Decentralized Wastewater treatment is the green future!

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Take home messages

- Circular wastewater treatment is better at local, decentralized level
- Vacuum toilets save 25% drinking water
- Wastewater streams are separated at the source, allowing for an effective treatment (black water/grey water)
- Green waste can be added to the wastewater treatment delivering more energy
- Black water treatment recovers biogas, nutrients
- 30% of the heat for heating houses can be extracted from grey water
- High quality water from grey water allowing reuse
- No sewer necessary

Our approach

➢ Closing loops

- Energy loop 
- Nutrient loop 
- Water loop 

Easier and cheaper at a local (decentralised) level

Whether a compound is defined as waste or as a resource is greatly depending on its concentration and the people's interest

Wastewater is concentrated by vacuum toilets

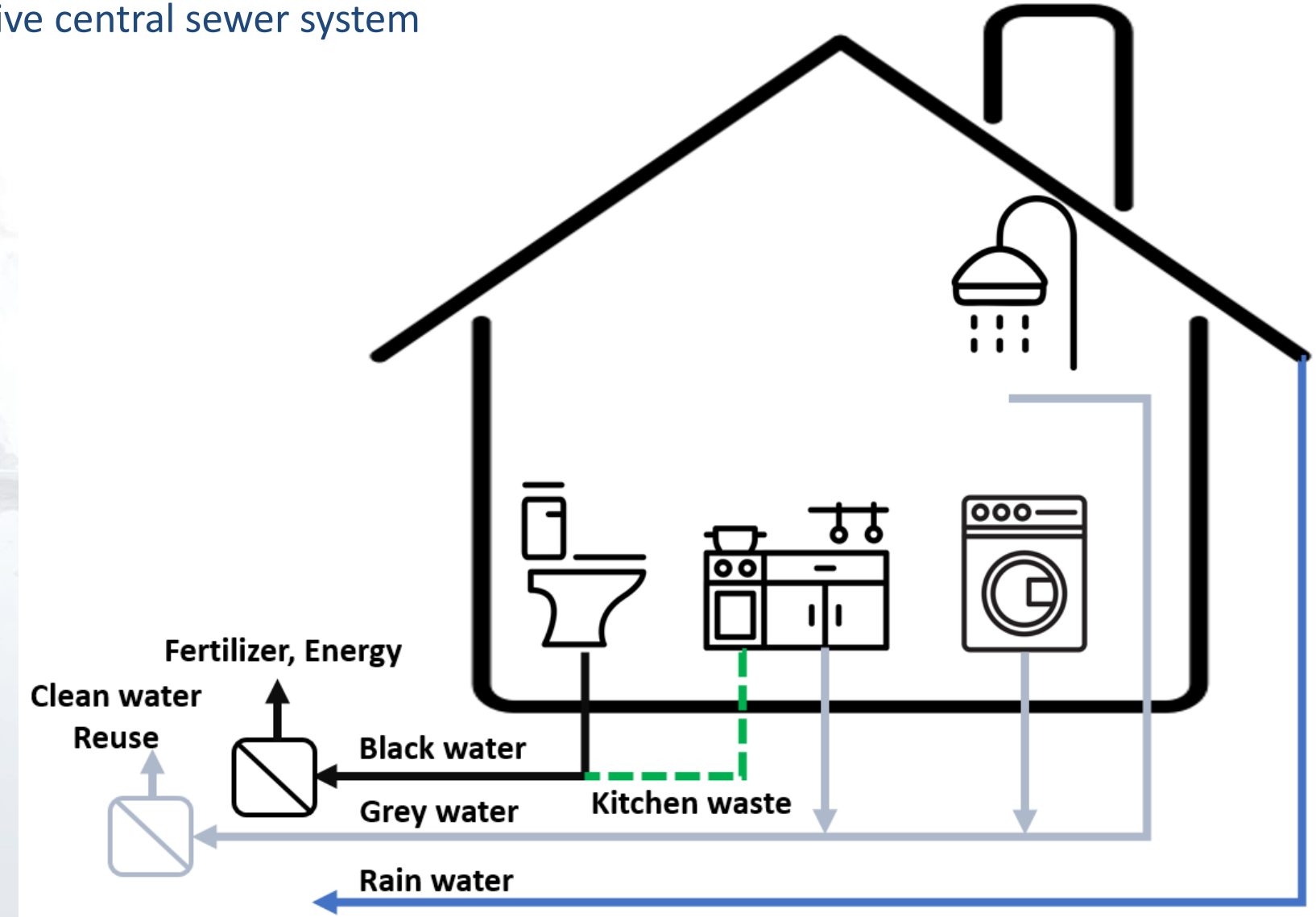
- Vacuum toilets flush with 1-1.5L of water and 100L of air (Conventional toilets -> 5-7 L).

- A reduction of 36L/p/d water (25% of total water consumption)

The concept: Separation at source concept

Applicable in new build environment, housing districts, hotels, offices, resorts etc.

No expensive central sewer system



Black water (8%) vacuum drainage

Grey water (92%) gravity sewer

Sound vacuum toilets comparable to water flushed toilets

NOISE LEVEL [dB]

Airplane Toilet

Street Traffic

Vacuum Cleaner

modern **VACUUM** toilet
with sound levels similar to
TRADITIONAL TOILET

No spread of aerosols!

