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DEUTSCHE ZUSAMMENARBEIT

Implemented by

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nexus

Energy & Material Cycle of Waste-water

- Waste water to Energy
- Recycling of Grey water

Innovative approaches for waste water management
are needed
adapted to the 21st Century with:

- global **population growth**
- a trend towards **urbanization**
- increase of consumption in **emerging markets**
- **key resources** becoming scarcer

Global changes make it important to think about **Energy- & Mass flow -cycles**

Closing the **material cycles** directly in the **residential areas** will **protect water resources** and utilize **waste water** to produce **energy**

Some facts about:

"Waste" (urine & excreta)

One person generates on average **per day**
1.5 liters of "waste" (urine, excreta) with:

- large proportion of **organic matter**, and
- **rich in nutrients** (high phosphate and nitrogen concentrations)

25 to 50 liters flush water per day (dependent on the flushing system) are needed for the transport of the "waste" to the septic tank or sewer plant:

- **dilution** effect through **flush water**
- **dilution** through **grey water** and **rainwater** during the transport

Some facts about:

Septic "collection" tanks

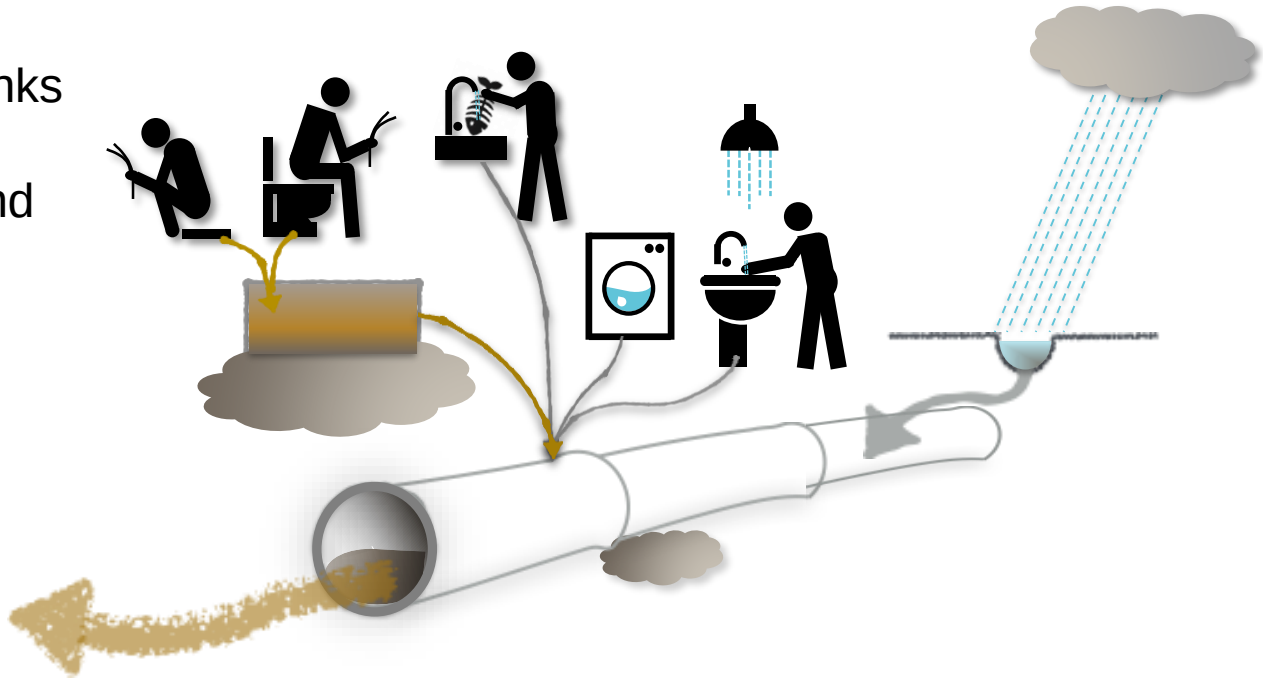
- **Fermentation** processes inside the tank **generate green house gas** (carbon dioxide and methane)
- **Septic tanks** built with bricks or concrete are **leaking** (contamination of soil and groundwater)
- **Septic tanks** require **periodic maintenance** (emptying)
- **Chemicals** (disinfection cleaner), **kill septic bacteria** (needed to operate the system)
- **Individual septic tanks** are **not suitable** for urban agglomerations

