Braunschweig 6.11.2013

Grey water (re)use options in a German urban context – necessities, challenges, barriers

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Bauhaus-Universität Weimar, Germany

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Separating solid waste is state of the art in many countries worldwide

Separating liquid waste: still a joke?

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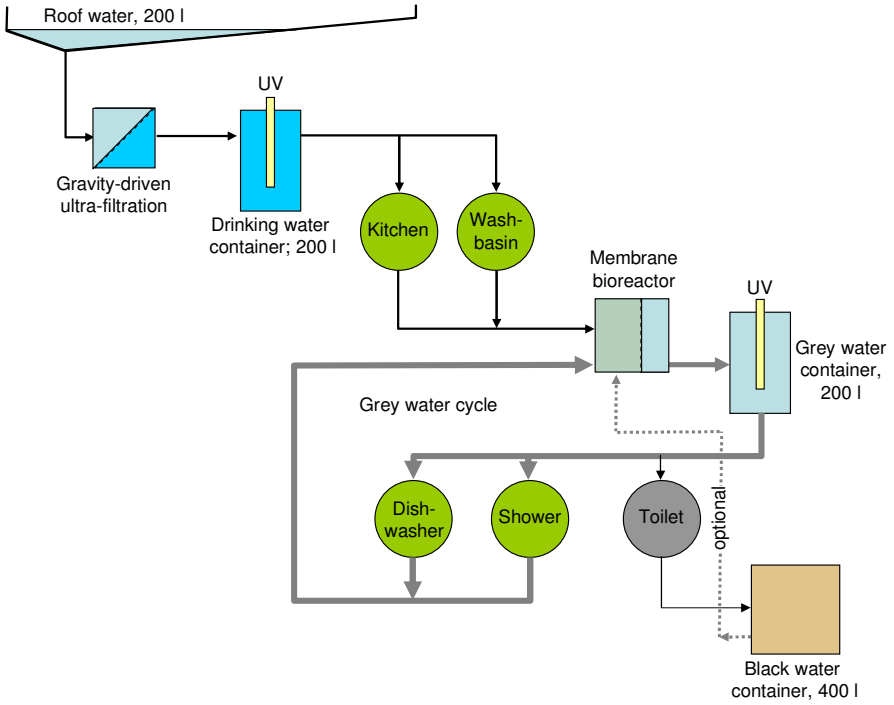
Not at all!

At extreme sites it is a need and it is possible

eawag
aquatic research

“self" is an energy and water independent cell for living and working.

A project of Empa, Eawag and the Zurich University of Arts



Content

- Meaning of resource based sanitation options and systematics of systems
- Greywater (re)use options in a German urban context
- Necessities, challenges, barriers
- Some examples
- Conclusions

it is helpful to define and name separable parts of domestic sewage:

Feces with flushing water and urine → **blackwater**

Urine with flushing water → **yellowwater**

Feces with flushing water without urine → **brownwater**

Other domestic sewage, without urine and without feces → **greywater**

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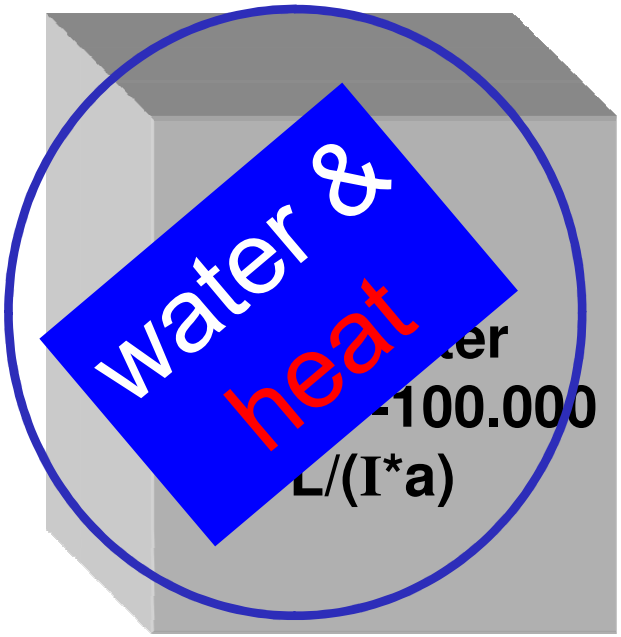


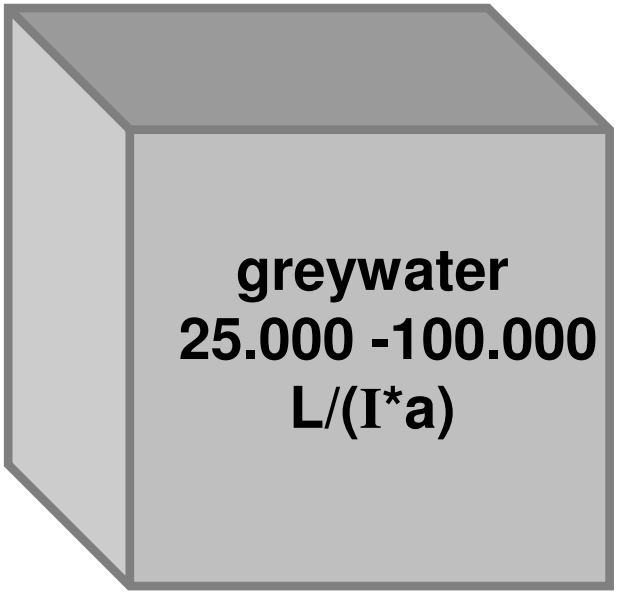
flow		ter ~100.000 L/(I*a)	urine ~ 500 L/(I*a)	feces ~ 50 L/(I*a)
N	~ 4-5 kg/(I*a)	~ 3 %	%	10 %
P	~ 0,75 kg/(I*a)	~ 10 %	~50 %	~ 40 %
K	~ 1,8 kg/(I*a)	~ 34 %	~ 54 %	~ 12 %
COD	~ 30 kg/(I*a)	~ 41 %	~ 12 %	~ 47 %

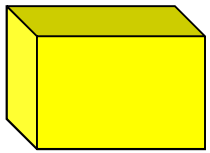
nutrients

pathogenes

Wastewater is characterized by a very unequal distribution of material fractions from different wastewater sources.

Potentials and challenges





urine
~ 500 L/(I*a)

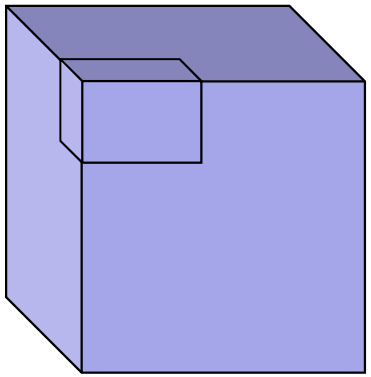
feces
~ 50 L/(I*a)

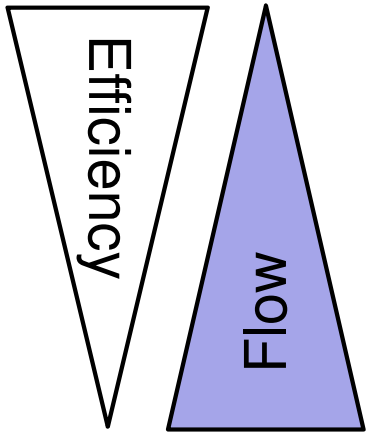
- Fertilizer production
- Elimination of micopollutants?
- Direct use in agriculture?

- Production of biogas
- Fertilizer (organic) production (biochar, terra preta)
- Elimination of micopollutants?

- Recovery of heat (locally ?)
- Treatment and reuse
- Use for irrigation, production of biomass

flushing water
(0) 2.000 – 25.000 L/(I*a)





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Resource based sanitation

Systems

Each sanitation system is based on components:

- Collection
- Transport
- Treatment
- Reuse

The components must be brought together to form a system.

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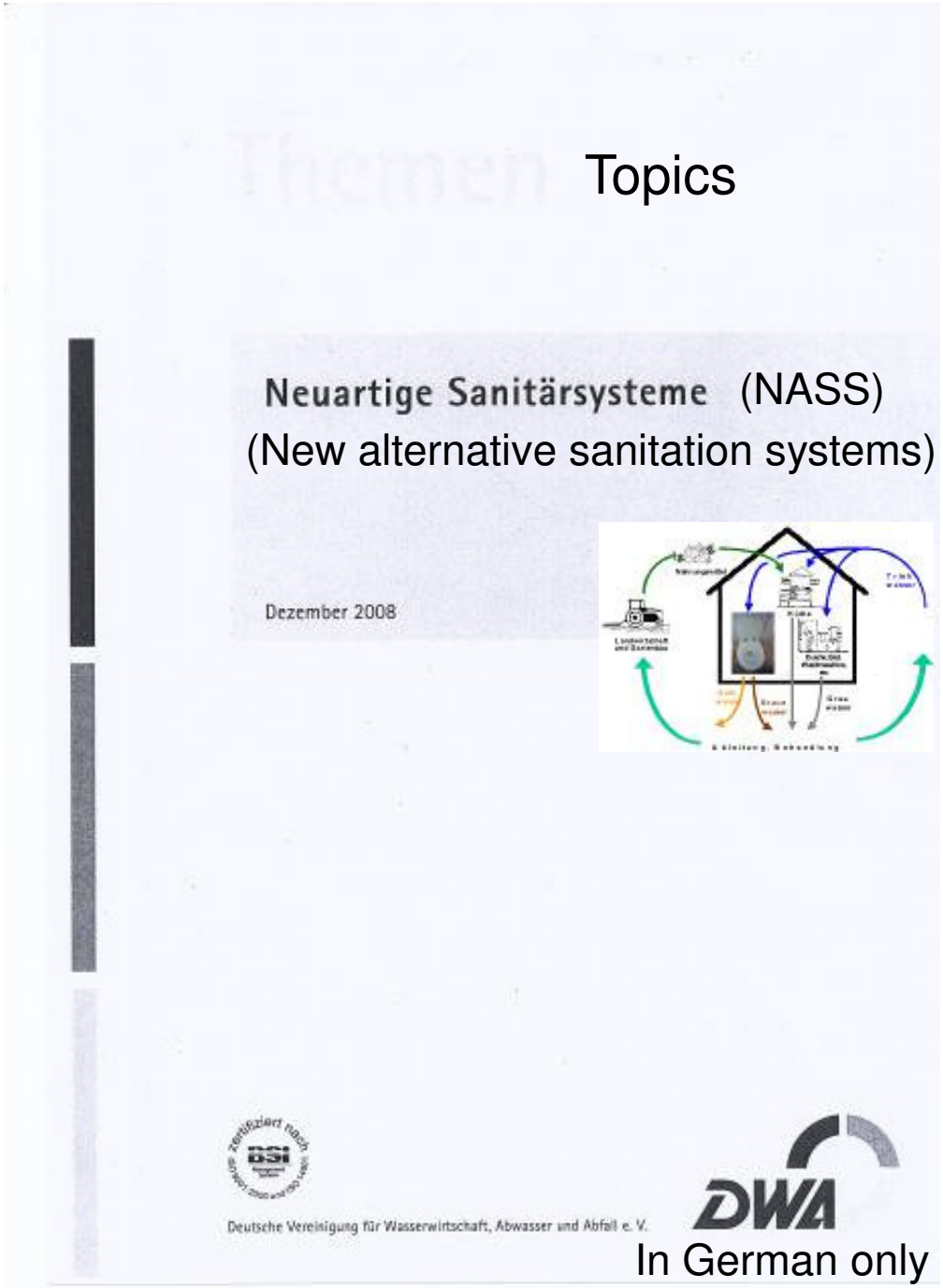


