Transitionswege WasserInfraSTruktursysteme:
Anpassung an neue Herausforderungen im städischen und ländlichen Raum

How can urban water infrastructures contribute to a sustainable urban metabolism?

Dr. Eve Menger-Krug (Fraunhofer ISI, Karlsruhe), Trust Conference in Mühlheim, April 2015

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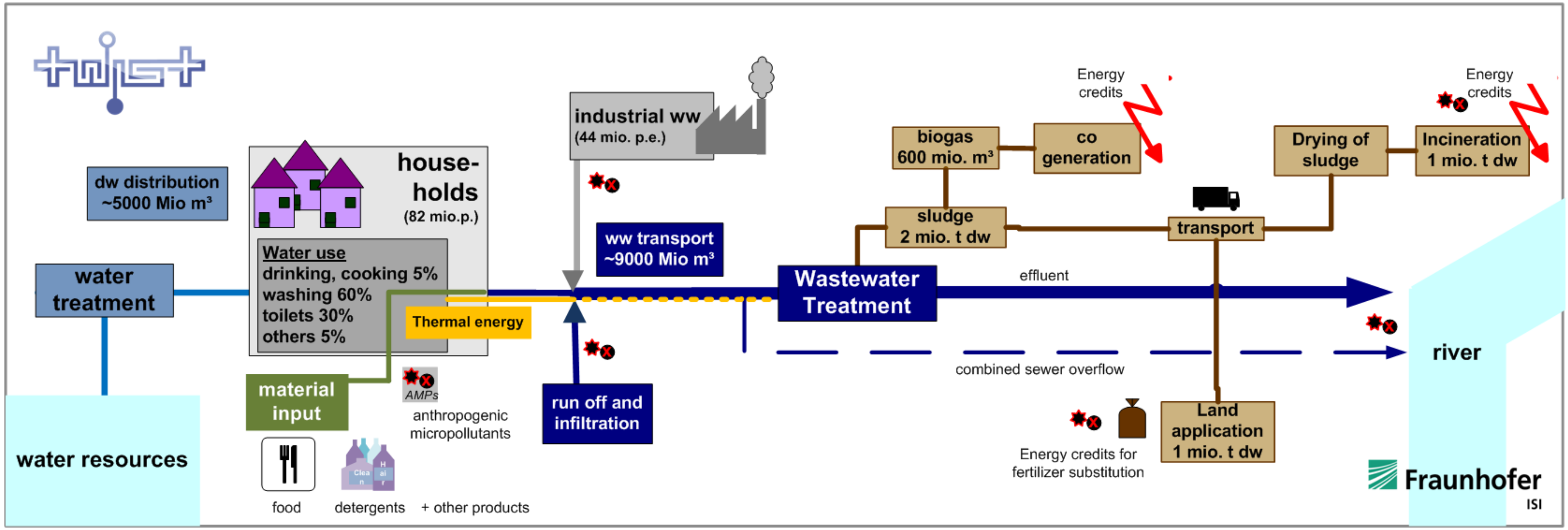
Intelligente und multifunktionelle Infrastruktursysteme für eine zukunftsfähige Wasserversorgung und Abwasserentsorgung

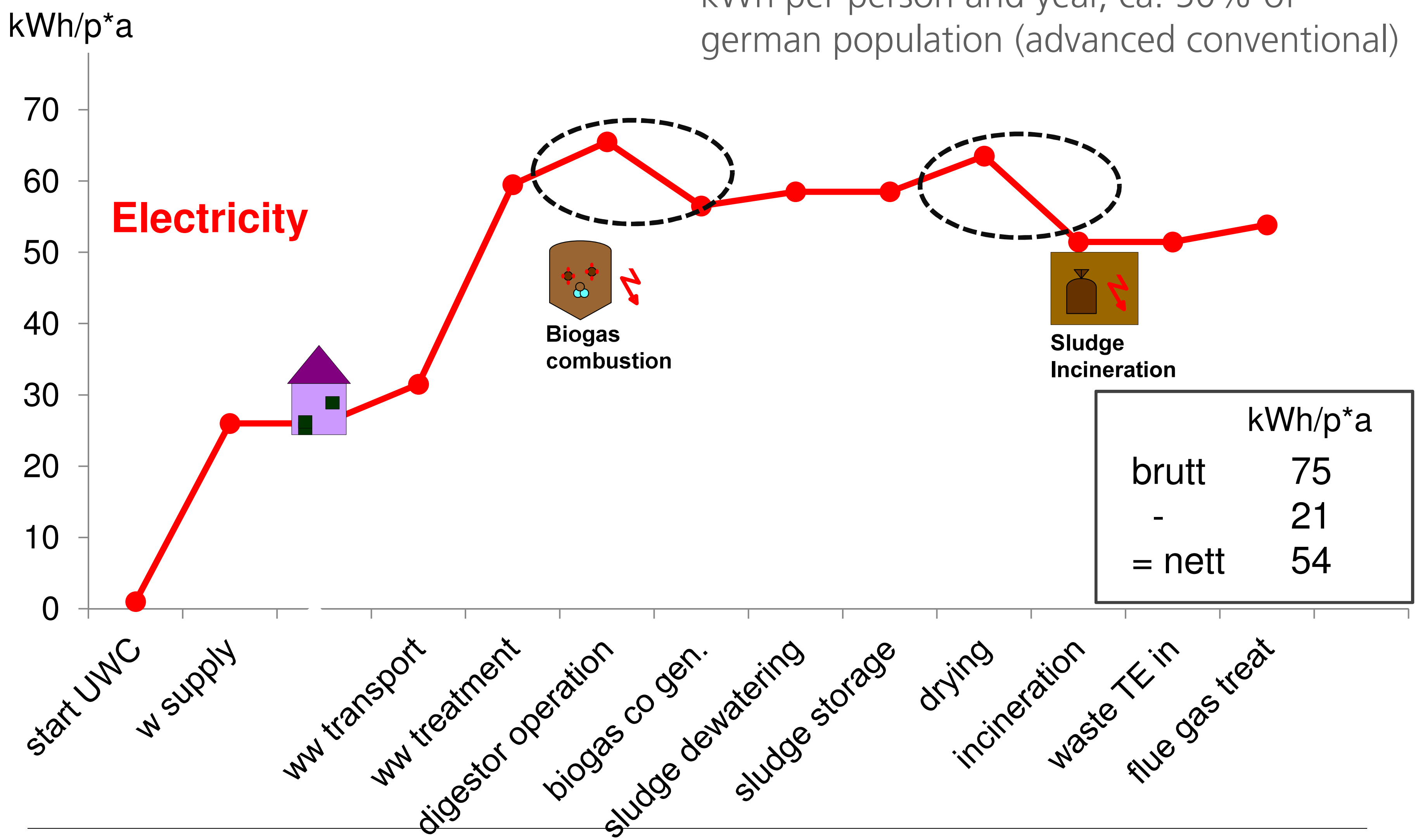
How can urban water infrastructures contribute to a sustainable urban metabolism?

