EINSTEIN in the Spa

Case studies in thermal baths

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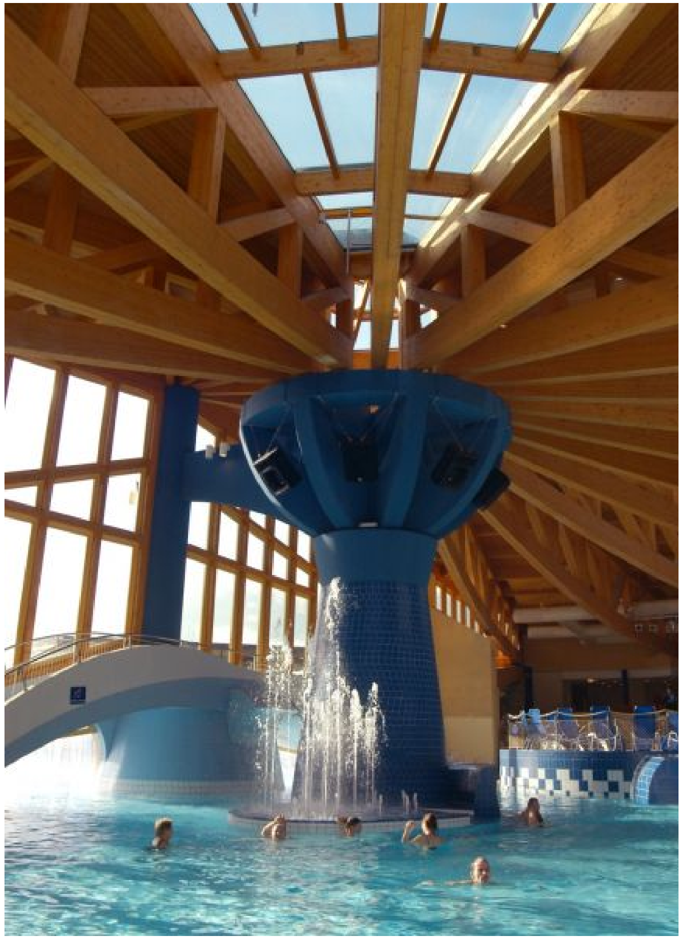
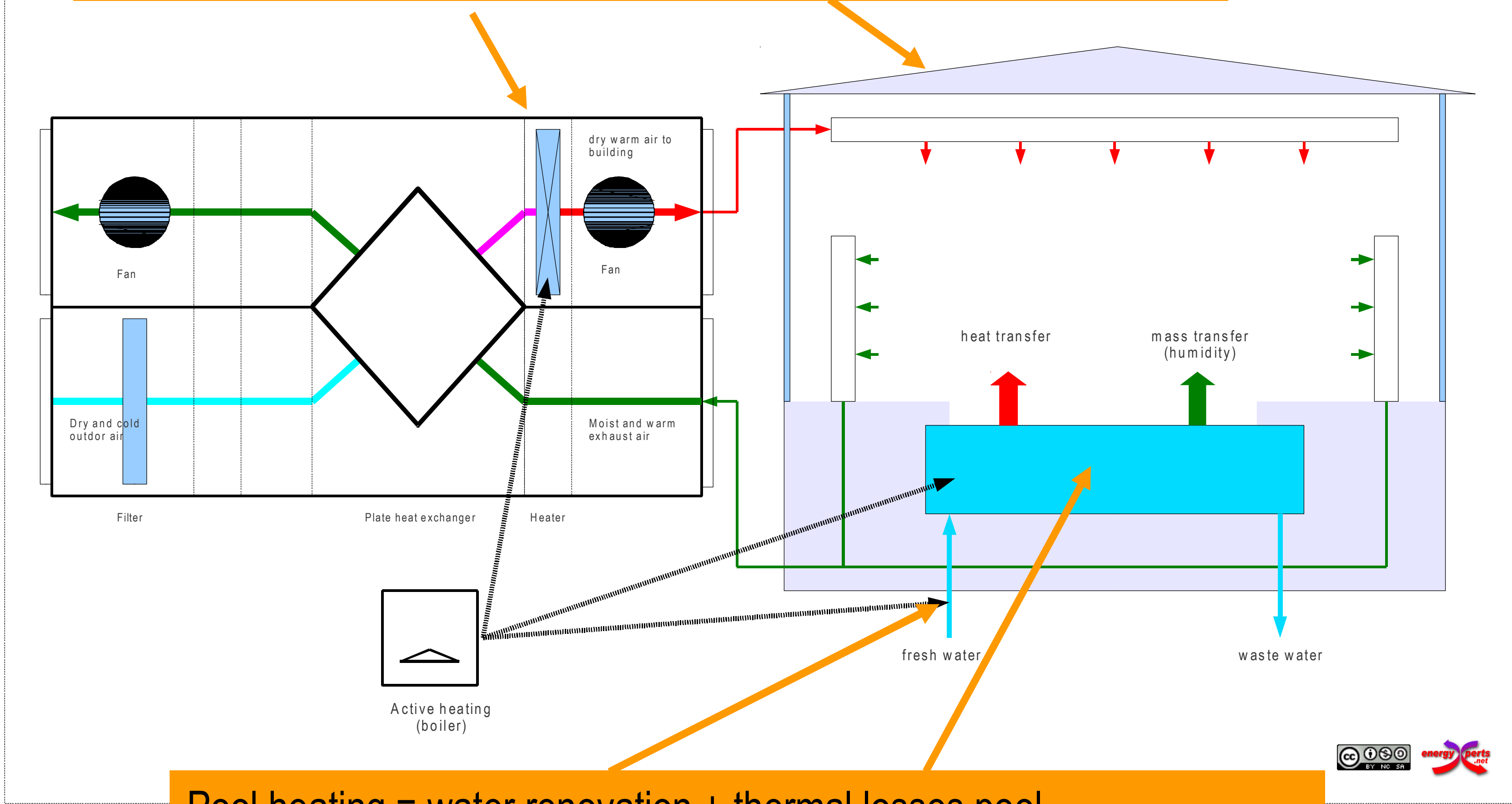
Analysis of present state