Some facts about:

Combined gravity storm- & waste-water collection system

Storm water drainage lines are used to drain:

- Effluent of the septic tanks
- Grey water (kitchens and bathrooms)
  > diluting effect
- Storm water (rainwater)
  > diluting effect
  > no energy recovery <



Some facts about:

Combined gravity storm- & waste-water collection

Sewer leaks (septic tanks & sewer pipes) can occur from:

- tree root invasion,
- soil slippage,
- seismic activity,
- washout, flooding, among other events

Fermentation processes inside the pipe network **generate green house gas** (carbon dioxide & methane).

When both, individual water wells and **septic systems** are used, there is a **danger** of **drinking water contamination**

Some facts about:

Combined gravity storm- & waste-water collection system

Storm water can cause combined systems to **overflow** (sewage contamination):

- bigger pipes to cover the storm water load will lead to clogging during dry season
- smaller pipes to avoid clogging will lead to overflow during rainy season

Combined systems are cheaper, but the **potential to harm health** is high

Some facts about:

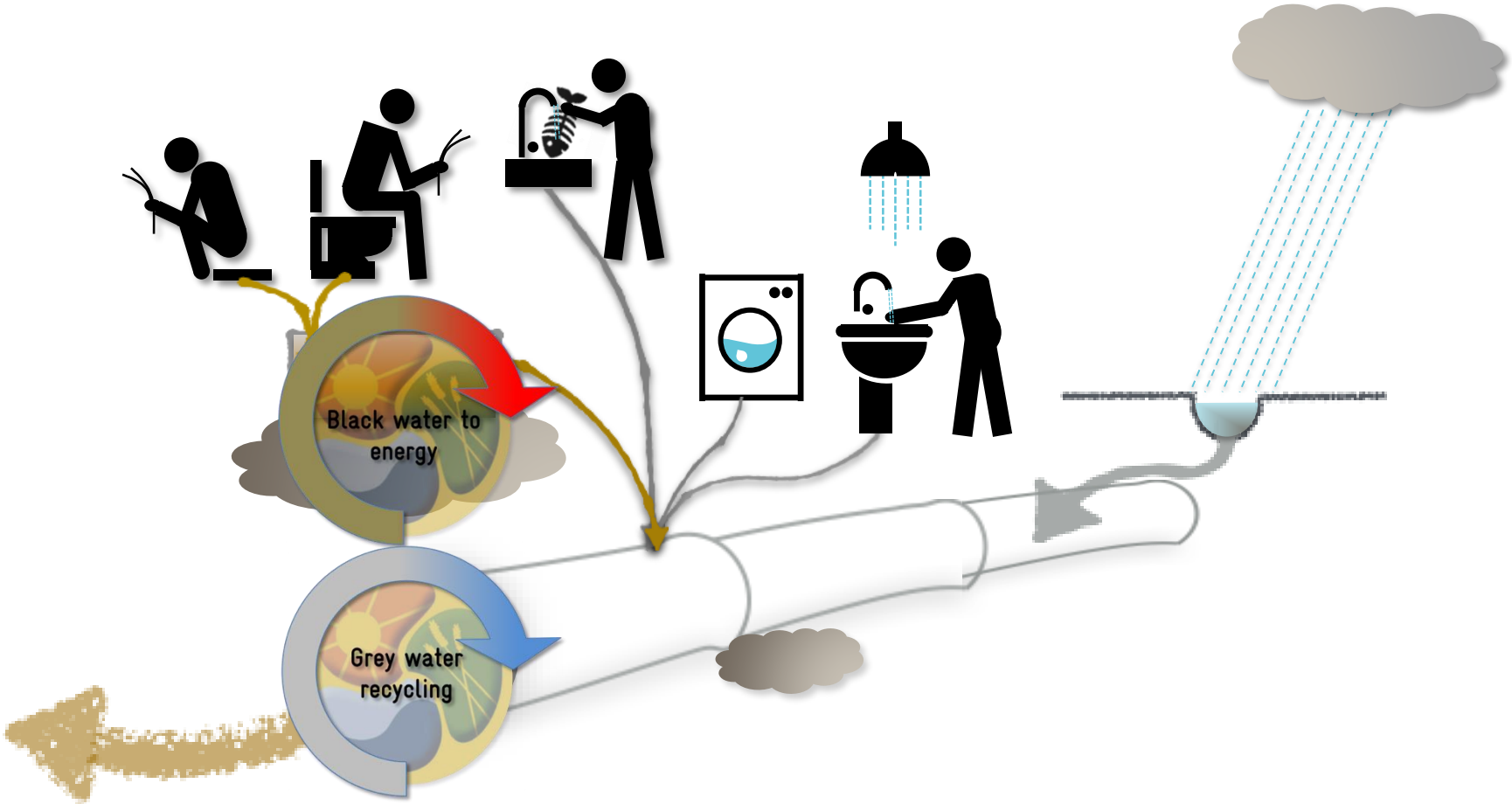
Treatment plants in combined gravity storm- & waste-water collection system