Topics

In German only

DWA Topics issue:

Systematic description and experiences concerning new sanitation systems

Assistance for evaluation and choice of systems and their integration in already existing systems

Identification of needs for research and development

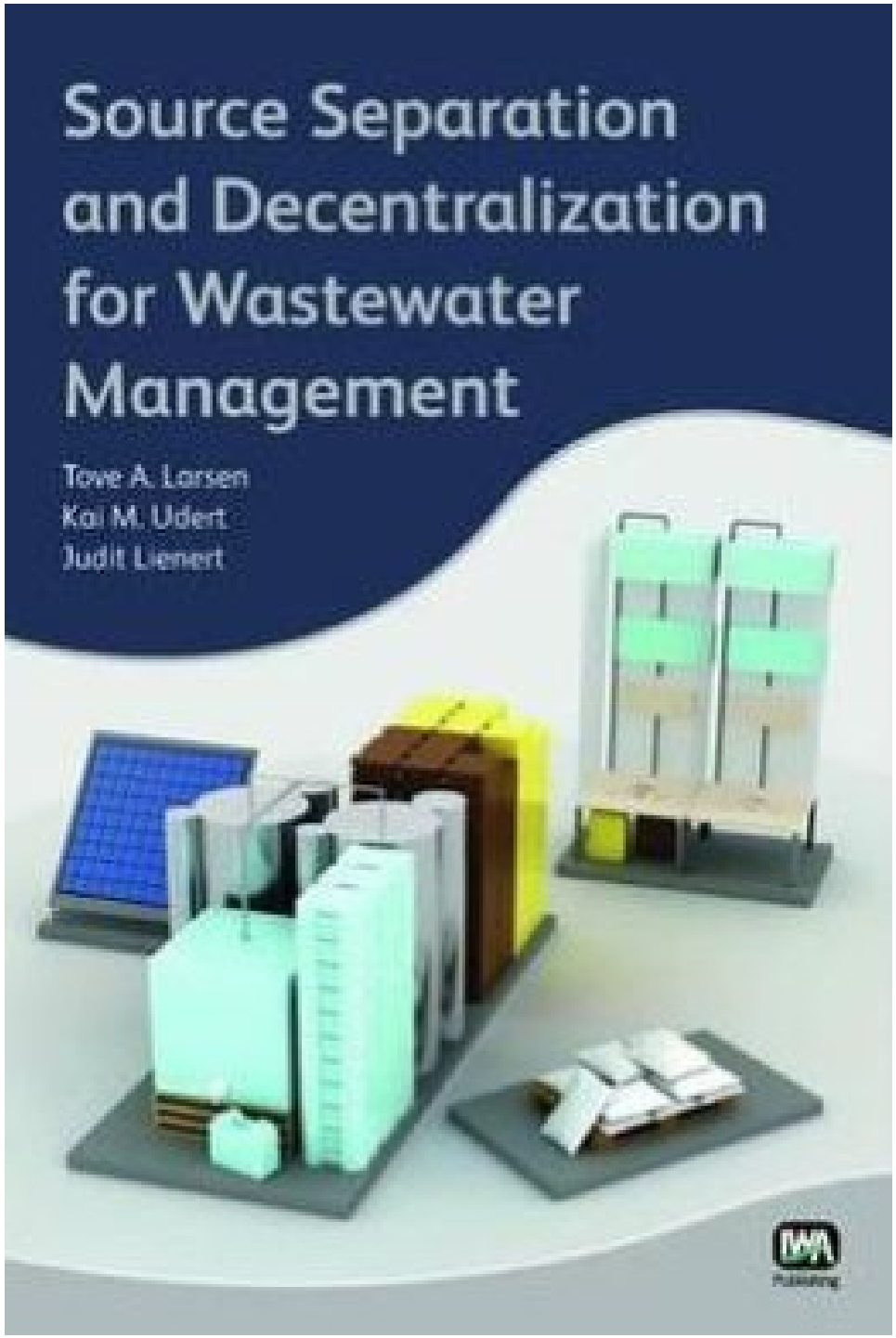
Presented at

Conference 2nd December 2008, Weimar

IWA book
Source Separation and Decentralization for Wastewater Management

A Milestone for source separation

2013



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Identification of 6 basic systems

1) Wastewater 1-Material-Flow-System

2) Blackwater 2-Material-Flow-System

3) Urine Diversion 2-Material-Flow-System

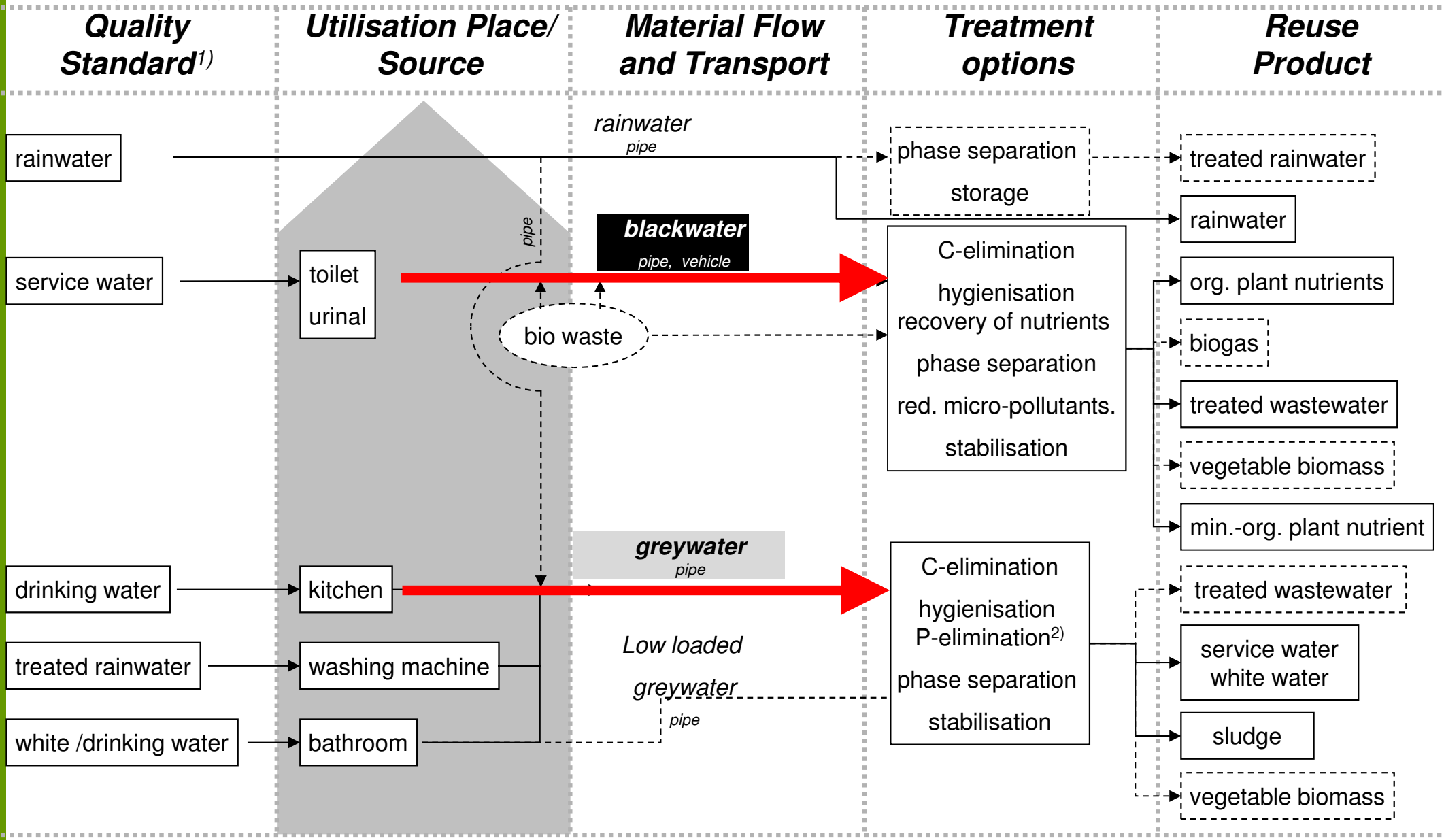
4) Urine Diversion 3-Material-Flow-System