Pool areas in Spa’s



Energy demand in the Spa (pool areas)

Space heating = air renovation + thermal losses building envelope



Pool heating = water renovation + thermal losses pool

Typical air handling unit

Modeling aspects

Straightforward definition of processes might lead to the following:

- Space heating (as building in EINSTEIN)
- Pool heating (as process with circulation: water renovation and maintenance demand: pool losses)

Problem: large amount of heat dissipated from pool into building leads to high energy gains in the building

=> negative maintenance heat demand

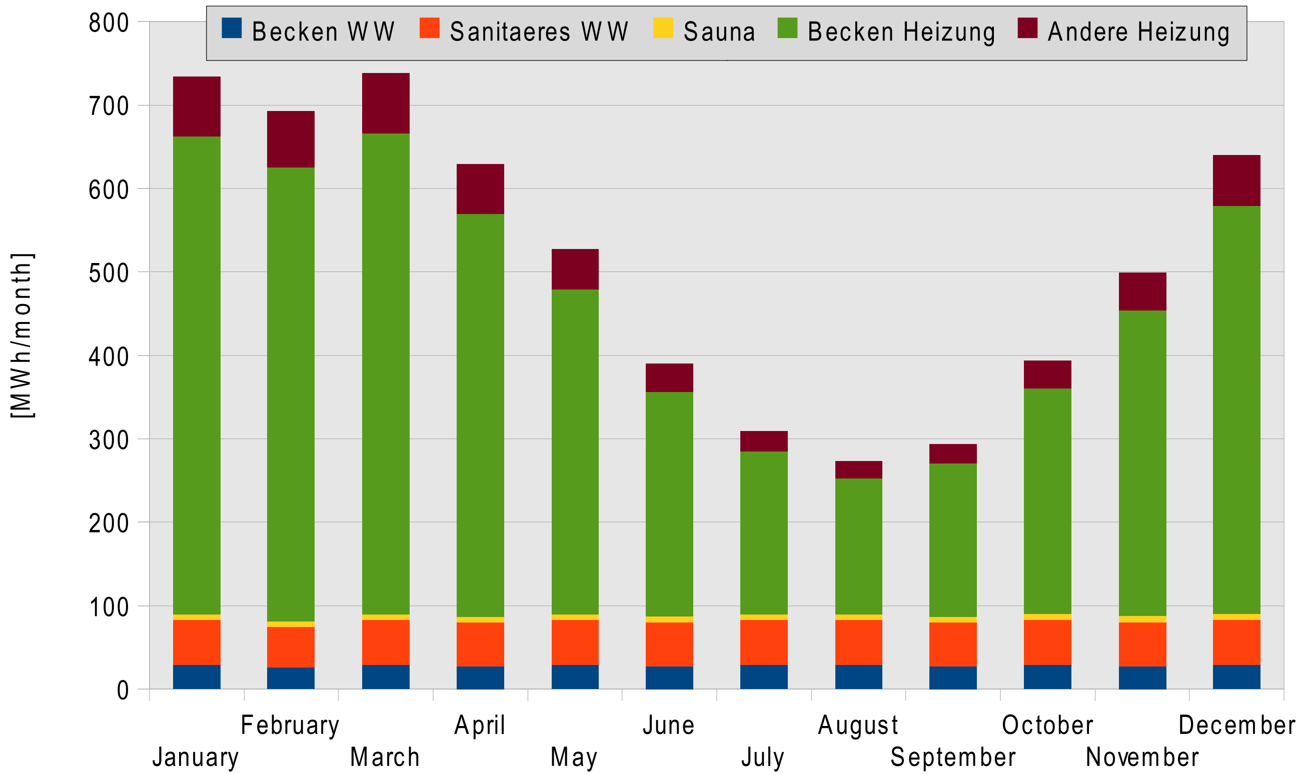
Q_maintenance = Thermal losses building – internal gains

=> direct modeling like this in EINSTEIN not possible, would require "tricks" and manual calculations

Solution: different grouping of energy demands

- Space heating <u>including maintenance of pool temperature</u> (as building in EINSTEIN, all year heating demand)
- Pool heating (<u>water renovation only</u>)

