Deutsche Gesellschaft
für Internationale
Zusammenarbeit (GIZ) GmbH

Energy from Wastewater – or energy efficient Sanitation systems?

GIZ Sustainable sanitation

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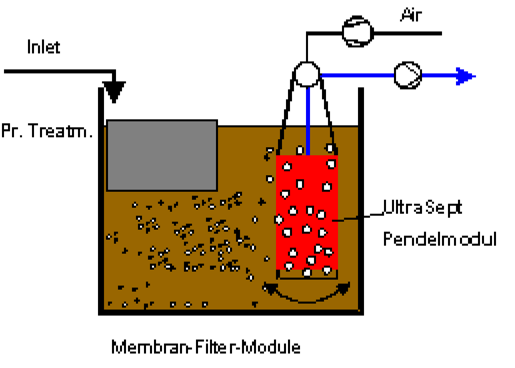
partner of
sustainable
sanitation
alliance

commissioned by
Federal Ministry
for Economic Cooperation
and Development

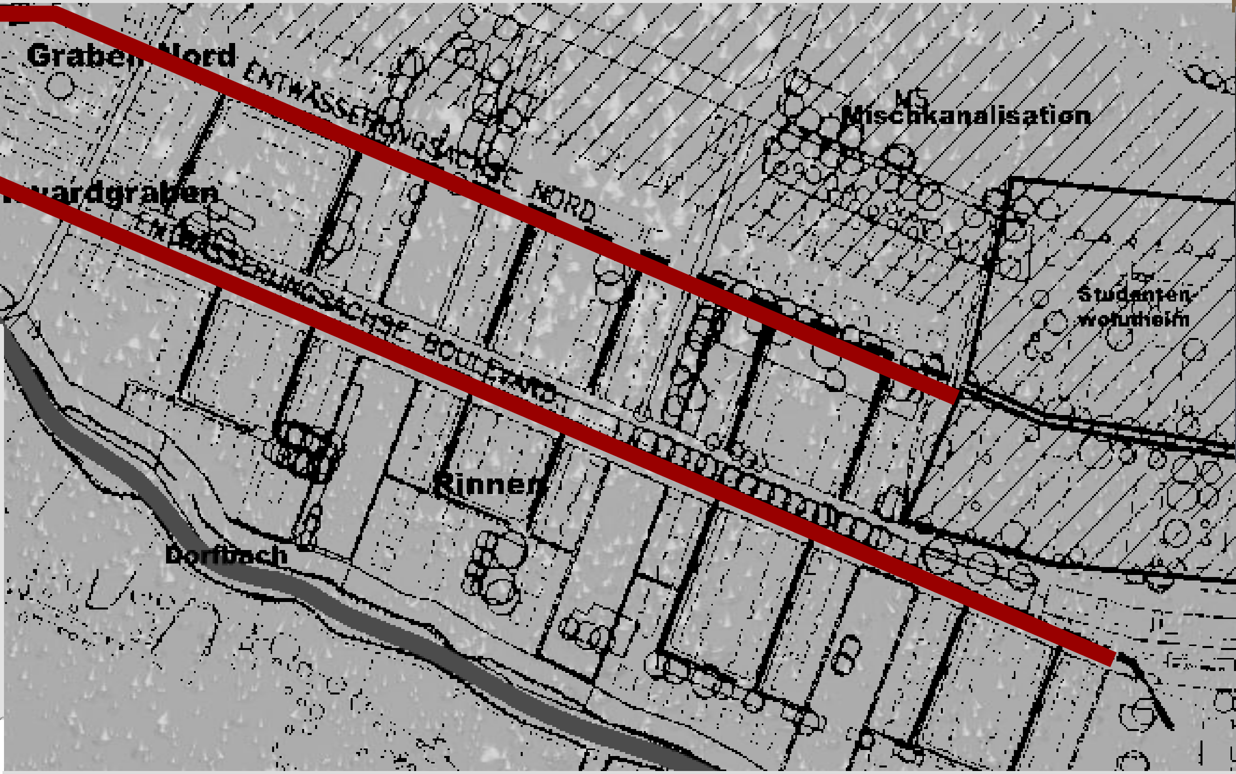
Personal note
eco-building "Wohnen & Arbeiten", Freiburg

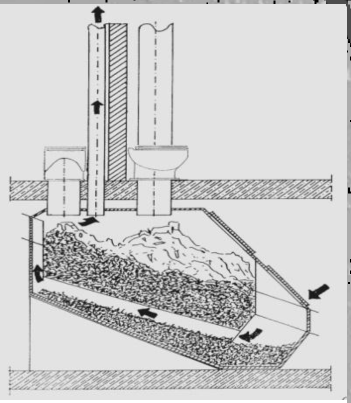


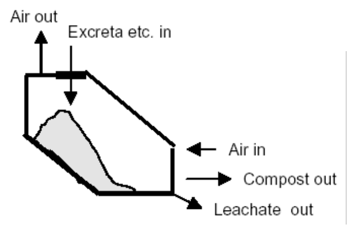
grey-water treatment with bio-membrane technology

eco-district "Vauban", in Freiburg, Germany

Special ditches help recharging < 50 % off the rainwater back to the groundwater; the rest goes into a small brook ("Dorfbach")