Treatment of diluted water (black-, grey- & storm water) is inefficient in terms of:

- energy cycle
- material cycle

- Treatment plants occupy large areas of land
- Energy generation not possible
- Reuse of water (recycling of water) very expansive (high energy cost)

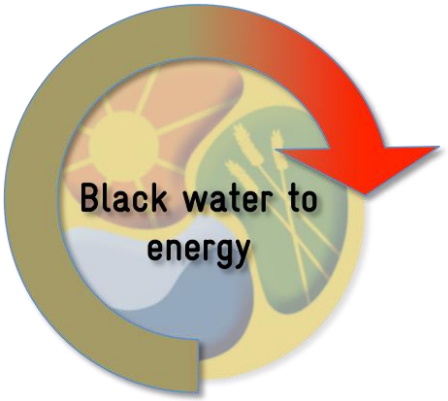
Energy & Mass flow-cycles from black & grey water



Energy & Mass flow-cycles from black & grey water

In order to **reduce flooding** and sewage contamination and to **recover energy** and **recycle** the **mass flow** from the waste water economically:

- storm water systems should be **separate**d from waste water (black- & grey water) by own pipes
- **toilets** should be **directly connected** to the black water system
- **septic** "collection" **tanks** should be **eliminated**
- **grey water** should be **collected and treated separately** from black water (recycling)