- *Spotlight on selected results of TWIST++*
  (please refer to www.twistplusplus.de for a overview of project results)
- Urban water chain: Extended energy balance and metabolism analysis
- Urban water chain in context of the urban metabolism:
  the big 4 of urban flows
- Presentation of a concept for water reuse in urban areas
  developed in TWIST++



Energy Balance

Example: Electricity consumption and generation along the Urban Water Chain in kWh per person and year, ca. 50% of german population (advanced conventional)



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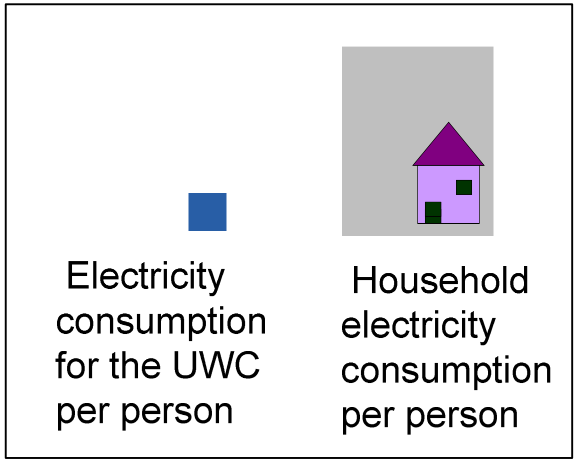
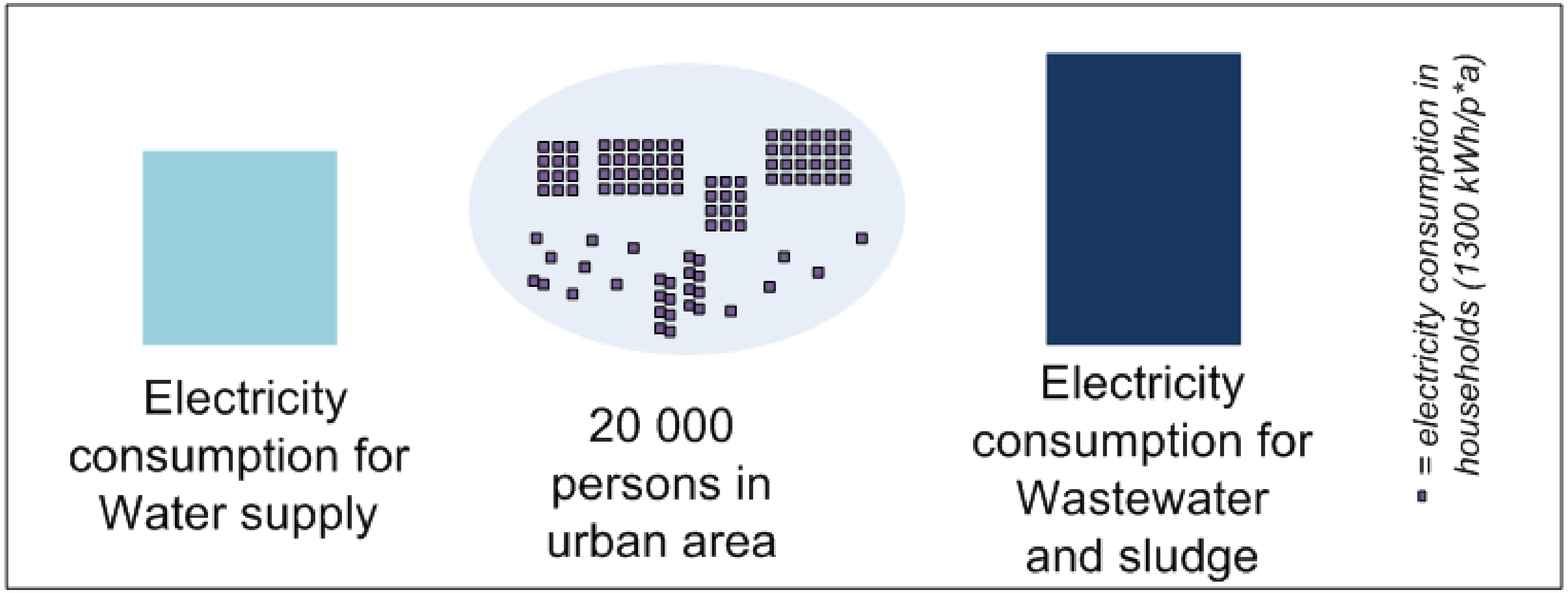
Energy Balance: Urban perspective