5) Excreta System 2- Material-Flow-System (Dry toilets)

6) Urine Diversion 3- Material-Flow-System (Dry toilets)

2

Blackwater 2-Material-Flow-System



1) higher water quality possible for usage
2) makes sense only for kitchen wastewater

- - - - optional

Source: [DWA, 2008]

In 4 of 6 the basic systems we will have to deal with greywater

1) Wastewater 1-Material-Flow-System
2) Blackwater 2-Material-Flow-System
3) Urine Diversion 2-Material-Flow-System
4) Urine Diversion 3-Material-Flow-System
5) Excreta System 2- Material-Flow-System (Dry toilets)
6) Urine Diversion 3- Material-Flow-System (Dry toilets)

Scenarios developed by the DWA working group KA 1 on new alternative sanitation systems (NASS)

Scenario	Main Technologies
➢ Schrumpfendes Dorv (shrinking village)	Grauwasseraufbereitung Kaskaden mit Wasserrückgewinnung, Schwarzwasser: Vakuumleitung zur Biogasanlage (landwirtschaftlich)
➢ Grüne Hotelkette (green hotel chain)	Grauwasserrecycling für Duschen, Schwarzwasseraufkonzentrierung, Biogasanlage, Teil-Urinseparierung
➢ Olympiadorf X-Dry (Olympic Village)	Trenntrockentoiletten, HTC für Fäkalien oder Trocknung und Kompostierung / Verbrennung, Struvit und Ammoniumnitrat (Verdampfung) aus Urin, Grauwasser- und Restabwasser Behandlung
➢ Ausgezeichnetes RuQ (awarded urban quarter)	Infrastrukturkanal, Schwarzwasser-Vakuumsystem mit Biogasanlage, Urban Gardening (Energiepflanzen für Biogasanlage), Struvitfällung, aerobe Grauwasser- und Restabwasser Behandlung

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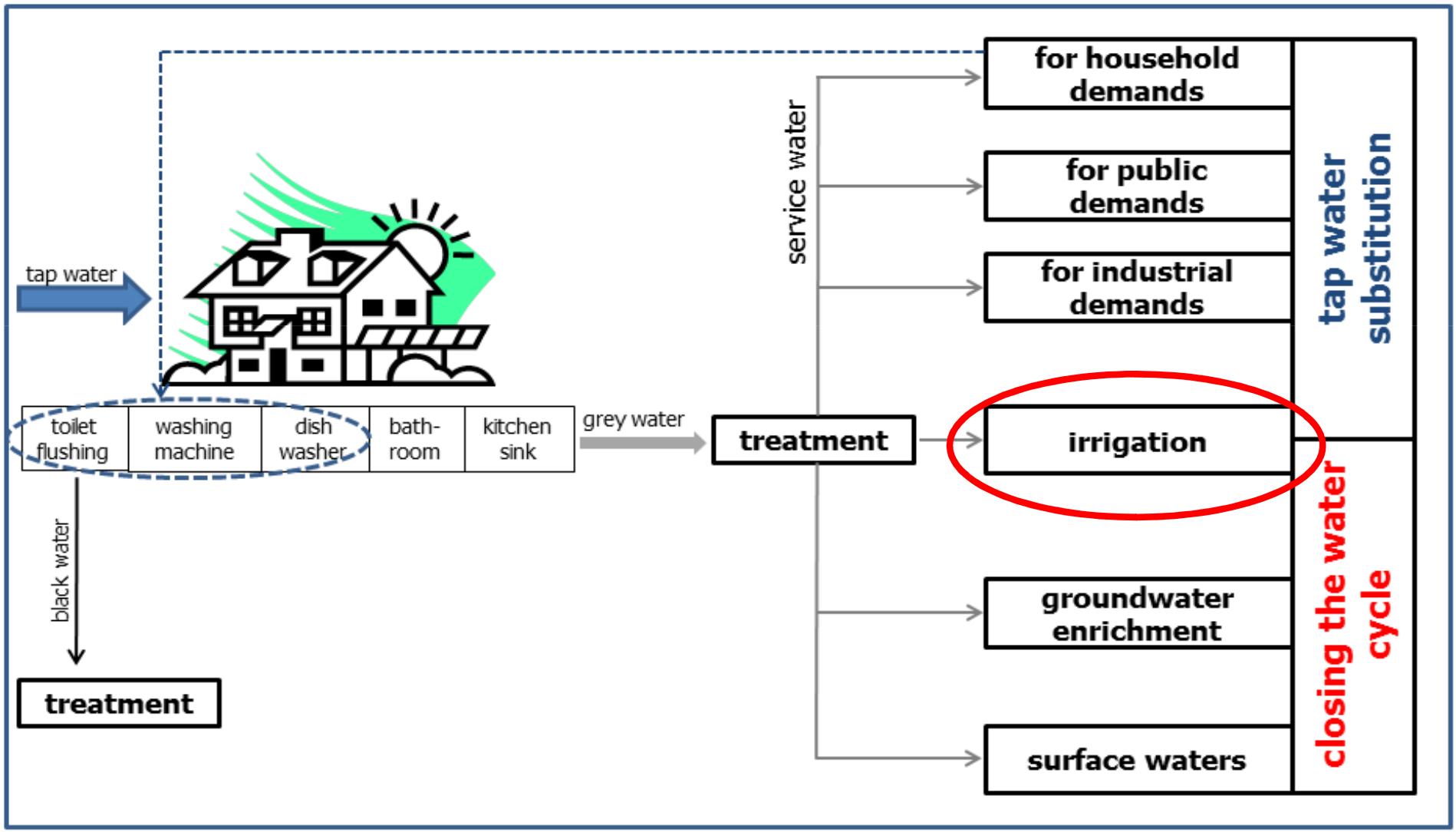
Grey**water** (re)use options in a German urban context



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Greywater in Irrigating Home Garden Crops

Jordania

What is greywater?

Greywater is the product water from dish washing, sinks, bathing, laundry and others except the product water that contains human solid or liquid wastes which is referred to as blackwater.

A general comparison between greywater and blackwater

- Greywater contains less Nitrogen compared to blackwater
- Blackwater represents a major source for pathogenic bacteria, unlike greywater
- The normal organic content of greywater decomposes at a much faster rate than of blackwater

Adopted criteria for graywater separation and collection

- Willingness and ability for the beneficiary to utilize graywater
- Adequate water consumption in the household
- Sufficient agricultural land area
- Appropriate soil quality for agriculture
- Sufficient rainfall to contribute in supplementary irrigation

Benefits of greywater reuse

- Conservation in domestic water use and consequently less value o water bill
- Reducing quantities of wastewater drained to the septic tank
- Contribution in development of home garden agriculture

Constraints of greywater reuse

- Insufficient greywater collected
- Lack of sufficient land and difficulty of reaching household sewe system
- Soil and climate are inappropriate for agriculture
- Lack of sound laws and regulations
- Inability of family to operate and maintain greywater system

IDRC CRDI
International Development Research Centre
Ottawa - Canada

The Inter-Islamic Network on Water Resources Development and Management
Amman-Jordan

Australia

South Africa

http://www.gardenresq.co.za

Vertical Garden, Musée du Quai Branly, Paris, 2007

Patrick Blanc, a French botanist, has created his tallest vertical garden at a residential development in Sydney. The garden wall uses 4,528 native Australian plants that are **fed by a grey-water dripper-irrigation system**. 2013

Vertical Garden, Düssmann KulturKaufhaus, Berlin, Jan. 2012

Milan, Italy **Stefano Boeri: vertical forest**

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Greywater treatment ?

http://www.aqua2use.com

Treatment by filtration

Matala® Progressive 3-Dimensional Filtration

No treatment,
just immediate distribution

Treatment close
to nature

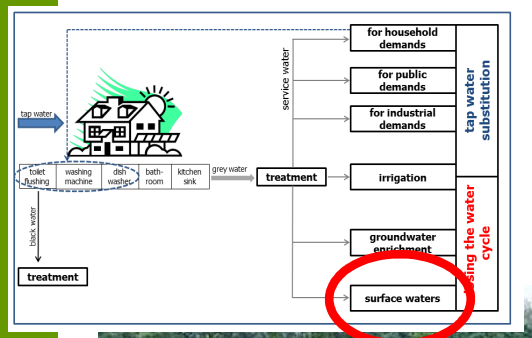
http://www.hydroscapesolutions.com

coarse-to-fine filtration, hydrogen peroxide and UV-light disinfection

Advanced membrane treatment for golf course irrigation

http://lomaprieta.sierraclub.org

Urban surface waters are lacking water



- Low flow in urban waters

  due to changes hydrological process like stormwater drainage, land sealing, lowering of ground water table

  with aesthetical and ecological impacts

- Restoring hydrologic processes in an urban landscape is difficult and expensive
- Recharging urban waters with sufficiently treated greywater would provide water at low flow