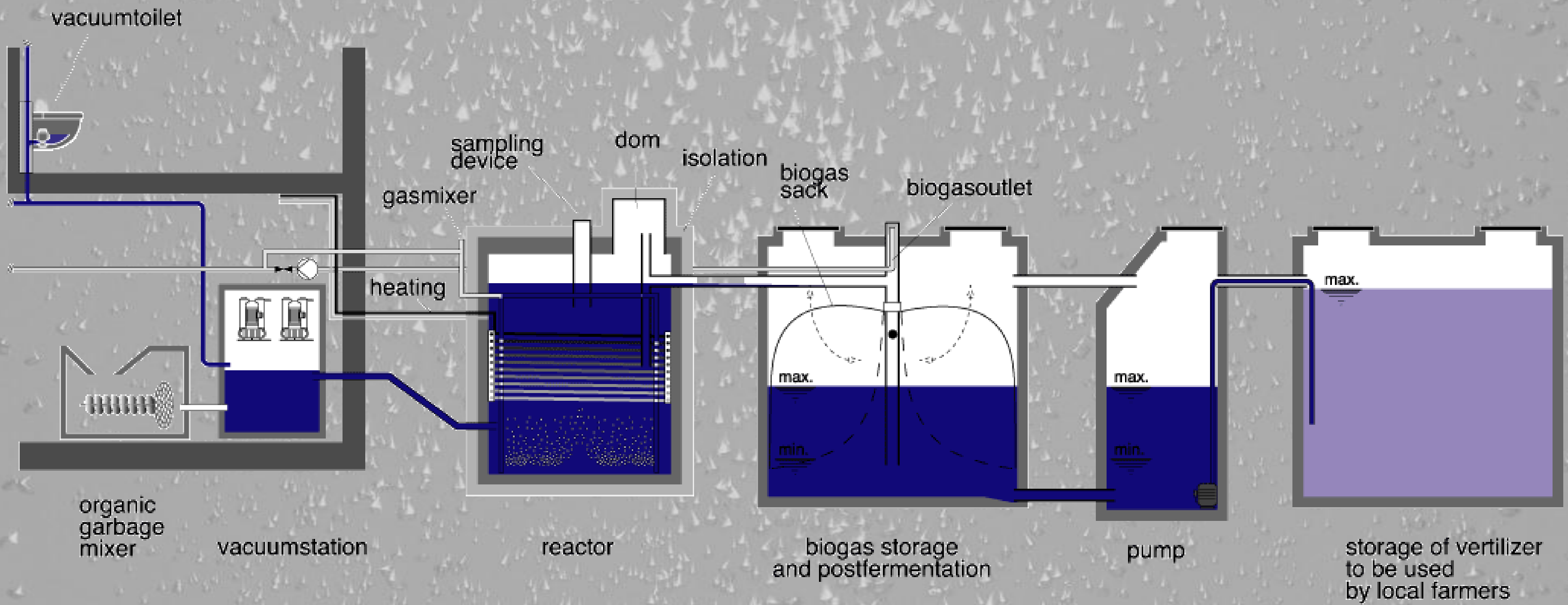
Clivius multrum composting toilet in use at an attended children's playground

© Panesar & Lange

model project „Wohnen & Arbeiten“ (Ökobau e.V)

scheme of the ecological sanitation concept

(in cooperation with TBW, Frankfurt)



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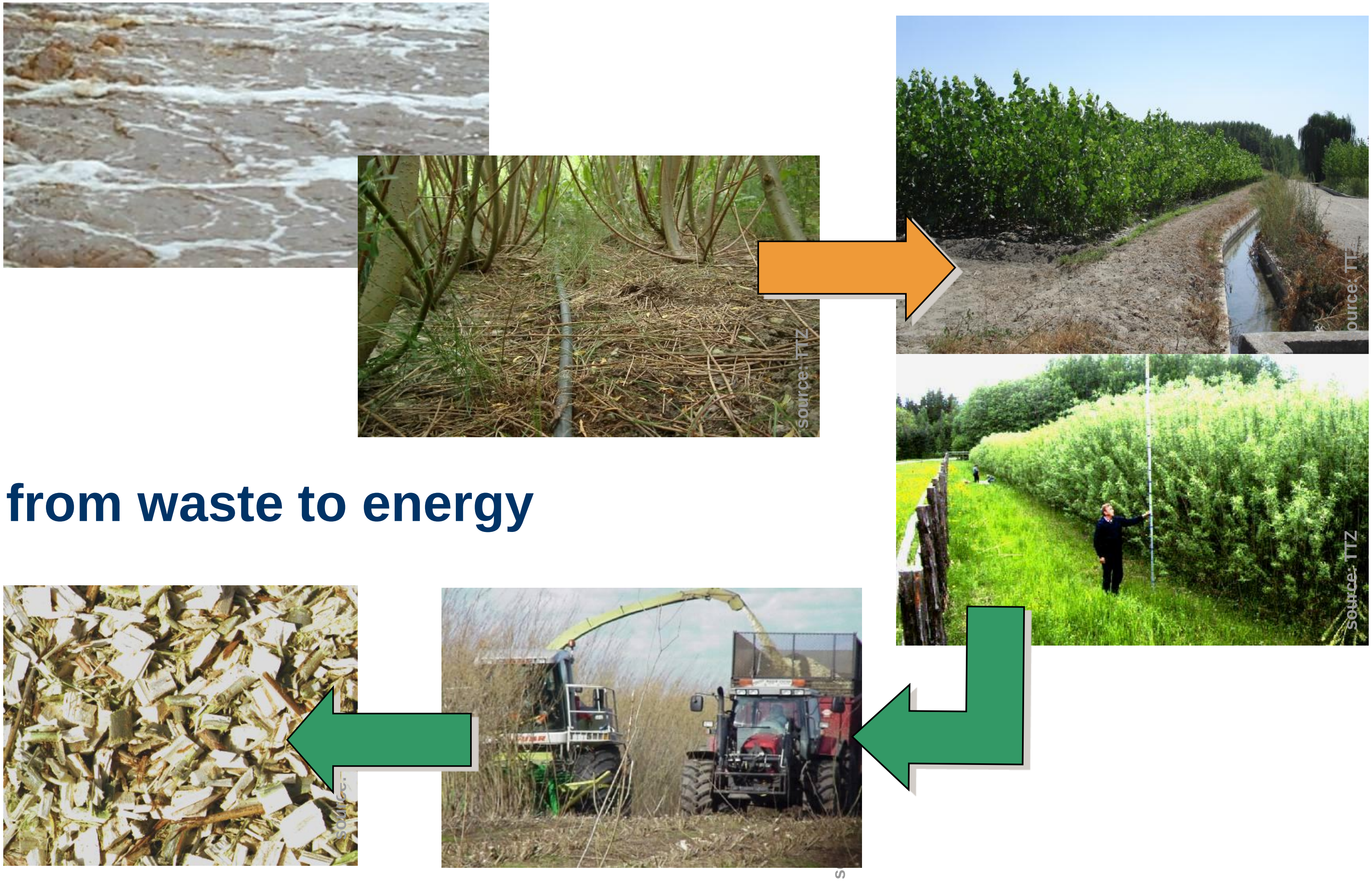