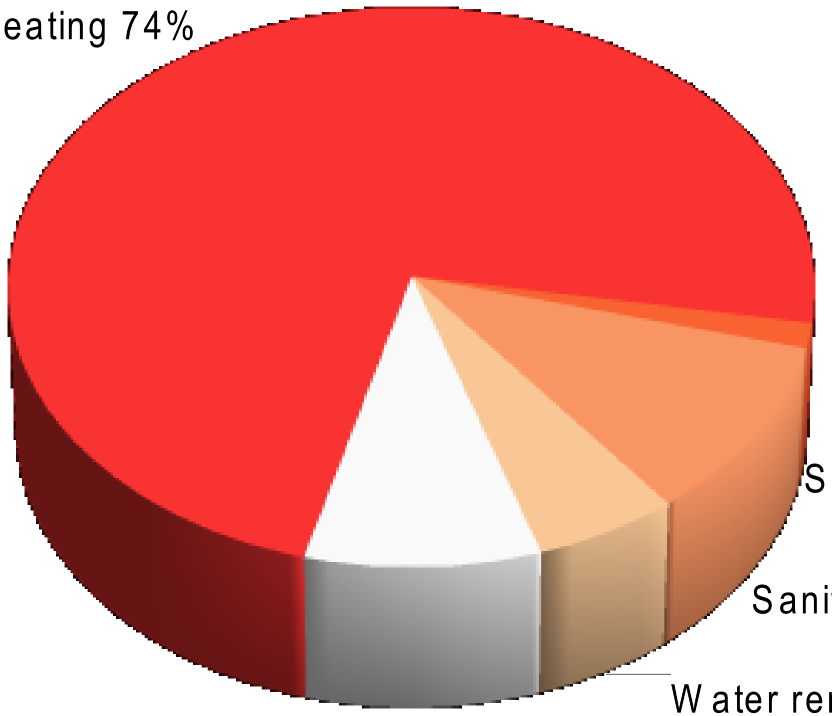
Composition of heat demand (2)



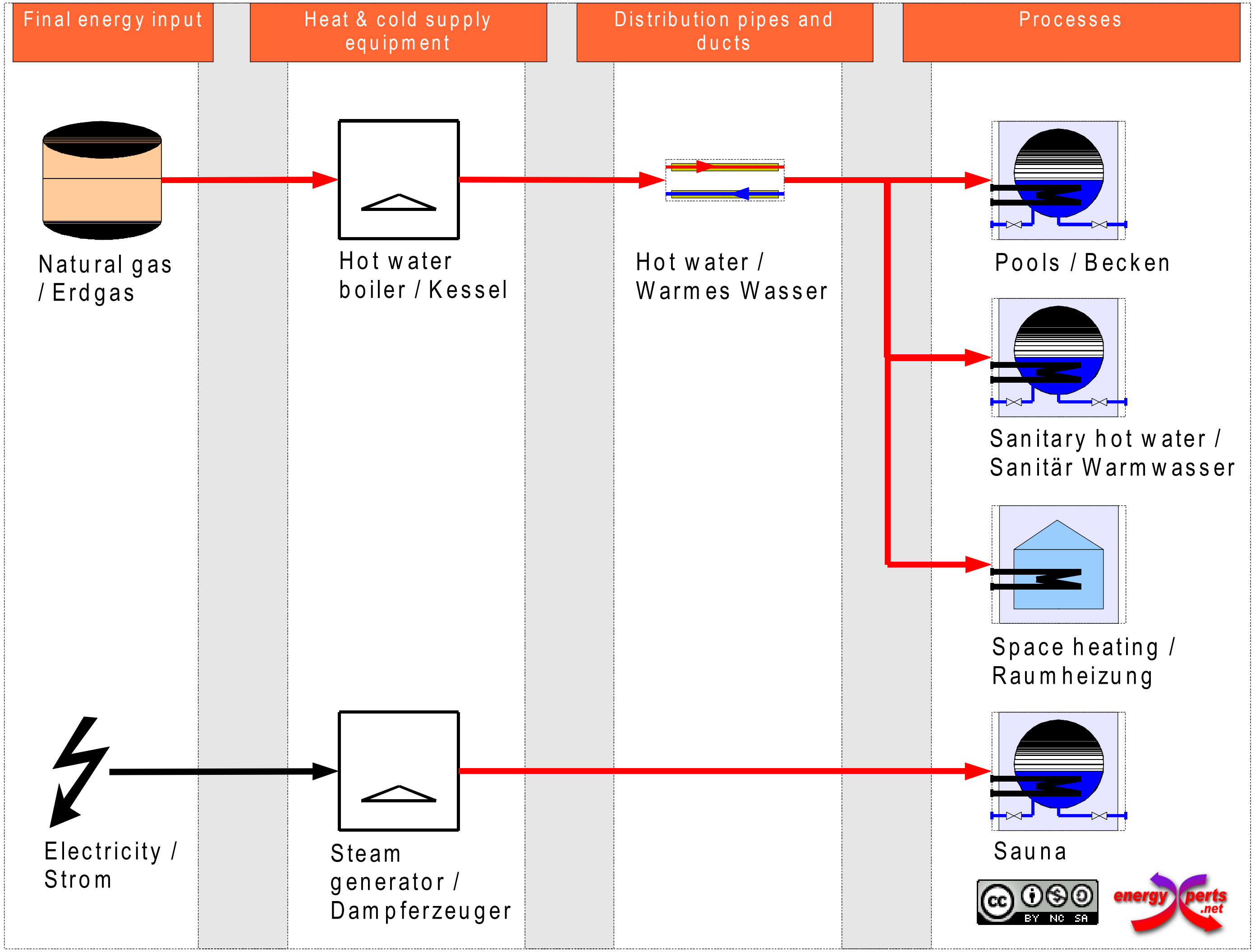
EINSTEIN limitations (restricted user input):

