heat storage

Latent heat stores **using PCM**

Two main types:

Sodium acetate & Paraffin

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Heat Storage

Water vs Latent Heat Cells

- **Latent heat cells have up to 4 times higher heat capacity**
- **Retains heat much better – less loss**
- **Can cope with higher temperatures**
- **Maintenance-free**

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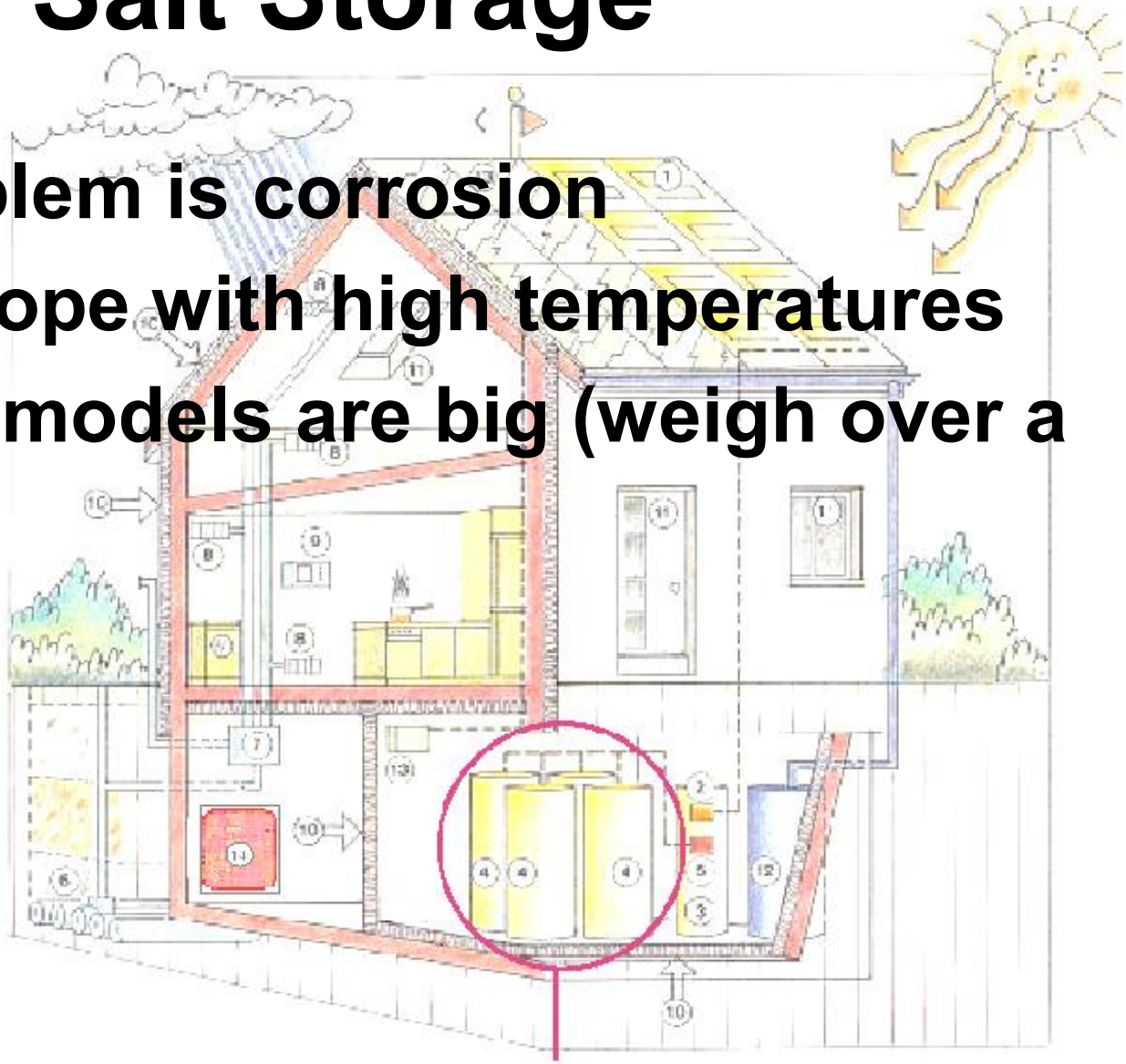
Salt Storage

- Main problem is corrosion
- Can not cope with high temperatures
- Available models are big (weigh over a tonne)



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Paraffin Cells

- Much smaller (60kg)
- Can be laid flat (e.g. in loft corners)
- Paraffin is absolutely harmless
- 100% recyclable
- Thermically stable up to 250°C
- Non-ageing & cycle-stable (physical process)

PowerTank latent heat cells are connected to a storage according to Tichelmann

Cells in horizontal position

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Paraffin Cells

From an information paper of the Solar Institute Jülich:

"By using paraffin storage instead of a water storage, the coverage rate of solar systems could be increased from 28% to 48% in an experimental procedure. This amount [in this case] is equivalent to an extra yield of the solar system of about 1800 kWh. For technically directly used solar heat and a principal separation of the use of service water and heating water coverage rates of between 70% and 80% can be achieved."