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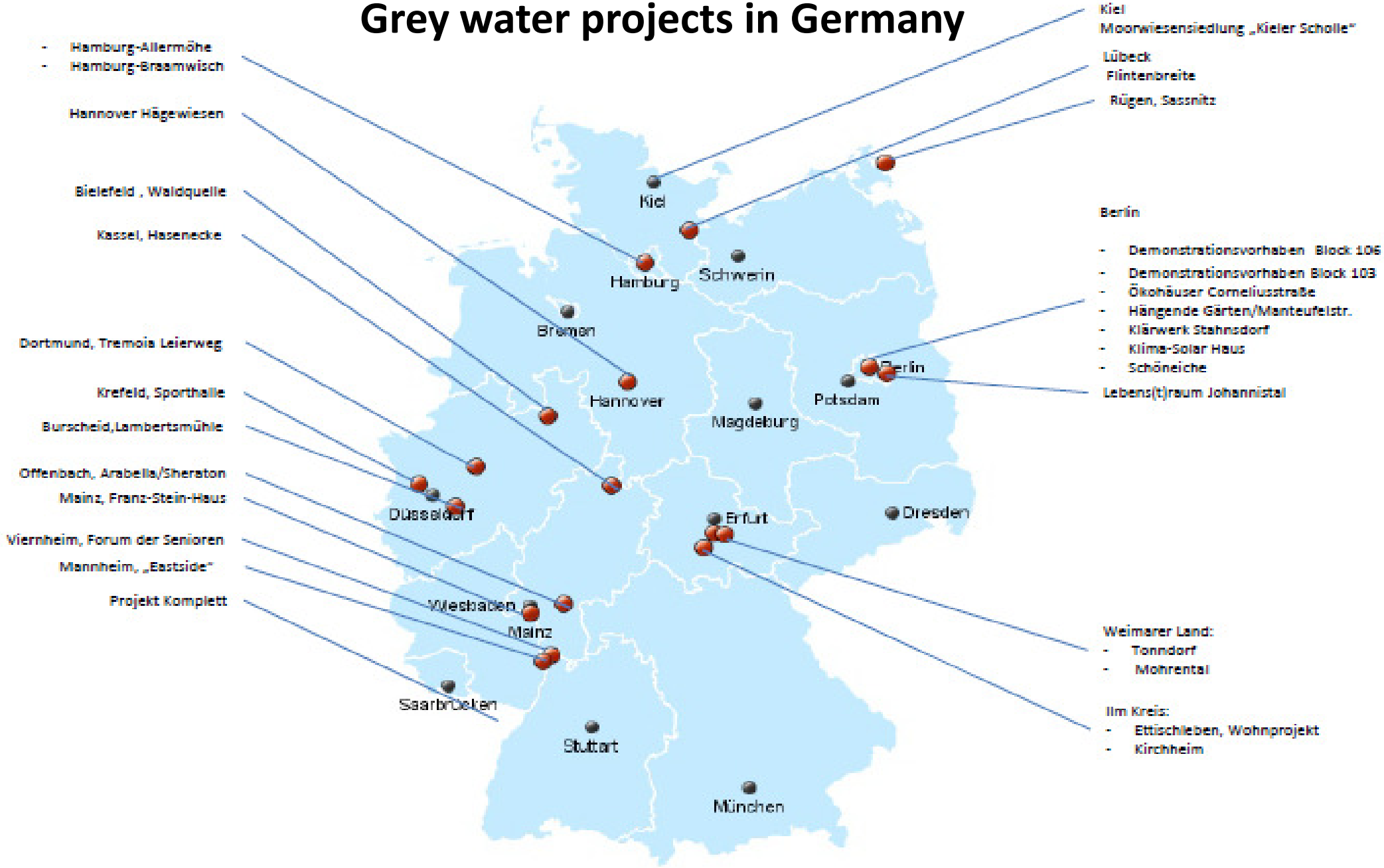
Grey water projects in Germany



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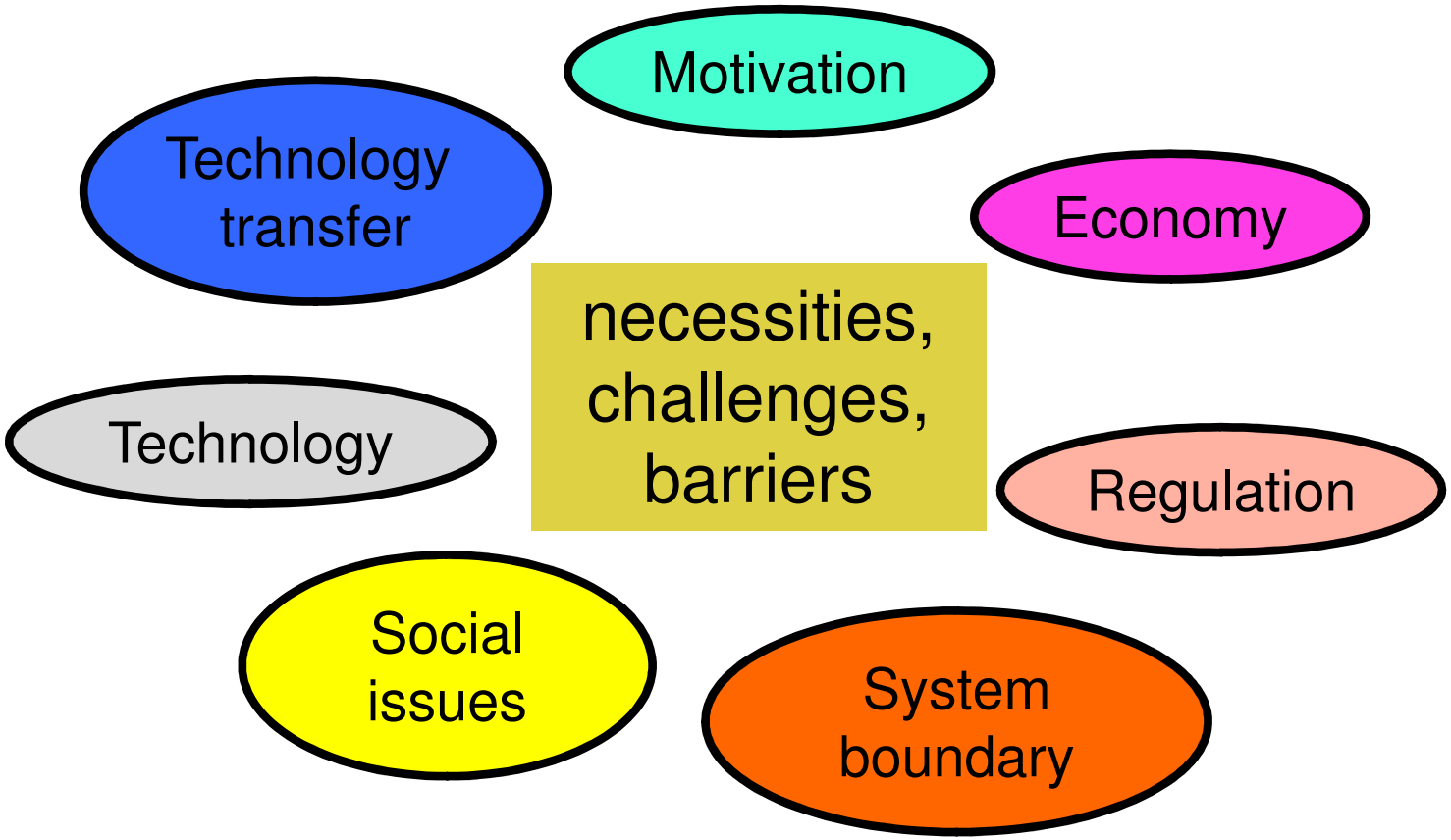
Necessities, challenges, barriers



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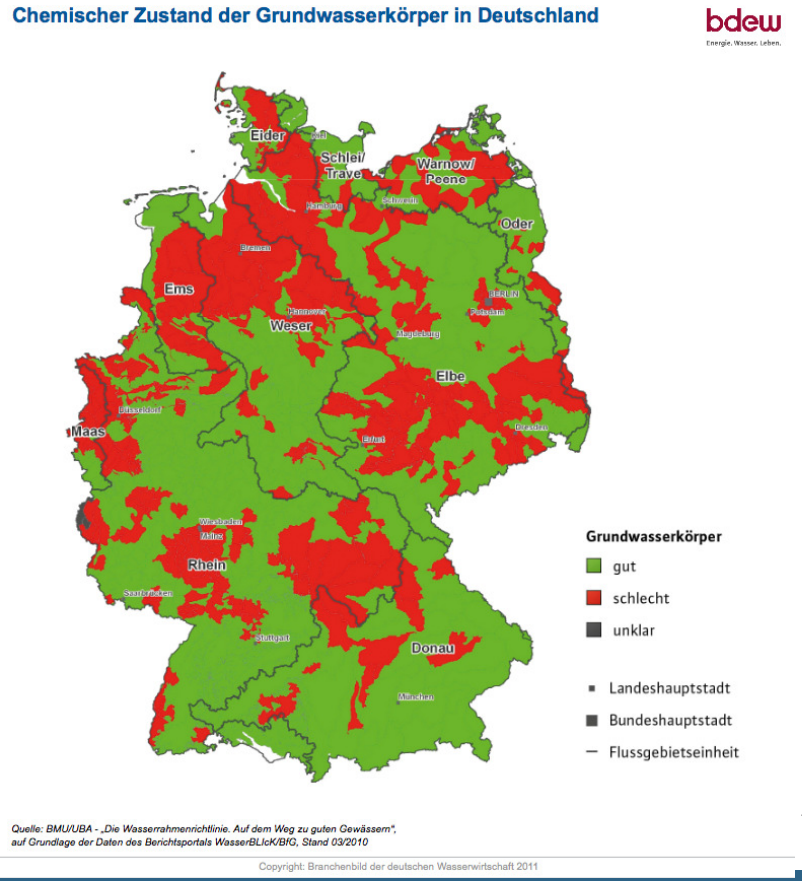
Motivation

From the point of view of **water availability**, there is no direct ecological necessity for a change in the sanitation system yet.