from waste to energy

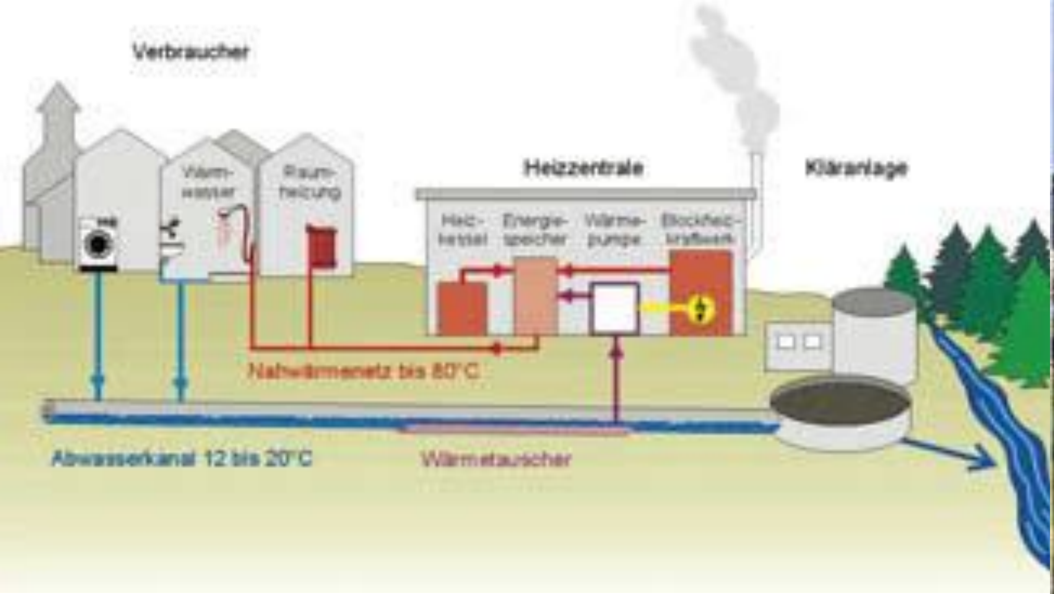
Rainwater harvesting at the GENOVA project in Freiburg Vauban

- storage capacity 7 m3
- pumping energy:
  → manuel or
  → through solar enery

Comparing energy
needed for pumping drinking water:

- Hamburg	at least 0,9 kWh/m3
- Stuttgart (from lake Constance)	at least 2,0 kWh/m3
- rainwater pumped from underground storage	0,3-0,5 kWh/m3
- Drinking water from the black forest	about 0,2 kWh/m3

Post - Muelligen, Zurich (Switzerland): Waste water heated offices



Heating and waste water – energy recovery

Office heating from waste water plant

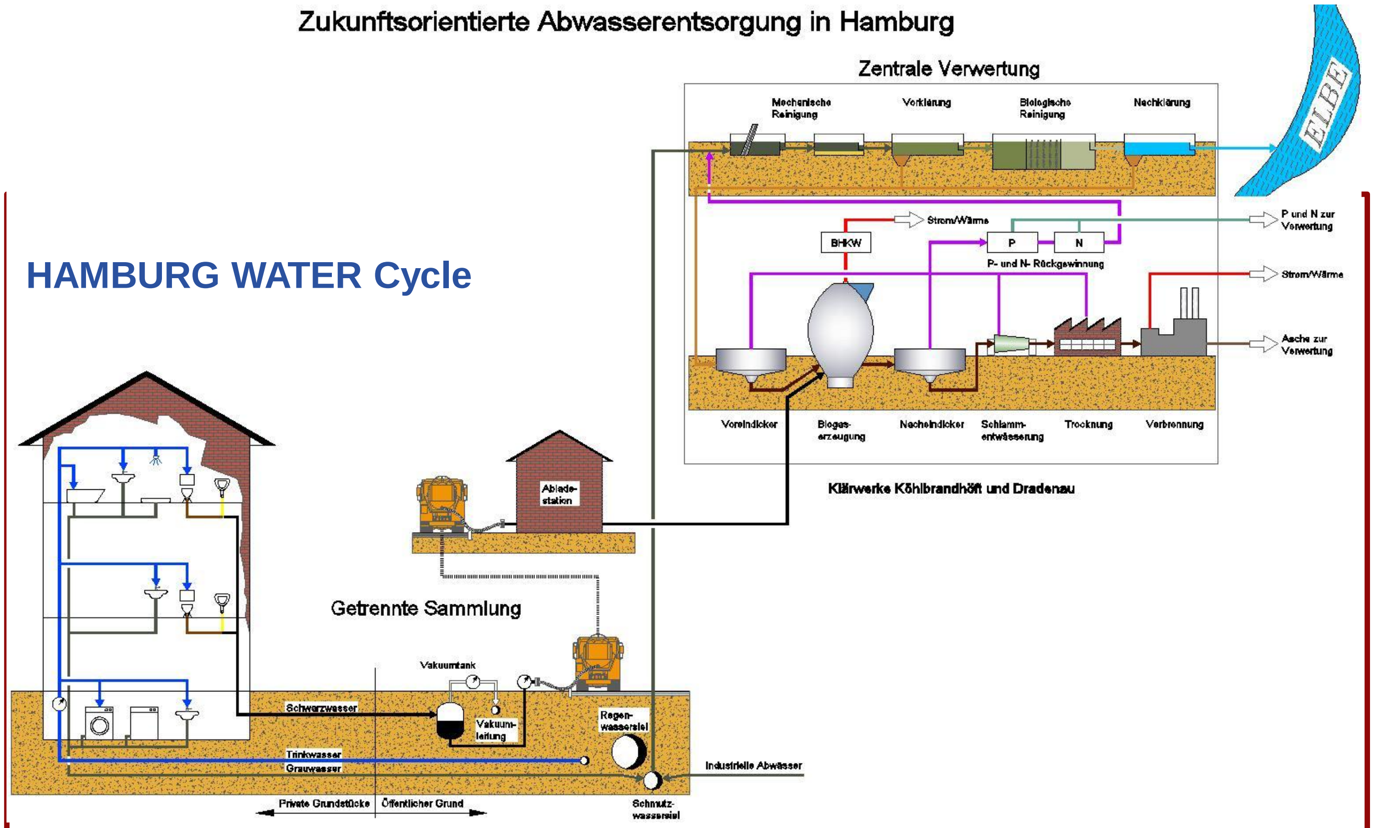
Heat exchanger in sewers

Recovery of heat from waste water in sewers (30 years of practice)

