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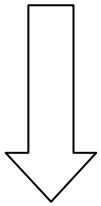
COSYPLACE
Demonstration of Energy Efficient Heating & Cooling System?

Workshop of IEA HPP Annex 32 at 9th IEA Heat Pump Conference 2008, Mai 19th

University of Applied Sciences Northwestern Switzerland
Thomas Afjei, Ralf Dott

SEK – Objective

- New trends in residential building sector, e.g. high insulated surface with large glass areas
- Rising heat loads and increasing demand for indoor comfort create interest in residential space cooling
- Heat pumps can cover space heating, cooling, hot water heating (and ventilation)
- Energy-efficient passive cooling can be well integrated in existing system configurations
- Best system layout and best cooling concept and control strategy to be identified
- Optimisation in simulation, proof in field test

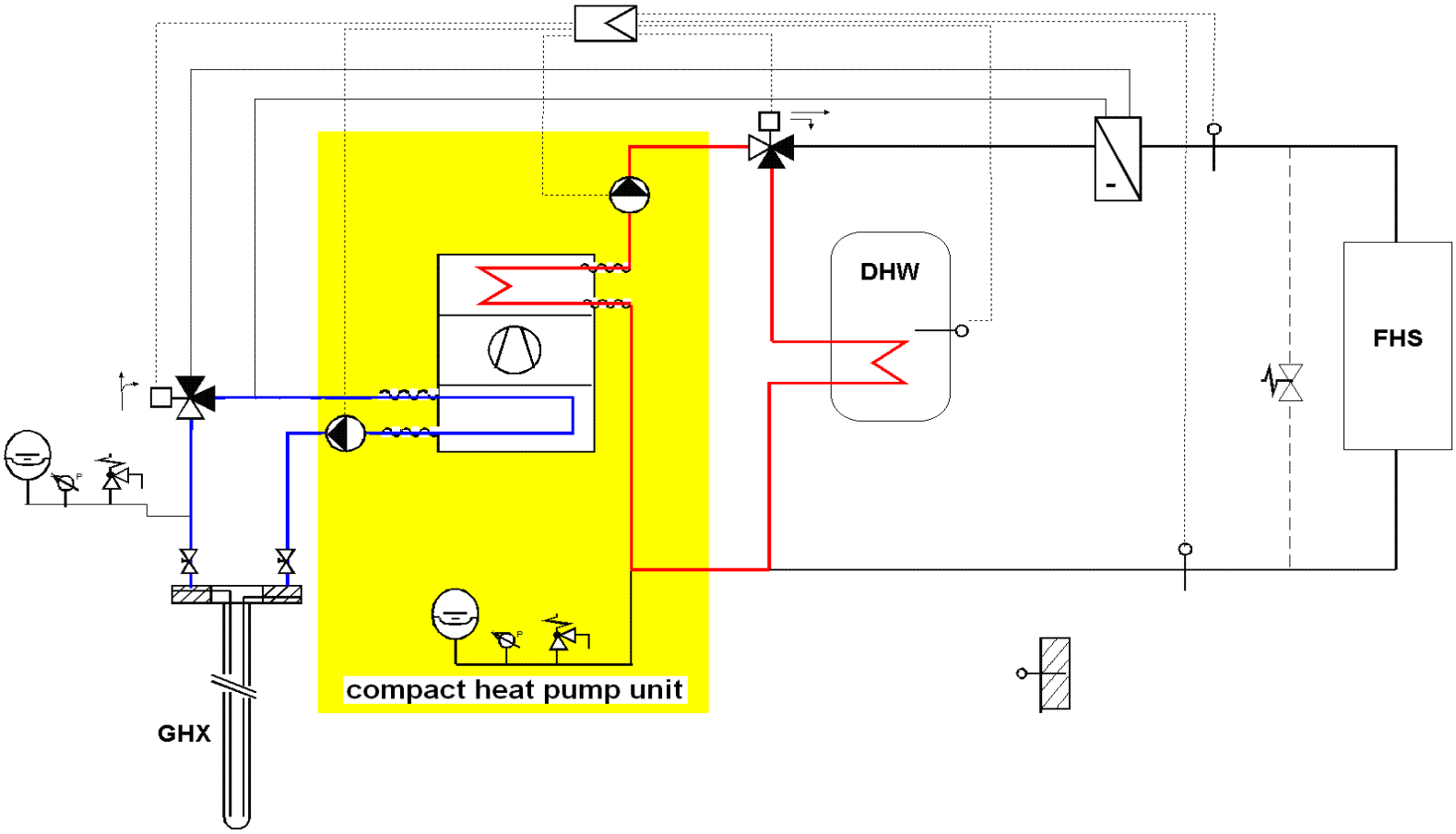


- SEK: Standard system solutions for energy efficient heating and cooling of residential dwellings with heat pumps

