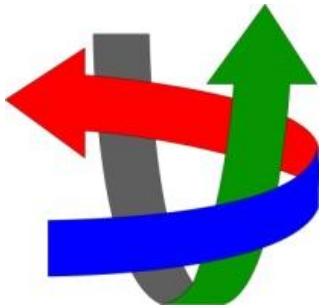
Nolde & Partner
innovative Wasserkonzepte

DECENTRALISED WATER AND ENERGY RECYCLING IN BUILDINGS: A CORNERSTONE FOR WATER, ENERGY AND CO_2 EMISSIONS REDUCTION



Speaker: Erwin Nolde, Berlin
mail@nolde-partner.de

Water Efficiency Conference 2014
Brighton, UK

Water and Energy Recycling (1960)

1. Energy production is a high water consuming process

Water demand of cooling tower[1] for the production of 1 $kWh_{elec.}$ from

- oil/gas: 2.6 litres of water/kWh
- nuclear reactor: 3.2 litres of water/kWh

- **CO_2 Production[2]:**
  Average Germany: 0.6 kg CO_2/$kWh_{elec.}$
- **Decreasing primary energy factor:**
  from 3.0 to 2.7, 2.6 and 2.4 (2014)
  to 1.8 $kWh_{prim.}$/ $kWh_{elec.}$ (2016)

[1] http://www.energieverbraucher.de/de/Umwelt-Politik/Umwelt-und-Klima/site__894/
[2] http://www.co2-emissionen-vergleichen.de/Stromerzeugung/CO2-Vergleich-Stromerzeugung.html#CO2-Vergleich-Stromerzeugung

2. Water treatment and distribution is a high energy consuming process

- **Berlin 2012**:
  Public water supply and wastewater treatment (for 3.5 m people excluding industrial sector) requires as much electrical energy as the household demand of a city with 280,000 inhabitants.
  (http://www.bwb.de/content/language1/html/7198.php 8326.php)

  Specific elec. energy demand in Germany:
  approx. 1 - 3 kWh/m³ and more.

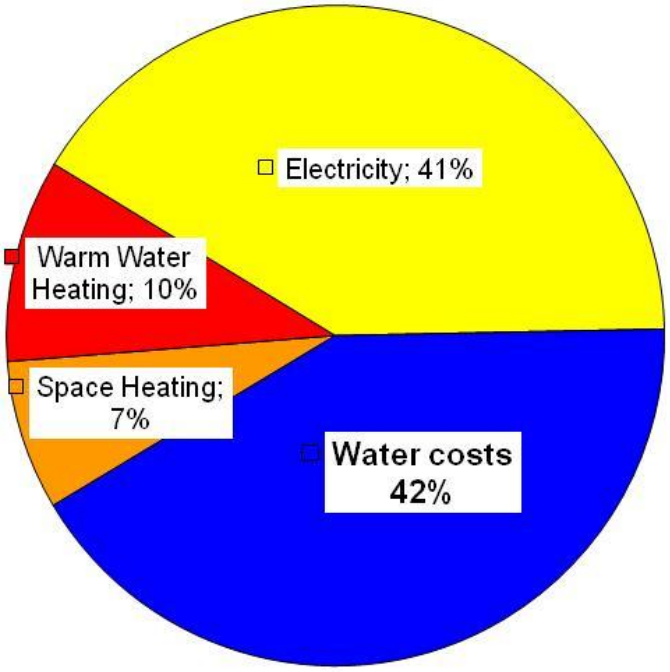
- Energy demand for only **desalination:** ca. **5 kWh/m³**
  (depending on salt concentration)
  - excluding water and wastewater transport and treatment and environmental impacts
  - produce three times more wastewater and CO_2

  (http://www.pca-gmbh.com/appli/desal.htm)

Requirements for water and energy recycling

- no hygienic risk for users
- no loss of comfort
- environmentally friendly
- low maintenance technology
- cost efficient