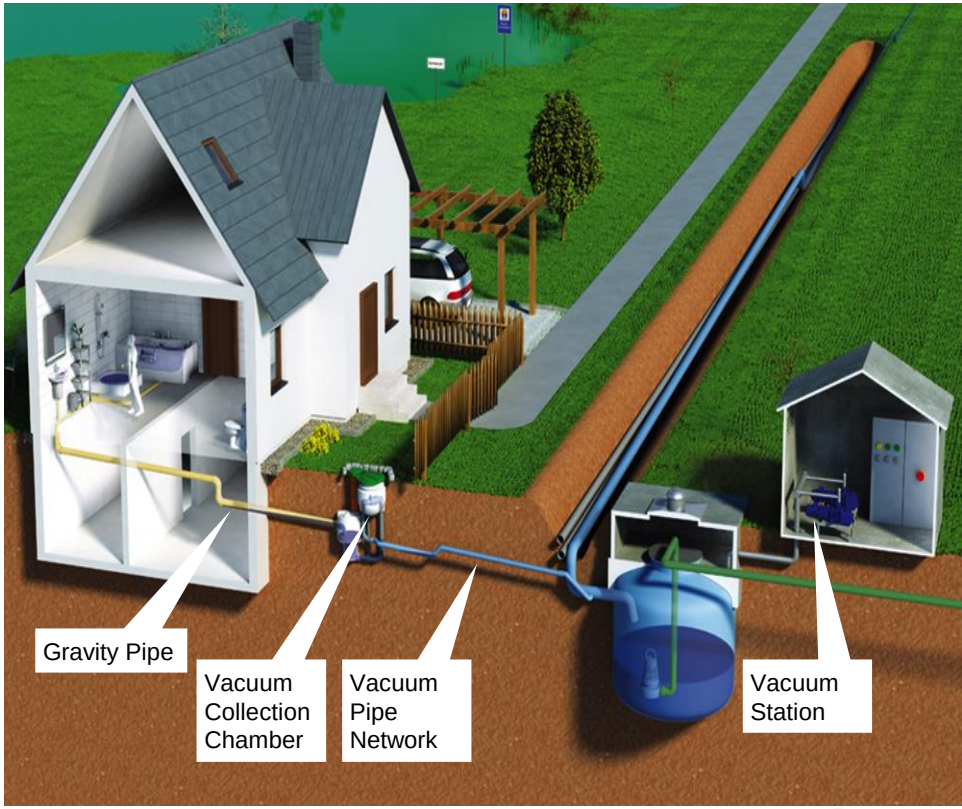


Energy & Mass flow-cycles from black & grey water

Vacuum sewer collection are mechanized systems of waste water transport, which use **differential air pressure** to transport the waste water.

Vacuum sewer operates as follows:

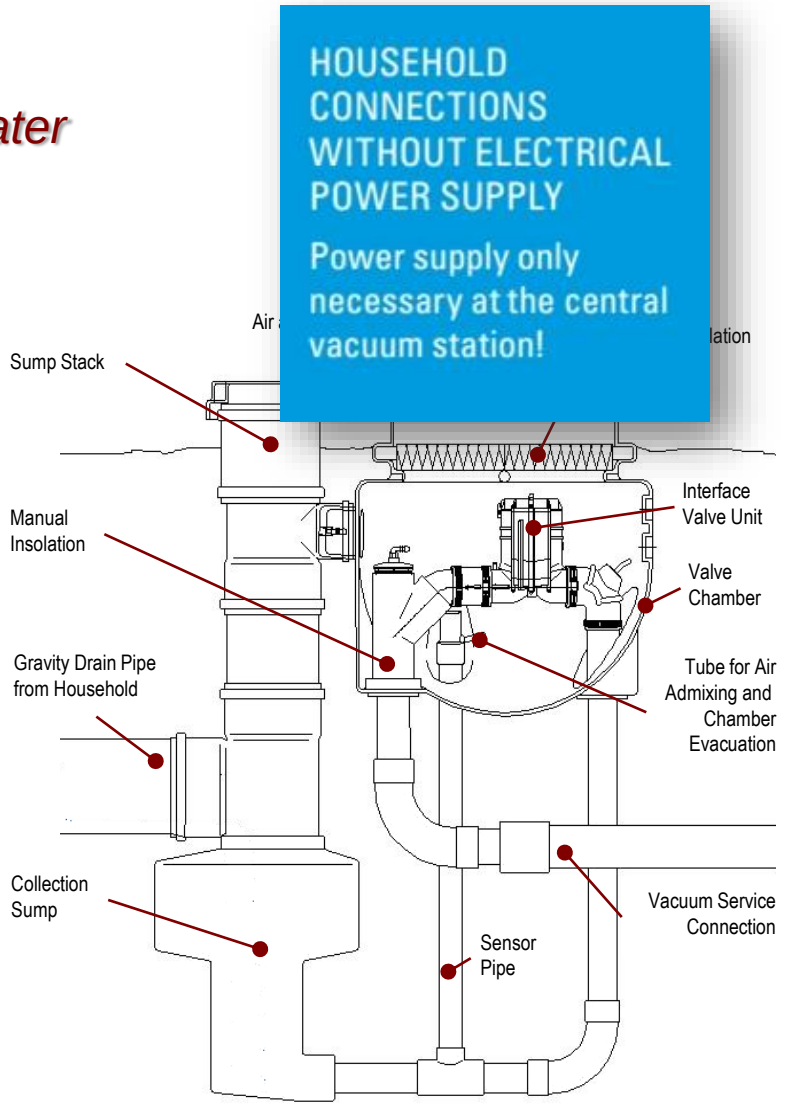
- Waste water is **drained** from the house to a vacuum collection chamber **by gravity**
- The **vacuum chamber** serves as interface between gravity pipe (from the household) and the vacuum sewer network
- Waste water collected in the vacuum collection chamber is evacuated through a vacuum valve into the **vacuum pipe network**
- The waste water is transported through a vacuum sewer network to the **vacuum station**
- From the vacuum station the waste water is discharged to the **treatment plant**