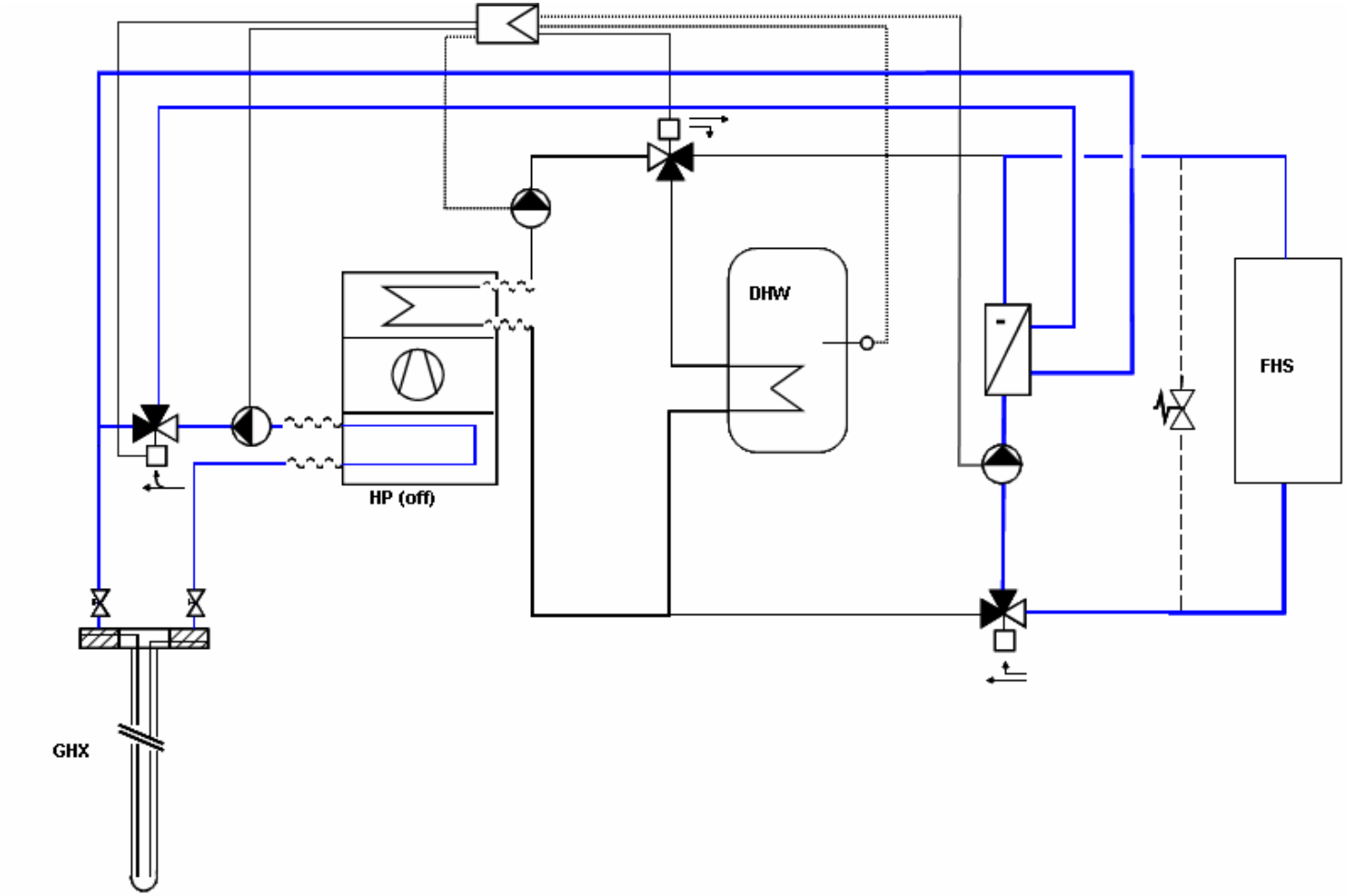
SEK – Systems

- **SEK 1: heat pump / air conditioner units for active space heating (SH) & active cooling (SC) & ventilation (VE), separate domestic hot water heater (DHW), heating/cooling by air (→ commonly used system as "bad reference")**
- **SEK 2: central reversible air source heat pump for SH & DHW with hydraulic emission system in floor for SH & active SC, separate VE**
- **SEK 3: central reversible air source heat pump for SH & DHW with hydraulic emission system in floor for SH and fan coils or ceiling panels for active SC, separate VE**
- **SEK 4: central ground source heat pump for SH & DHW with hydraulic floor / tabs emission system for SH and passive SC, separate VE (→ COSYPLACE)**
- **SEK 5: central air source heat pump / ventilation compact unit for SH & DHW & VE, passive SC by night time ventilation and ground-to-air heat exchanger (→ passive house)**

