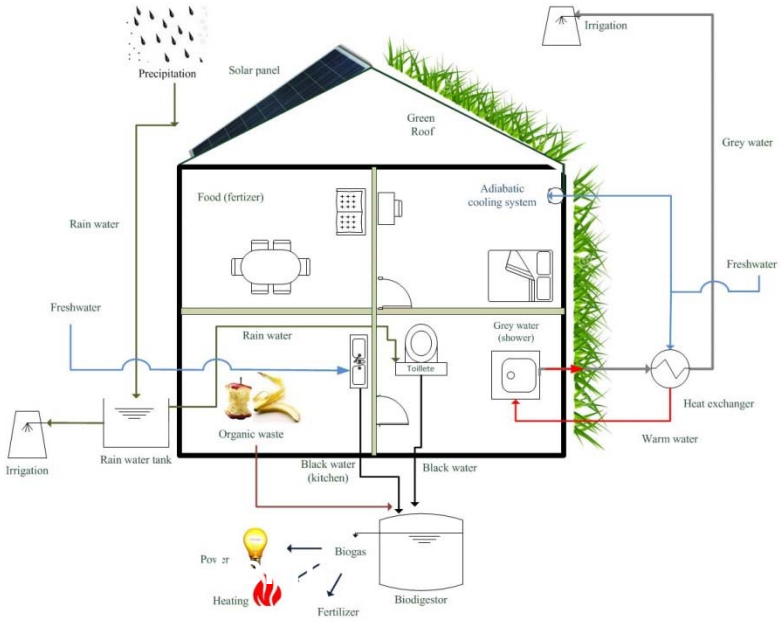
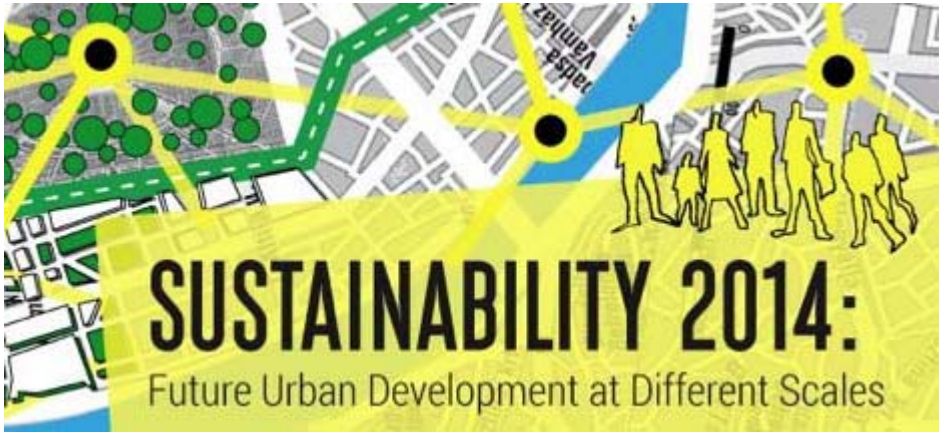
Karlsruhe Institute of Technology

ITAS Institute for Technology Assessment and Systems Analysis

Developing the energy saving building to more resource efficiency





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Heidelberg – Old Town

Heidelberg Bahnstadt

Area of urban district: 116 ha
Inhabitants in future: ~ 5.000
Working places in future: ~ 7.000
All buildings according passive house standard ➡ energy demand for heating: from ~ 200 kWh/(m² a) to ≤ 15 kWh /(m² a)

Passive house standard: only the beginning . . .

Energy

- to warm rooms (passive house) **≤ 675 kWh/(P a)**

- to warm water **~ 1200-1400 kWh/(P a)**

- Contained in black water (toilet)
  Nitrogen and Phosphorous: **ca. 100 kWh/(P a)**
  Carbon compounds (biogas): **ca. 100 kWh/(P a)**

Building Materials
Different kinds of solid waste
Different kinds of waste water

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Building Materials

Different kinds of solid waste

Different kinds of waste water

Waste water: an important resource

For the supply of

- thermal energy (grey water)
- process water
- chemical energy (carbon-compounds -> biogas)
- nutrients (Nitrogen, Phosphorous, Potassium)

Don‘t mix !

**To make available this new ressource optimally,
a separate treatment of
different partial flows of waste water is recommended**

Separate pipe systems are necessary

Step I:
separate treatment of storm water

But pollution of stormwater by building materials possible !