Energy & Mass flow-cycles from black & grey water

Vacuum sewer collection

- Wastewater is collected in the sump of the collection chamber;
- Once the wastewater reaches a predetermined level within the sump, the hydrostatic pressure inside the sensor pipe activates a pneumatic controller and the controller opens the vacuum valve for one cycle;
- The wastewater from the sump of the collection chamber will be pushed by the differential pressure into the network;
- The air that enters the system after the sump is emptied will transport the wastewater through the network towards the vacuum station;
- After the predetermined time for one cycle elapsed, the vacuum valve closes and one evacuation cycle is complete.



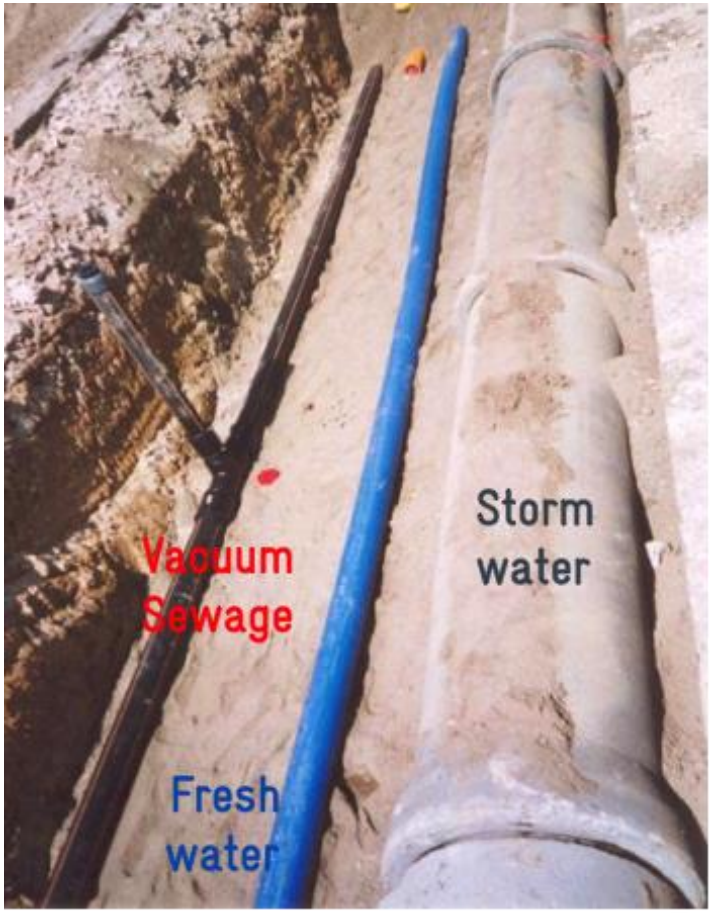
Energy & Mass flow-cycles from black & grey water

