Ecological sanitation- an overview

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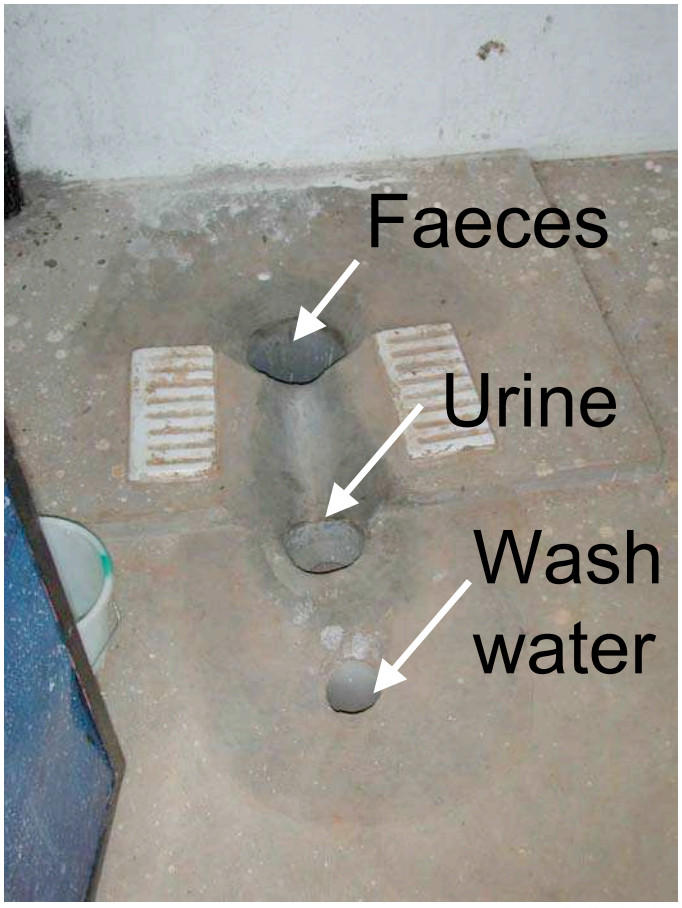
Ecosan toilet center Bangalore India



Ecosan toilet center Bangalore India

- Serves 800 people
- Produces 50 tonn bananas/year
- Produces compost for sale
- Employs 10 people
- Annual cost
  10 US$/user

Experience from Bangalore

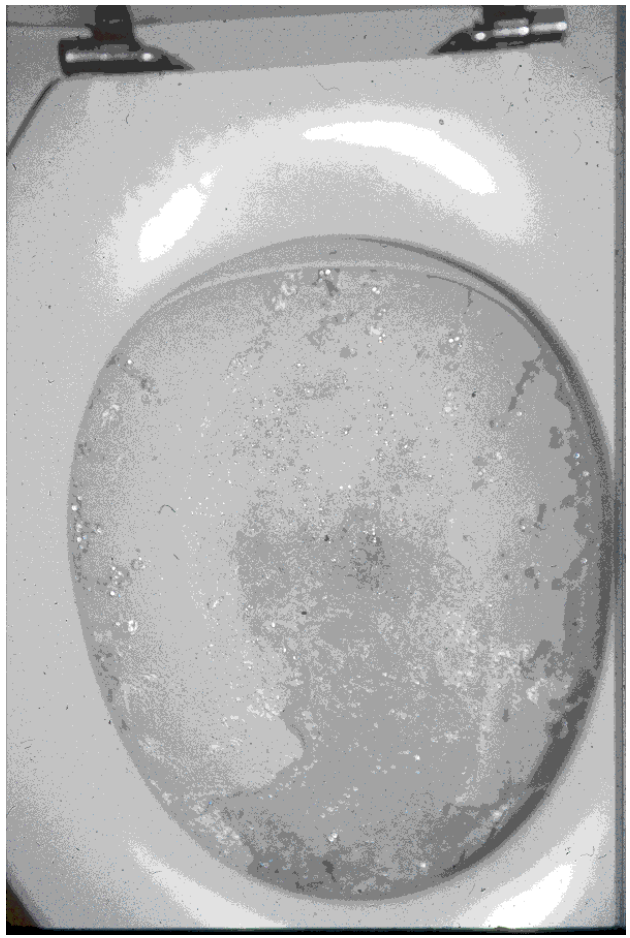
- Application of **compost** increases the plants tolerance to water stress
- Application of **compost** is essential for nutrient utilization in weathered (red) tropical soil