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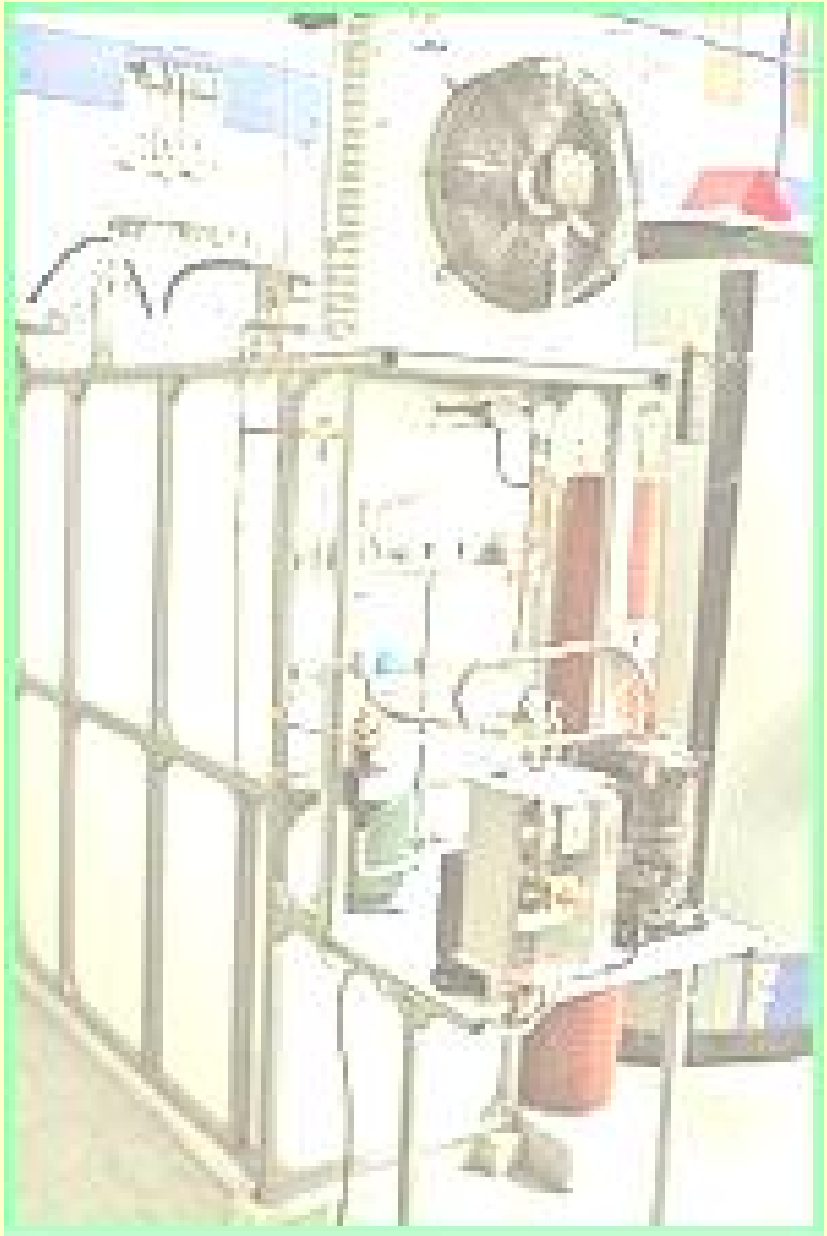