Energy and water costs in a passive house (123 persons and 41 dwellings covering an area of 4,600 m²)



	specific demand		yearly demand	unit	price		yearly costs
Space Heating	15	kWh/m²/a	69.000	kWh/a	0,07 €	/kWh (Gas)	4.830,00 €
Warm Water Heating	760	kWh/P/a	93.480	kWh/a	0,07 €	/kWh (Gas)	6.543,60 €
Electricity	875	kWh/P/a	107.625	kWh/a	0,25 €	/kWh	26.906,25 €
Water	122	L/P/d	5.477	m³/a	5,00 €	/m³	27.385,95 €
						total	65.665,80 €

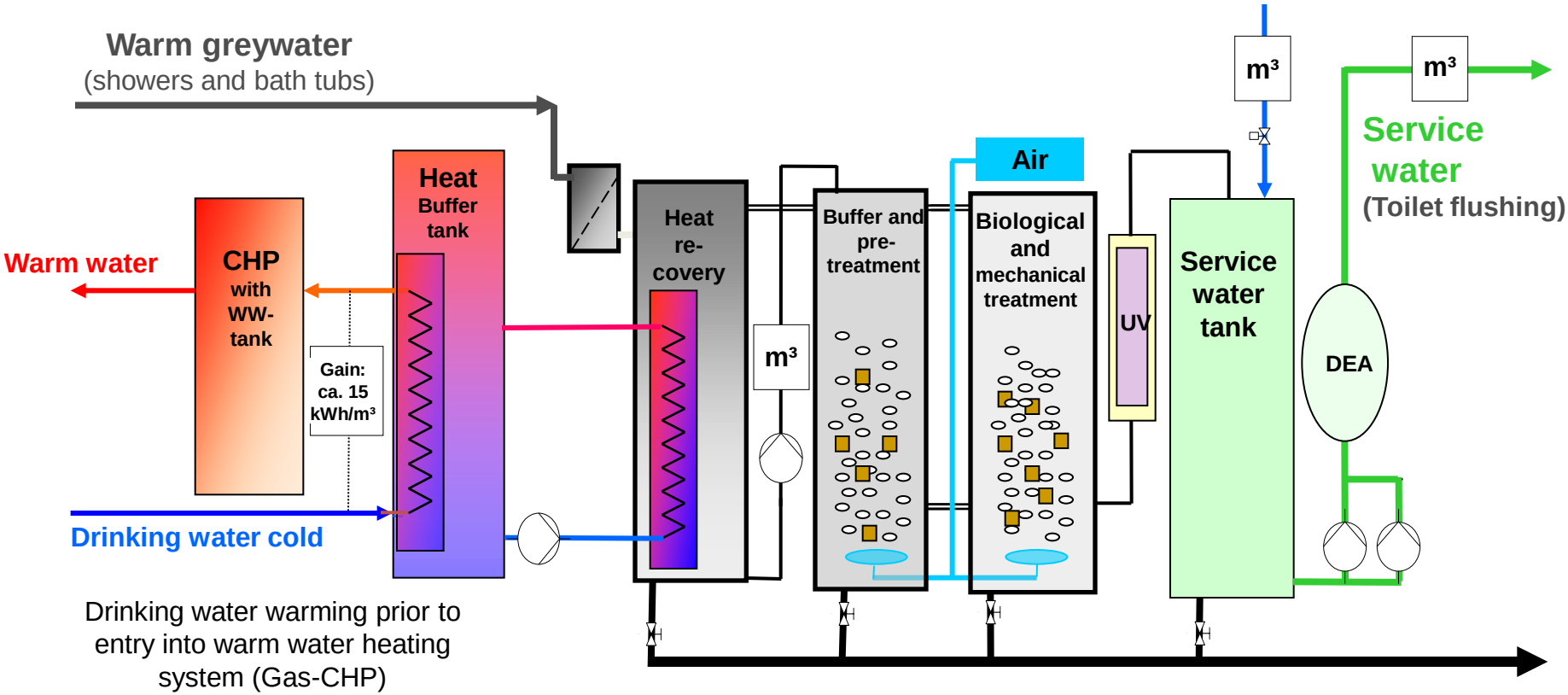
Saving potential:

approx. 200 kWh//P/a = 1,700 €/a

approx. 60 L/P/d = 13,000 €/a

Greywater recycling with heat recovery©

First passive house in Berlin for 123 tenants with 41 dwellings and 4 trade units



Quality guidelines and service water quality

Microbiological parameters in accordance with the EU Guidelines for Bathing Waters (76/160/EWG)*:

Total coliforms:	**< 100/ml**	**Range:**	**0.1 - 1/ml**
E. coli:	**< 10/ml**		**0.03 - 0.3/ml**
P. aeruginosa:	**< 1/ml**		**0.2 - 0.7/ml**

Physical and chemical parameters according to Berlin guidelines**:

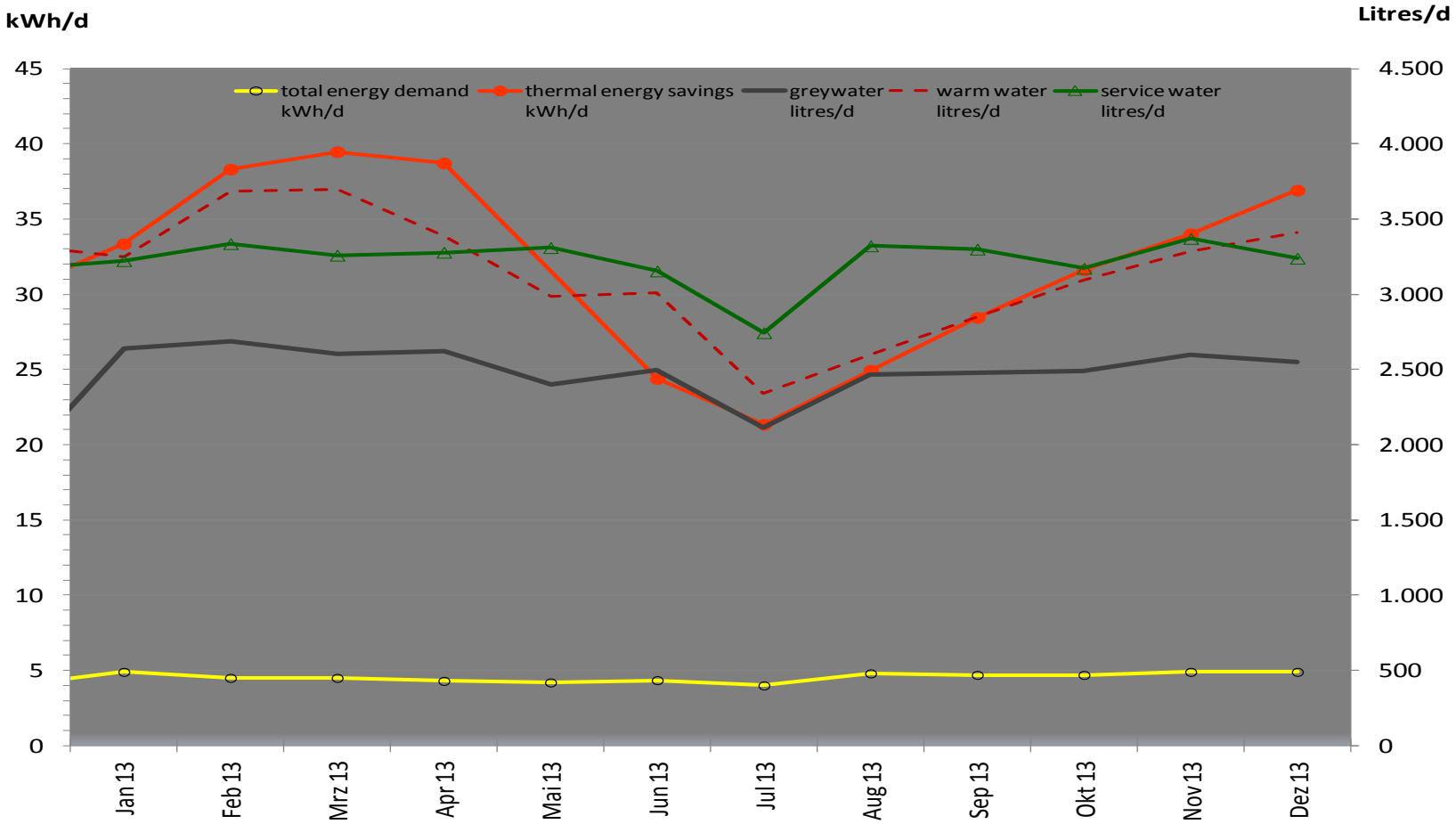
BOD_7:	**< 5 mg/l**	**Range:**	**< 3 - 5 mg/l**
O_2-Saturation:	**> 50%**		**60 - 90%**
UV-Transmission $_{254\ nm}$:	**> 60%**		**70 - 75% (local drinking water: 80%)**
		Turbidity:	**0.5 - 1.5 NTU**

Not a single German centralised WWTP is producing such a high quality!