- **Per Person:**
  Electricity Use of Water Infrastructures
  << Electricity Use in Housholds

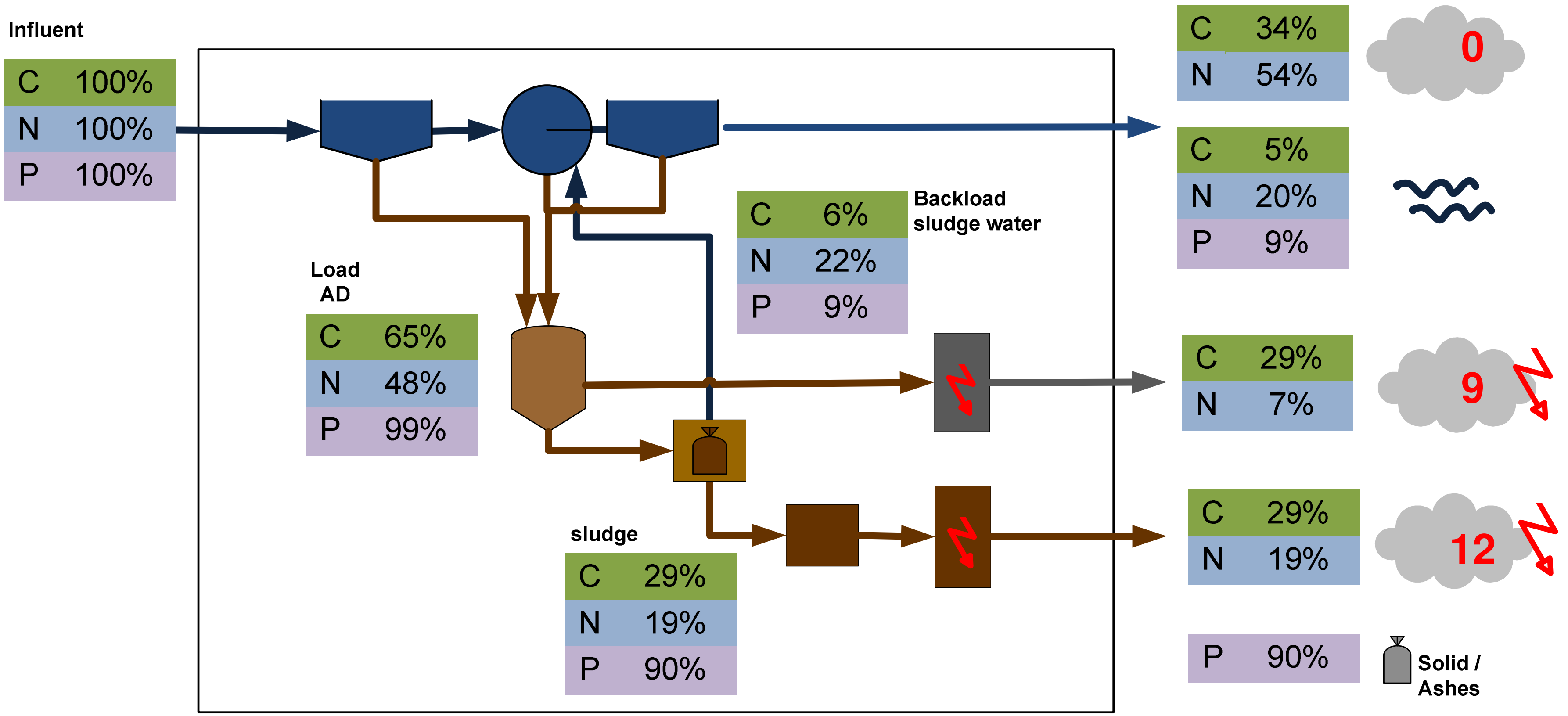
- **City Perspektive:**
  Electricity Use strongly clustered





Substance Flow Analysis

CO_2-Emissionens (renewable) vs. **Energy Recovery [kWh/p*a]**



SFA shows the pathway of the Elements Carbon C, Nitrogen N and Phosphorus P in the processes Wastewater and Sludge Management and the Emissions to the different environmental compartments