Think Innvovation

A new way of

Heating

Storing

Air Conditioning

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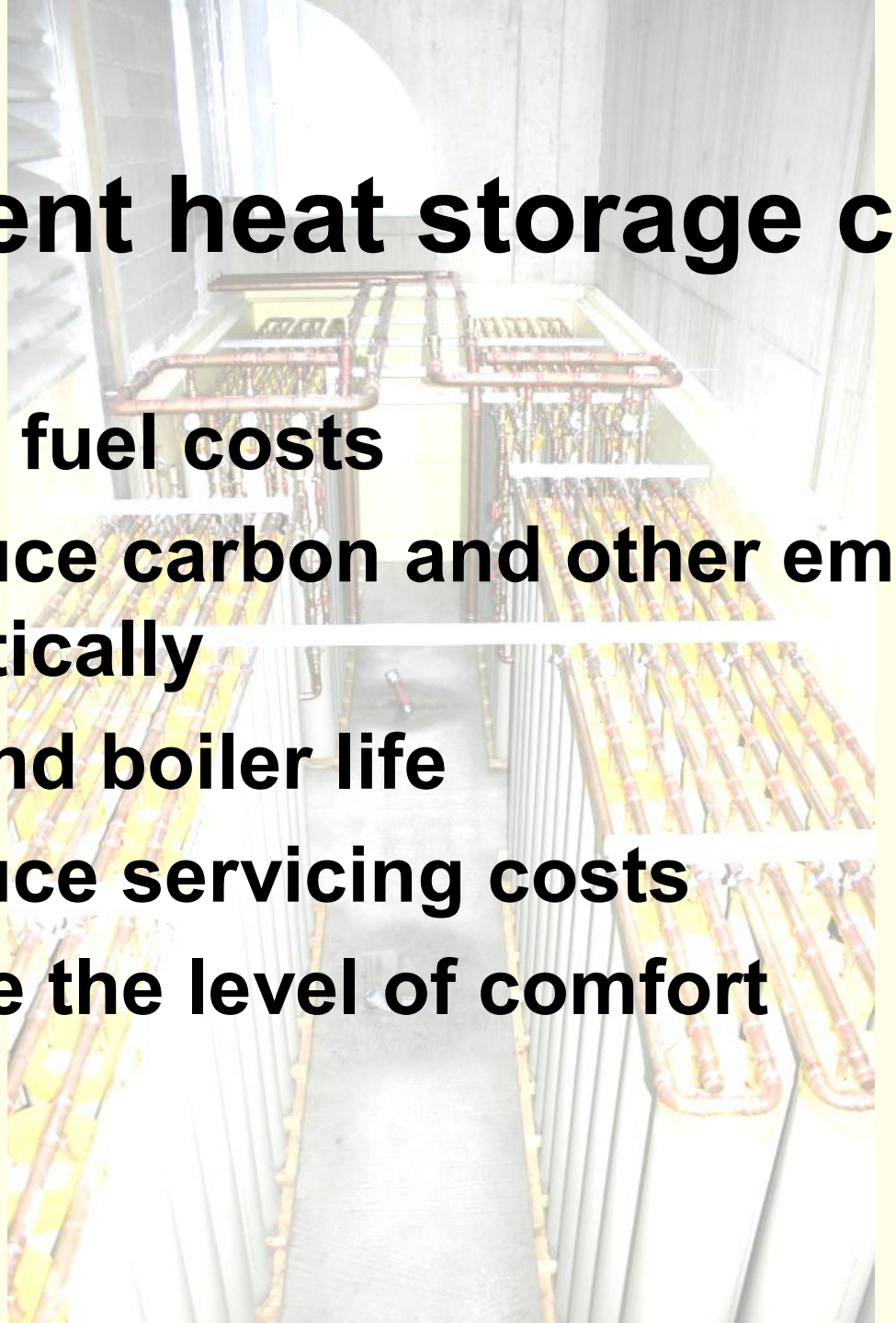
Latent heat storage cells



- Save fuel costs
- Reduce carbon and other emissions drastically
- Extend boiler life
- Reduce servicing costs
- Raise the level of comfort

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Reduction of fuel consumption

- Up to 40% fuel saving through reduced switching and storage losses alone
- Smart Energy Concept includes lowering of flow temperature (1°C higher flow temperature equals 3% more fuel consumption)
- SEC works with max. 2°C lowering of room temperature during the night
- 70% fuel saving (or more) with solar panels added
- Boiler size can be reduced

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Reduction of emissions

- Full efficiency of a burner is reached only after 3-6 mins of running time
- 95% of all burning cycles end BEFORE that time
- A burner switches 30,000-50,000 times a year on and off
- After the first 20sec only 36% efficiency has been reached
- With the latent heat system added, only 1,000 starts/a (or less) will occur
- A typical overall efficiency of 92% will be reached
- 98% reduction of unburned hydrocarbons emission

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Reduction of servicing costs

- Every burner start creates a layer of soot
- 1mm of soot results in a 50°C rise of the exhaust gas temperature
- With a 98% reduction in cycles, theoretically a clean-out is only needed every 50 years (if it was once a year before)
- With a 98% reduction in cycles, igniters etc. live much longer