SFr 40 million

48.700 MWh / year

HAMBURG WATER Cycle

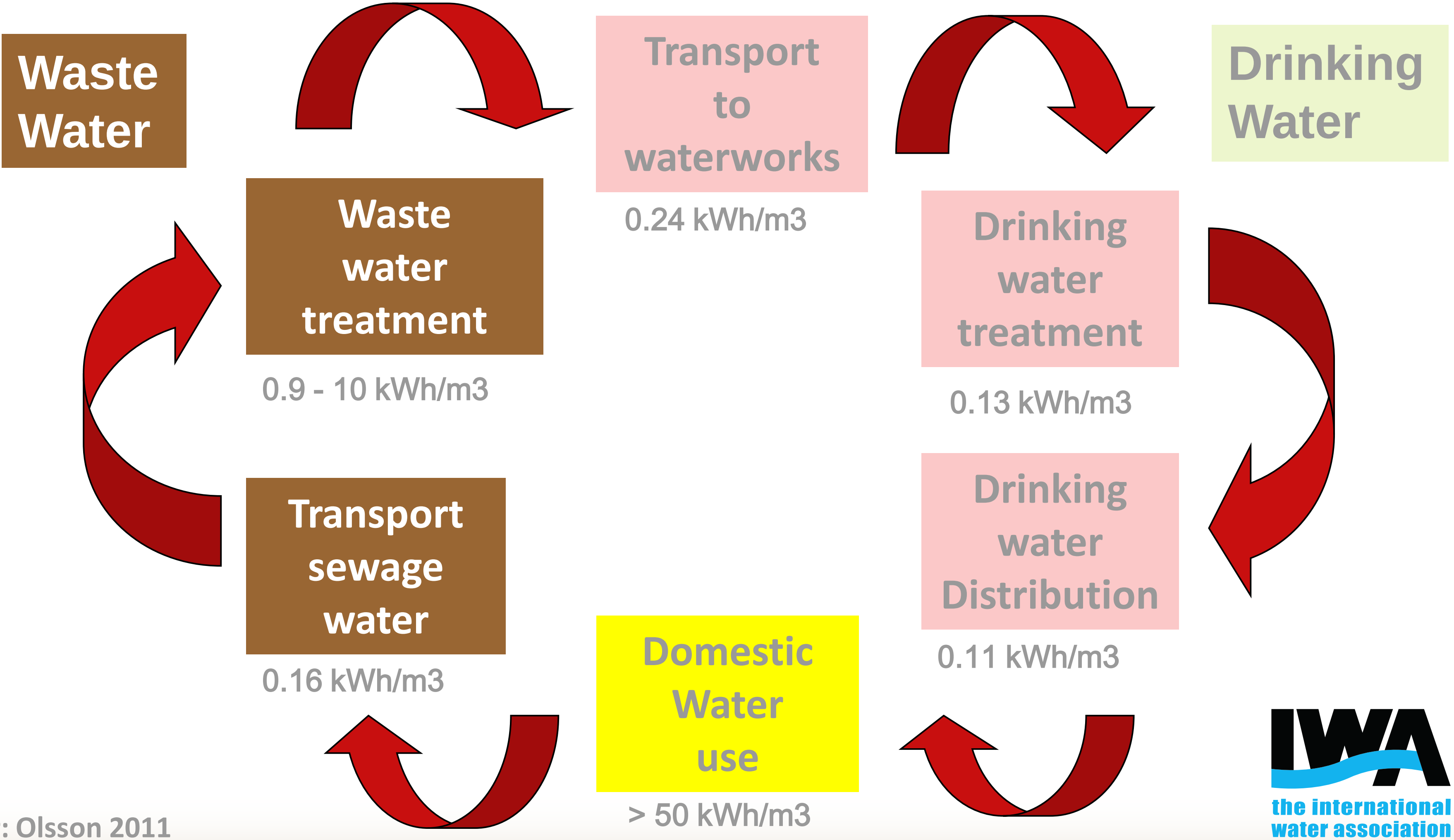


Possible solution for Hamburg:

- Separate, decentralized collection
- Centralized treatment / recovery

© Hamburg Wasser

Urban Water-Wastewater-Energy Nexus



Waste Water

Drinking Water

Waste water treatment

0.9 - 10 kWh/m3

Transport to waterworks

0.24 kWh/m3

Drinking water treatment

0.13 kWh/m3

Drinking water Distribution

0.11 kWh/m3

Domestic Water use

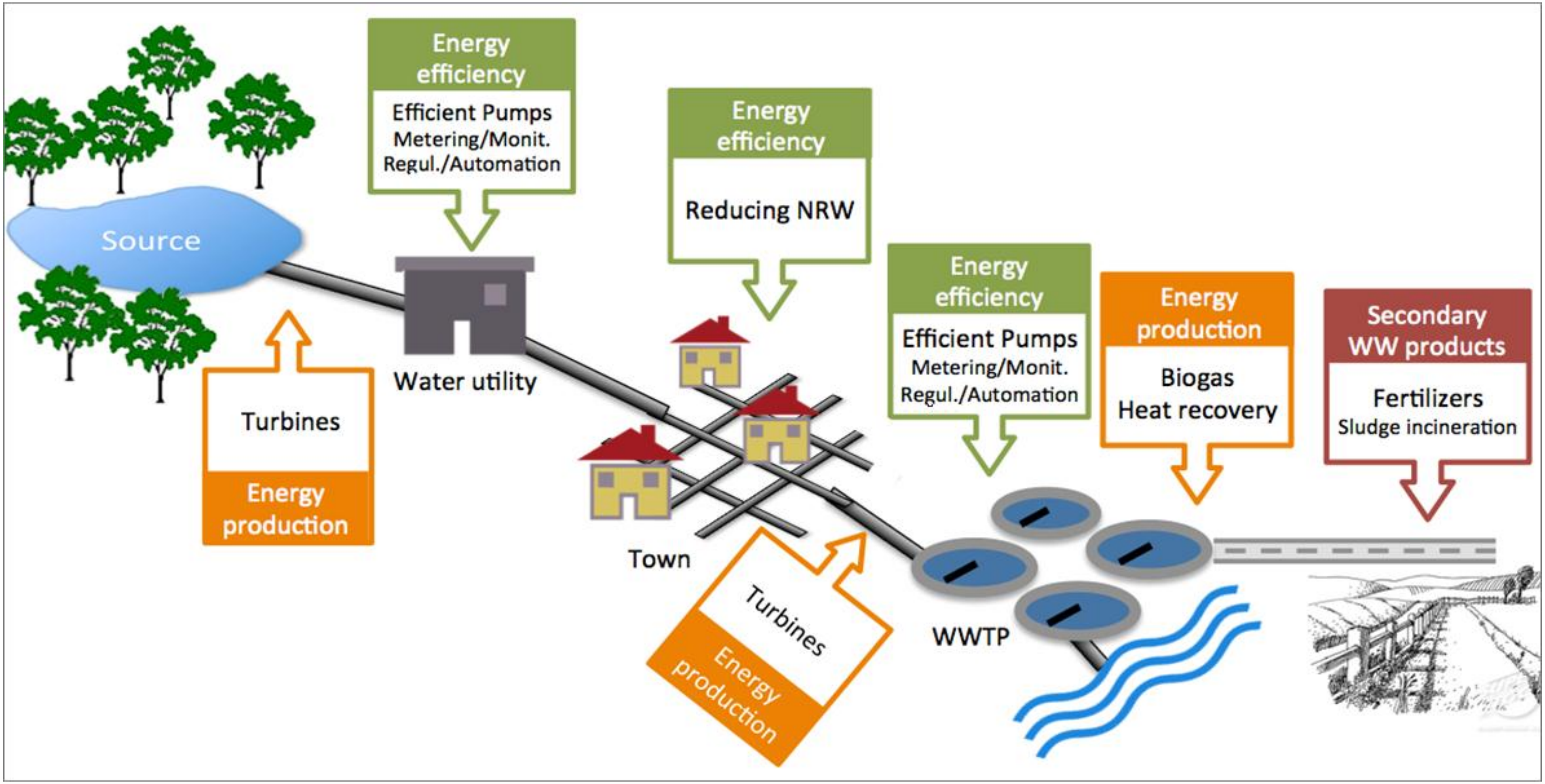
> 50 kWh/m3

Transport sewage water

0.16 kWh/m3

After: Olsson 2011

Reducing GHG emissions in the water sector



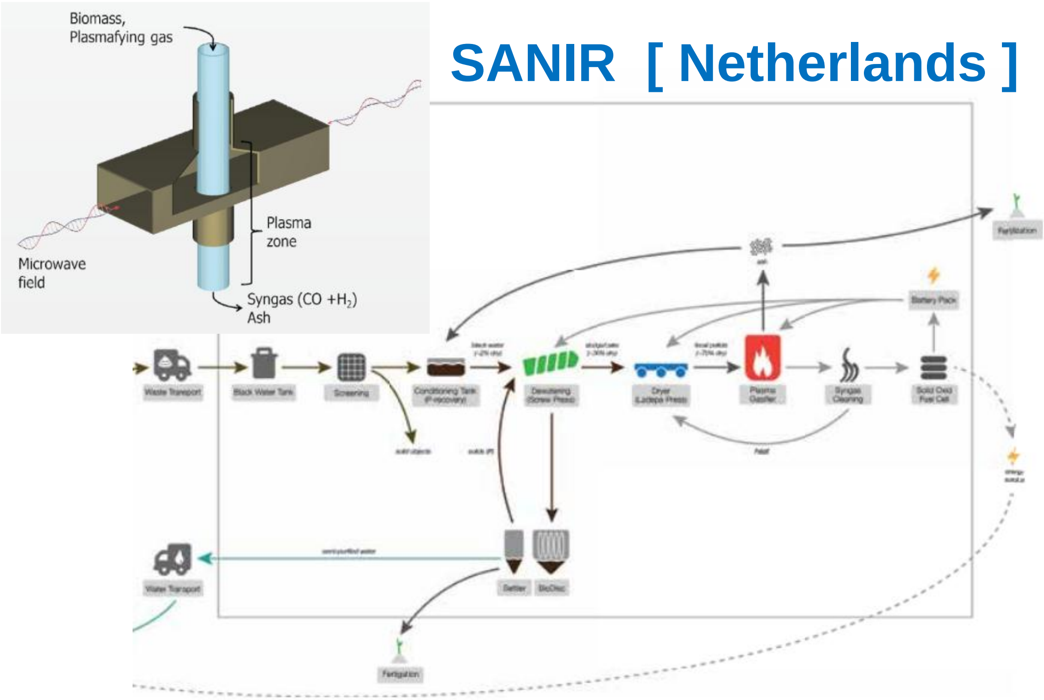
Biogas: Examples from Kenya

EcoSan Pilot Project G.K. Prison in Meru

Treatment of the wastewaters of about 1,500 inmates and 350 staff Served by a 110m^3 biogas plant, baffled reactor and a 4-door UDDT EcoSan Toilet for staff