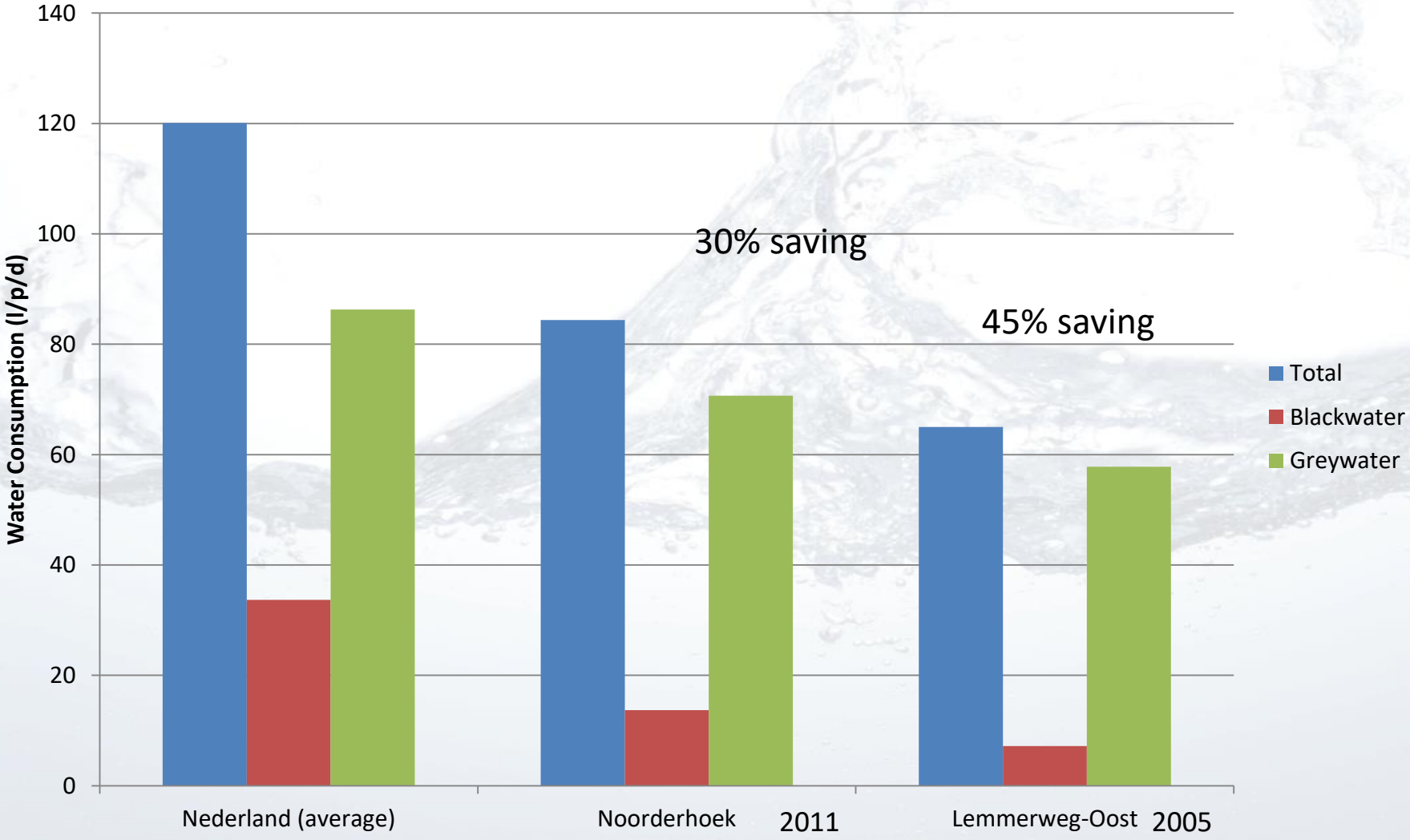
1985

1995

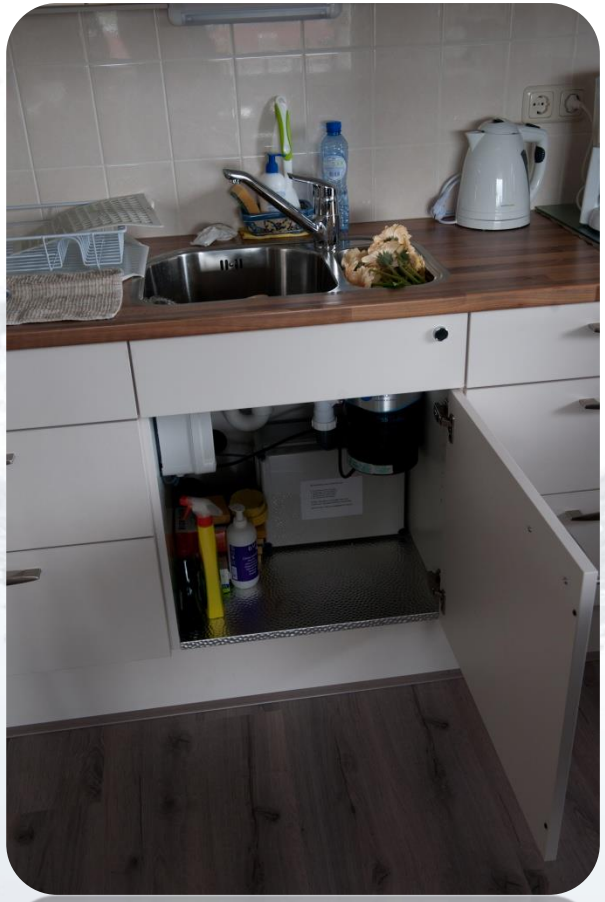
2005

2015

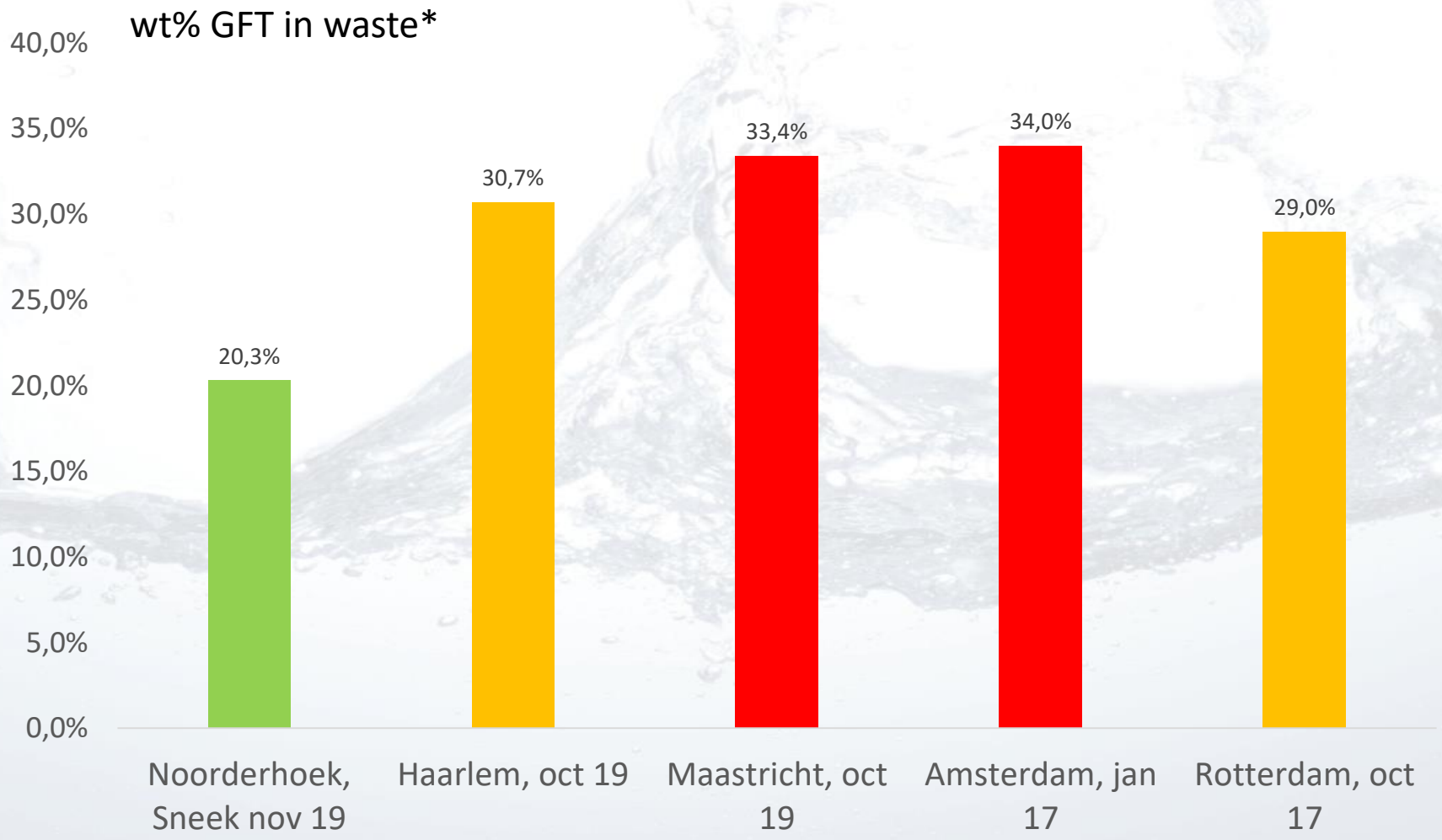
30% water saving through vacuum toilets



Green waste can be added to the black water throuhg a kitchen grinder.



