gtz ecosan program recycling oriented wastewater management and sanitation systems

ecosan ecological sanitation

Overview of anaerobic treatment options for sustainable sanitation systems

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Presentation content

1. Quick basics of anaerobic digestion
2. Anaerobic treatment technologies for sustainable sanitation
3. Two project examples

1. Quick basics of anaerobic digestion

Mantopi Lebofa (from NGO TED) lighting the biogas flame (Lesotho, Dec 2006)

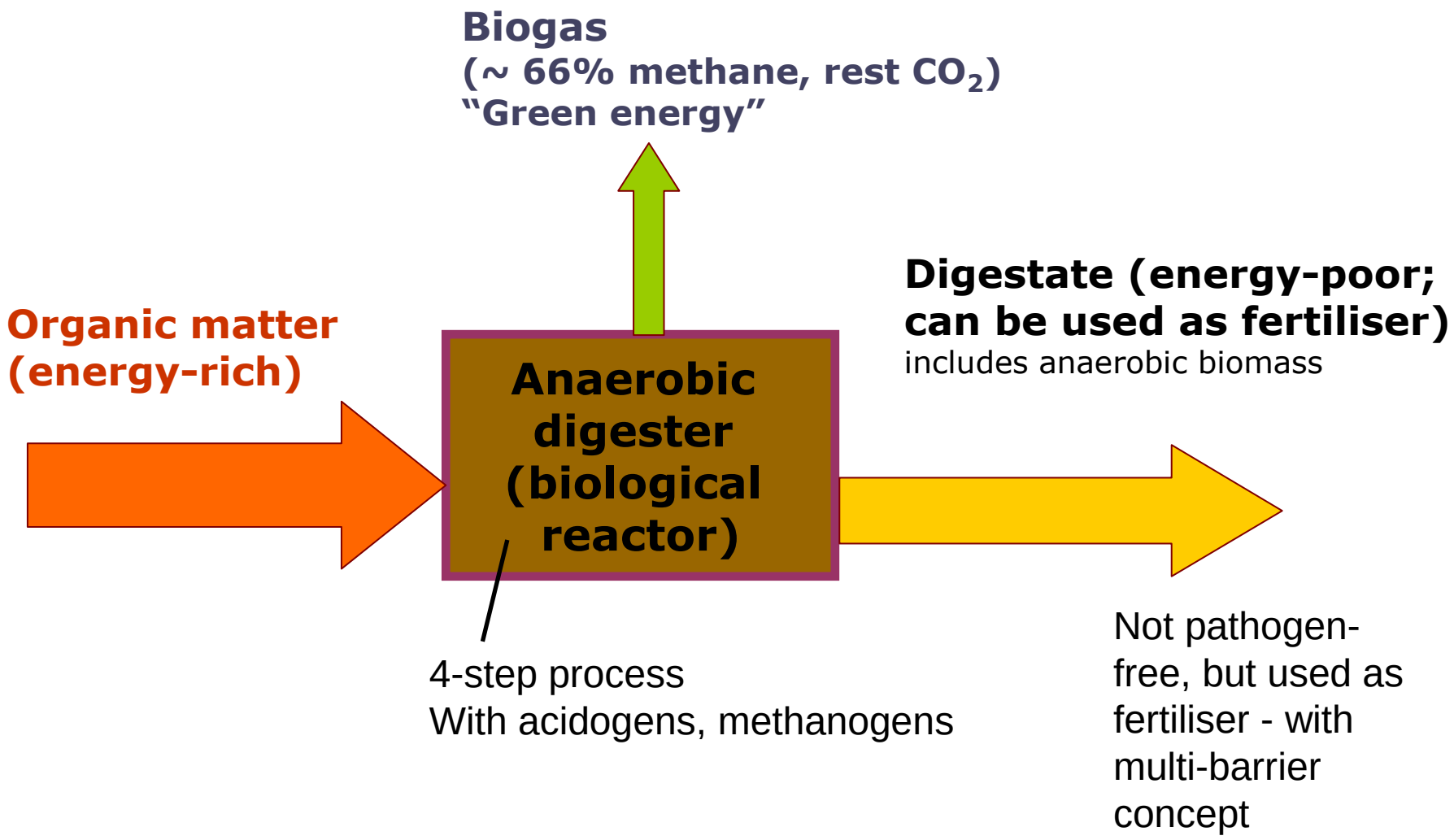
Possible substrates (input materials) in sustainable sanitation context