Extended Energy Balance

C	14 kg	17.9 kWh/kg C
N	4 kg	16.4 kWh/kg N
P	0.7 kg	7.9 kWh/kg P

✖

Chemical Energy

„Grey“ Energy

=

Material Resources
per Person and Year

Large Potential for Bioenergy

Energy-intensive Fertilizer

Limited essential Resource

Large Potential for Heat Recovery

15% recovered

C

250 kWh/p*a

Pollutant Problem

N

4%

65 kWh/p*a

P

6 kWh/p*a

20% recovered

Thermal Energy

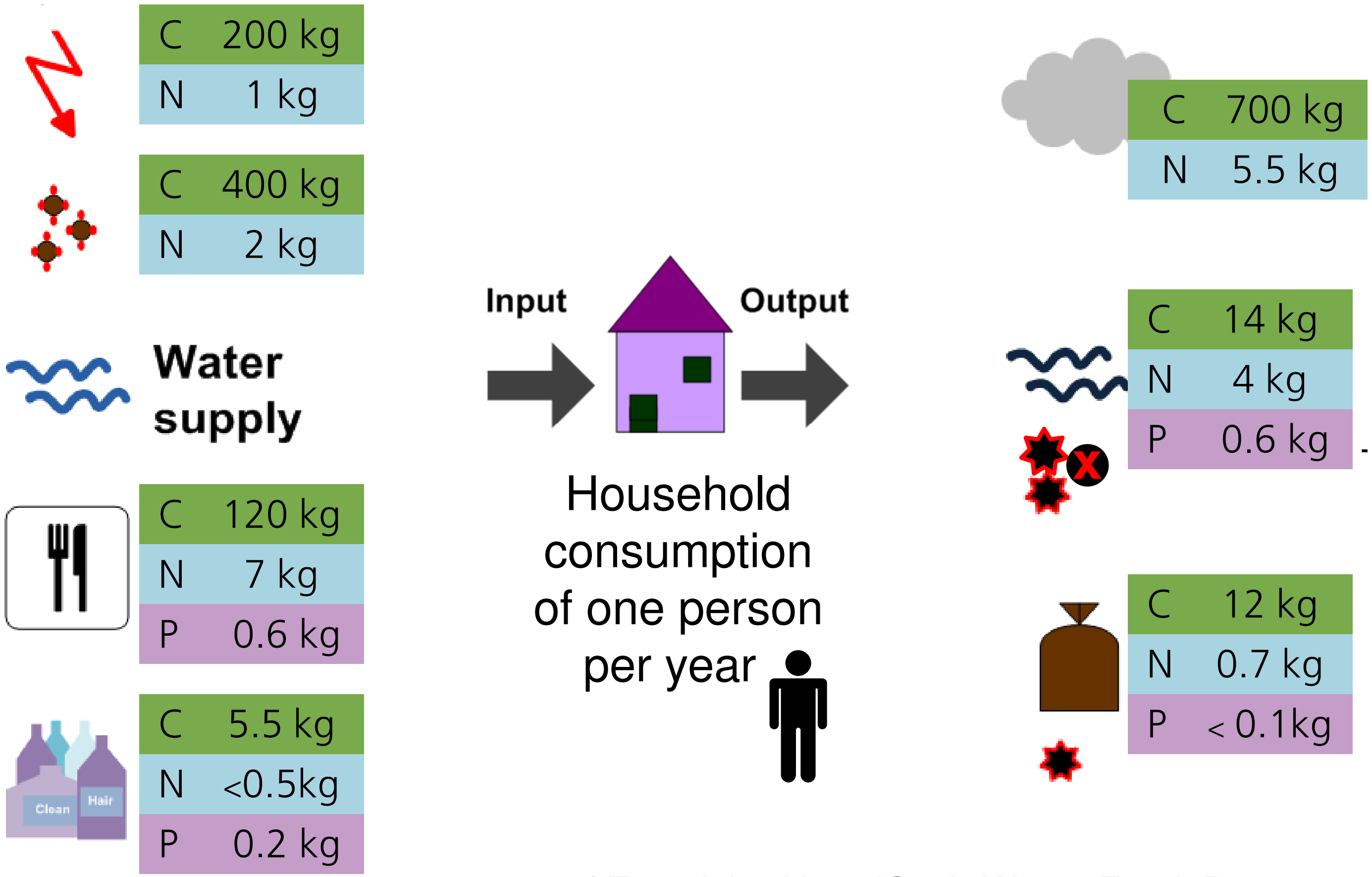
Primary energy
700 kWh/p*a

Exergy
(greywater)
200 kWh/p*a

Exergy (mixed)
35 kWh/p*a

Urban Metabolism

Semi-hypothetical model city: Household consumption of one person per year



Input of Electricity, Heat (Gas), Water, Food, Detergents, Pathways to air, wastewater, and organic waste

Urban Metabolism

Urban Water Flows	Urban Energy Flows	Urban Nutrient Flows (C, N, P)	Urban Pollutant Flows

Relevance of urban water chain for urban Metabolism today

Very high relevance	**High relevance**	**Very high relevance**	**Very high relevance**
Water Use (Tap) Flow dynamics Water Quality (Urban Stream Problem)	Total Energy Consumption (clustered)	Emissions to Water (Eutrophication)	Emissions to Water (Soil, Air)

Tomorrow

Very high potential	**Very high potential**	**Very high potential**		**Very high potential**
contribution to natural water cycle	for Renewable Energy Production	for Nutrient Reuse	↔	for Emission Reduction

So far, our Water Infrastructures worked well, why should we change them.

Your Thinking !

The World is changing. We need infrastructures that support a sustainable metabolism for the green cities of tomorrow.