- Ratio of summer to winter heat demand is fixed (f_scale oscillates from 0,5 to 1,5)

Composition of heat demand



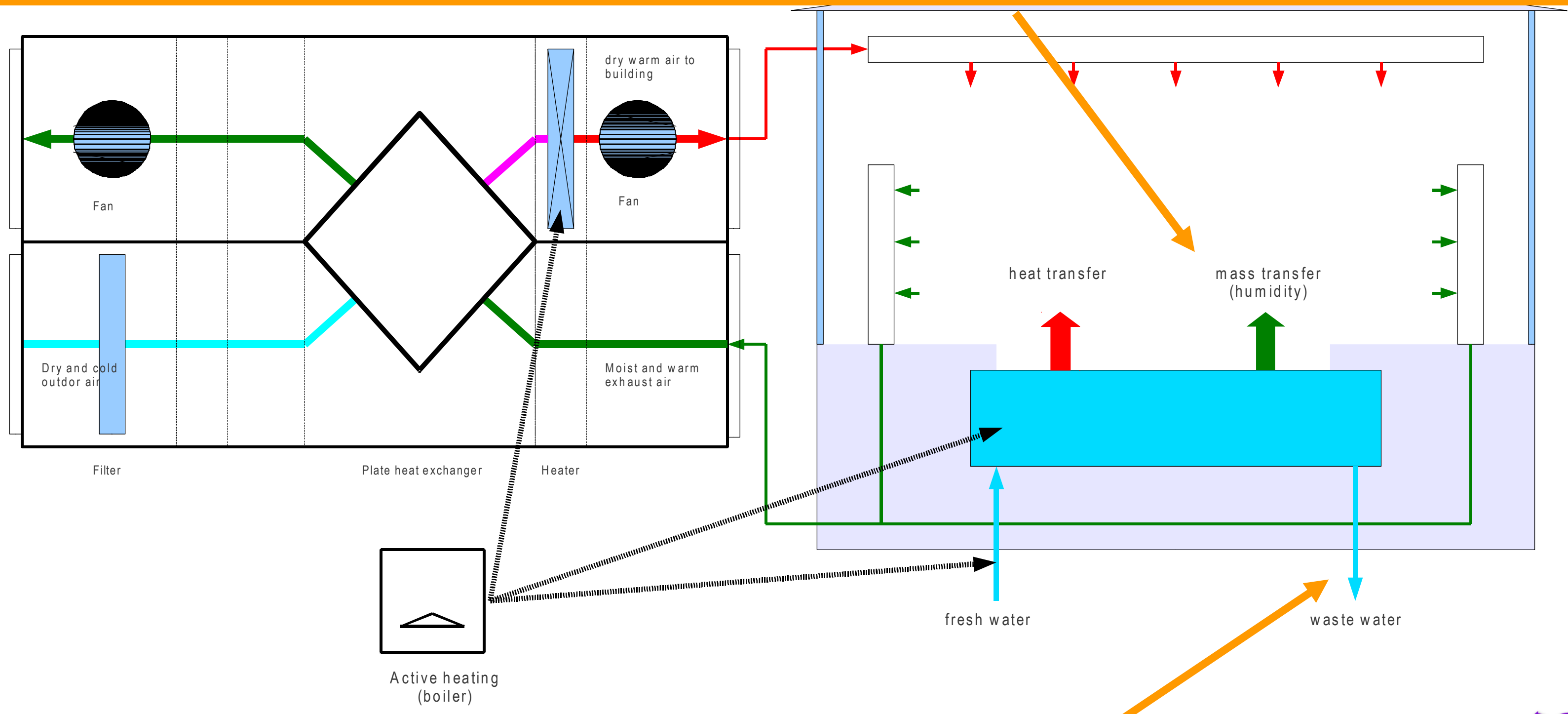
Heat supply system (present state)