- High-strength greywater (as a pre-treatment step), rule of thumb: BOD > 400 mg/L (BOD = biological oxygen demand)
- Blackwater / brown water (faeces, urine, small amount of water – e.g. from vacuum toilets)
- Human excreta together with animal excreta and greywater

High-strength grewyater (example from Jordan)

"Blackwater" from vacuum toilets in Sneek, the Netherlands

Anaerobic digestion process schematic



Biogas uses

Mantopi Lebofa, Lesotho, Dec. 2006

1. Biogas can be burnt and used for cooking or lighting
2. Biogas can also be converted to electricity and heat (part of the heat can be used to heat the digester) → "Combined heat and power plants" (CHP)

→ If biogas is not used it should be flared because methane is a greenhouse gas

Removal of different compounds by anaerobic digestion

Compound	Removal
Organic matter	High level of removal (but not good enough for direct discharge to surface waters; would need aerobic post-treatment)
Nitrogen and phosphorus	No removal
Pathogens	Not much removal unless operated at thermophilic* temperatures and very long retention times →multi-barrier approach for reuse
Heavy metals	No removal

* Thermophilic (~55°C) anaerobic digestion will achieve more pathogen removal than mesophilic (~ 35°C) anaerobic digestion

2. Anaerobic treatment technologies for sustainable sanitation

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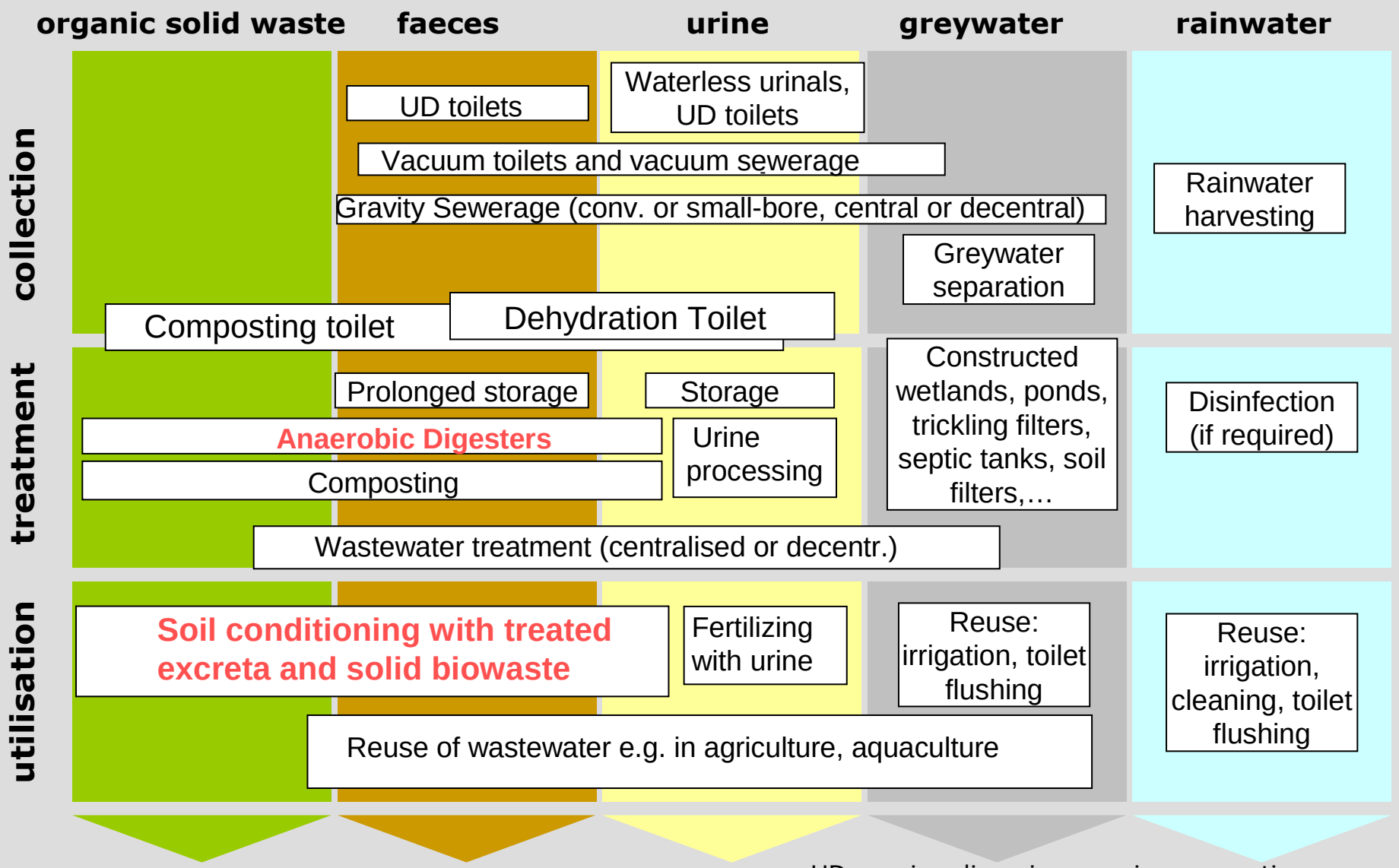
Overview of ecosan technology components