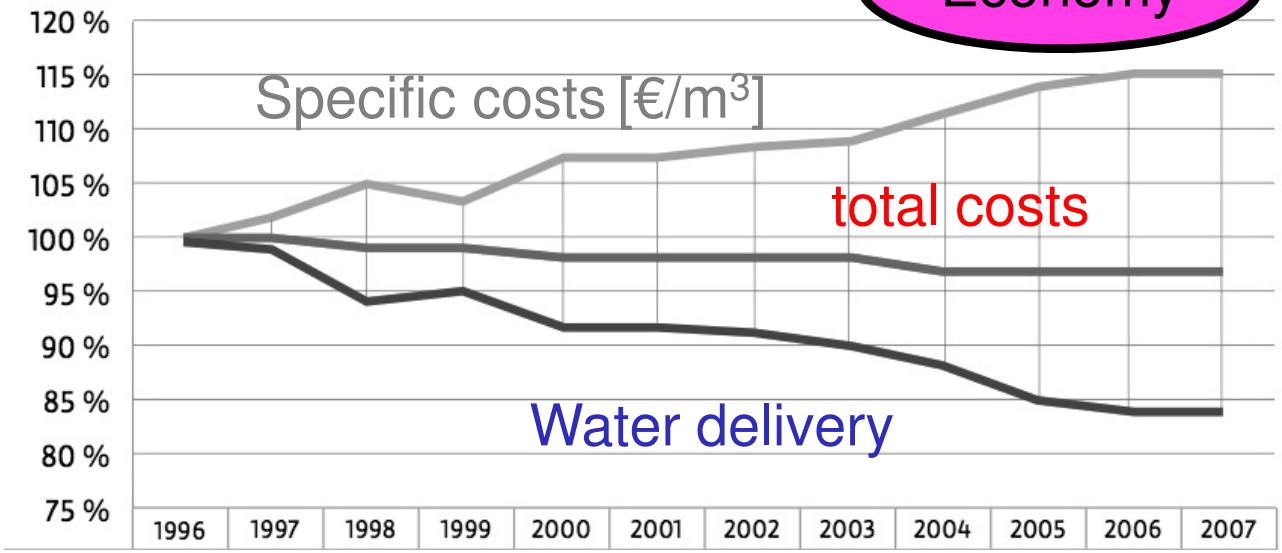
Consequently society and authorities do not promote any changes.

But: Ground water status is bad in many regions (red)



Germany has the highest rates for water and wastewater services in Europe with high fixed costs.

Economy



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Bieker and Birte, 2010; Londong et al., 2011, Hillenbrand, 2012 , Branchenbild 2011

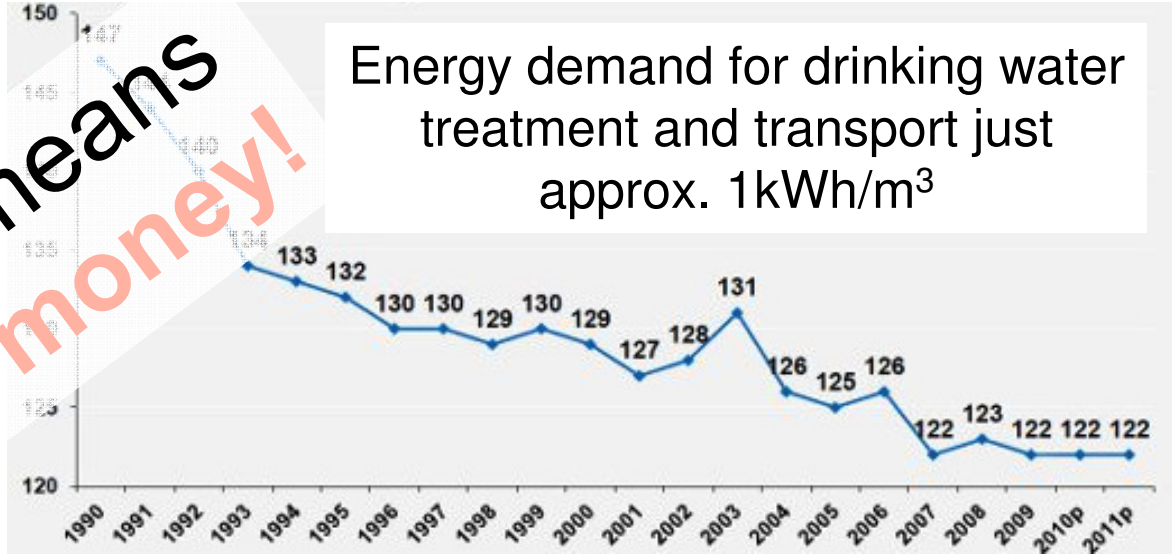
Daily specific water consumption

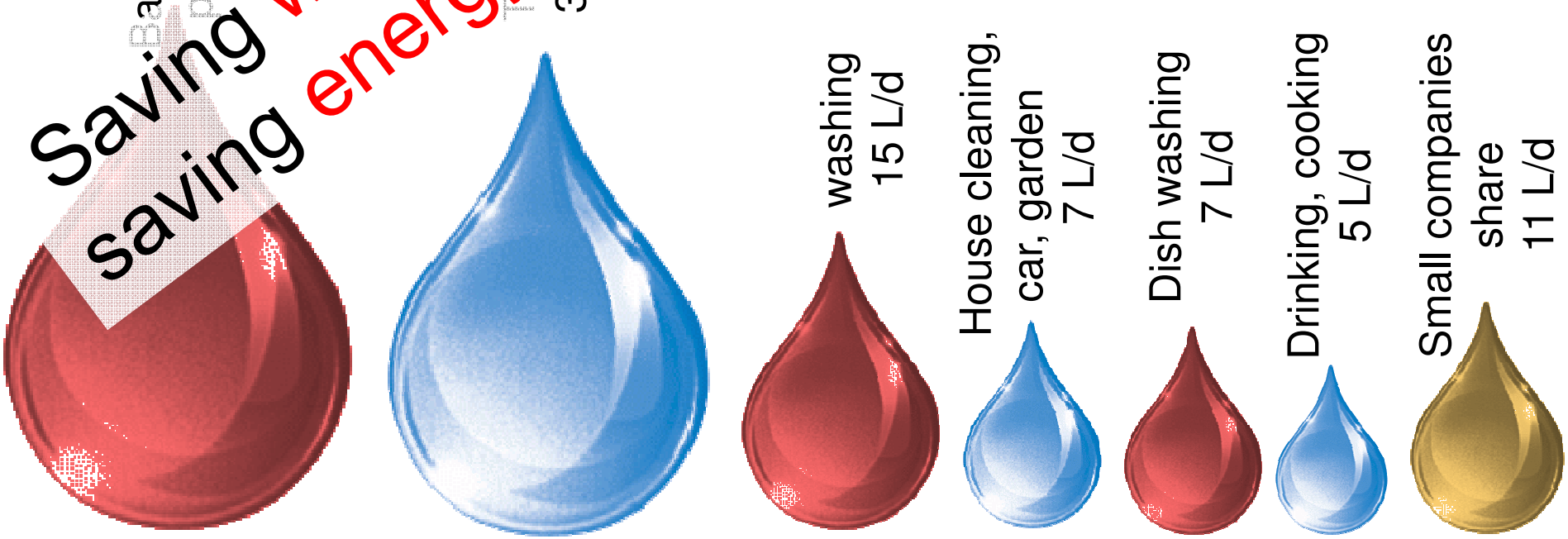
Motivation

Economy

Saving warm water means saving energy and money!

Energy demand for drinking water treatment and transport just approx. 1kWh/m³





Data source: BDEW, Branchenbild, 2011

Many open questions about economy

Economy

Fee systems

Financing transition

Subsidising options for system changes

Dealing with different benefactors (private – public)

…

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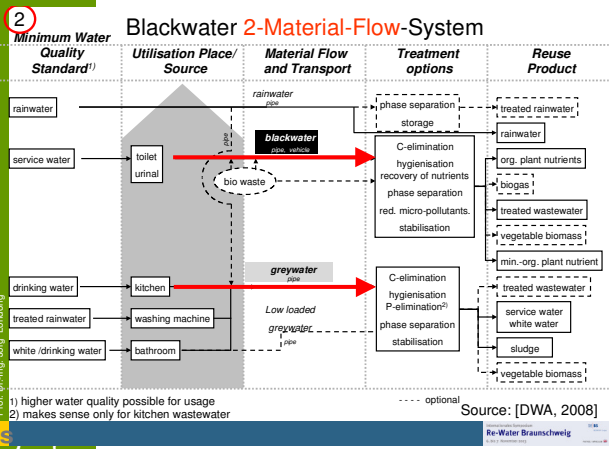
The current sanitation system in Germany is inflexible and cost-intensive. How could a system change work?

System boundary

Paying attention to the **transition phases** is an important aspect of system changes.



It is necessary to consider **system boundaries** and **interdependencies**.

Referring to the implementation of greywater use it will be inevitable to consider **blackwater** and **rainwater** as well.

Greywater use on a household level will reduce the demand of **tap water** especially if greywater is used for toilet flushing.

Most people are not interested in thinking or talking about their sanitation.

Social issues

louisa_catlover/Flickr

www.treehugger.com

Greywater reuse needs **acceptance** of the users.

Greywater usage systems have to guarantee the same **comfort** as today our centralized traditional system.

…

Important regulations are missing

Regulation

Regulations for the greywater quality depending on (re)use

Technical design standards for greywater treatment

Without these necessary law and regulation framework no planer will be willing to implement greywater (re)use in any project.