RTTI Innovations from BMGF Grantees

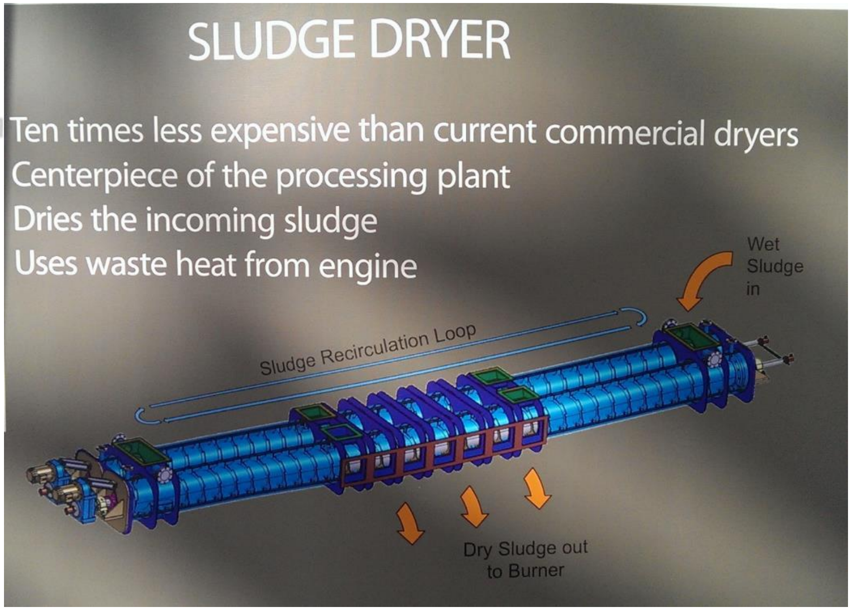
SANIR [Netherlands]



Conversion of urine and feces to energy at an omni-gasification plant intended to treat waste of 50,000 people /day

Treatment consists of drying, conversion to syngas using microwave plasma gasification, and feeding of gas into a fuel cell.

OMNIPROCESSOR [USA]



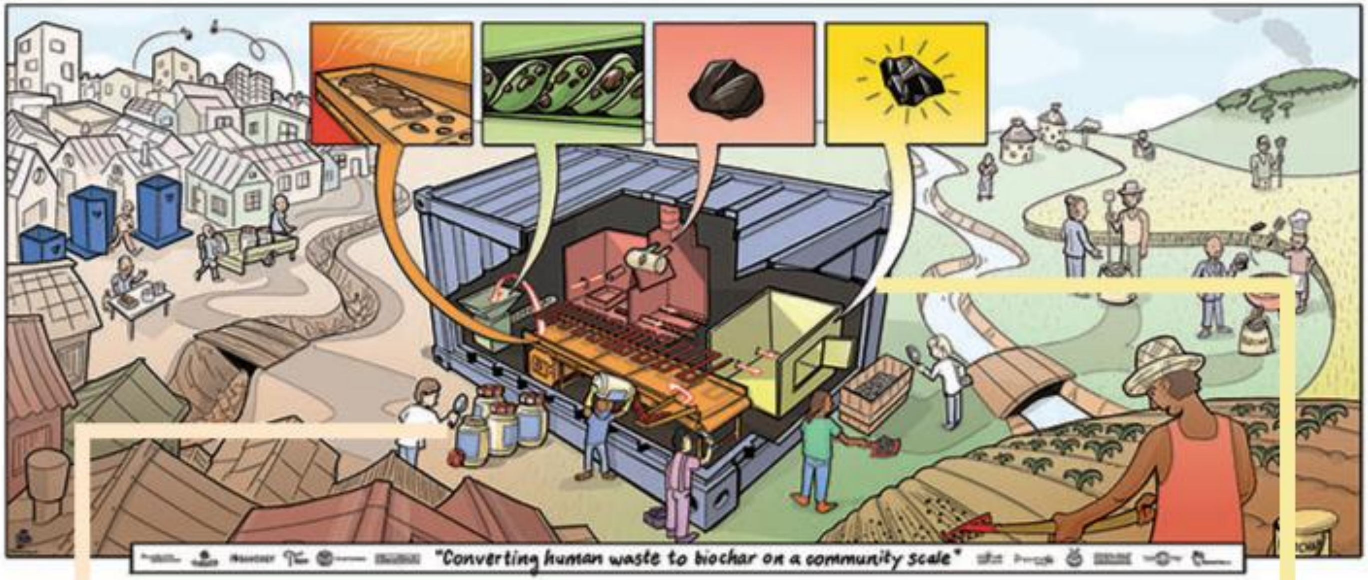
SLUDGE DRYER

Ten times less expensive than current commercial dryers
Centerpiece of the processing plant
Dries the incoming sludge
Uses waste heat from engine

- Unit size: 2 shipping containers: 8x15m
- 120 kW net electricity generation thru piston steam engine
- Endproducts: ash, sanitized hot water & electricity

RTTI Innovations from BMGF Grantees

The biochar reactor for human waste serves several thousand people per day, converting solids to biochar for <$0.05 per person per day.



System Specifications
- Processes up to 100 kg/human waste/hour
- 75%->30% moisture dryer system
- ~7% mass of wet waste remains as biochar
- 200C+ sanitizes; 300C+ chars
- Recapturing heat of condensation for energy-efficient drying
- Works independently of grid, sewer, water

Business Specifications
- Target cost of reactor in local production $60,000
- Processes human waste for <$0.05 pp/pd
- Biochar as an agricultural soil supplement can be sold for $550/ton
- Works independently of grid, sewer, water

http://www.climatefoundation.org/what-we-do-b/land-carbon-sequestration

Wastewater, energy and climate change – What to do?

- Reducing or preventing direct greenhouse gas emissions
  Reducing methane emissions from treatment tanks and sludge
- Producing and using renewable energy [and fertiliser]
  Producing biogas from wastewater
- Reduce amount of wastewater (dilution) to reduce energy needed for its treatment
- See sludge as a resource (energy and nutrients)
- Substituting processes that would use energy elsewhere
  Recovering nutrients from wastewater instead of producing artificial fertiliser

What are the benefits for wastewater utilities?