... then

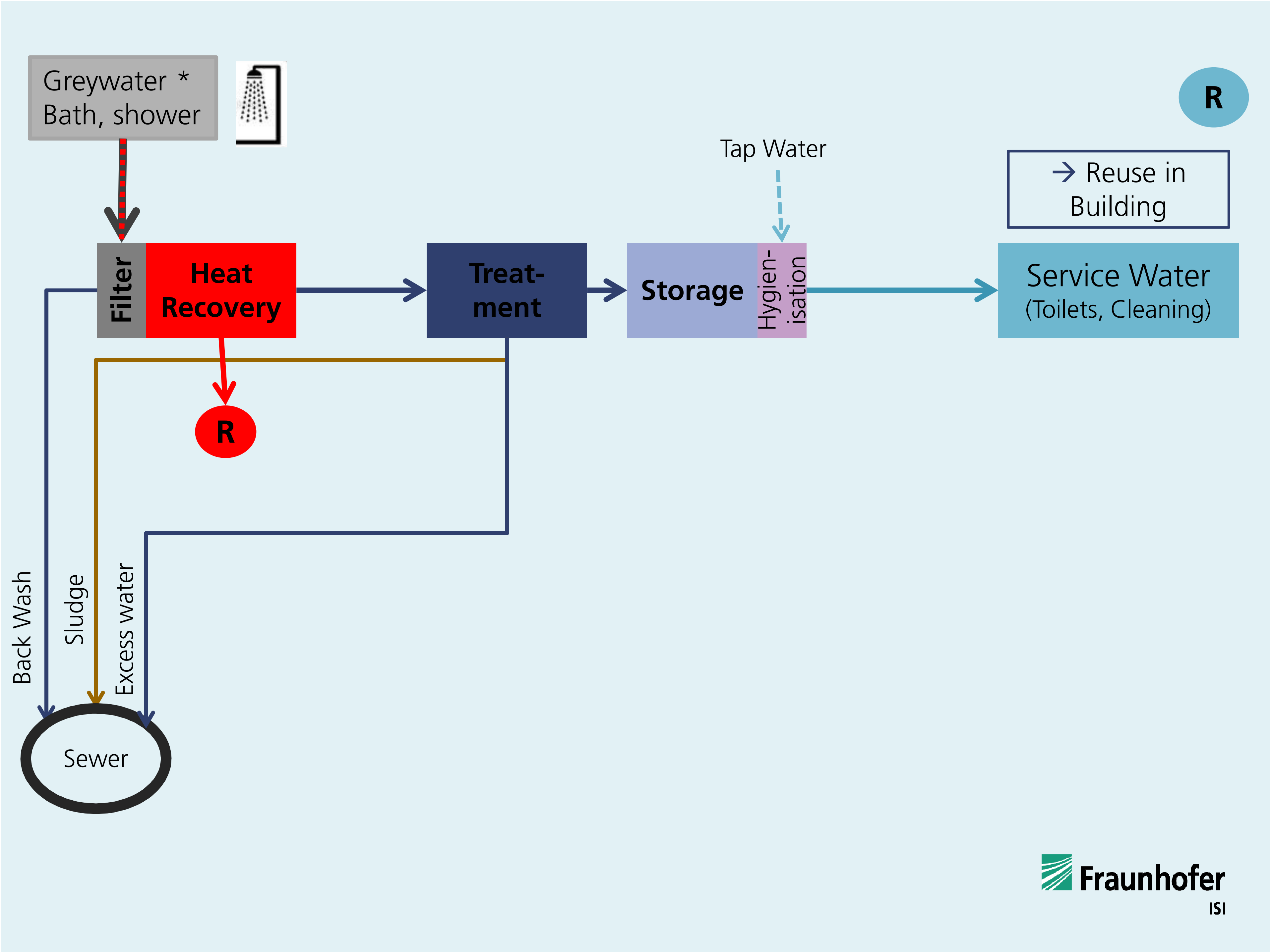
Your Cities !

i.WET (innovative Water Energy Transistion - working title)

- From this holistic perspective on the big 4 of urban flows, we developed a concept for water reuse
- outside the box of traditional grey infrastructure approach
- based on a hybrid system including **technical modules** and **eco-engineered urban landscapes**
- providing **service water** in buildings and **“fertigation” water** for gardens

- Thinking outside the box has advantages:
- supports natural water balance (- run off, + evapotranspiration)
- optimizes energy balance
- protects from eutrophication, and reuses nutrients for bioenergy production
- eliminates and buffers pollutants
- and provides **water** for **urban landscapes** and their **ecosystem services**