Options for reuse: storage and use for

- Irrigation
- Process water in the household (e.g. toile
- Infiltration to raise groundwater level
- Leading to surface waters to increase the
- Design urban living spaces

Pollution of stormwater and combined sewage

Regulation for roof material and house installations is necessary

Parameter	Storm water	Sewage
COD [mg/l]	**47 – 120**	**176 – 720**
NH_4-N [mg/l]	**0,1 – 4,0**	**0,1 – 17**
PO_4-P [mg/l]	**0,3 - 1,7**	**3,0 – 4,3**
TSS [mg/l]	**7 – 446**	**327 – 758**
lead [µg/l]	**20 – 422**	**12 – 213**
copper [µg/l]	**10 – 235**	**27 – 136**
cadmium [µg/l]	**5 – 16**	**0,7 – 4,7**
zinc [µg/l]	**610 – 6100**	**411 – 1430**

[Fuchs 2000]

Step II:
Further separation of domestic sewage

⇨ depending on
- specific volumes
- place of origin

⇨ depending on the content of
- energy
- pollutants
- nutrients
- germs

in

⇨ **Grey Water** from bathtub, shower, washing machine

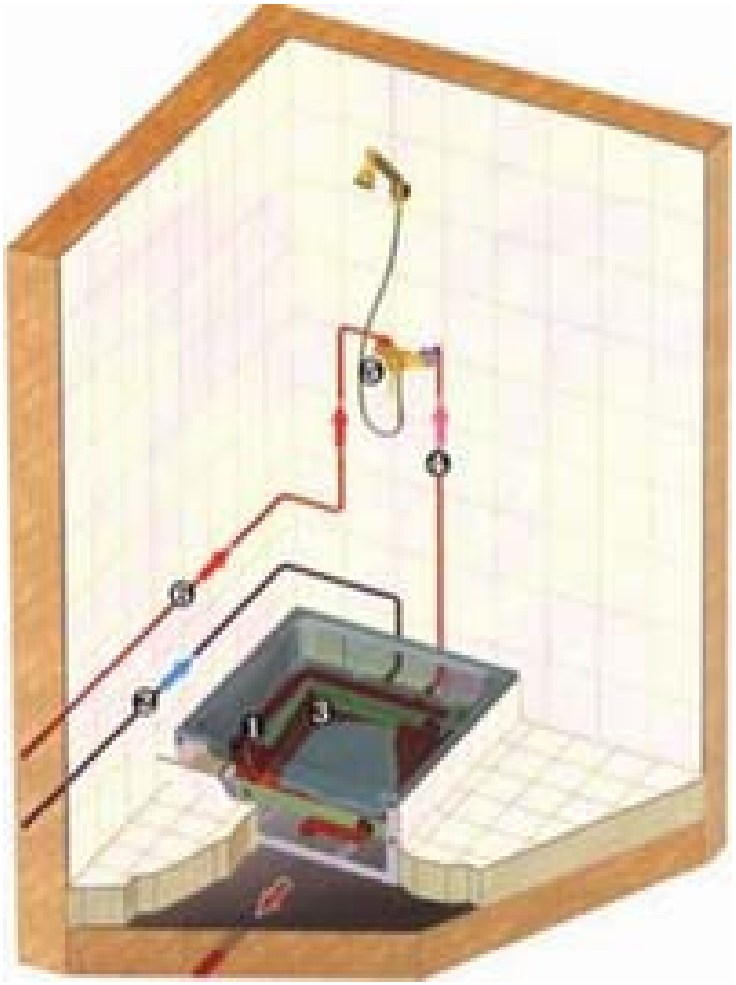
⇨ **Black Water** from toilet, (kitchen)

Specific volumes and mass flows in domestic sewage

		Grey water	Black water
Parameter	Mass Flow (kg/cap* year)	Specific volume (l/capita*year)	
		~ 30.000	~ 550

[Otterpohl 2001]