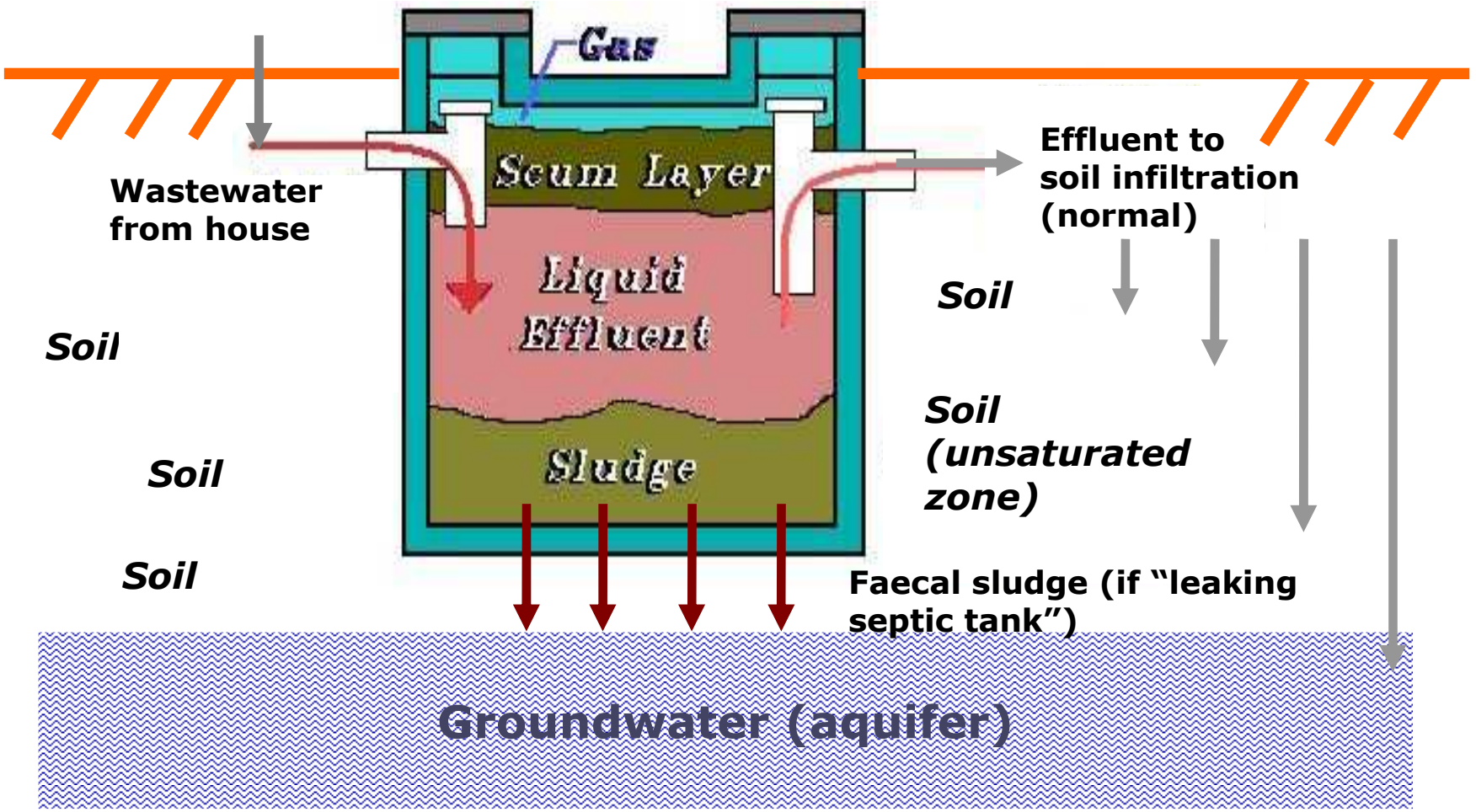


Overview of commonly used anaerobic treatment technologies

#	Process name	Optimised mixing	Covered reactor	Biogas collection	Scale
1, 2	Septic tanks, anaerobic baffled reactors (ABR)	No / somewhat (for ABRs)	Yes	No / rarely	Household or neighbourhood
3	Household biogas plants*	No / somewhat (round shape)	Yes	Yes	Households, neighbourhoods, institutions, farms