- Reduced operational costs of utilities
- Less dependency on fluctuations of energy prices
- More efficient use of water resources
- Contribution to the country's climate mitigation goals
- Nutrient recycle and enhanced food security through lower dependency on artificial fertilisers

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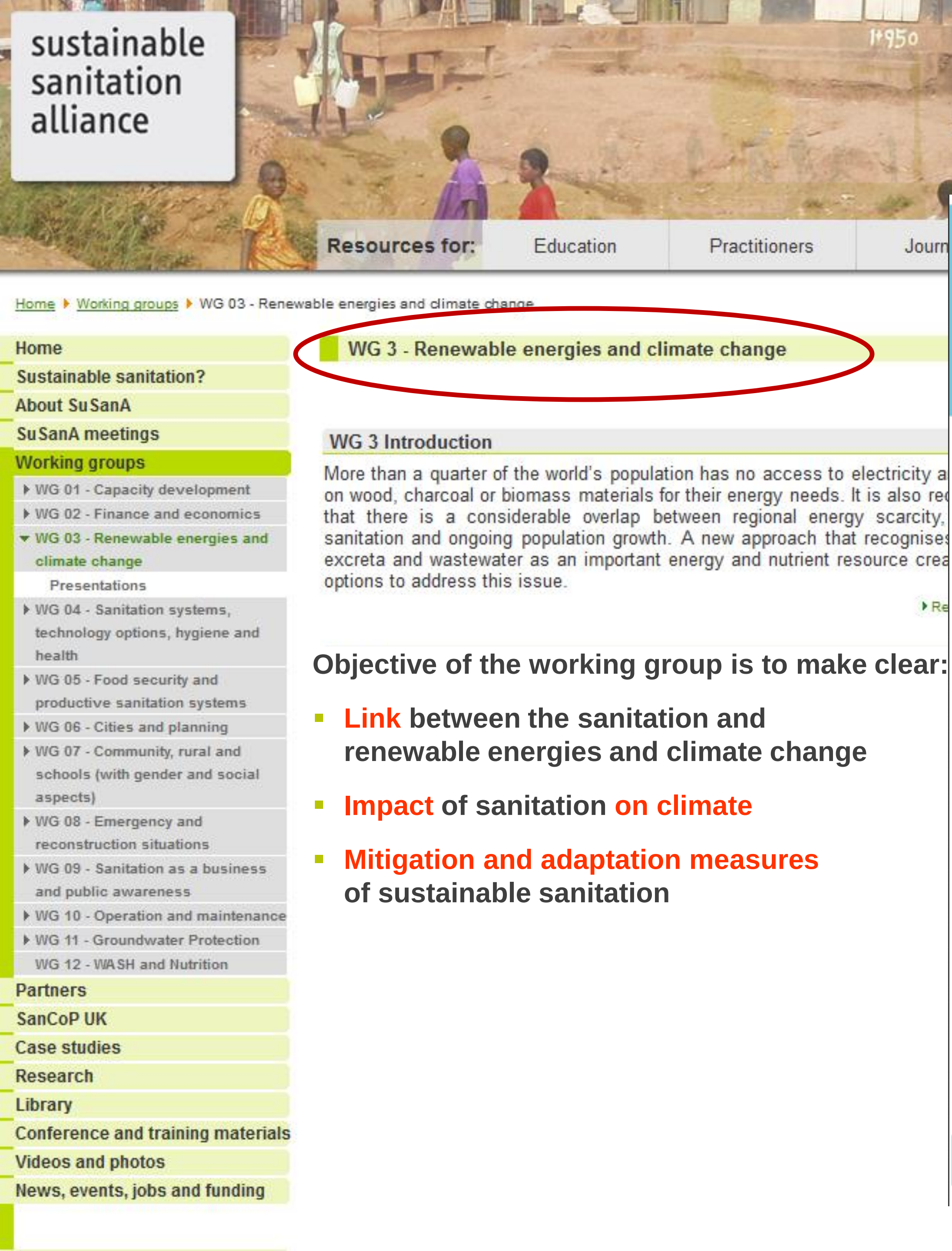

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WG 3 - Renewable energies and climate change

WG 3 Introduction

More than a quarter of the world's population has no access to electricity a
on wood, charcoal or biomass materials for their energy needs. It is also re
that there is a considerable overlap between regional energy scarcity,
sanitation and ongoing population growth. A new approach that recognises
excreta and wastewater as an important energy and nutrient resource crea
options to address this issue.

▸ Re

Objective of the working group is to make clear:

- **Link between the sanitation and renewable energies and climate change**
- **Impact of sanitation on climate**
- **Mitigation and adaptation measures of sustainable sanitation**

sustainable
sanitation
alliance

SuSanA factsheet

Links between sanitation, climate change and renewable energies

April 2012

1 Summary

Sustainable sanitation projects can contribute to both climate change mitigation (through energy or nutrient recovery) and to climate change adaptation (through innovative sanitation systems and wastewater management).

Measures of renewable energy production consist basically of either biogas production from waste water or biomass production through the use of waste water to grow short rotation plantations for firewood. Biogas can also be used for heat generation while heat exchangers can recover heat energy from wastewater in sewers. Measures of nutrient recovery are primarily based on nitrogen reuse. Adaptation measures in the area of sanitation aim at coping with increasing water scarcity or flooding.

By using reuse-oriented sanitation systems with energy, nutrient or wastewater recovery and reuse, anthropogenic greenhouse gas emissions can be reduced (mitigation) as well as people's capacity to cope with climate change impacts can be increased (adaptation).

In cases where these measures for reduction of greenhouse gases are achieved in developing countries, the emission allowances can be sold on the international emissions trading market and thus can contribute additional financial benefits. In order to be financially viable, there is a minimum project scale due to fixed transaction costs, with project bundling the minimum scale can be achieved.

This factsheet emphasises the need for climate change mitigation and adaptation measures in the area of sanitation. In addition, it provides an overview of the possibilities of using sanitation systems for renewable energy production, nutrient recovery and it explains the financial benefits that emission trading can bring.

2 Introduction

2.1 Overview

UNFCCC[1] defines 'Climate change' as a "change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods". Some of the major climate change effects that have been predicted are the significant rise in temperature due to greenhouse gases, rising sea level and shifts in precipitation and evapotranspiration patterns (IPCC, 2007a). By 2050, the number of countries facing water stress or scarcity could rise from 48 to 54, with a combined population of four billion people i.e. about 40% of the projected global population of 9.4 billion[2].