SEK 4 – Heating



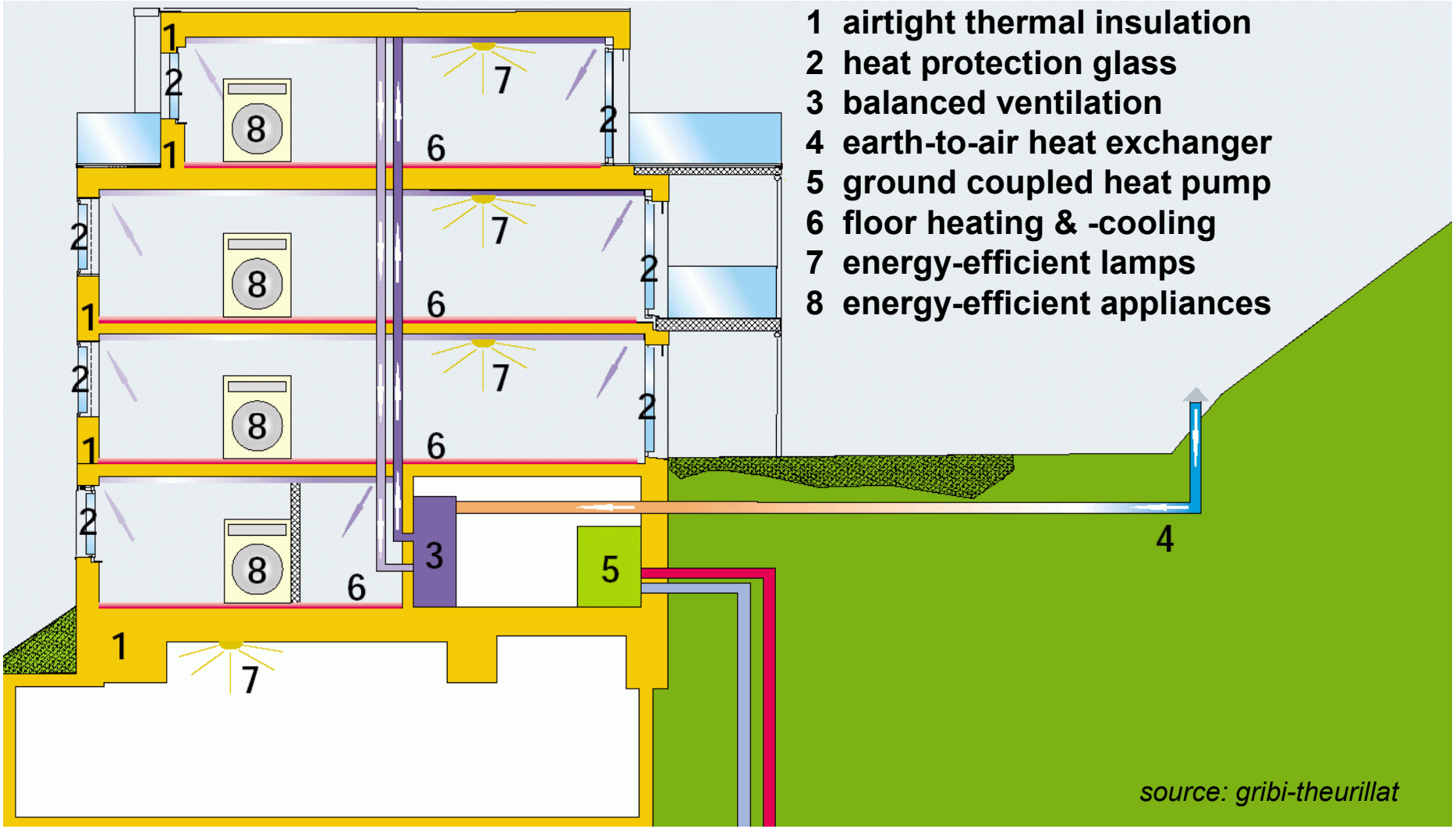
SEK 4 - Cooling



SEK – Outlook

- **Comparison of system energy requirement and achievable comfort conditions**
- **Optimization of control and combination of different cooling strategies**
- **Reduction of commissioning work by check list and web based monitoring**
- **Sensitivity on changing climate conditions**
- **Proof of economical feasibility**