4	Anaerobic ponds	No	No / sometimes	No / sometimes	Community
5	Upflow anaerobic sludge blanket reactor (UASB)	Yes	Yes	Yes	Neighbourhood, community, industries

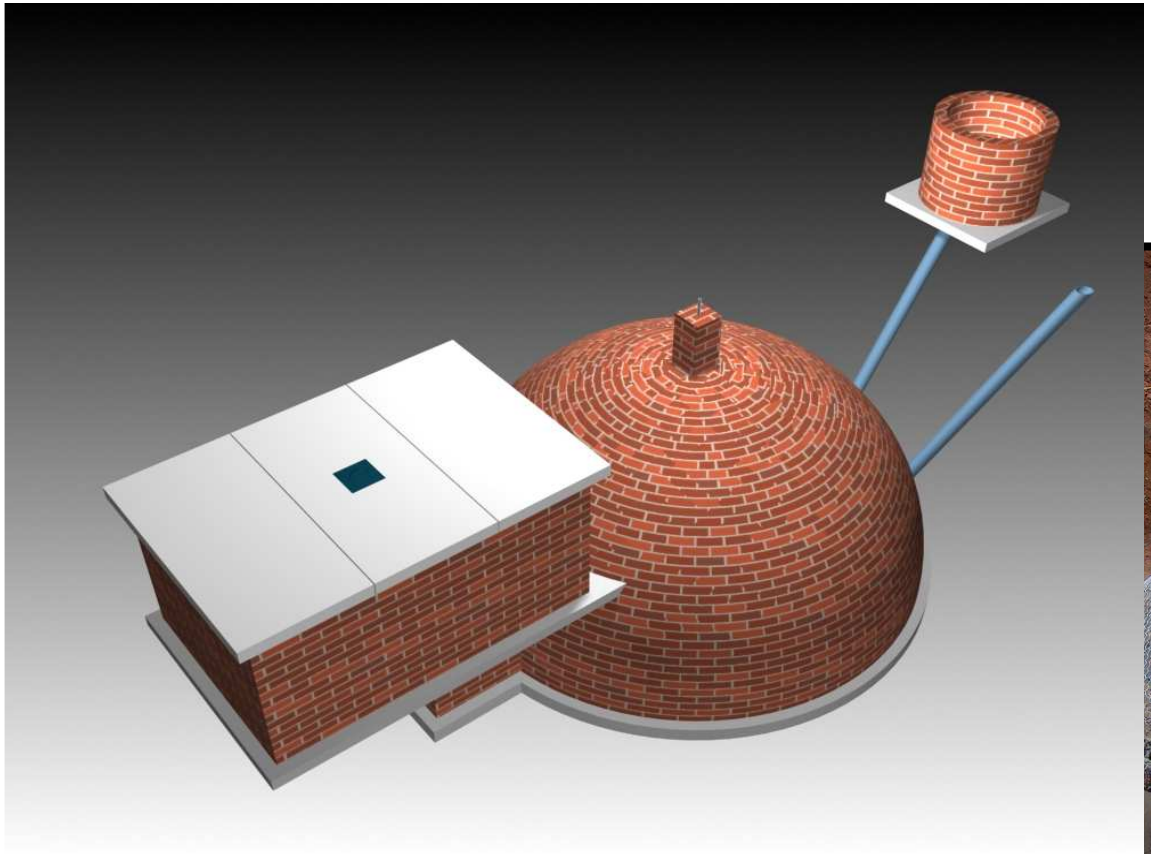
* Also called household biogas digesters or decentralised biogas plants (i.e. not just limited to households) – currently less well-known than the other technologies