Kitchen grinders: better green waste separation



*CREM, waste management

Effective wastewater treatment though source separation

Black water (vacuum toilet):

- High organic levels-> digestion generates biogas
- High concentrations of nutrients -> fertilizers can be recovered easily
- Hormones and medicine traces can be removed more effectively

Grey water

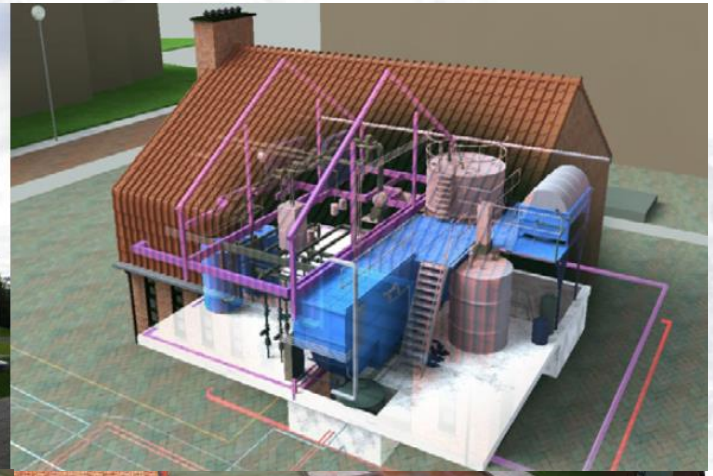
- Less polluted -> less energy needed for treatment
- high temperature -> recovery of heat
- Low heavy metal and salt concentration (good for irrigation)

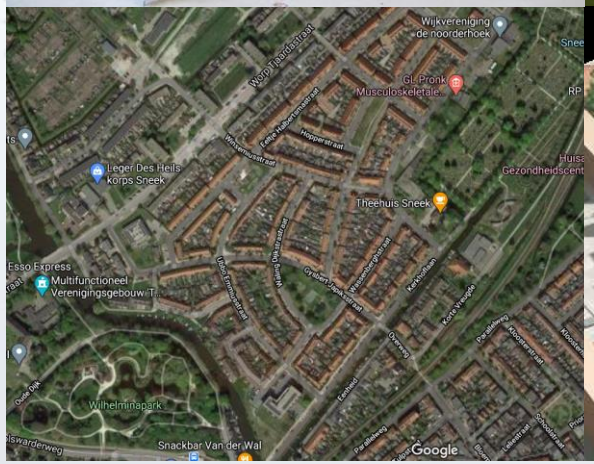
Application of source separtion

- Buildings (e.g. hotels, resorts, offices and recreational facilities) and housing estates
- Rural areas and remote locations (e.g. drilling sites, mining sites and army bases)
- Newly build districts and districts converted to high rise building (sewage/WWTP can’t handle the hydraulic load)

Noorderhoek, Sneek the Netherlands

230 Houses (2010)





Process scheme

heat

Biogas
32 l/p/d (12 m^3/p/y)

N_2

$MgCl_2$

Struvite
(fertilizer)
Phosphate removal
80%

Oland, bacteria
Ammonium removal
70-80%

UASB 35°C
Organic matter
80-90%
removal

Black water (8%)

Sludge
3,5 kg.ds /p/y

$Mg(NH_4)PO_4 \cdot 6H_2O$
0,2 kg/p/j

Removal of micropollutants

Grey water (92%)

Grey Water treatment
Activated sludge system
Removal 80-90%

20°C

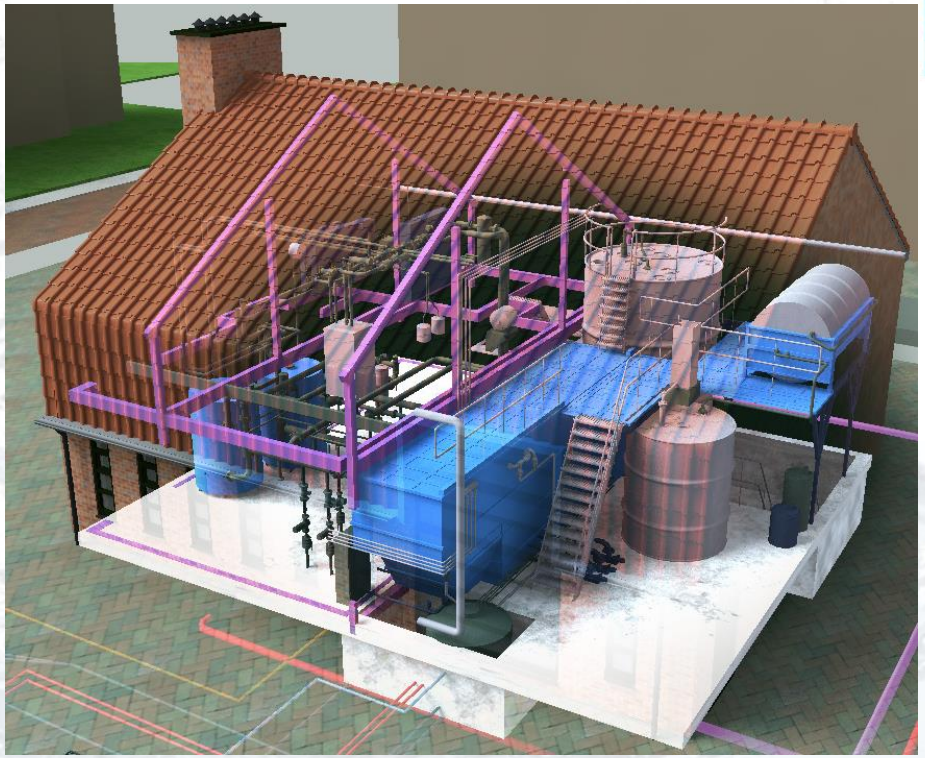
Clean water
Allowed for discharge

Nanofiltration
(high water quality)