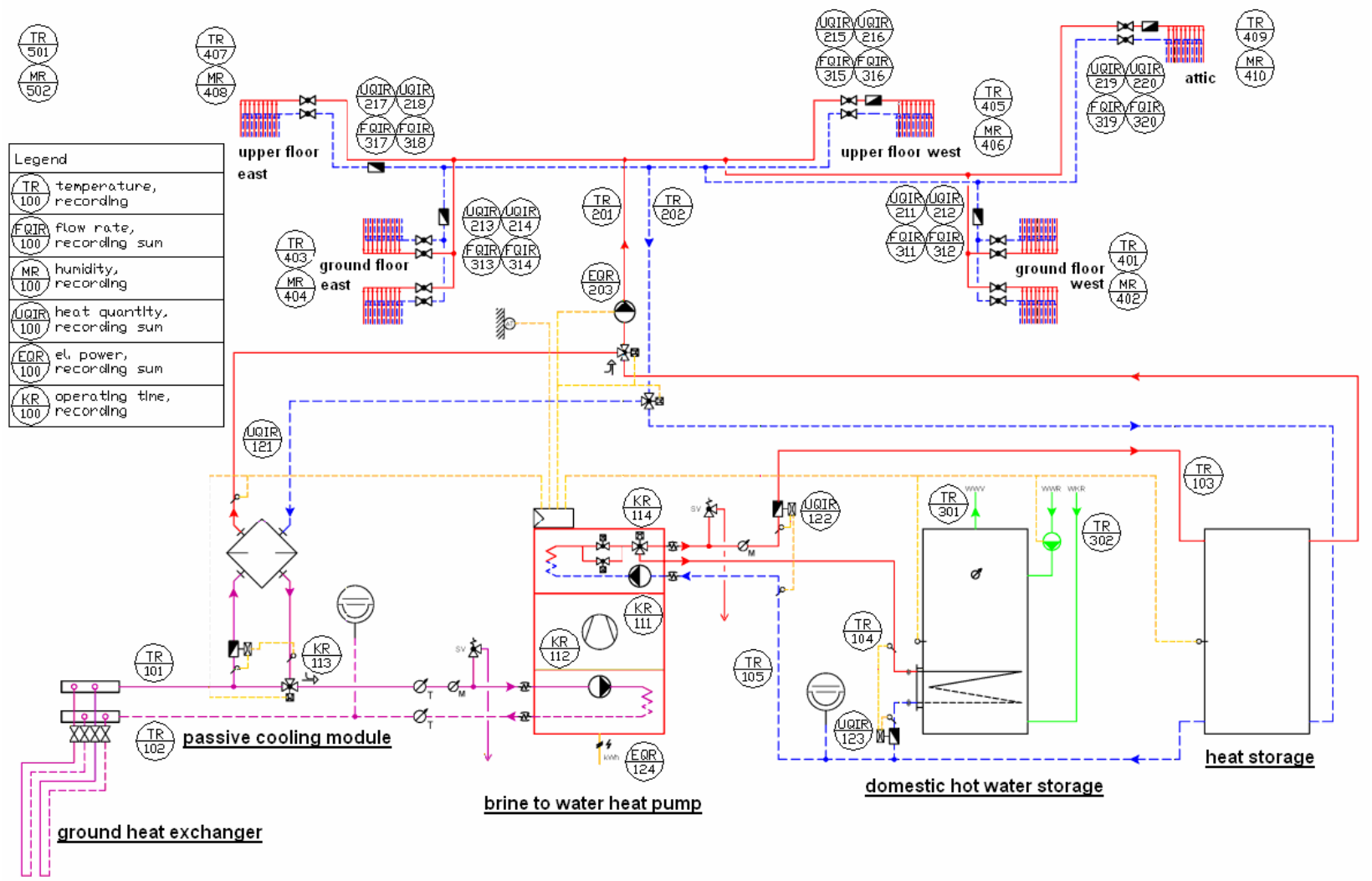
COSYPLACE – BUILDING CHARACTERISATION



COSYPLACE – BUILDING CHARACTERISATION

- Multi-family residential building with 5 apartments with solid construction walls at north oriented situation 300 m above sea level
- 3 stories with additional attic and underground parking lot
- Hydraulic floor heating and passive ground coupled cooling system
- Mechanical air ventilation with heat recovery (air change 0.4 h^{-1})
- Energy reference area 1'064 m^2 (net living space area 741 m^2, air volume 1'890 m^3)
- Specific heating energy acc. Swiss standard SIA 380/1 = 36 MJ/m^2a
- Heating power demand acc. Swiss standard SIA 384.201 = 11.8 kW
- Supply and return temperatures at outside air temperature of -8°C are 30/25 °C