C
N
P


Greywater *
Bath, shower
R
Tap Water
→ Reuse in Building
Filter
Heat Recovery
Treat-ment
Storage
Hygien-isation
Service Water
(Toilets, Cleaning)
R
Back Wash
Sludge
Excess water
Sewer
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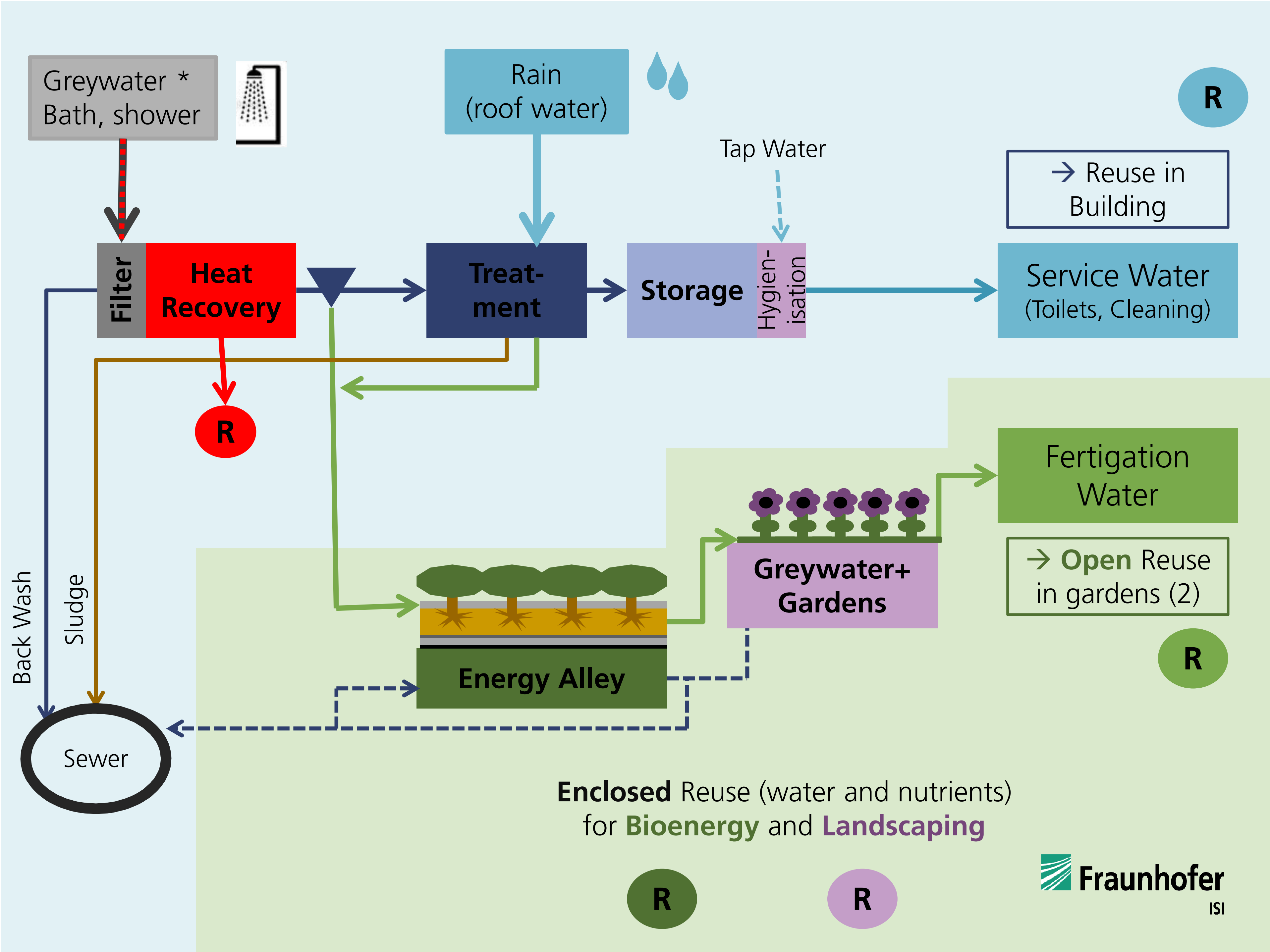


Greywater *
Bath, shower
Rain
(roof water)
Tap Water
R
→ Reuse in Building
Filter
Heat Recovery
Treat-ment
Storage
Hygien-isation
Service Water
(Toilets, Cleaning)
R
Fertigation Water
Greywater+ Gardens
→ Open Reuse in gardens (2)
R
Back Wash
Sludge
Energy Alley
Sewer
Enclosed Reuse (water and nutrients)
for Bioenergy and Landscaping
R
R
Fraunhofer
ISI

Ecosystem Services

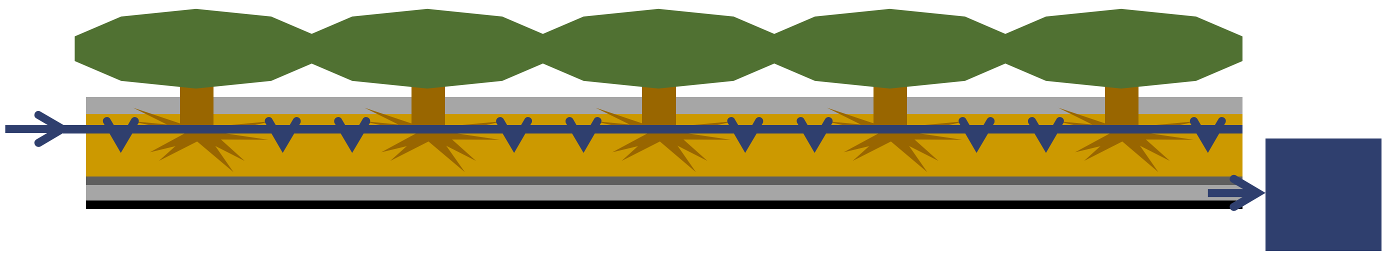
Evapotrans-piration for urban climate	Habitat for Biodiversity
Nutrient reuse	Carbon Se-questration
Barrier for Eutrophication	Barrier for Pollutants

Producing

- Bioenergy (Wood Pellets)
- Water for Open Reuse
- Integrated Water Storage

Sub-stituting

- Stressed „conv." trees and hedges
- Fertilizer (N and P)
- Agricultural Land
- Elimination of CNP at MWWTP
- *Anti-Depressants*



Greywater+ Gardens

- Water loving plants for garden design
- Robust system with low maintenance

- Turn over lower than for Energy Alley
- Cascade use of water and Multi Barrier Approach