Heat recovery
20-40% heating houses

Case studies, Sneek, The Netherlands

2005, 32 houses with vacuum toilets

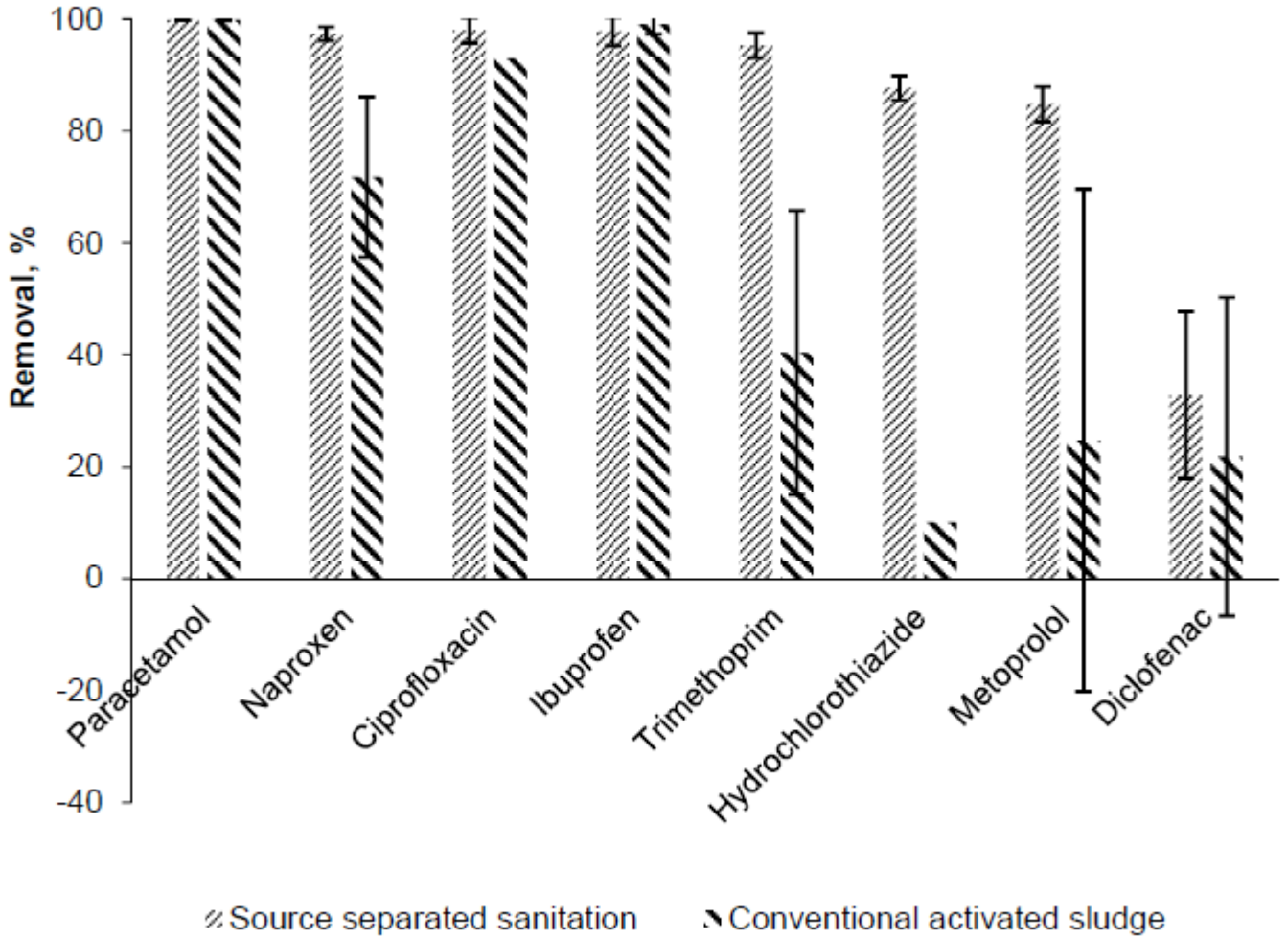


2010, 230 houses with vacuum toilets and kitchen grinders

Results:

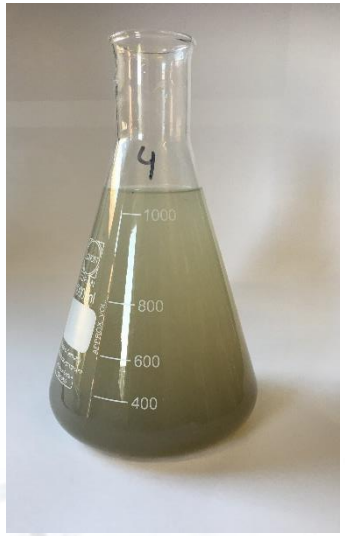
- 25% less drinking water use
- Better collection green waste (30% more separation)
- 12 m^3 biogas per person per year
- 2-3 times lower sludge production (no heavy metals)
- Struvite recovery
- Heat recovery from warm effluent (30% of total heating needs)
- Clean effluent, no micropollutants!
- No central sewer system