COSYPLACE – HEATING & COOLING SYSTEM



COSYPLACE – HEATING AND COOLING SYSTEM

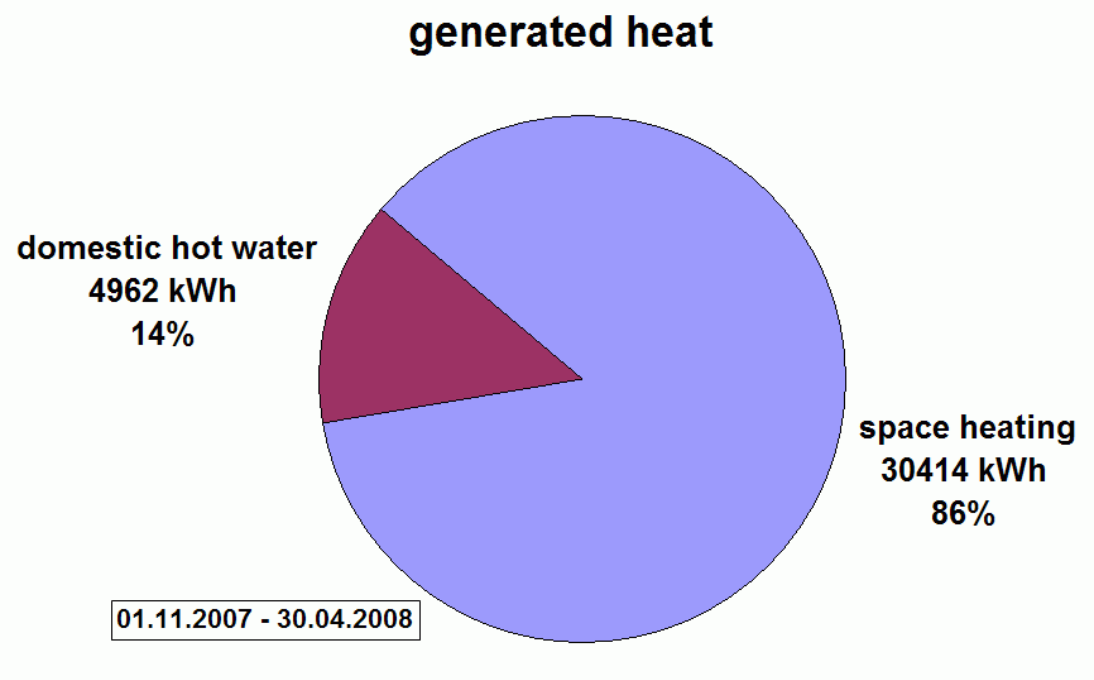
System:

- 15.5 kW heat pump
- 2 * 130 m ground heat exchanger (GHX)
- 800 l DHW boiler
- 300 l SH storage
- floor heating system (design temp. 30/25 °C)
- passive floor cooling with GHX
- mechanical ventilation with heat recovery & ground to air heat exchanger

COSYPLACE – ITEMS OF INVESTIGATION IN FIELD MONITORING PROJECT

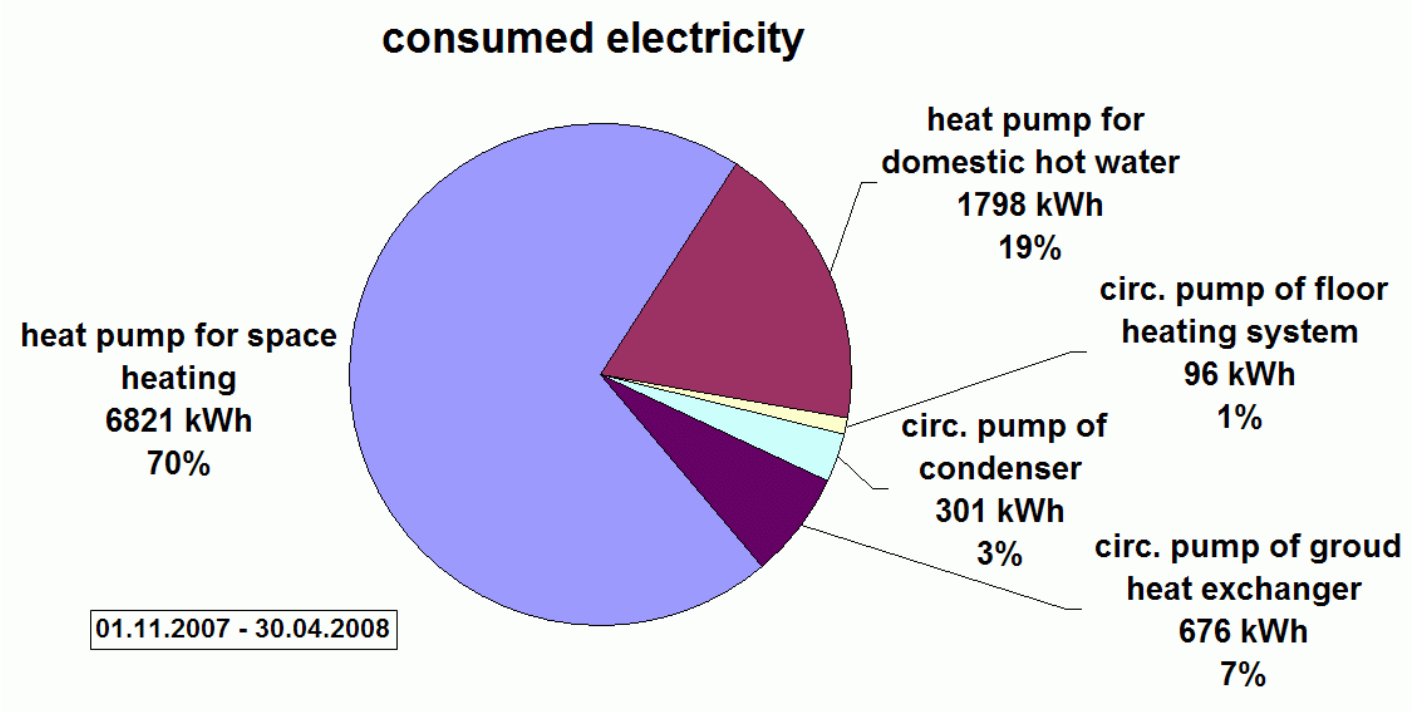
- Which room temperatures are reached?
- How much space heating energy is produced in total?
- How much energy is used for the DHW-operation?
- How much electricity is used for the generation of space heating and DHW?
- Seasonal performance of space heating and DHW?