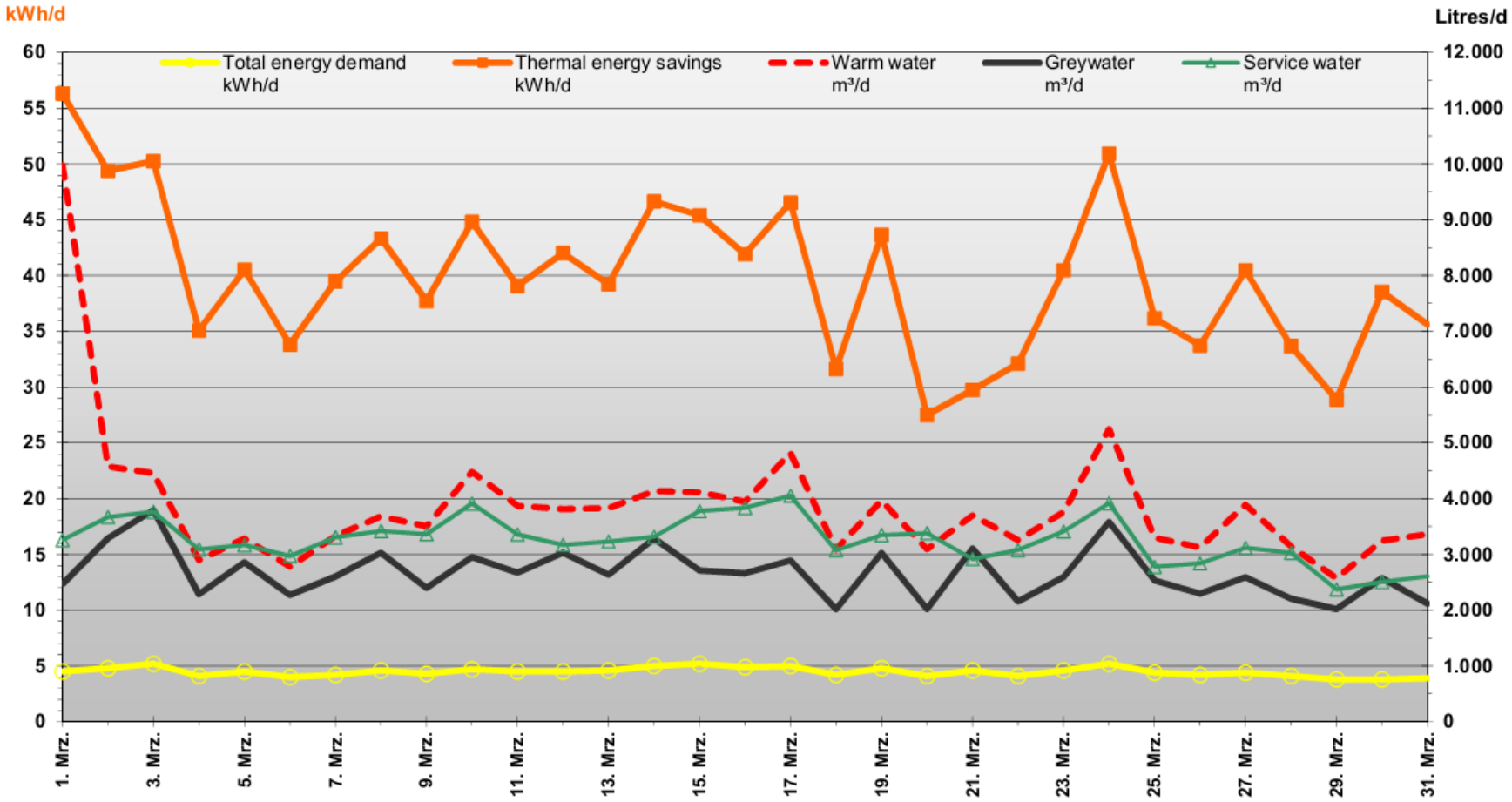
*http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:064:0037:0051:EN:PDF