Inefficiencies detected

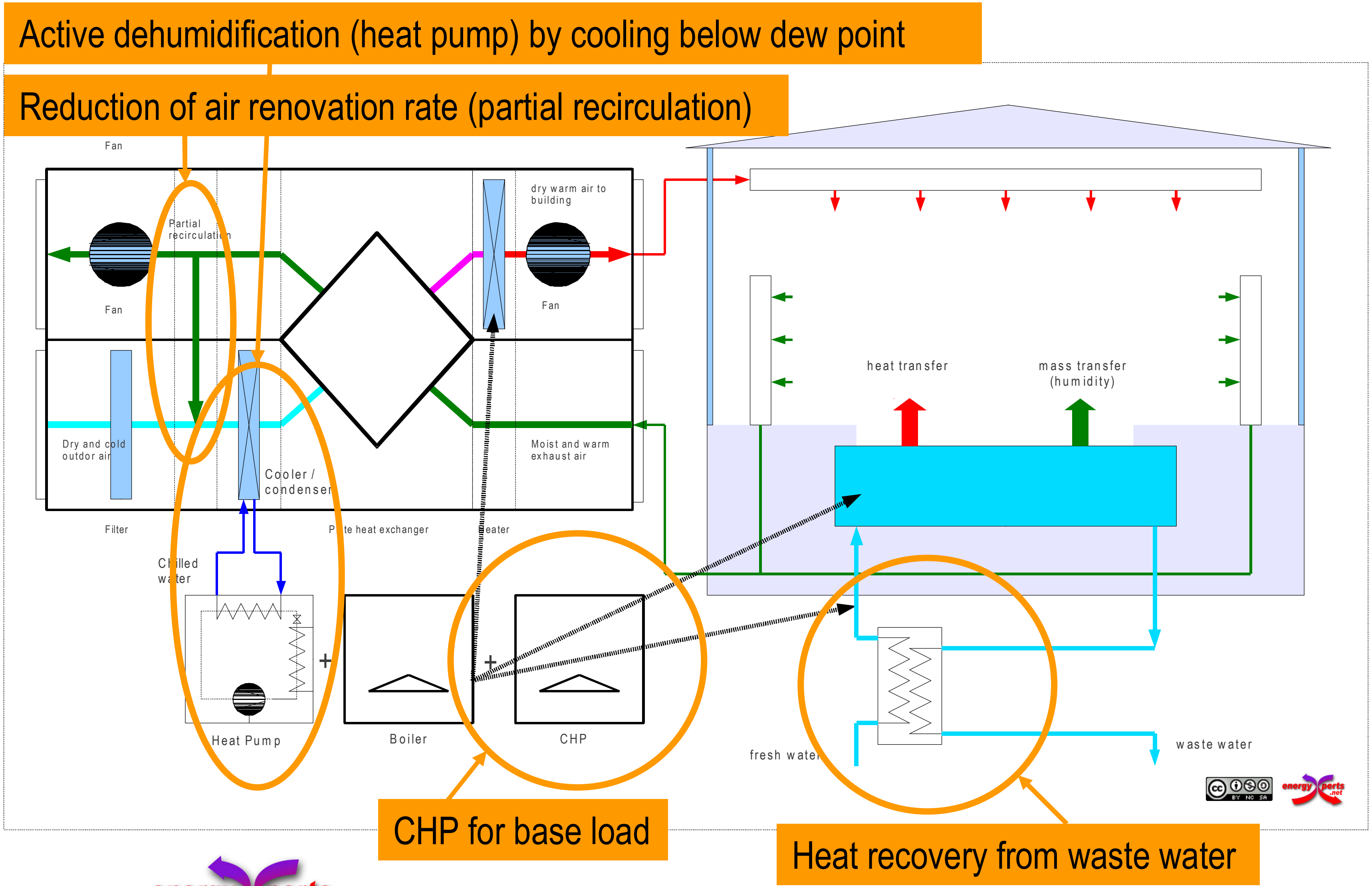
- Dehumidification by ventilation (increased air renovation rate)

  ⇒ Dehumidification for free, but at the price of higher heating demand



- No heat recovery from waste water

Measures studied



Modeling aspects: active dehumidification

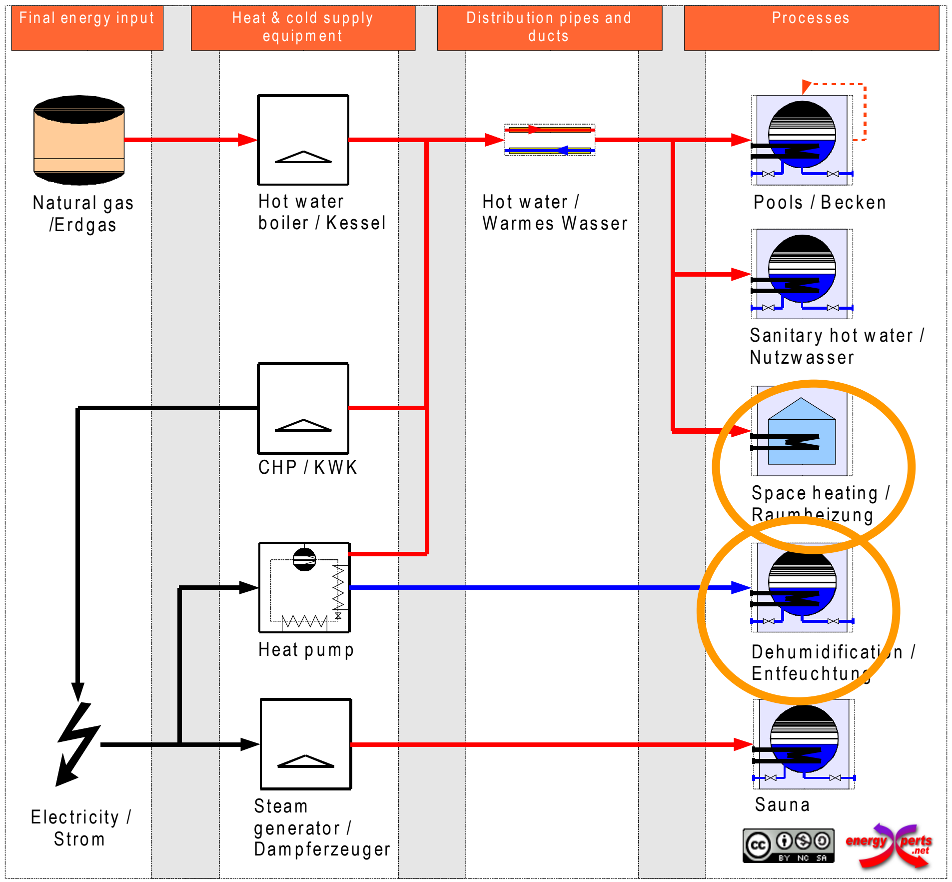
Modification of building heat demand (now possible in V2.2):