COSYPLACE – BUILDING ENERGY PERFORMANCE



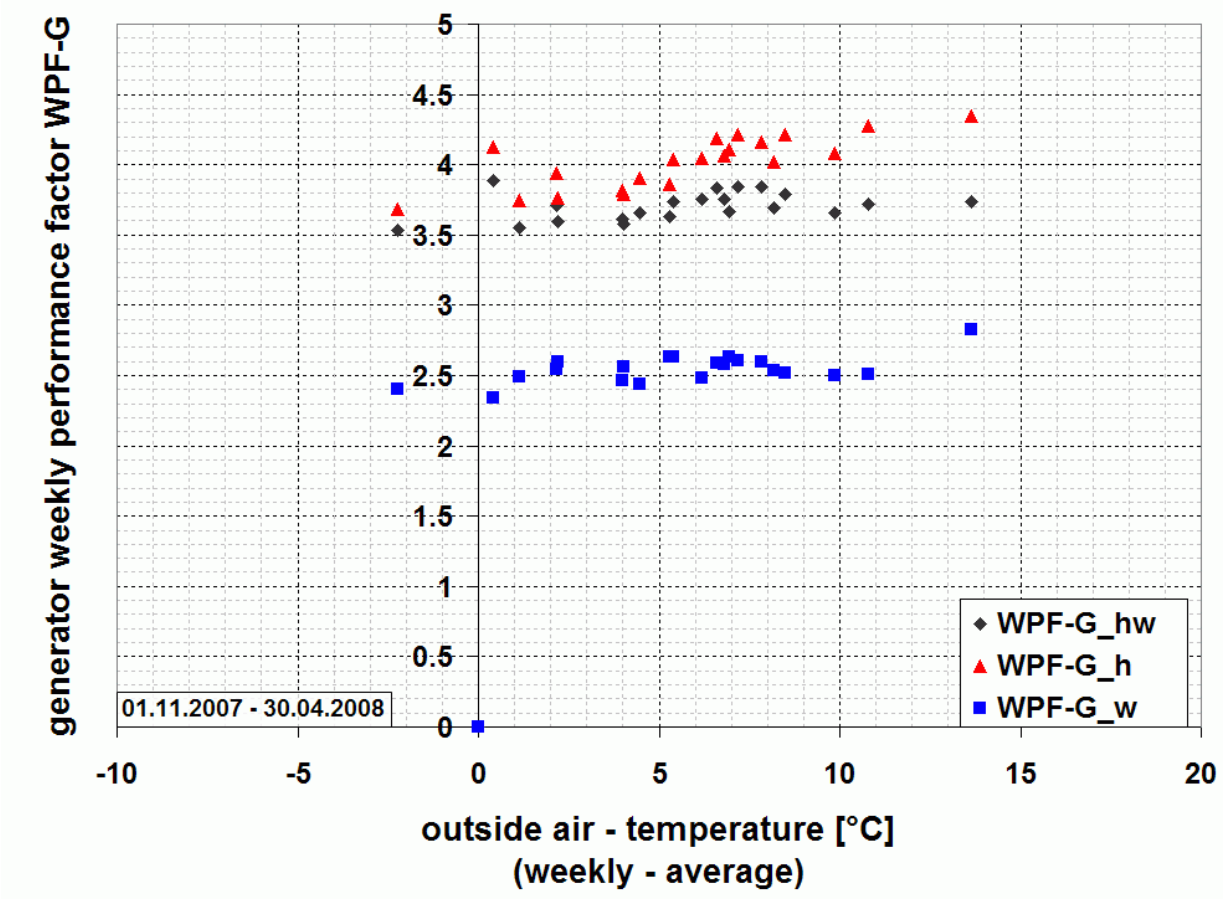
- 30'414 kWh or 103 MJ/m^{2}a for space heating only is compared to SIA 380/1 value of 36 MJ/m^{2}a rather high. Supposed reasons are room temperatures above 20°C, initial dry-out of the building and special user behaviour since not all apartments have been occupied yet and interior construction work was still going on.
- The domestic hot water consumption of 29.8 l/pers./d (4.96 kWh/pers./d) corresponds to a typical demand per person and day. (5.5 inhabitants at present)