Vacuum sewer collection

Vacuum sewerage systems are reducing the impact on the environment and have the **lowest carbon footprint** of any municipal sewerage system;

The **totally closed Vacuum sewerage system** is collecting waste-water by vacuum means, thereby minimizing:

- Risks to the Environment
- Emissions of methane gas
- Odor
- Diseases
- Contamination
- Energy Use
- Water Use



Energy & Mass flow-cycles from black & grey water

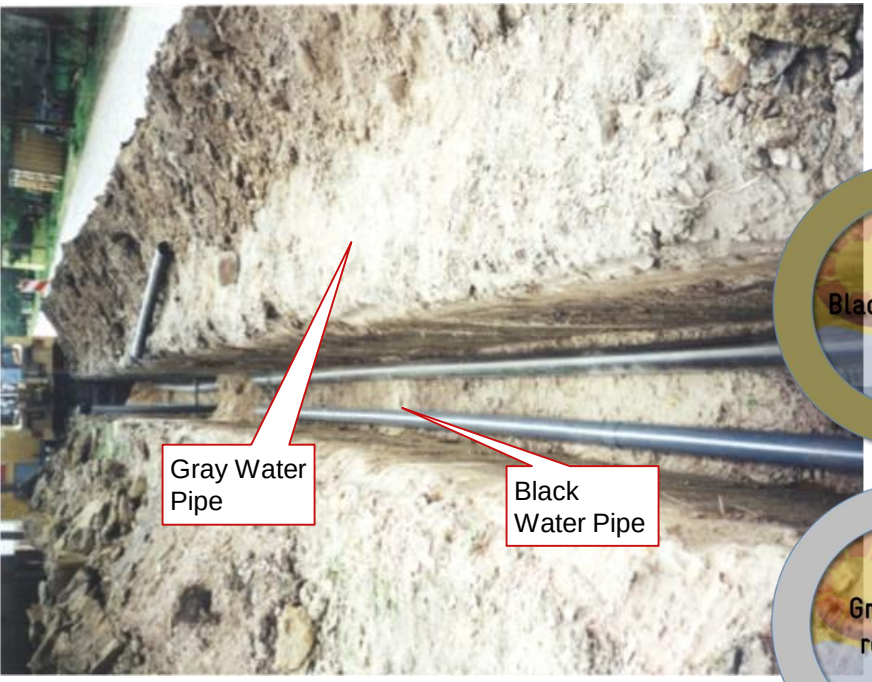
Vacuum sewer collection

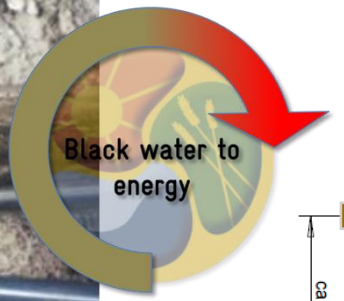
Vacuum System: *Cost effectives*

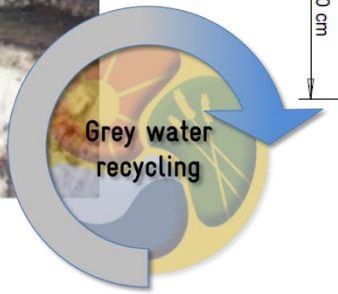
- Small pipes (80-250mm)
  - Shallow, narrow trenches (0,6 - 1.2m)
  - Simple and fast
  - Simple or even no machinery required *(Energy saving potential)*
- No manholes, inspection pipes only
- No lifting (pump-) stations required
- Fresh water and waste water pipes in the same trench allowed