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Some pilot projects of NASS

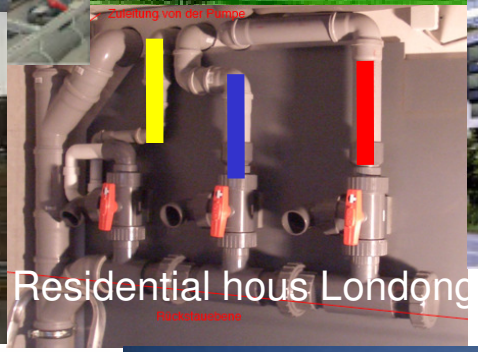
Ökologische Wohnsiedlung
flintenbreite, Lübeck

NOVAQUATIS
Ein integratives Forschungsprojekt

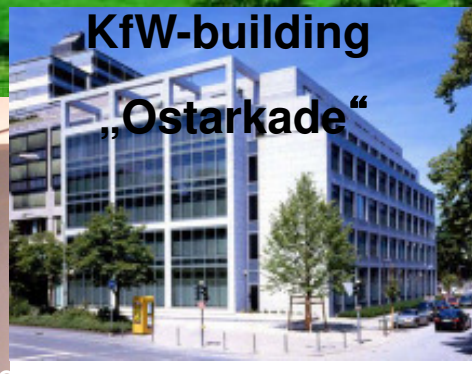
GTZ Eschborn

URINE SEPARATION

Experiences from Sweden

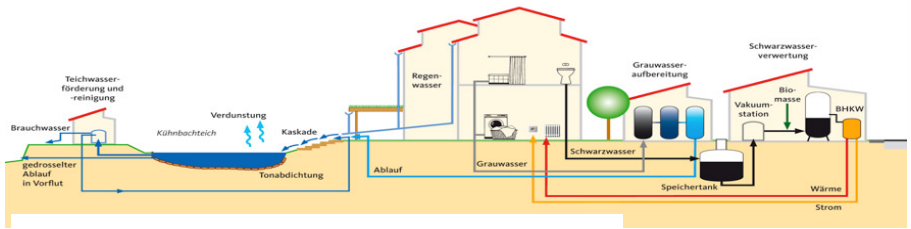


Residential hous Londong

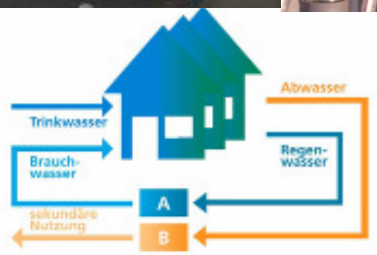


KfW-building
„Ostarkade“

Lambertsmühle



KREIS Hamburg Jenfeld



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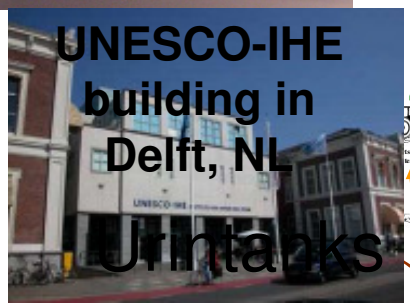
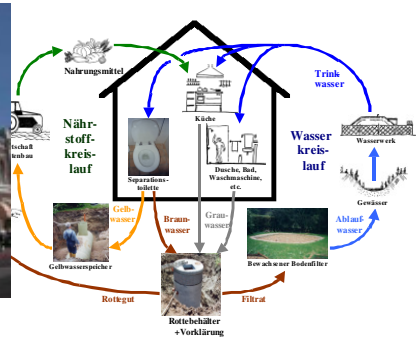


UNESCO-IHE
building in
Delft, NL

Urintanks



Nolde & Partner
innovative Wasserkonzepte

Passive house
at Arnimplatz Berlin Prenzlauer Berg

Bruttogeschossfläche:	6.620 m²
Wohnfläche (living space):	4.600 m²
Gewerbefläche:	600 m²
Anzahl der WE:	**41**
Bewohner:	**123** Personen
Anzahl der GE:	4
Raumwärmebedarf (heating demand):	73.400 kWh/a
Warmwasser (hot water):	103.636 kWh/a
Gas BHKW:	16 kW elek. 35 kW therm.
PV 92 Module mit 20 kWp	18.000 kWh
Wasserbedarf:	5.477 m³/a

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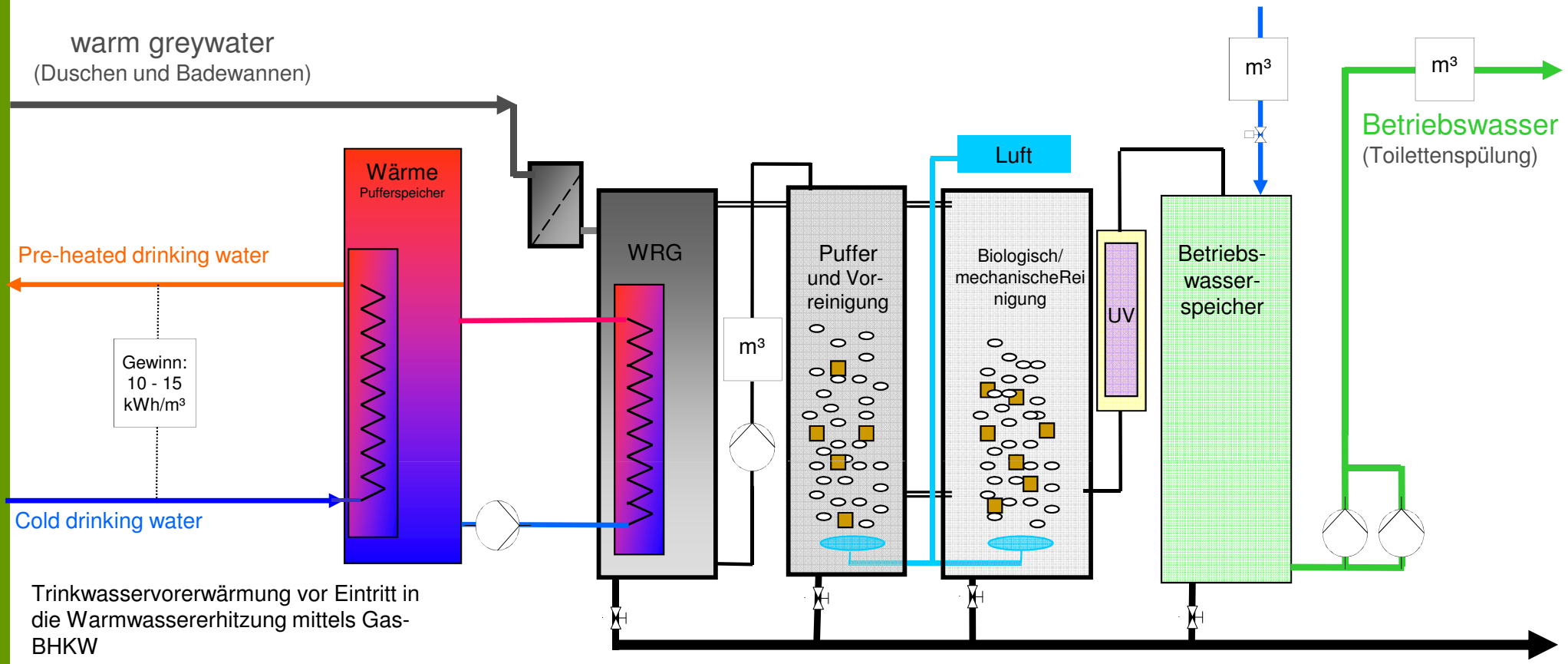
Greywater recycling with upstream heat recovery©