COSYPLACE – BUILDING ENERGY PERFORMANCE



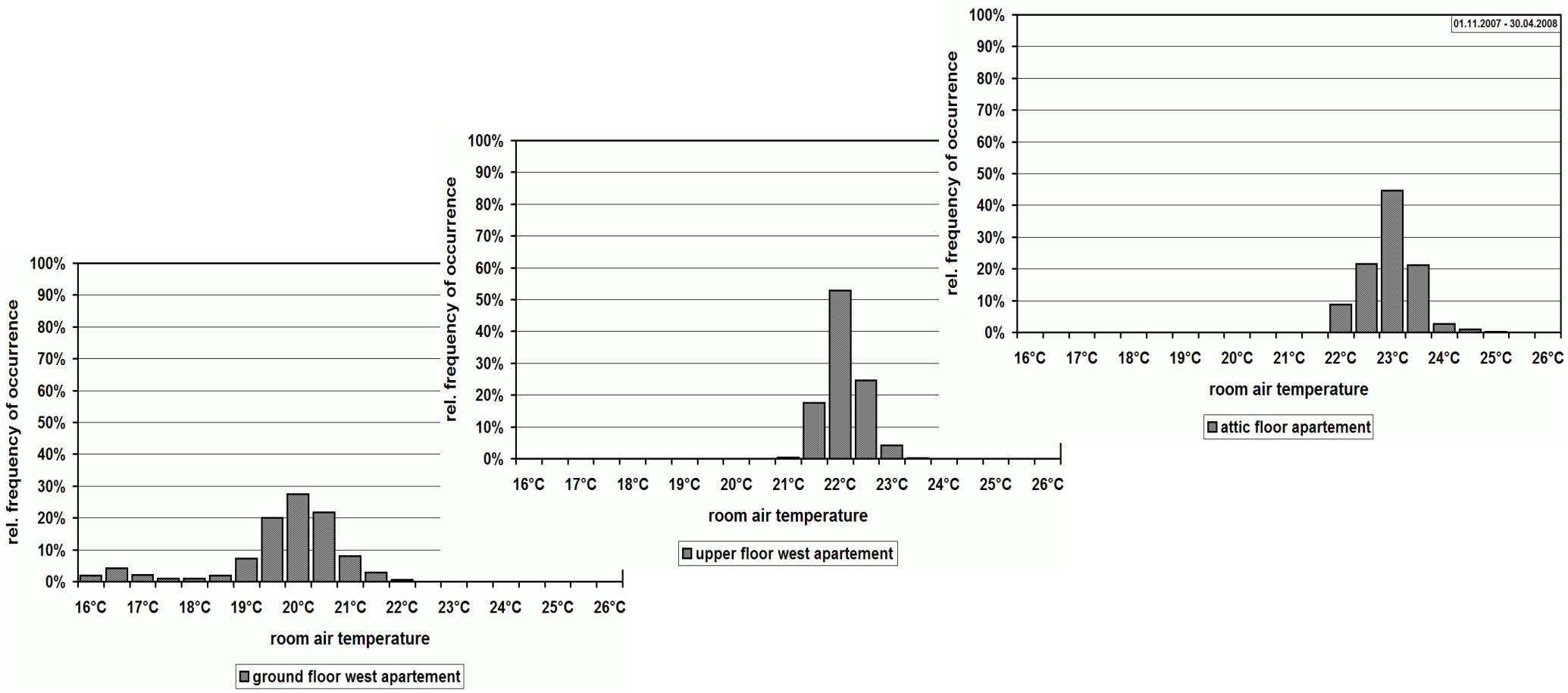
- electricity demand for heating 70 %, DHW 19 %, circulating pumps 11 %
- very low electricity demand of high efficiency floor heating circulating pump