Micropollutants are better removed in source separted sanitation

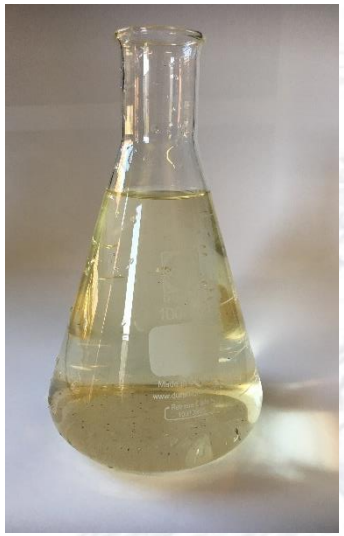


* Thesis A. Butkovskyi
Removal of micropollutants in source separated sanitation

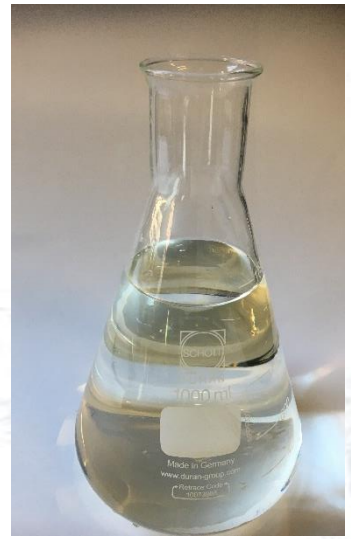
High water quality after treatment with nanofiltration



Grey water influent



After activated sludge



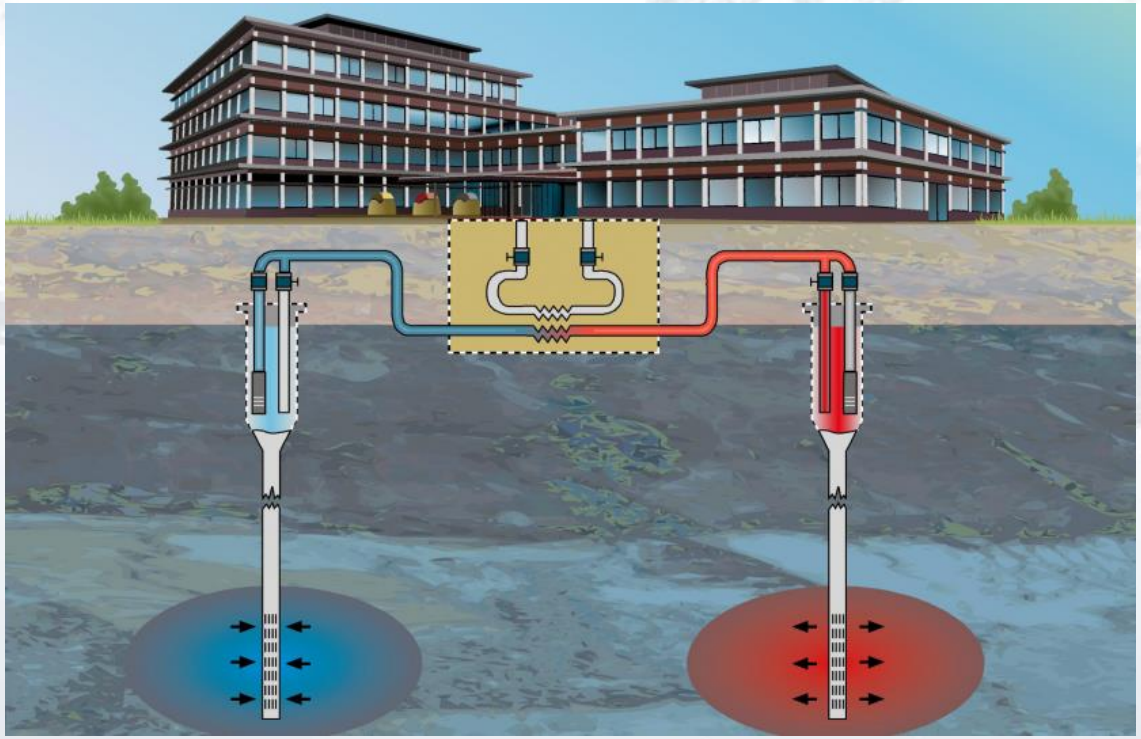
After nanofiltration

Results grey water treatment plant:

Parameter	unit	Influent	Effluent without NF	Discharge requirements wastewater	Optional: Effluent + NF (high water quality)
Organic material (COD)	[mg/l]	630	70	125	13
Particles (TSS)	[mg/l]	200	20	-	-
Total Nitrogen (TN)	[mg/l]	26	11	15	4
Ammonium (NH_4-N)	[mg/l]	12	2	-	0,37
Nitrate (NO_3-N)	[mg/l]	0,5	0,35	-	0,22
Total Phosphorous (TP)	[mg/l]	9,5	1,2	2	0,34
Bacteria (CFU)	[#/100 ml]	>1000	>1000	-	0

Heat recovery from wastewater

- Decentral treated wastewater is warm ± 20°C and locally available
- This heat can be used for a ATES system or heat pump
- Heat content of the wastewater represents 30% of the heating needs



Aquiver Thermal Energy Storage
Disbalance in heating and cooling
Heat of wastewater can be used to charge the cold well