Septic tanks can lead to groundwater pollution



The effluent from septic tanks is commonly infiltrated into the ground (on purpose). But faecal sludge is NOT meant to leak out from the septic tank (but often does if not designed properly).

Household biogas plants
(here: fixed dome type)



Household biogas plant
Source: Jan Lam, SNV (at NBP Dhaka, March 2007)

Widespread use e.g. in China, Nepal (SNV program)

Source: Mantopi Lebofa, Lesotho, 2006

3. Two project examples

- Housing estate Lübeck-Flintenbreite (**Germany**), partly operational since 2000
  - Similar concept to be built 2010-2013 in Hamburg Jenfeld (HAMBURG WATER cycle: for 700 housing units)
  - Similar concept also operational in Sneek, the Netherlands since 2006

- Vocational Training Institute DSK of Navsarjan Trust in Nani Devti village (Gujarat State, **India**), operational since 2006

Terraced and Twin houses

Constructed wetlands (for greywater treatment

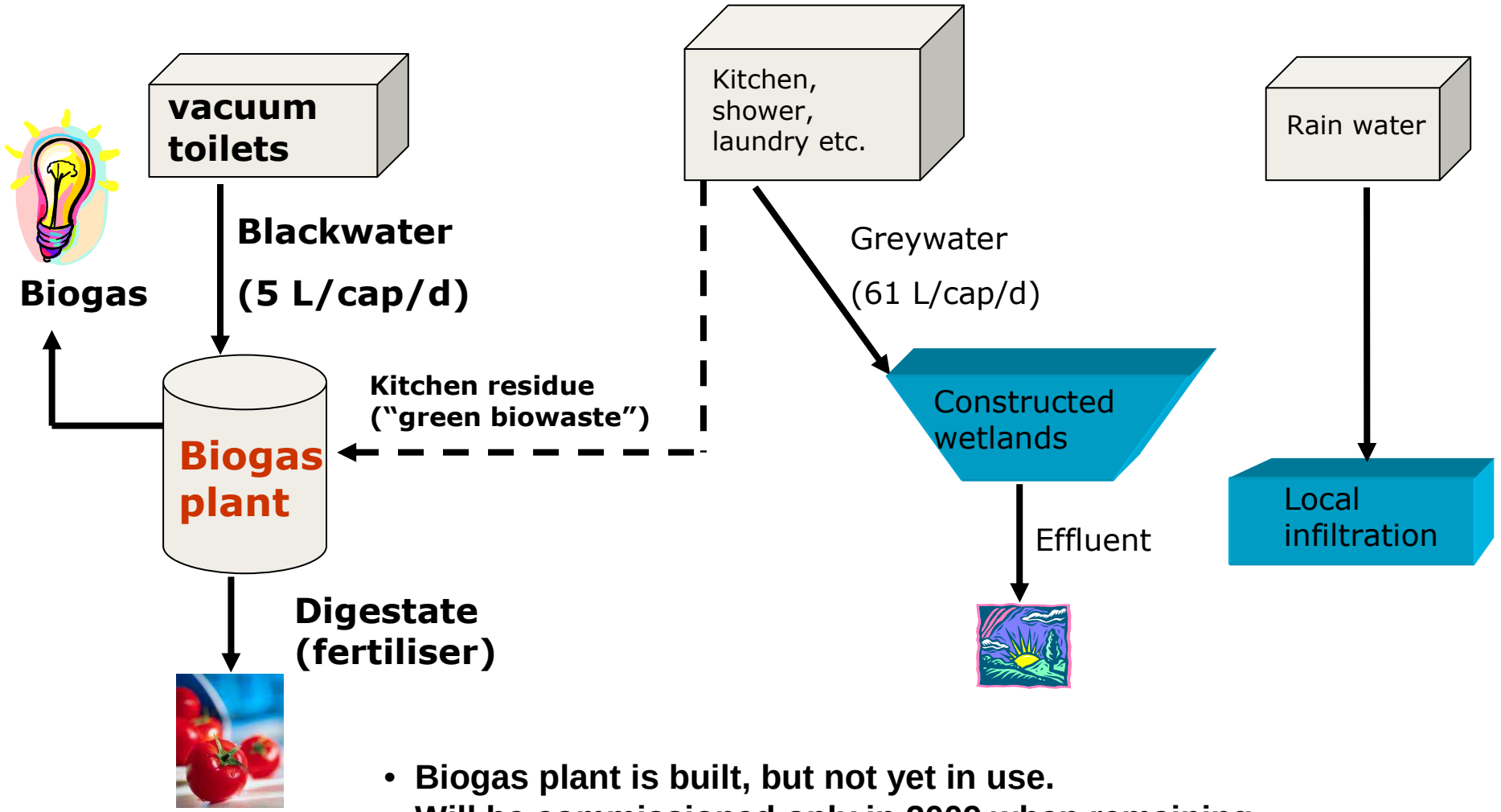
- **In use since year 2000 (111 inhabitants)**
- **2008/2009: new developer to build remaining units (to reach 350 inhabitants in total)**

Central building

Source: Claudia Wendland, TUHH, 2008

Process schematic (Flintenbreite)