COSYPLACE – HEAT PUMP PERFORMANCE



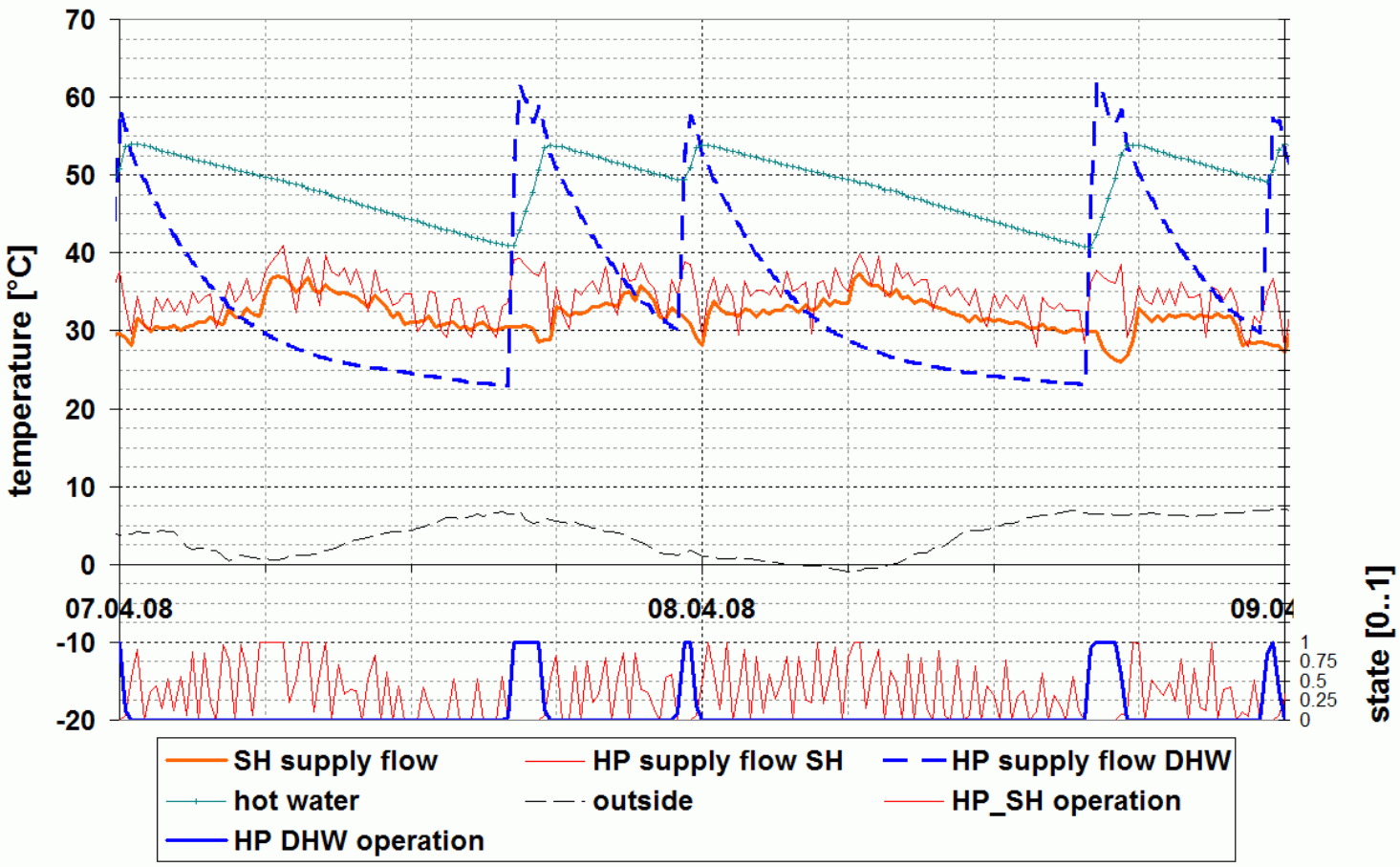
- **WPF-G: ratio between produced heat & consumed energy during a week of generator heat pump**
- **WPF-G_h (space heating): 3.7 … 4.3**
- **WPF-G_w (domestic hot water): ~ 2.5**

COSYPLACE – ROOM AIR TEMPERATURES



- **ground floor apartment: varies between 16 °C and 22 °C (over 88% in a range from 19 °C to 22 °C)**
- **upper floor apartment: mainly between 21.5 °C and 23 °C**
- **attic apartment: between 22 °C and 25 °C**

COSYPLACE – HEAT PUMP HEATING OPERATION DYNAMIC



- frequent cycling of heat pump with short operation times (presumably caused by variable temp. in small buffer storage)
- high supply flow temperature of heat pump with reduced mass flow
- relative low maximum temperature in DHW boiler compared to high HP supply flow

COSYPLACE – CONCLUSION

- **satisfactory efficiency of heat pump in heating and domestic hot water mode**
- **noticeable increased building space heating energy demand in first heating season (due to higher room temperatures and special user behaviour since not all apartments have been occupied yet)**
- **average room air temperatures in the range of 20 … 23 °C**
- **partly insufficient room air humidity, in the range of 20 … 50 %**
- **very low electricity demand of high efficiency floor heating circulating pump**
- **frequent cycling of heat pump with short operation times (presumably caused by variable temp. in small buffer storage)**

- see more in presentation
  GENERIC SYSTEM SOLUTIONS FOR HEATING AND COOLING OF RESIDENTIAL DWELLING
  in parallel session III, Thursday 8.50, room Zürich