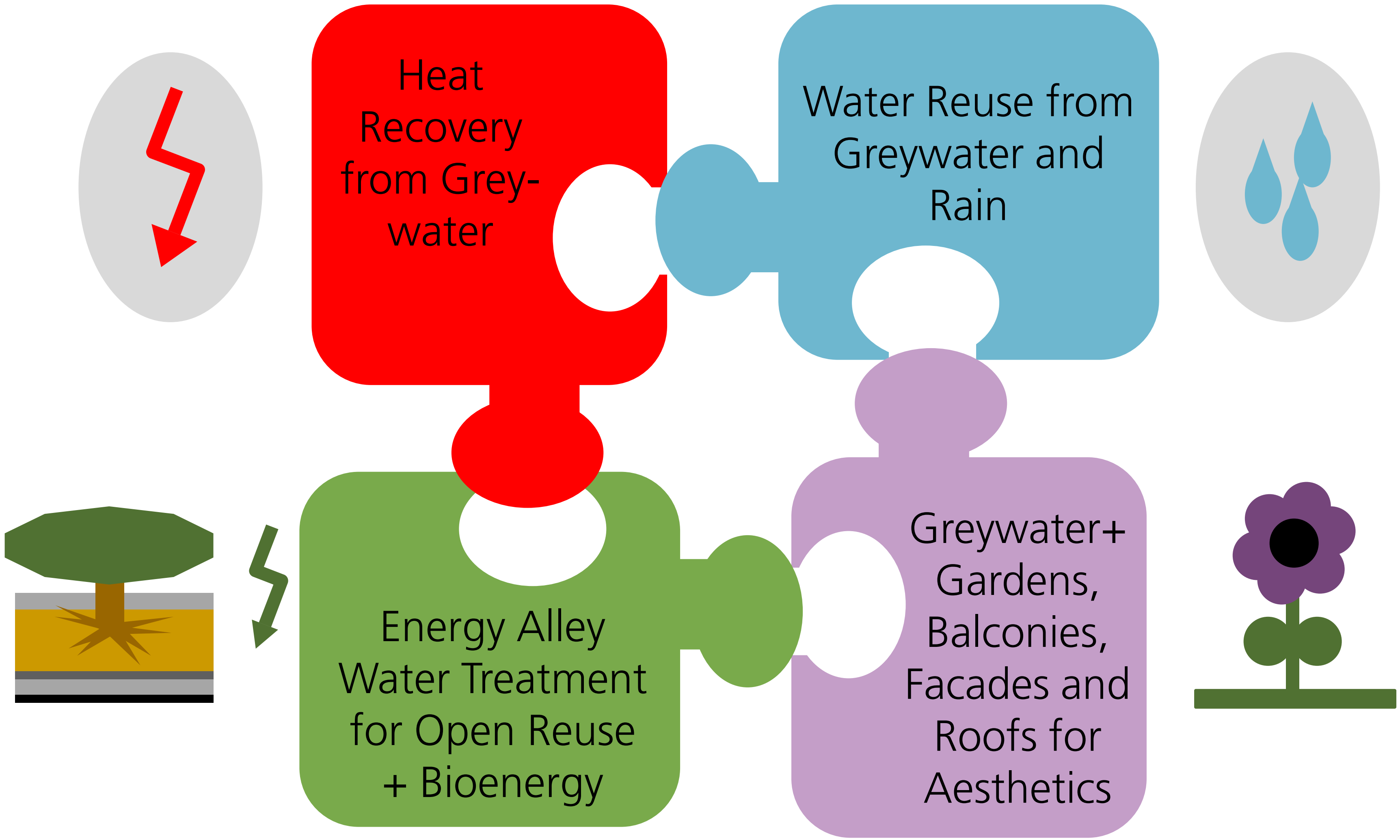
- Plant selection
- Season-ality

Iris versicolor

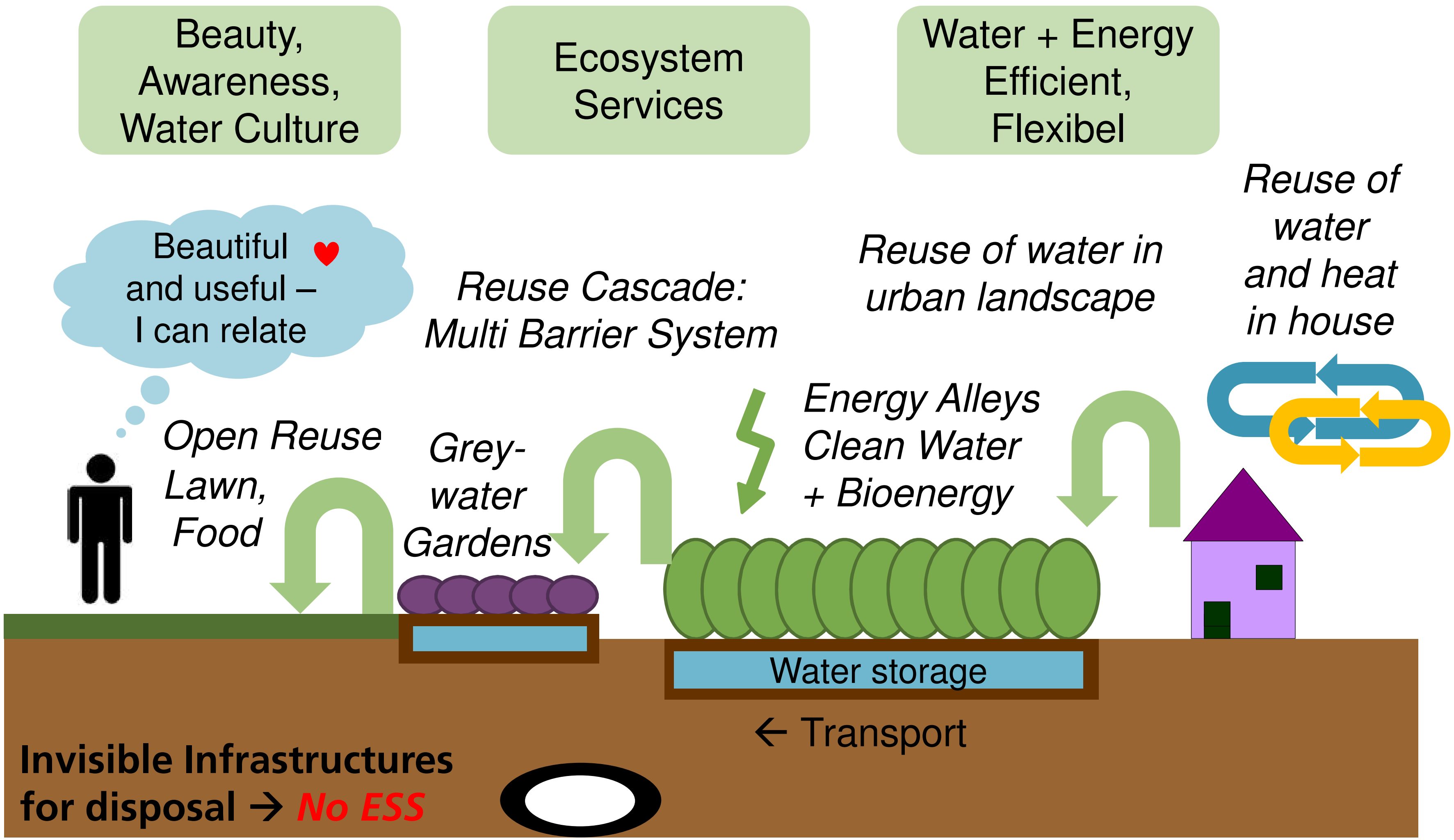
Lythrum salicaria

Hemerocallis minor

Ajuga reptans


Heat Recovery from Grey-water
Water Reuse from Greywater and Rain
Energy Alley Water Treatment for Open Reuse + Bioenergy
Greywater+ Gardens, Balconies, Facades and Roofs for Aesthetics

Visible Colourful Infrastructures for Reuse in Water-Sensible Cities



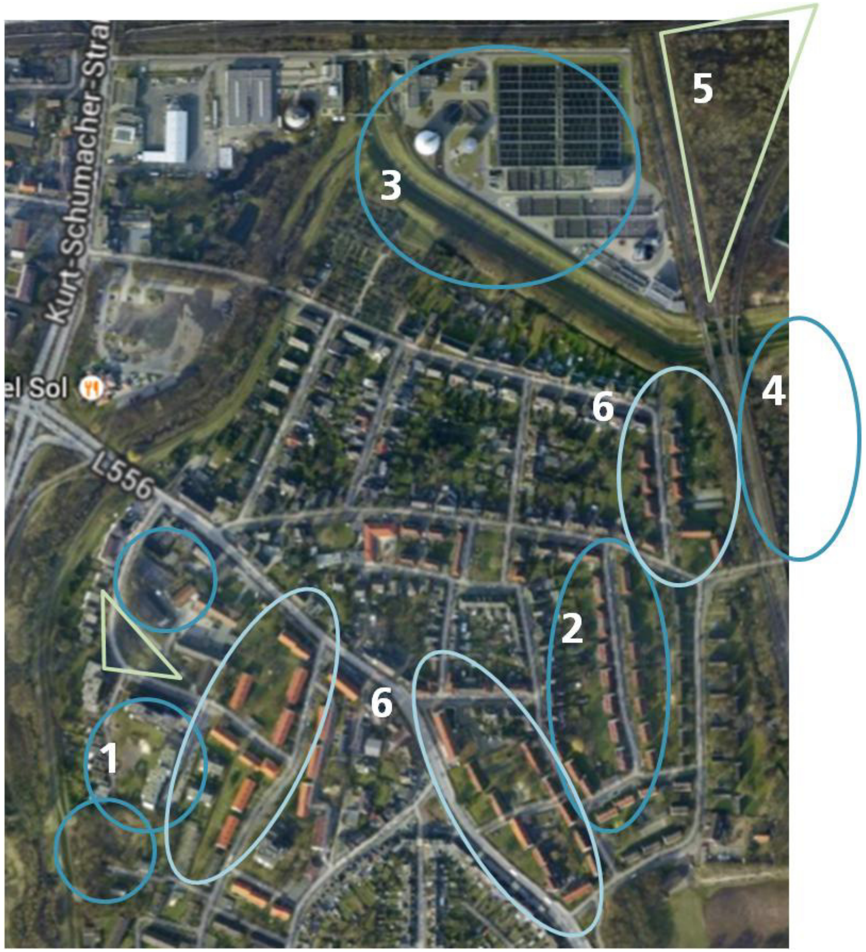
Transition Pathways

- Example: Town of Luenen

- i.WET for greywater and rainwater
- Introduce with building renovation
- -50% volume in sewer → mitigation by flushing sewer with surplus water from energy alley

- Vacuum for blackwater
- Introduce with sewer renovation
- Co Substrate for Digestion

- Flexible Transition Pathway



Thank You for Your Attention

Thanks to BMBF and all TWIST++ Partners

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