Increasing water scarcity combined with increased food demand and water use for irrigation as a result of less precipitation are likely to be a driving force leading to water reuse. Areas with low sanitation coverage might be found to be practising more uncontrolled water reuse i.e. reuse performed using polluted water or even wastewater (Bates et al. 2008).

Sustainable sanitation has a strong link to climate change and renewable energy production. For example, sanitation systems can be designed in a way to produce renewable energy sources (biogas or biomass) which in turn may mitigate climate change by reducing greenhouse gas emissions. Sanitation systems may also serve to help people adapt to climate change by reusing energy, nutrients and treated wastewater and thus substituting the use of primary resources.

Figure 1: Urine Diversion Dehydration Toilets (UDDT) withstood the flood waters that resulted from a cyclone that struck southern Bangladesh in 2009 (source: A. Deleplere). More photos from this project: www.flickr.com/photos/gtzecosan/sets/72157626407064863/

Another example is dry toilets such as Urine Diversion Dehydrating Toilets (UDDT) with a raised platform and safe containment of excreta and which use no water for flushing (suitable for areas with increasing water scarcity) or which

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[1] UNFCCC – United Nations Framework Convention on Climate Change, www.unfccc.int

[2] See: www.maps.grida.no/go/graphic/increased-global-water-stress

Renewable energies and climate change: Working Group 3 - page 1

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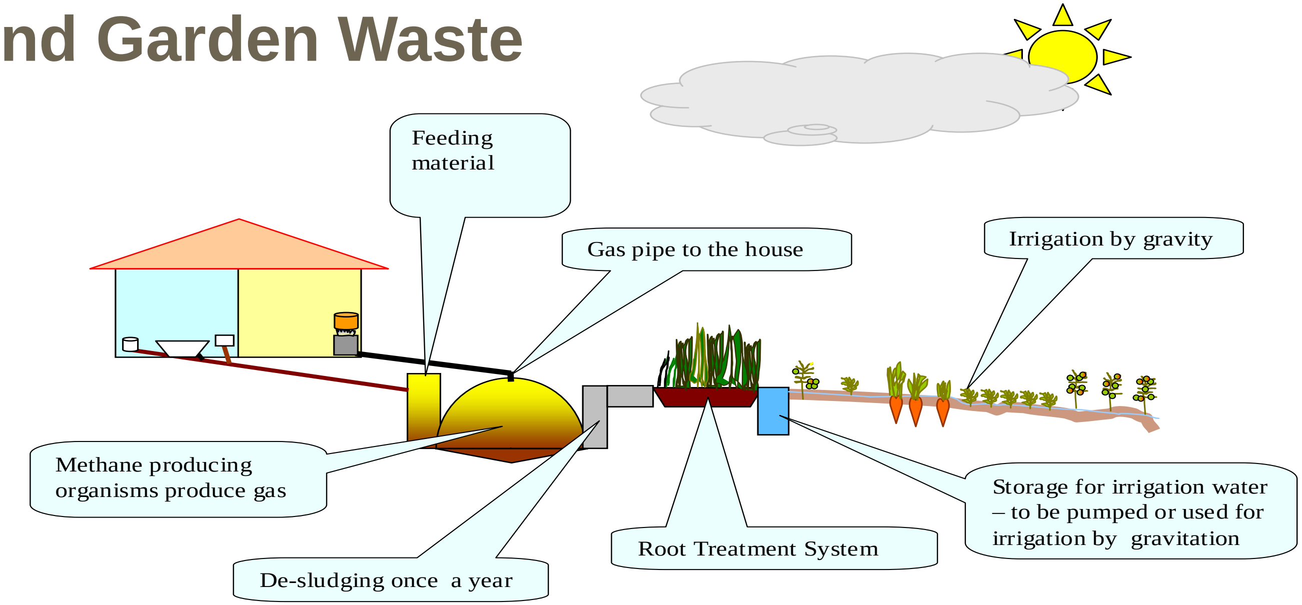
Small Biogas Plant For Wastewater, Kitchen And Garden Waste



Sketch of biodigester replacing a septic tank. Wastewater as well as kitchen and garden waste enter the digester and are broken down to biogas and fertile water.

The advantages: No more emptying of septic tank. Reuse of all water in the garden. Less cost on cooking energy.

Advantages: energy generation, cash savings and/or reduction of deforestation, low capital costs, long life span, water reuse in irrigation, dried sludge as soil conditioner, less work required to empty septic tanks

Biogas: Examples from Kenya

Public Toilet with biogas digester and water kiosk in Naivasha

Source: SuSanA 2010

Facts and Figures

- Daily Visitors: >1,000 (Operating since 2008)
- 5 toilet cubicles at a bus park and a new water kiosk
- Wastewater from toilets, showers, hand wash basins:

  → drained into underground biogas plant
  (anerobic treatment)

  → biogas production
- Supported by ACP EU Water Facility, GIZ, SIDA

Management Model

- Designated asset holder is Rift Valley Water Services Board
- Implementation/facility managemt by Naivasha Water and Sanitation Company
- O&M concept provided by Water Services Trust Fund (supported by GIZ)
- Private Water Service Provider in charge of O&M (instead of Municipal Council)

Biogas: Examples from Kenya

EcoSan Pilot Plant Kaurine Primary School (Maua District)

Sanitation facilities with up to 21 pit latrines on a school compound in a watershed area needed improvement.
124m3 Biogas plant, baffled reactors and 2x5-door poor flush toilet building

What is the ideal setup for biogas sanitation to be advisable?

1. Locations where lots of people come together, such as prisons, public toilets, schools
   - Or situations where animal waste is available and can be combined with human waste
2. Toilets with low amount of flush water, such as pour-flush latrines, vacuum toilets (the more concentrated the better)
3. Where the liquid effluent from the biogas reactor can be used as fertiliser
4. Where local expertise for construction, operation and maintenance is available (leading countries for biogas sanitation: China, India, Nepal, Vietnam, Rwanda, Kenya)

When is biogas sanitation not advisable?

- If only single households (without animal waste) are to be connected
- If a sanitation system is required that can easily be built and maintained by the users themselves
- If dry toilets are used (unless in conjunction with other waste)
- If there is no possibility to reuse or treat & discharge the digester effluent
- If there is no local biogas expertise in the country