Energy balans positive for decentralized systems

		Desah	Reference WWTP
Drinking water production and transport	kWh/p/j	-35	-58
Heat demand treatment	kWh/p/j	-126,7	-6
Gasoline consumption	kWh/p/j	0	-3
Heat pump*	kWh/p/j	167,7	0
Electricity heat pump	kWh/p/j	-67,3	0
Heat biogas**	kWh/p/j	149,9	6
Electricity treatment	kWh/p/j	-72,25	-75
Electricity production	kWh/p/j	0	61
Energy transport wastewater	kWh/p/j	-72	-13
Total primair	**primair**	**-46**	**-88**

*heat pump not optimized (low COP)
** CHP unit could also deliver electricity

Financial analysis

		Noorderhoek (optimized)	Reference (wwtp 100.000 p.e.)
Transport	€/PE*y	18	18
Additional costs sanitair	€/PE*y	22	-
WWTP	€/PE*y	97	47
Heat and kitchen-waste	€/PE*y	-52	-
Drinking water (**1,25 Euro/m³**)	€/PE*y	-12	-
Total	**€/PE*y**	**73**	**65**

- at 1200 p.e. source separated system is 11 % more expensive compared to wwtp of 100.000 p.e.
- equal at 50.000 p.e. wwtp
- local water reuse not taken into account.
- micropollutant removal not taken into account.

Decentralized vs Centralized

Compared with a centralized WWTP (100.000 p.e.) the DeSaH concept:

- Similar OPEX (incl. depreciation) at a scale of 3000 p.e.
- 200% more energy production than an energy optimized plant, equal to 25% of total household heating demands
- Recovers 250% more P than the current state of the art;
- Produces 2x times less surplus sludge, with higher quality
- Footprint is ~0.2% of the total footprint of the connected houses
- Removal of micropollutants and effluent with a high quality

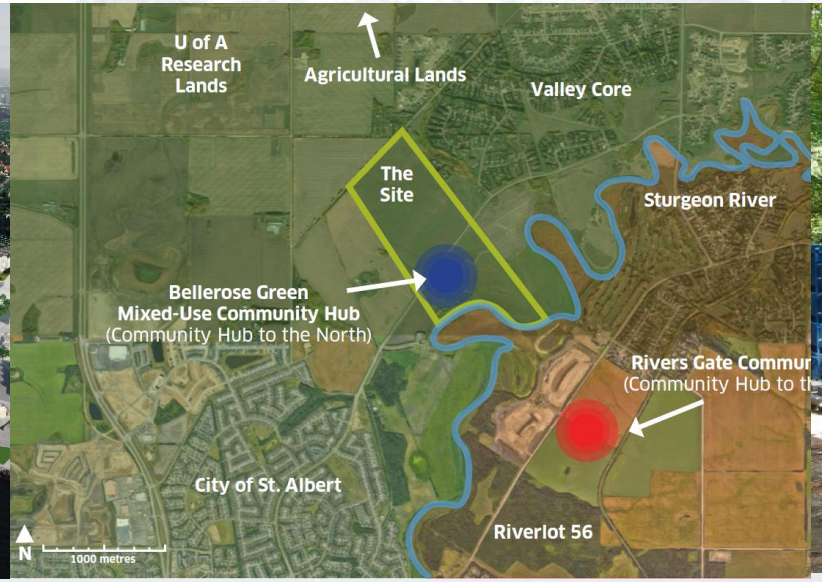
References:

The Netherlands: Digestor (office building Den Hage)

Amsterdam (Buiksloterham, 2021; 1500 p.e.)

Amsterdam (Strandeiland, 2024; 20.000 p. e.)

