SEMICENTRALIZED SYSTEMS

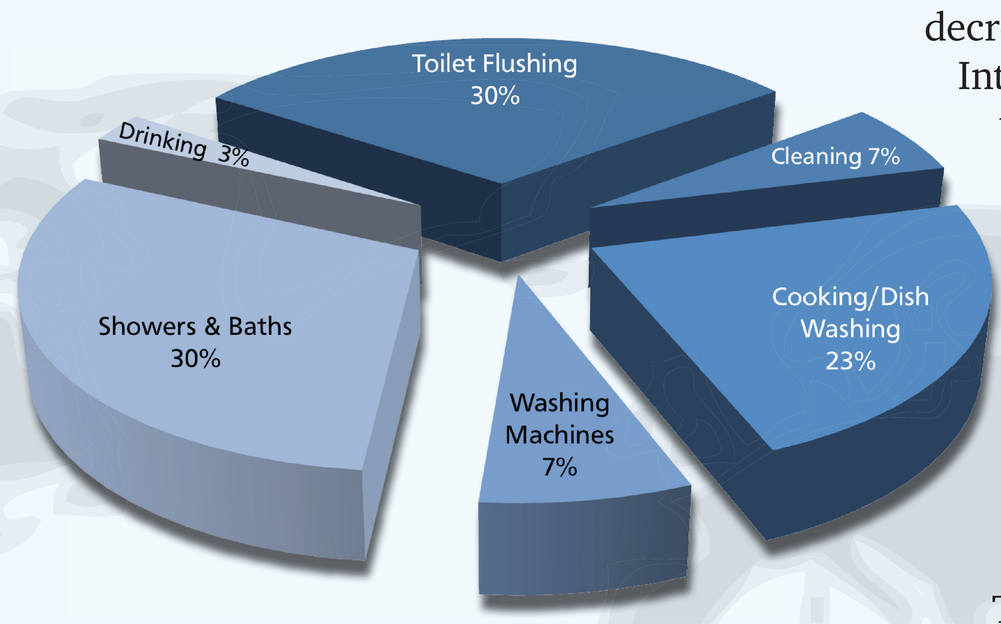
Raising Water & Energy Efficiency

TECHNISCHE UNIVERSITÄT DARMSTADT

IWAR

Potentials for Water Reuse within the Semicentralized Concept

Wastewater contains water - a valuable resource - in concentrations of more than 99.5 %. Thus, water reuse is an essential component of integrated water resource management, not only in arid and in water deficient areas, but increasingly also in densely populated urban areas, where water demand and supply diverge widely.
Intra-urban reuse of water for utilizations which do not require drinking water quality offers a high potential to save valuable water resources and reduce wastewater discharge. But water reuse requires the transition from conventional centralized to nodal, semicentralized supply and treatment systems, with short distances from the firsthand user to the treatment units and back to the secondhand reuse.
Intra-urban water reuse facilitates the reduction of drinking water consumption to the quantity needed for cooking, drinking, and personal hygiene, as the reused greywater –after adequate treatment– covers the demand of water needed for toilet flushing.



water consumption in Qingdao

By reusing adequately treated water, the demand of potable water could already be reduced by 30 %. At the same time, the amount of wastewater to be treated would decrease by the same amount.
Intra-urban water reuse not only preserves valuable resources, but often it is more energy-efficient and more cost-effective. In case treatment is carried out close to the greywater's origin, its high temperature can be used for heat recovery and collection and distribution pipes are short and costs for pumping and losses during transport are low.

The size of a system plays a decisive role regarding costs of sanitation systems. Against the background of the reuse of material flows and therefore the need of dual piping and sewer systems, investment and operation costs of the grid may be one of the limiting factors for the system size, however, when referring to treatment costs, economies of scale for treatment and operation have to be considered. Optimum resource conservation requires a minimum size of technical plants, yet, a compact piping and sewer system in order to minimize the energy input.
Research shows that the recommendable size of integrated semicentralized systems for new development areas ranges between 50,000 and 100,000 inhabitants. Generally there cannot be a universal solution for everywhere. The individual circumstances and interests need to be considered in order to find an adapted and locally-fitted solution.

Case Study Qingdao, China

In the Qingdao Case there are three core aims: (1) reducing water demand by intra-urban water reuse, (2) ensuring reliable treatment for sewage sludge, and (3) offering energy self-sufficient treatment for all material flows.
Saving 30 % of potable water by using treated greywater for toilet flushing is only the first step – even higher reduction rates can be achieved by treating the whole amount of the arising greywater and enabling industrial use or for public purposes like e.g. irrigation, street cleaning or fire fighting.The integration of sewage sludge and waste treatment leads to an increase of the overall system efficiency and a decrease of the amount of residues to be disposed. At the same time, the sludge is stabilized and a solution for the currently tense and severely deficient treatment situation of wastewater sludge is given.
The integrated anaerob treatment of sewage sludge and biowaste gains sufficient biogas for generating electricity for the overall treatment facilities within a semicentralized supply and treatment centre and even to produce a surplus of electric energy.