- Reduced air flow rate => reduced circulation heat demand

Introduction of a new process: cooling demand for dehumidification

Hypothesis and manual calculations necessary: no explicit treatment of humidity control in building module

- Hypothesis: Minimum required rate of air renovation
- Conversion of active dehumidification demand into an equivalent cooling demand (cooling power, temperature level)

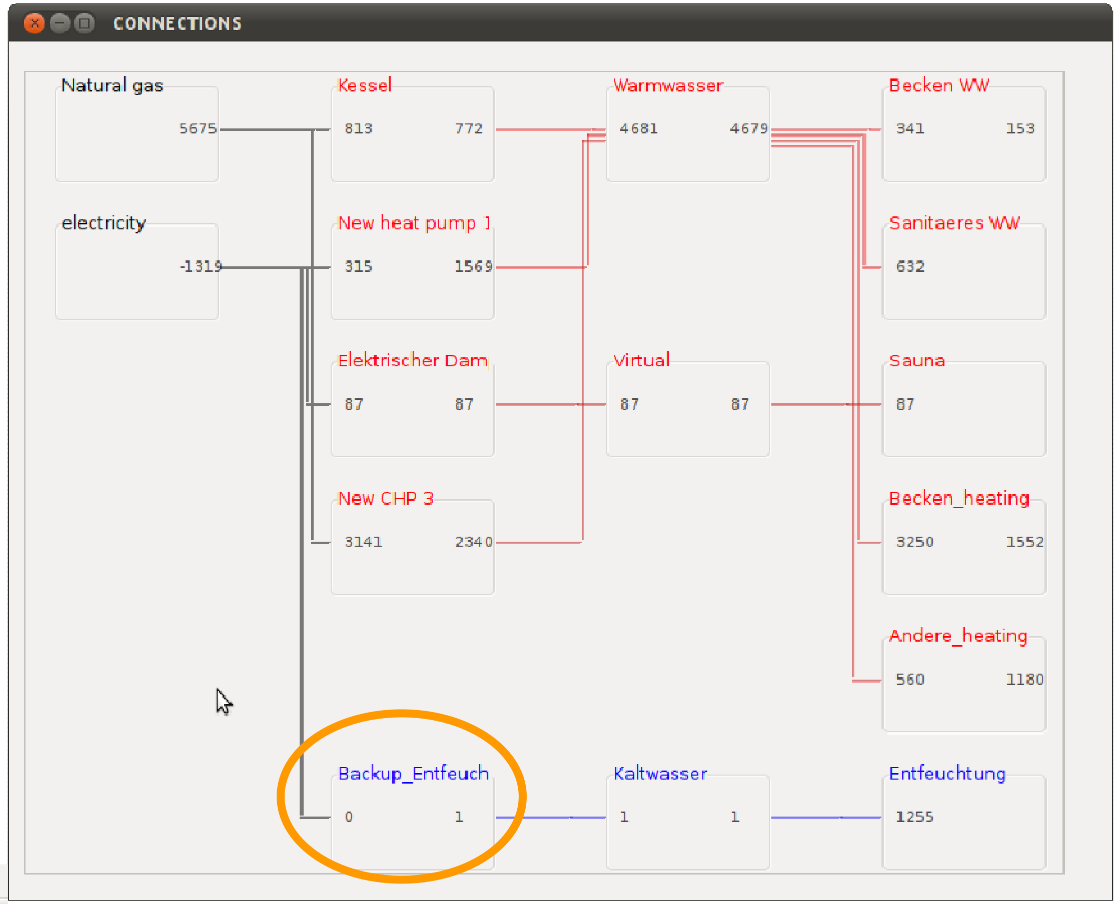


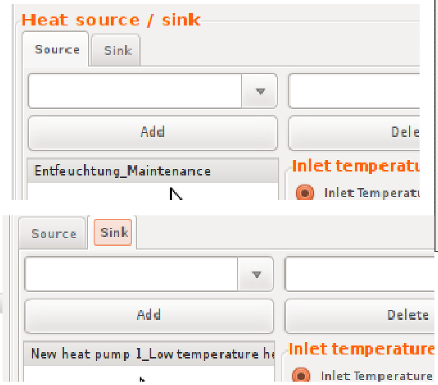
Modeling aspects: compression heat pump

Heat pump for simultaneous heating and cooling:

-Dummy chiller necessary

-Coupling of cooling side via virtual HX



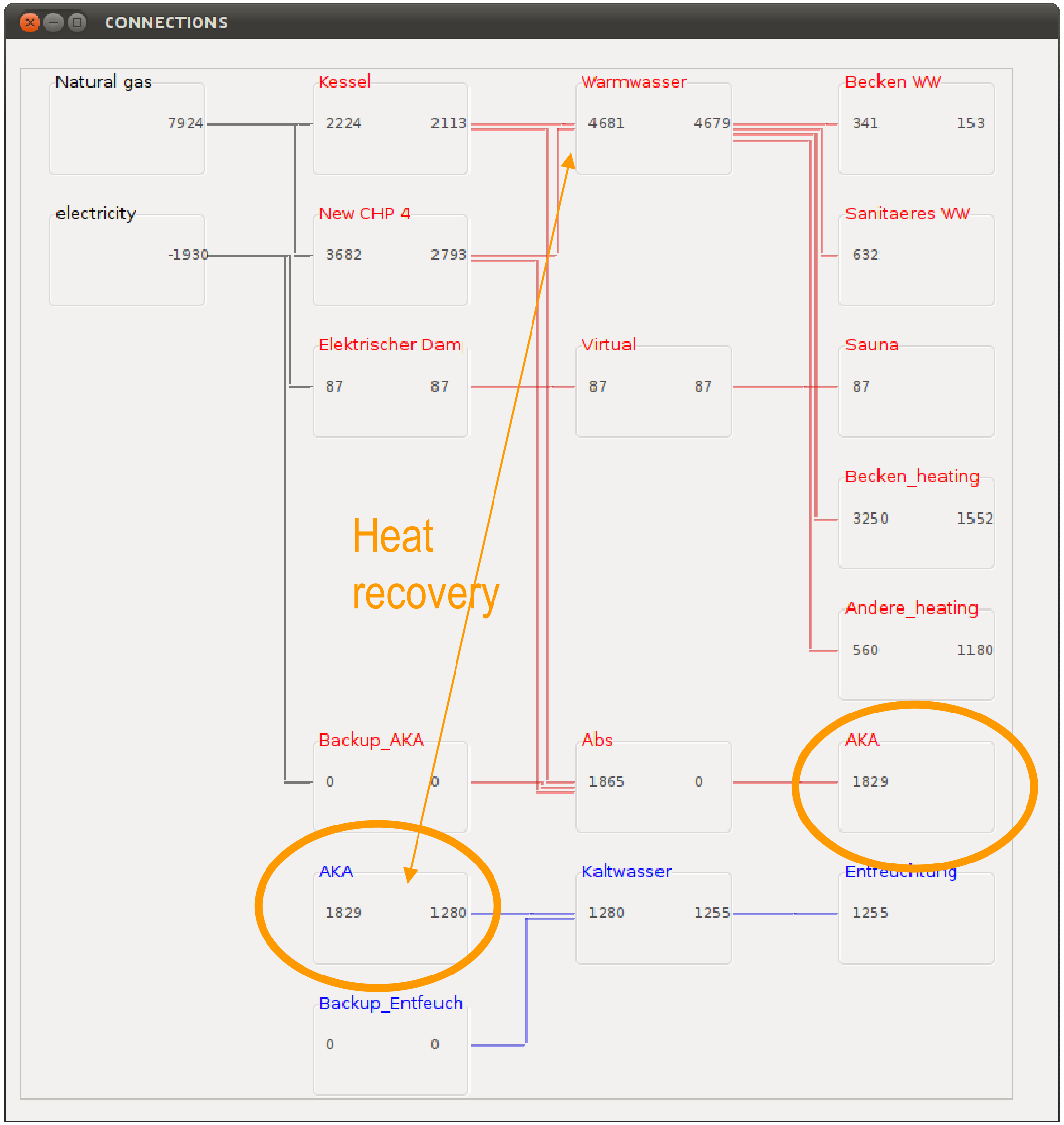


Modeling aspects: absorption chiller

Absorption chiller for simultaneous heating and cooling:

-Absorption chiller as cooling equipment

-Coupling of heating side via HX (connected to hot water pipe)



Comparison of alternatives

Alternatives studied

KWK:

CHP only (Current project of the company)

KWK + WP (finally proposed alternative):

CHP + active dehumidification (compression heat pump) + heat recovery

KWK + AKA:

Like CHP + WP, but with absorption heat pump

KWK + AKA + ST:

Like CHP + AKA, but additional solar thermal system

KWK2 + AKA:

Like CHP + AKA, but double size of CHP plant

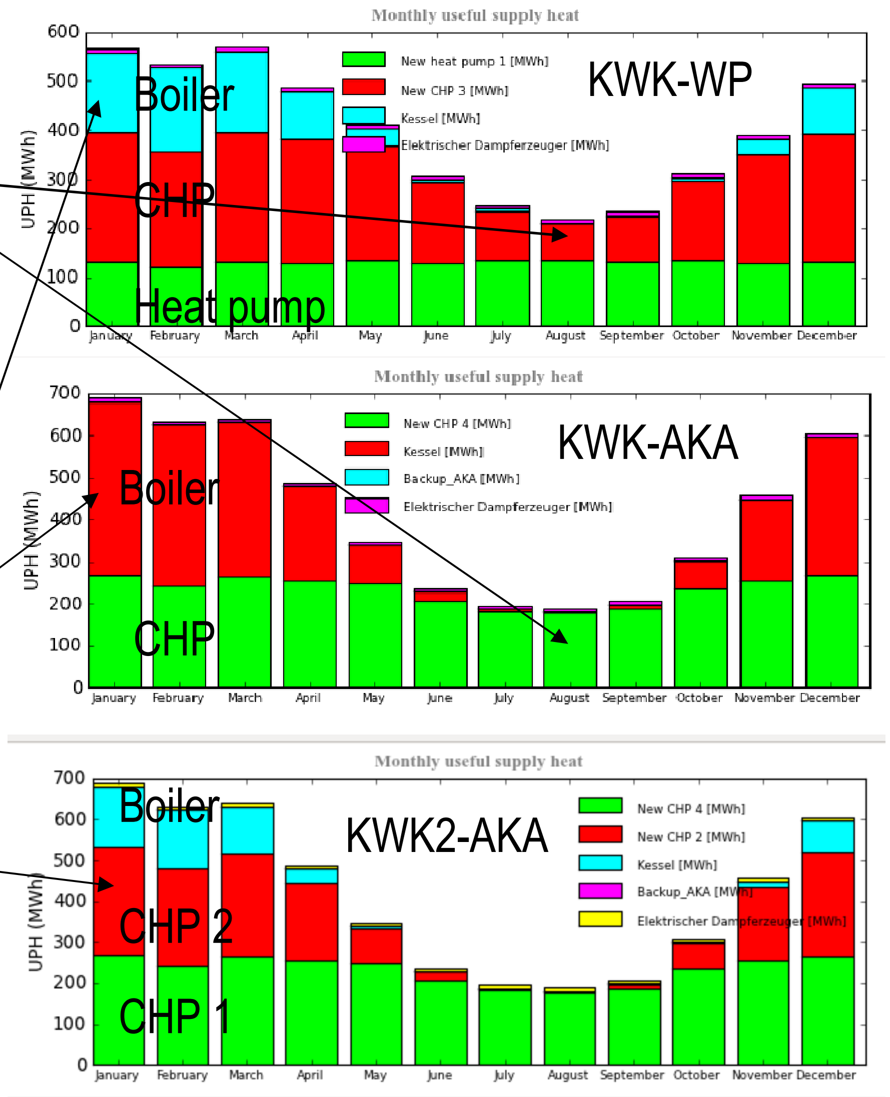
Design process 1: WP vs. AKA

Advantages absorption:

- Higher utilisation of CHP plant in summer

Disadvantage:

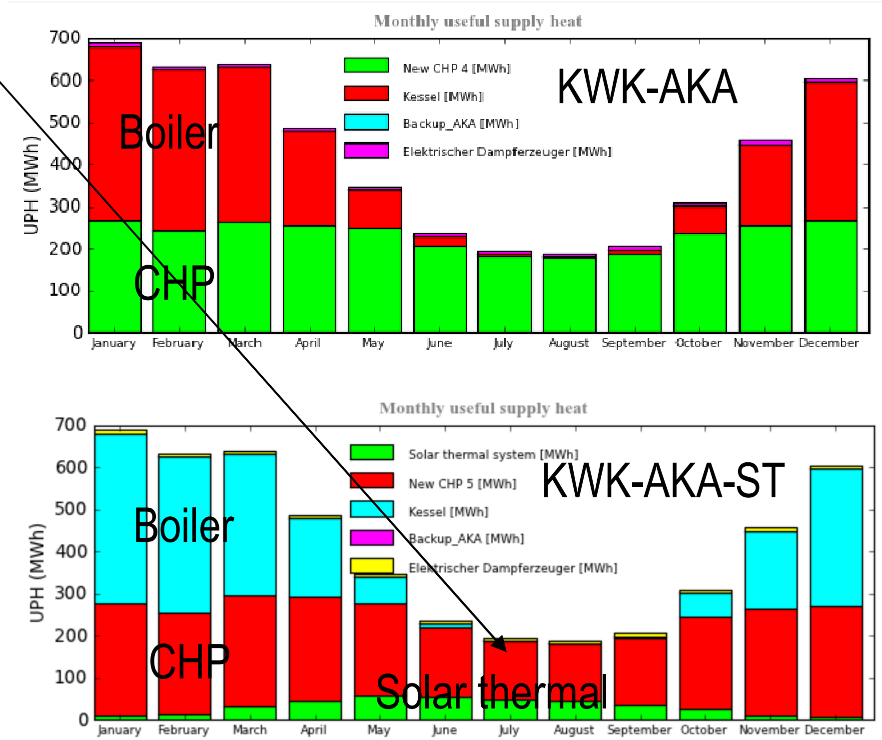
- Due to capacity constraint, additional heat demand partially covered by increased input from boiler
- Can be compensated by increased size of CHP



Design process 2: Addition of solar thermal

Problem of combined solutions CHP + solar:

- "Competing" for heat demand in summer



Alternatives: comparative study