Grauwasserzulauf, mechanische Vorrreinigung und Wärmerückgewinnung

Puffer und biologische Vorreinigung

Biologisch/mechanische Reinigung und UV-Desinfektion

Betriebswasserversorgung inkl. Trinkwassernachspeisung bei Betriebswassermangel

Bauhaus-Universität Weimar
Prof. Dr.-Ing. Jörg Londong

Nolde & Partner
innovative Wasserkonzepte

Lokus GmbH

Projekt: Arnimplatz
Bauherr: Dr. Grunow
Inbetriebnahme: März 2012

heinhaus architekten

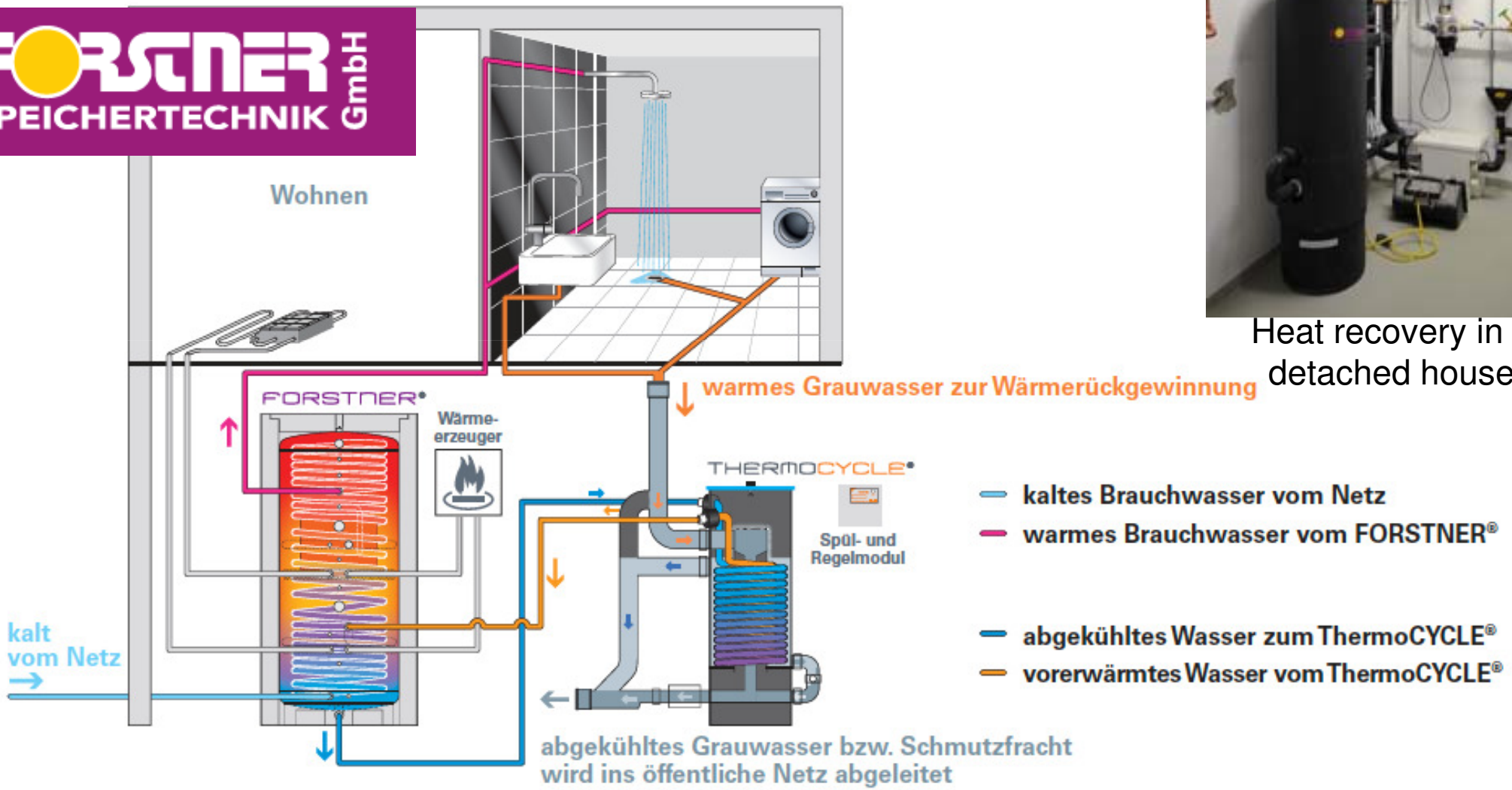
DBU
Deutsche Bundesstiftung Umwelt

b.is

Studien | Gutachten | Forschung | Entwicklung | Anlagenplanung | Verfahrensoptimierung
Nolde & Partner
innovative Wasserkonzepte

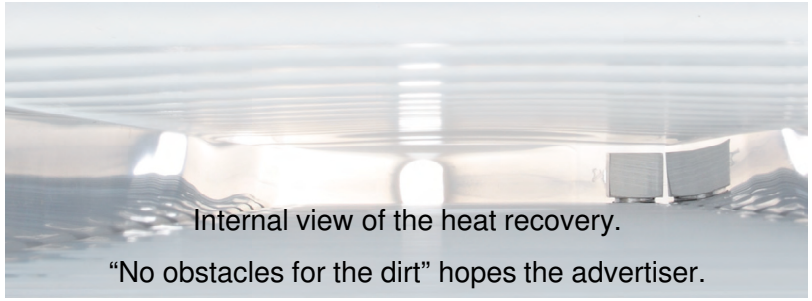
Is there a market?

Heat recovery in a detached house



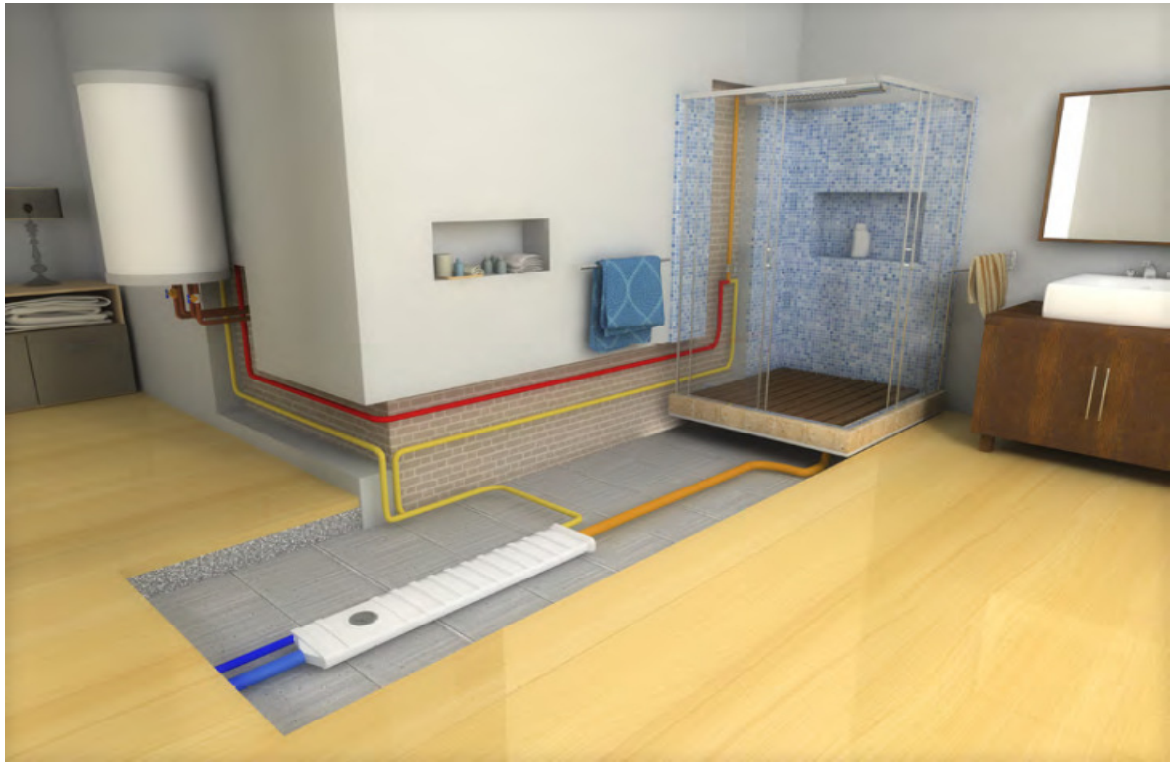
Quelle: http://www.speichertechnik.com/grauwasser.html

BEE - The heat recovery system



Internal view of the heat recovery.

“No obstacles for the dirt” hopes the advertiser.



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KREIS Demonstrationsvorhaben *Stadtquartier Jenfelder Au [2011- 2014 (Phase I)]*

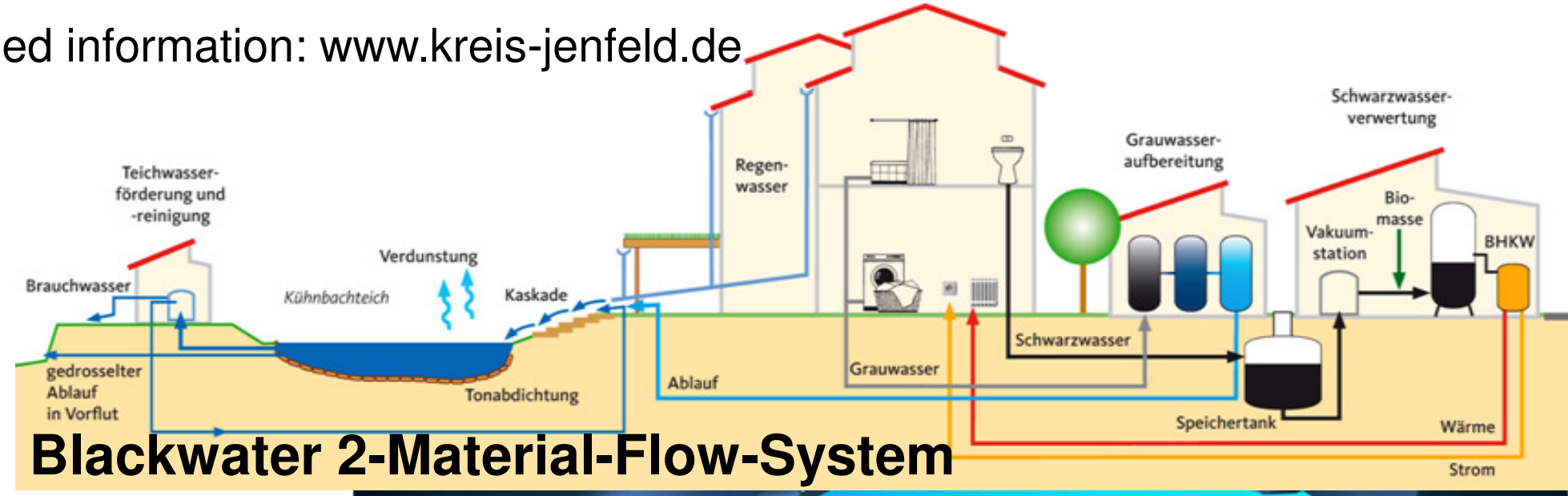
-Kopplung von regenerativer Energie-gewinnung mit innovativer Stadtentwässerung

-coupling of regenerative energy recovery with innovative urban drainage

project management: Hamburg Water (operator)

scientific coordination: Bauhaus-Universität Weimar

detailed information: www.kreis-jenfeld.de



Blackwater 2-Material-Flow-System

GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung
FONA Nachhaltiges Wassermanagement BMBF