Heat Recovery from Grey Water



Heat exchanger

Heat Recovery in a Passive House of 41 flats in Berlin

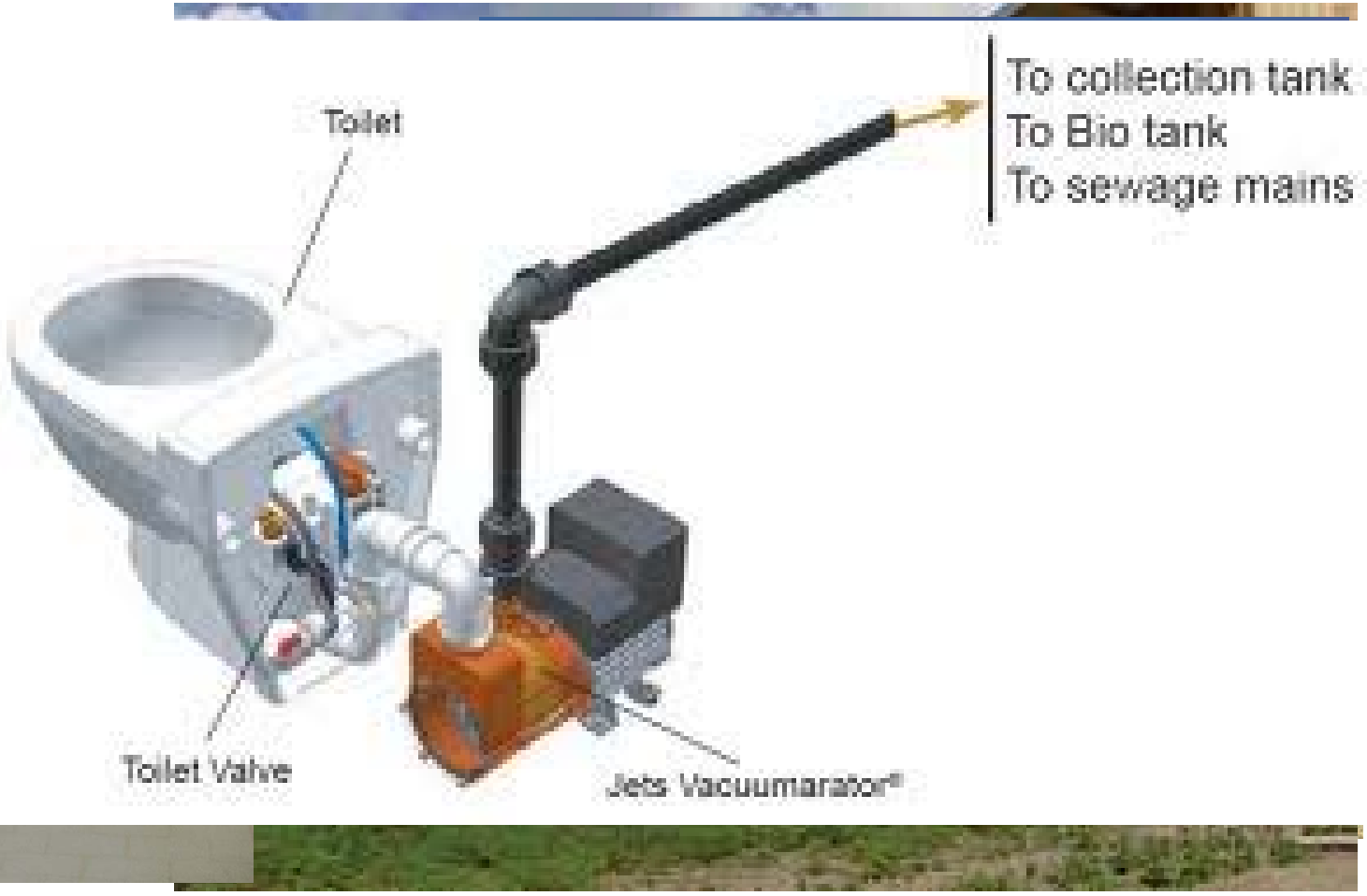

Grey water
treatment
Grey water
heat exchanger

Mass flows in domestic sewage

		Grey water	Black water
Parameter	Mass Flow (kg/cap* year)	Specific volume (l/capita*year)	
		~ 30.000	~ 550
		percentage	percentage
Nitrogen (N)	~ 4 - 5	~ 3 %	~ 97 %
Phosphorous (P)	~ 0,75	~ 10 %	~ 90 %
Potassium (K)	~ 1,8	~ 34 %	~ 66 %
COD	~ 30	~ 41 %	~ 59 %

[Otterpohl 2001]

Decentralised waste water infrastructure – case of Lübeck



Step III: Separation of urine

- Highest concentration of nutrients

	Grey Water (GW)	Urine	Feces
Parameter Massflow	**30.000 l/cap yr**	**~ 500 l/cap yr = 1 % of GW**	**~ 50 l/cap yr** = 1‰ of GW
Nitrogen (N) ~4 – 5 kg/cap yr	**~ 3 %**	**~ 87 %**	**~ 10 %**
Phosphorous (P) ~0,75 kg/cap yr	**~ 10 %**	**~ 50 %**	**~ 40 %**
Potassium (K) ~1,8 kg/cap yr	**~ 34 %**	**~ 54 %**	**~ 12 %**
COD	**~ 41 %**	**~ 12 %**	**~ 47 %**

Swedish toilets for separation of urine

German model of a no mix toilet

Toilettenschüssel (Seitenansicht)
Toilet bowl (side view)

Toilettenschüssel (Pfeil zeigt auf Urinablauf)
Toilet bowl (arrow points to urine drain)

Step III: Separation of urine

- Highest concentration of nutrients
- - use in agriculture (Sweden)

  - conversion to a mineral fertilizer (GIZ, EAWAG)