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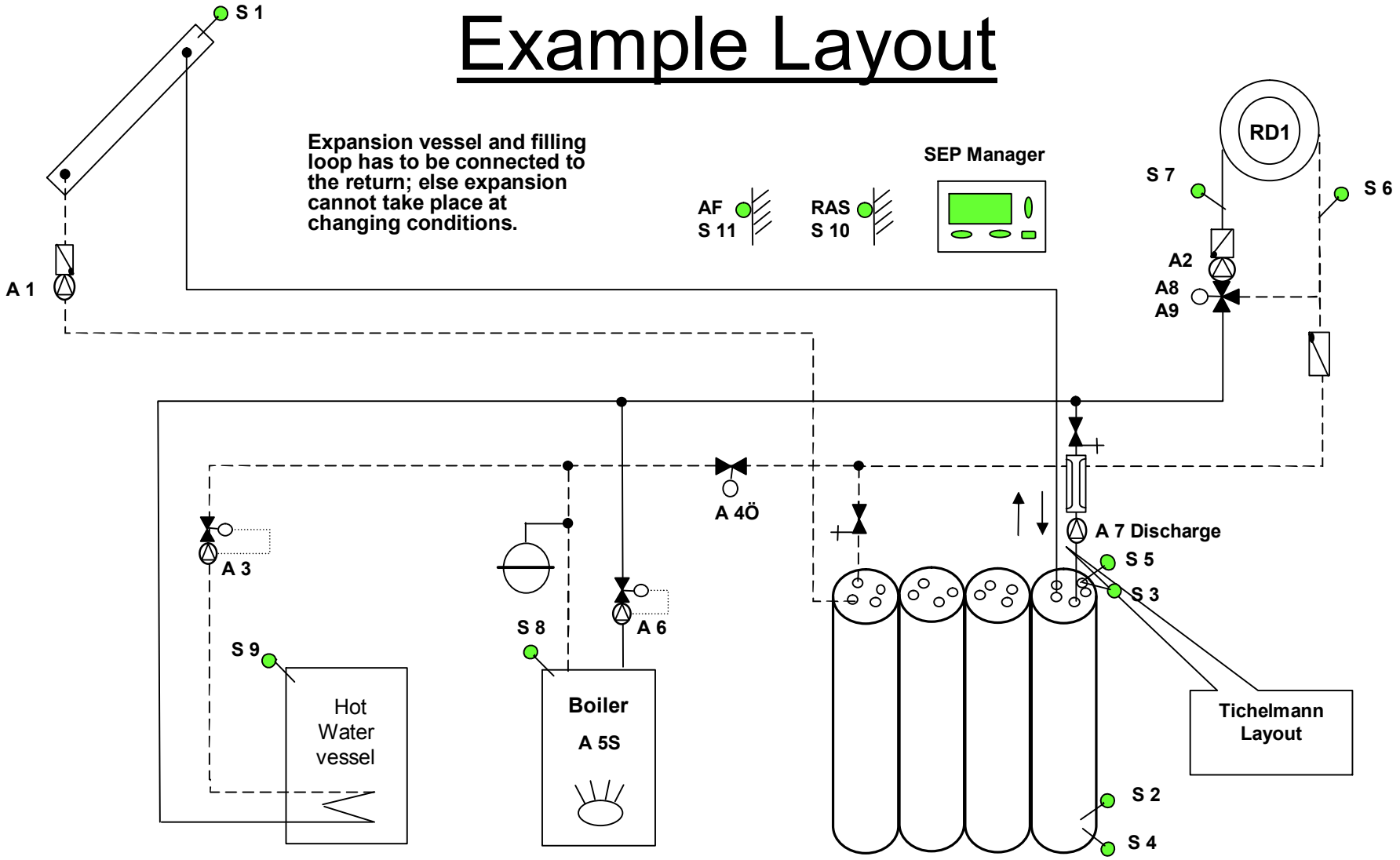
Raise of Comfort

- No need to turn your house into a fridge overnight
- With fresh water cells, no hot water cylinder needed – better hygiene
- Steady, balanced room temperature
- In the low-energy-house: Less space is needed for heat storage

Example Layout



= Zone valve "stromlos geschlossen" A4 activatet: Valve closed (A4Ö stromlos) A4 inactive: valve open (Phase on A4Ö)

= Tacosetter direction of flow in discharge direction, 1,4 l/cell

= Valve with KFE-Tab (for flushing the power tanks)

Project: SEP Hydraulik 1 HK
Drawing: Lessing/Bornträger
Version: 2006/A

This layout does not replace planning on the actual job and does not claim to be exhaustive. Changes may be needed.

Combined Heat & Power

- Most efficient use of fuel
- With appropriate fuel 100% carbon neutral
- Possibility for backup & island solutions
- Possibility to sell heat and/or electricity
- “Peak problem” solved through storage of heat and electricity and/or grid connection
- Standard is approx. 30% electric energy and 60% heat output

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CHP – Dachs RS

Runs on pure vegetable oil

- Saves up to 60 tonnes CO2 emissions/year
- Runs on locally produced fuel
- No need to convert oil into bio diesel
- 100% environmentally friendly fuel
- In Germany you get 19 cent for every kWh fed into the grid

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Other CHP Models

- Deutz Bio Diesel

- Solo

- Gas Turbine
- Biomass

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THANK YOU FOR LISTENING!

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As on 09/10/2007; subject to change and error