NaWaM INIS

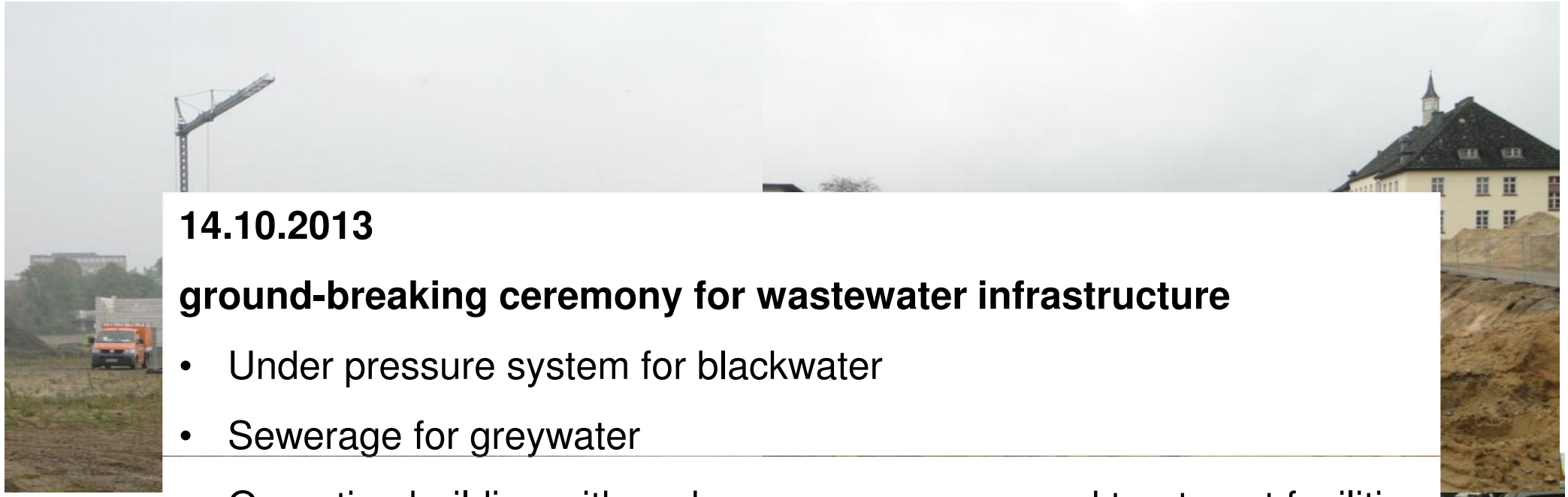
Intelligente und multifunktionelle Infrastruktursysteme für eine zukunftsfähige Wasserversorgung und Abwasserentsorgung

niversität Weimar
g. Jörg Londong

The Urban Quater Jenfelder AU

- Revitalisation of a former military site
- 45 ha total area, 35 ha reconstructed
- Realisation: 2012 - 2016
- 720 accommodation units about 2.000 inhabitants
- High energy standards
- Commerce and green areas

Constructions at Jenfelder Au



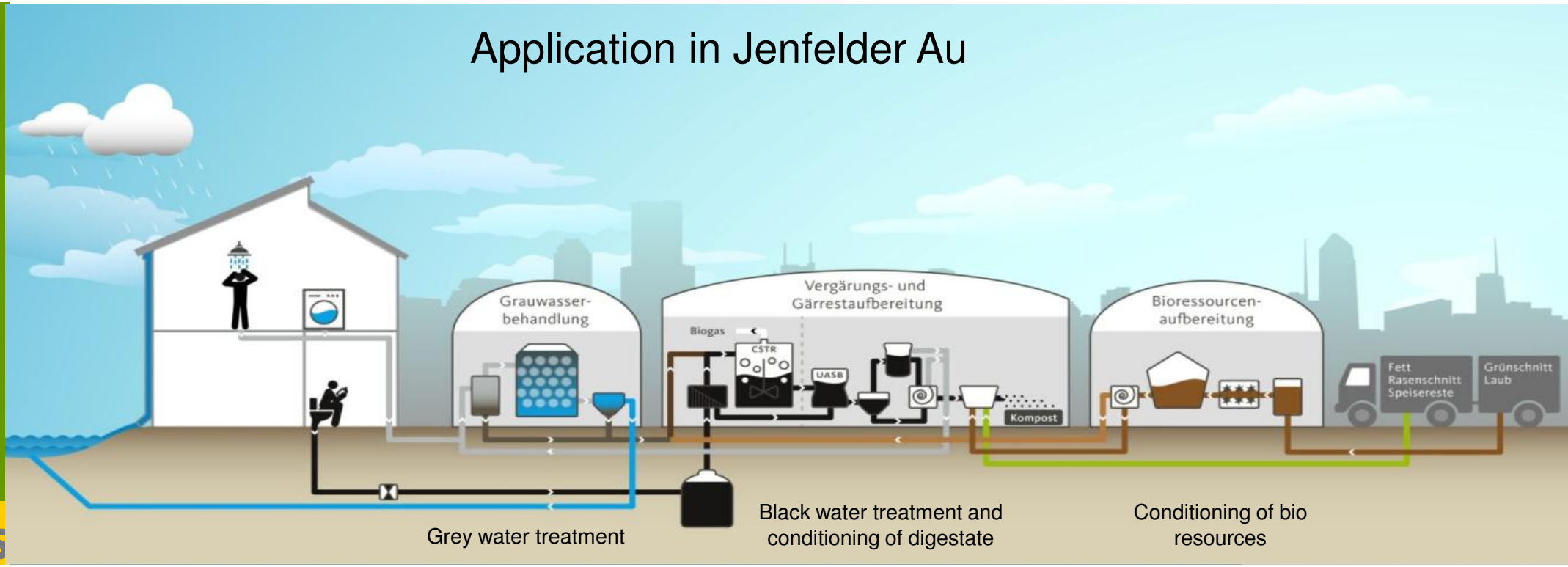
14.10.2013

ground-breaking ceremony for wastewater infrastructure

- Under pressure system for blackwater
- Sewerage for greywater
- Operation building with under pressure pumps and treatment facilities

Hamburg Water Cycle®

Application in Jenfelder Au



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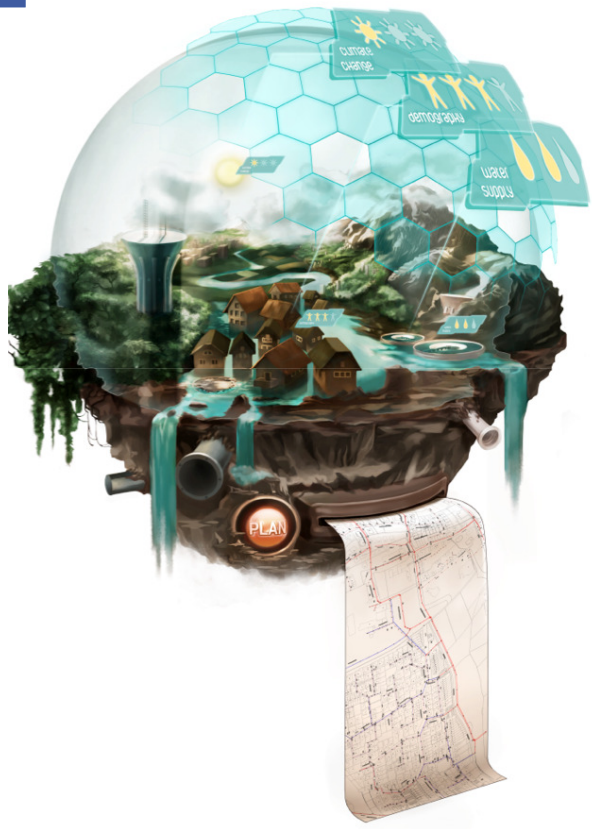
Transitionswege WasserInfraSTruktursysteme:

Anpassung an neue Herausforderungen im städtischen und ländlichen Raum



- Transition
- Concepts for water supply and (waste)water (re)use
- Tool box to support calculations
- Serious game for decision makers

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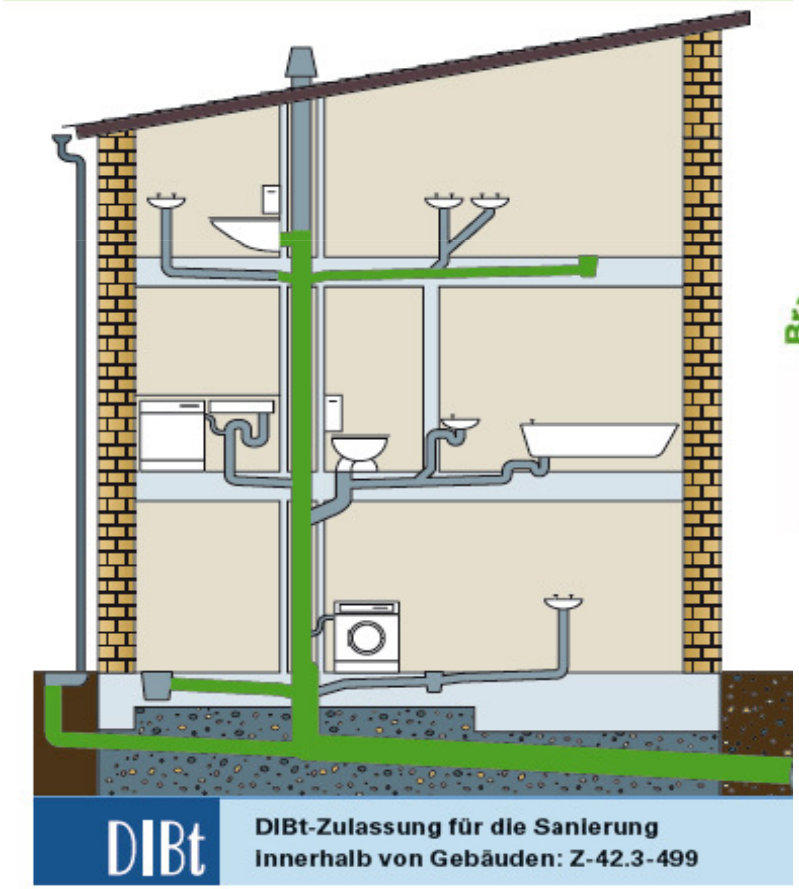
GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung
FONA Nachhaltiges Wassermanagement BMBF
NaWaM Nachhaltiges Wassermanagement INIS

EVaSENS

Reconstruction of existing pipes with a second pipe for blackwater?



ROEDIGER

Gefördert durch:

Bundesministerium
für Verkehr, Bau
und Stadtentwicklung

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Conclusions

- Our established system has deficits in sustainability (costs, re-use of water, energy, nutrients)
- Measures at the source might be better than our end-of-pipe-system. Interesting projects are on the way.
- Greywater is in integral part of systems based on source separation.
- If a modularized, compact and mass produced technical solutions for decentralized sanitation could be found (financed, further developed, tested, implemented firstly in a developed country) a huge marked could be explored.

Will cities in Germany look like this in the future?

Water reuse can contribute!

Bauhaus-Universität Weimar
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