The energy balance of a potential system in Qingdao in figures:

- Demand for the different treatment steps:

greywater:	- 9-18	kWh/(C·a)
blackwater:	- 20	kWh/(C·a)
waste/sludge:	- 36	kWh/(C·a)
	- 65-74	kWh/(C·a)

- Generation by conversion of biogas into electricity:

  + 110 kWh/(C·a)

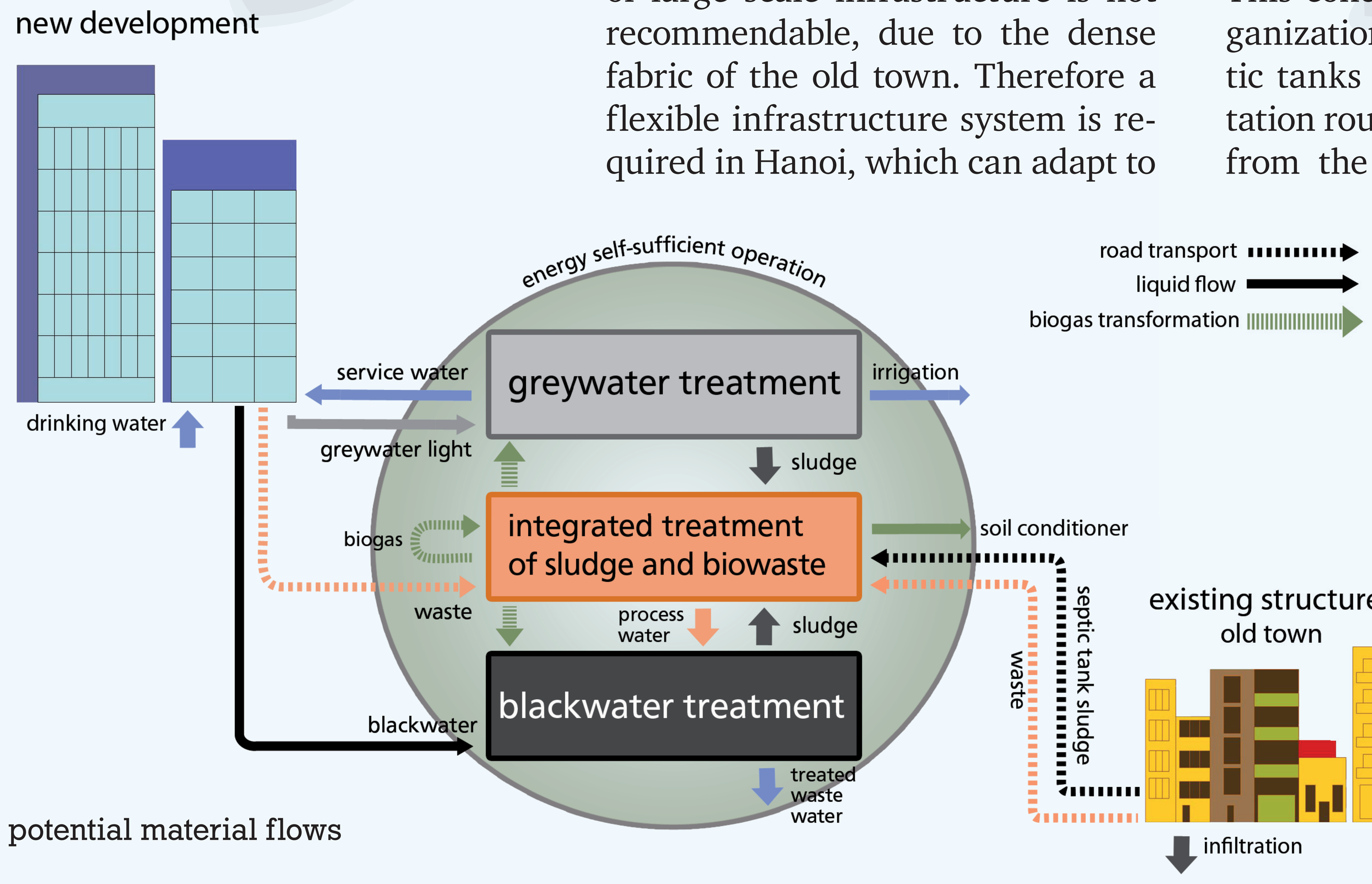
- Overall surplus:

  +35-44 kWh/(C·a)

Additionally, the caloric heat of the separated greywater can be recovered. Between 117 and 131 kWh/(C·a) of caloric heat can be gained from greywater for heating purposes.
The energy is (nearly exclusively) gained from organic material, the wastewater treatment sludge as well as biowaste and residuals. Using the biogas out of this sludge and waste, not only the energy bill is reduced to a minimum, but also the CO_2 balance of the whole system is significantly improved.

Case Study Hanoi, Vietnam

Vietnam is experiencing rapid urbanization with urban growth rates of more than 5 % in 2005.
The wastewater situation is characterized by a lack of treatment plants. Only 41 % of Vietnam's urban population is connected to reticulated sewerage, thus wastewater is mostly drained without purification, leading to serious environmental degradation. Prevalent means of sanitation are septic tanks installed under the buildings for the collection of blackwater, with the overflowing liquids draining uncontrolled into the soil. Greywater is regularly drained into open storm water sewers along the streets without purification.
The rapid, intensive and partly uncontrolled growth of the city complicate the anticipatory provision of central infrastructures. On the other hand, the subsequent installation of large scale infrastructure is not recommendable, due to the dense fabric of the old town. Therefore a flexible infrastructure system is required in Hanoi, which can adapt to the rapidly changing situation.
In contrast to existing plans for the upgrading of Hanoi with conventional centralized sewerage systems, the semicentralized approach focuses on supply and treatment structures on the neighborhood level concentrating on closed cycles with the combined treatment of septic tank sludge, waste water and biowaste for biogas production (see scheme left).
This concept shall include the organization of the drainage of septic tanks as well as the transportation routes of the vacuum trucks from the tanks to the projected supply and treatment centre.
On the basis of the research an operation scheme for the integrated supply and treatment system will be developed, defining the scope of responsibilities of private and public actors.



potential material flows

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