**http://www.stadtentwicklung.berlin.de/internationales_eu/stadtplanung/download/betriebswasser_englisch_2007.pdf

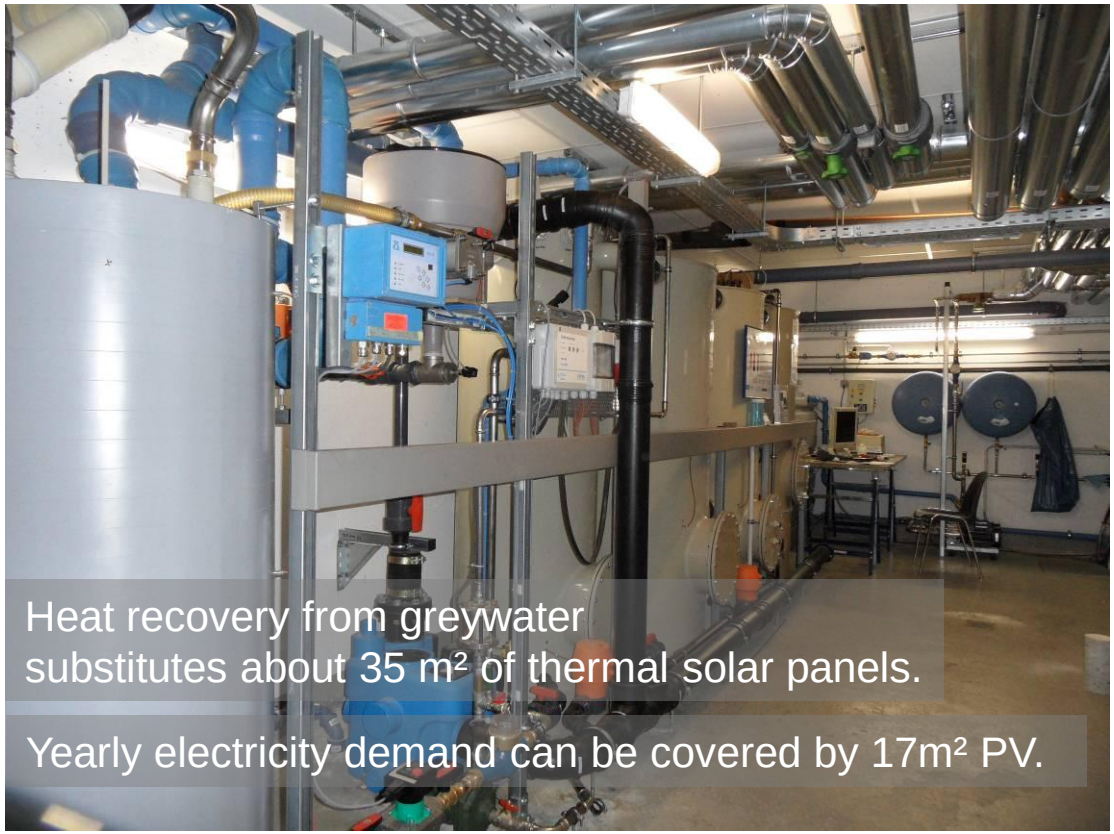
Water and energy input and output (Monthly median values for 2013)



Results (March 2013)
Drinking water temperatures 8 C; Average heat recovery 15.5 kWh/m³



Greywater recycling with integrated heat recovery (Arnimplatz)



Space requirement (prototype):

9 m² = 0.1 m²/Person
(equi. to A4 paper size)

Investment costs (prototype):

additional costs: 11.30 € /m²
of living space (825 €/P)
including assembly and **19% VAT**

Water savings:

5,000 €/a
approx. 1,100 m³/a of high quality service water are made available

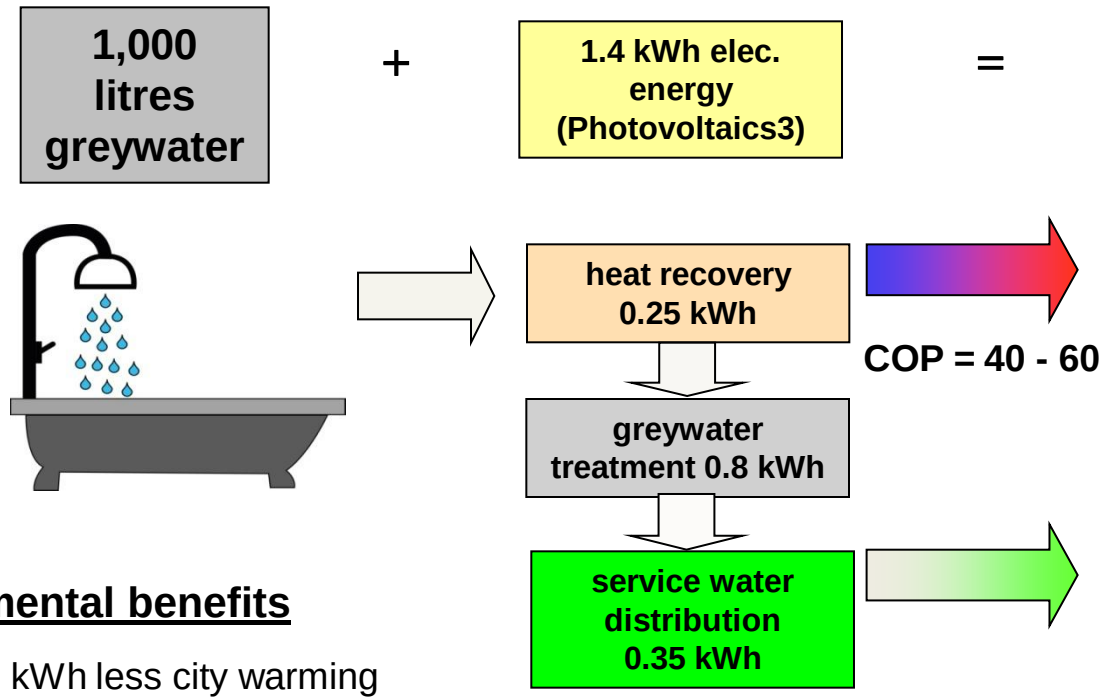
Heat recovery from greywater:

approx.13,000 kWh/a (1,000 €/a)

Maintenance and operation:

- Electricity requirement:
approx. 1,700 kWh/a (500 €/a);
- very little maintenace following
12 months of operation.

Greywater Recycling with Heat Recovery



Individual Benefits

Environmental benefits

(1) 10 – 15 kWh less city warming
(2) 1,000 litres of groundwater saved
(3) 1 - 3 kWh saved from drinking water and wastewater treatment including pumping
(4) saving on chemicals for drinking water and wastewater treatment
(5) less concrete corrosion in sewer
(6) CO_2 reduction (0.251 kg CO_2 per kWh recycled thermal energy **plus** 0.6 kg CO_2 per kWh saved electric energy for water service).

Conclusions

1. Recycled greywater safely fulfils all quality requirements. The pilot plant is running since more than two years with permanently good results and nearly maintenance-free .
2. Water and energy recycling is most resource efficient on site, where wastewater can be collected and recycled in the building. Upstream heat recovery (COP 40 - 60) is more than 10 times resource-efficient than with conventional centralised systems, where thermal energy is lost in the sewer before reaching the heat pump (COP 3 - 4).
3. Individual planning and dimensioning of the plant is indispensable.
4. With the presented prototype, payback periods of less than 10 years can be achieved with customised planning and design. Qualified plant monitoring is being currently used to increase the efficiency of the system.
5. Decentralised water and heat recovery should become an essential component for all new buildings because it acts as **a cornerstone for water, energy and CO_2 emissions reduction.**

Thank you for your attention.

„Es ist nicht genug, zu wissen,
man muss auch anwenden;
es ist nicht genug, zu wollen,
man muss auch tun.“

Johann Wolfgang von Goethe (1749 – 1832)
(Werk: Wilhelm Meisters Wanderjahre)

Further information or site tour:
Erwin Nolde, Berlin
mail@nolde-partner.de