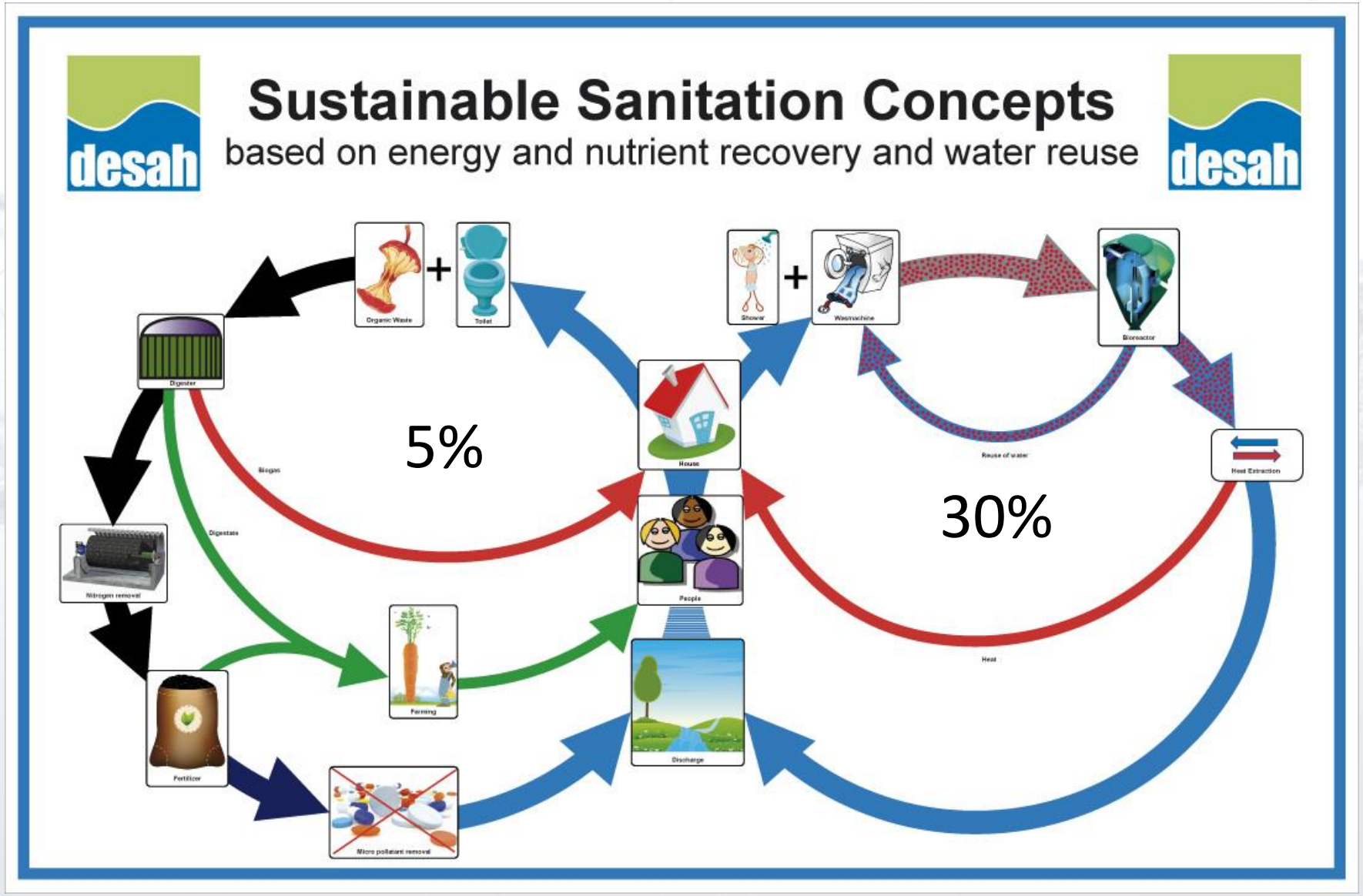
Sweden (Helsingborg, 2020; 2000 p.e.)



Canada (St. Albert, 2021; 1500)

Ukraine (The Crimea, 2008; 1500 p.e.)

Zirkuläres Wasser, Energy und Dünger



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Desah offers:

- More than 15 years of experience in decentralized wastewater treatment
- Several reference projects available in the Netherlands and Europe
- Provider of technology
- Feasibility studies, design, delivery, construction, management and maintenance of installations

- <u>Possible next steps:</u>
  - Quick scan -> feasibility study -> conceptual design -> pilot project

Contact info

- www.desah.eu
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- https://www.youtube.com/channel/UCuD4b8eP6PDKZMt-3NoD3sg
- https://www.linkedin.com/company/desah/
- https://www.facebook.com/desahbv/

Additional slides

References vacuümtoilets in houses/buildings

630 woningen Hamburg:
https://www.hamburgwatercycle.de/en/the-jenfelder-au-neighbourhood/the-hwc-in-the-jenfelder-au/
Den Haag, kantoorgebouw ministerie:
https://english.rijksvastgoedbedrijf.nl/real-estate/rijnstraat-8-the-hague-government-office
Sneek 230 woningen:
https://www.waterschoon.nl/
114 appartement en 15 woningen in Kerkrade:
https://www.superlocal.eu/primeur-circulair-woningconcept-ontwikkeld-binnen-superlocal-project/
Onderzoeksgebouw Wetsus:
www.wetsus.eu
Buiksloterham Amsterdam:
https://www.waternet.nl/werkzaamheden/nieuwe-sanitatie/
Strandeiland Amsterdam (8000 woningen):
https://www.winnovatie.nl/innovatie/nieuwe-sanitatie-strandeiland
400 appartementen in Gent de wijk van de toekomst:
https://ducoop.be/initiatieven
Helsinborg, Sweden 350 appartementen en 3 kantoorgebouwen:
https://hplus.helsingborg.se/reco-lab/
Het meest duurzame gebouw ter wereld:
https://jetsgroup.com/jets-magazine/article/en/the-most-sustainable-office-building-in-the-world
Kantoor Desah
www.desah.nl
NIOO wageningen

- Cruiseschepen, vliegtuigen, treinen

Sludge composition UASB

	Heavy metal (mg/kg ds)	Desah*	Reference WWTP 30.000 p.e.	Reference WWTP 100.000 i.e.
Slib productie (kg.ds /inw/j)		3,5	17	16,7
As	15	5,7	**16**	
Cd	1,25	0,8	**1,3**	
Cr	75	16	37	
Cu	75	**268**	**400**	
Hg	0,75	0,6	**1,0**	
Ni	30	16	28	
Pb	100	43	**127**	
Zn	300	**975**	**1096**	

*UASB sludge lower heavy metal content compared to cow manure

Advantages DeSaH

- Energy production
- Water saving of at least 25%
- Treatment of wastewater and organic waste
- Closing energy and nutrient loop
- No harmful by-products
- Very high removal efficiencies for COD and nitrogen
- More cost effective on the long run
- Its operation generates money in stead of consuming