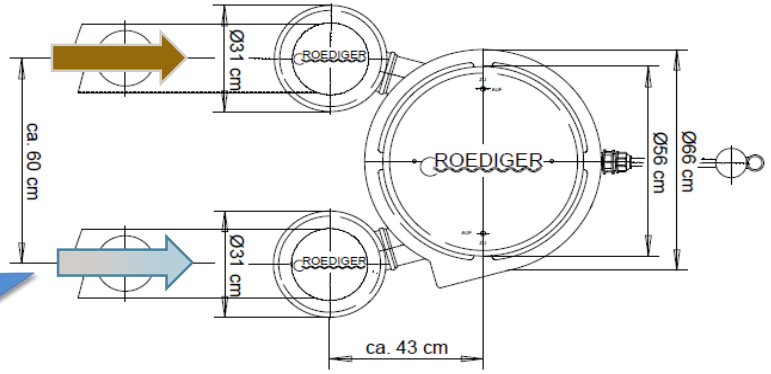
Energy & Mass flow-cycles from black & grey water

Separated vacuum sewerage collection for black- & grey-water









Energy & Mass flow-cycles from black & grey water

Vacuum sewer collection *sample Da Nang*

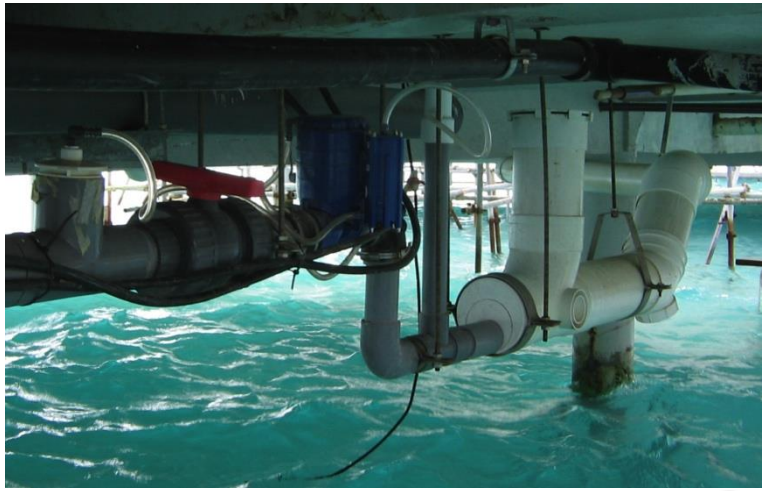
The drainage channel is under the walkway between the houses.

The vacuum sewer system will be installed here after.

Energy & Mass flow-cycles from black & grey water

Vacuum sewer collection

Villas built over the water, accessible by pile-bridges,
e.g. Tanjungpinang/Senggarang



Energy & Mass flow-cycles from black & grey water

Anaerobic black water treatment

The **domestic waste water** - sucked via vacuum from collection chambers - is **treated** in an **anaerobic cleaning reactor** with built-in membrane technology.

The fully **anaerobic process technology** is able to convert the solids and bio waste from households as well as liquids from black water **into biogas**.

The energy in the **biogas** produced by anaerobic waste water cleaning is over **100 kilowatt hours** per resident each year.
The **vacuum station** produces the vacuum required for this process.

Energy & Mass flow-cycles from black & grey water

Grey water treatment

Less diluted black water becomes much **more profitable** for energy production

(water-saving toilets concentrating the black water)
Water - filtrated by membranes - is suitable for **irrigating** and **fertilizing** farmland.

Membrane filtration removes the bulk of germs (bacteria's) from the water, it is **safe to use** as fertilizer.

Ammonium or **phosphate** which occur in high concentrations in the waste water **remains**.

Black water is not just waste, it is an essential resource of renewable energy

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"We can not solve problems with the same level of thinking that created them"

Albert Einstein

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