  - reducing costs for de-nitrification in classical WWTP
- Separation of pharmaceuticals

But: cultural reservation, limited acceptance, technical problems

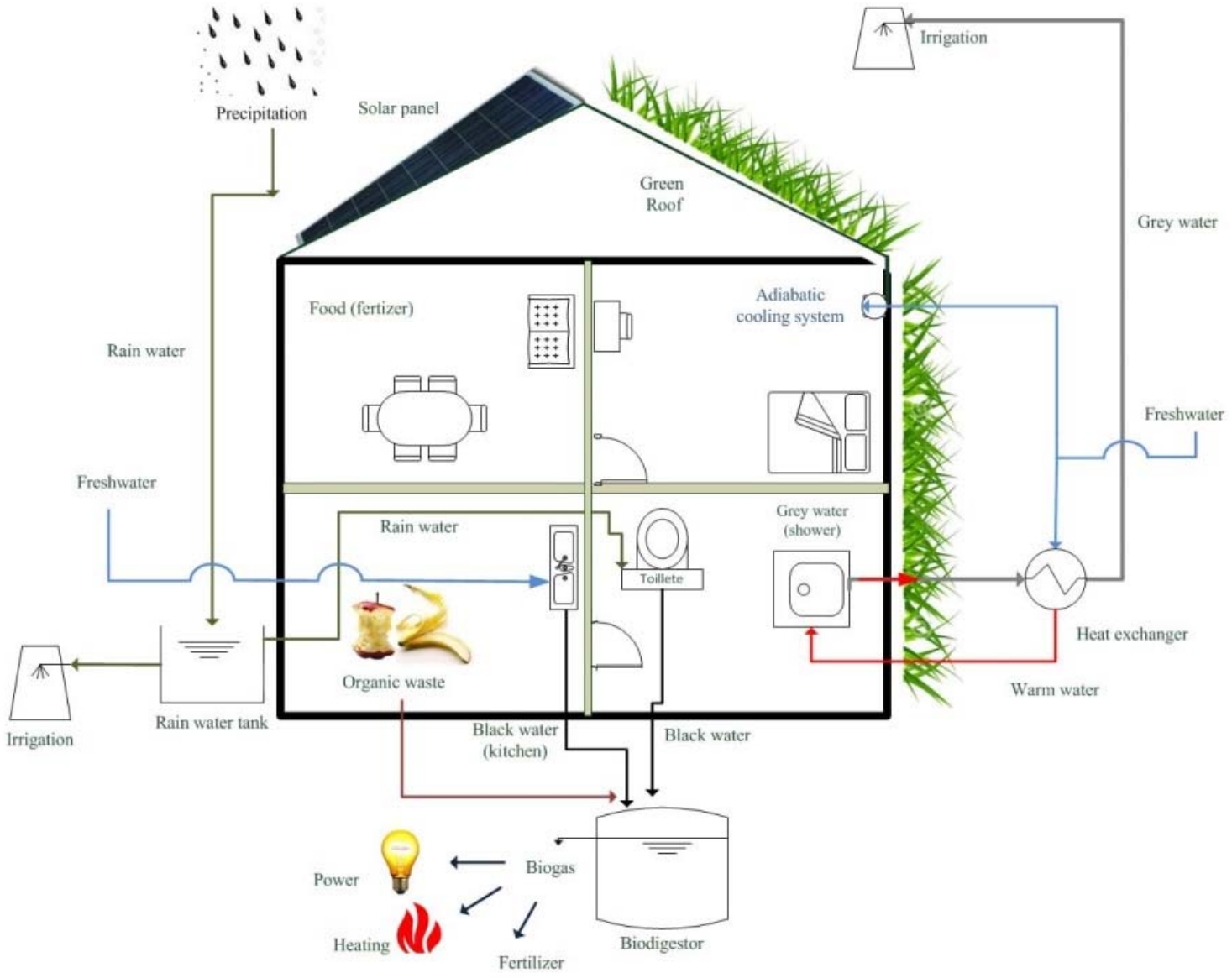
Adiabatic cooling of buildings with water

Evaporation of 1 kg water at 35 °C needs 0,67 kWh or 577 kcal

To replace classical air conditioning
- by plants (transpiration of trees…)

saves energy but needs more water
option: recycling of grey water

Waterflows in a resource efficient house



Waste Water Separation is…

… a promising option for **new built up areas**:

-> chance to leapfrog the traditional sewerage system

Therefore the energy efficient house should be further developed to **the resource efficient building**

necessity of different pipe systems

-> concepts for new buildings should be more flexible and upwards compatible

Hamburg: new settlement „Jenfelder Au“
for 2.000 residents under construction

Thank you very much

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