Measured total average per capita water use: 66 L/cap/d



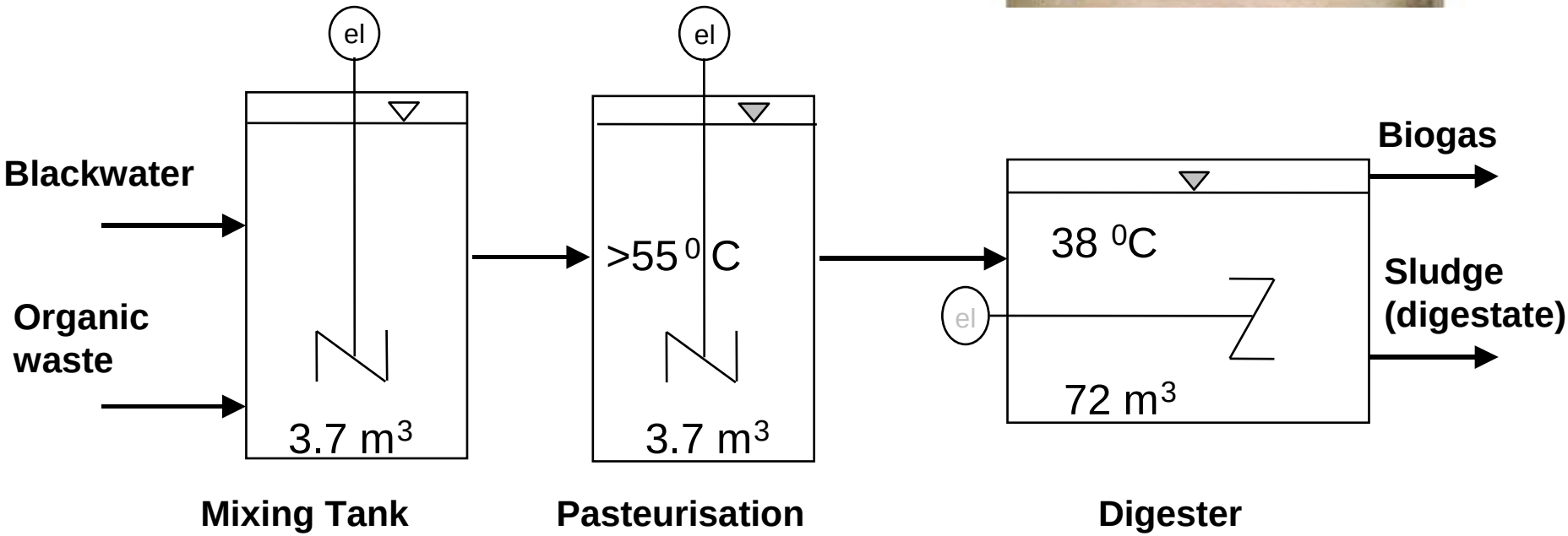
- **Biogas plant is built, but not yet in use.**
- **Will be commissioned only in 2009 when remaining units are built**

Vacuum pumping station

Organic waste grinder

Vacuum toilet
Rödiger, Germany

Technical Components of Blackwater Collection and Treatment


el
el
Blackwater
Organic
waste
3.7 m3
>55 0 C
3.7 m3
38 0C
el
72 m3
Biogas
Sludge
(digestate)
Mixing Tank
Pasteurisation
Digester

Laboratory research with blackwater from Lübeck-Flintenbreite at university TUHH (Hamburg)

- Expected biogas production (vacuum toilets and kitchen waste): 25 L CH_4 / cap/d
- Only 5% of heating requirements of the houses could be met with this biogas
- → Biogas is (only) a by-product of a wastewater treatment process (amount not that significant)

Source: Claudia Wendland, PhD thesis (2008), TUHH

Navsarjan Trust Vocational Training Institute DSK Campus in Gujarat, India

Biogas plant during construction

- **300 students on the campus (established 1999)**
- **New ecosan sanitation system inaugurated August 2006**
- **Project review Sept. 2008: working satisfactorily**

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DSK campus sanitation complex

- **Sanitation complex comprises 22 toilets**
  - **Constructed as a circle with a biogas plant in the centre**
  - **Low-flush pour-flush squatting toilets (design: 2 L, actual: 4 L per flush with cleansing)**
- **Biogas: 2-3 cylinders of biogas per month (only) – used for cooking**
  - **Quantity low (could be increased by adding kitchen waste and cow manure)**
- **Digestate: drying bed, composting, used as compost**

Biogas plant

Waterless urinals for females (squatting type)

Concluding remarks regarding anaerobic digestion for sustainable sanitation

- Great potential: provides for waste treatment, biogas and fertiliser (close nutrient loop)
- Most interesting for:
  - Institutions (e.g. prisons, public toilets, schools, universities)
  - Applications in combination with animal waste (more biogas)
- Remaining issues:
  - Pathogen removal in mesophilic AD is quite low → use multiple-barrier approach for reuse
  - South-South knowledge transfer urgently needed

Thank you!

www.gtz.de/ecosan and www.susana.org

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On behalf of
Federal Ministry
for Economic Cooperation
and Development