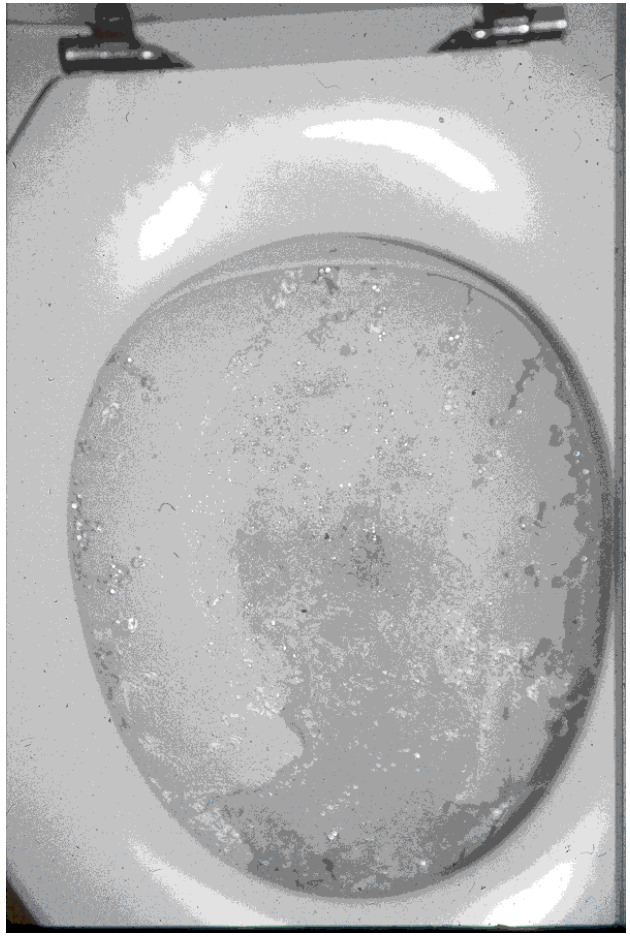
1st. generation

Bangalore - India

2nd. generation

design: Lin Jiang, China





20 - 40% water consumption in sewered cities is due to the water toilet

(Gardner 1997)

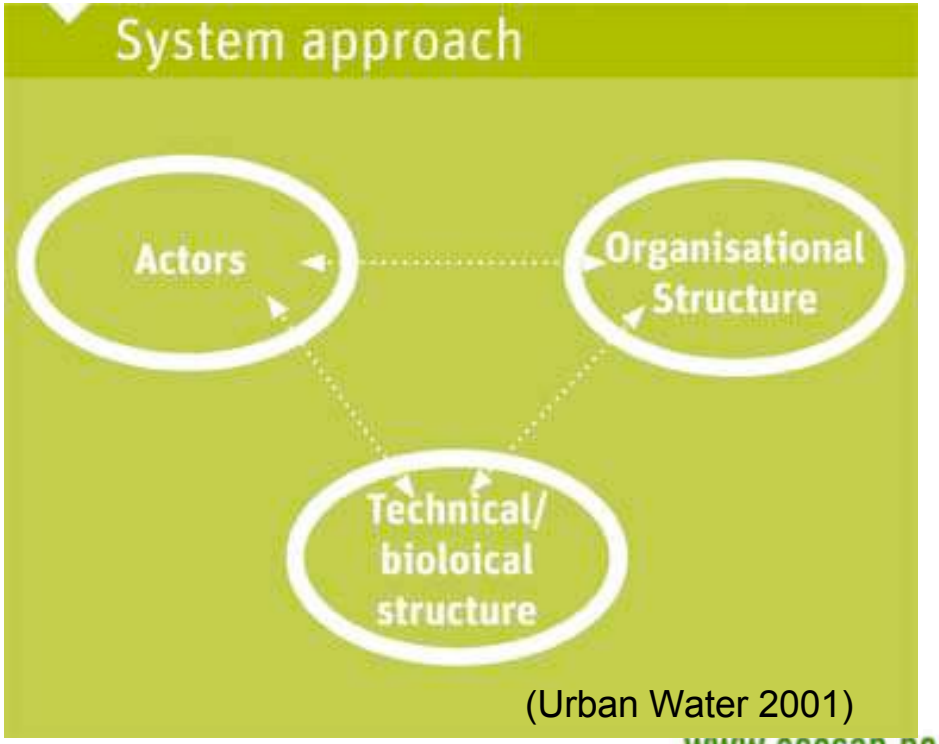
Ecological engineering

The development of human society with nature for the benefit of both.

(W.J. Mitsch and S.E. Jørgensen in **Ecological engineering,** 1989)

Design
of ecological sanitation systems

- System approach



(Urban Water 2001)

Resources in wastewater

Annual discharge from one person

- Nitrogen (N) 4.5 kg
- Phosphorus (P) 0.6 kg
- Potassium (K) 1.0 kg
- Organic matter (BOD) 35 kg

Loss of Soil Fertility (slow but dramatic, global scale)
Can be counteracted by **returning treated biowaste**

(Map from WWW.FAO.ORG)

The wastewater resource

The fertilizer value of the nutrients dicharged to the sewer systems in **Norway**

30 million USD

per year

The wastewater resource

The fertilizer value of the blackwater from
900 Mio people in rural
China

2.5 billion USD

per year

(UNESCO 2001)

Recycle?

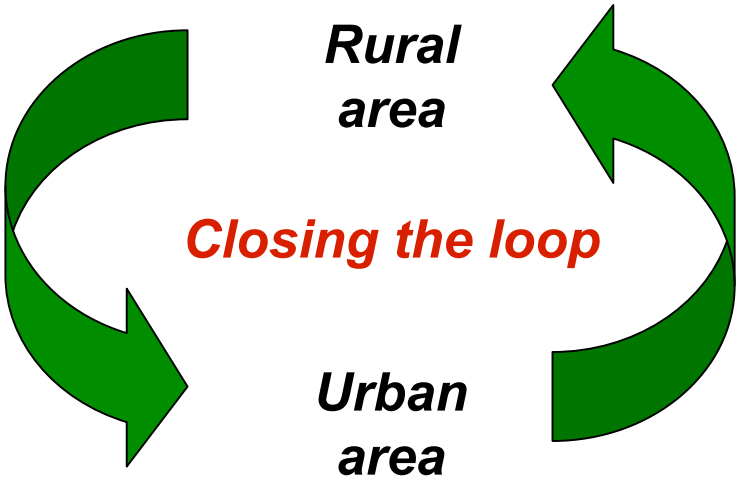
Phosphorus is a limited resource.
Present mineral P-sources
will last 100 - 200 years.
(Bøckman et al. 1991)

Production of 1kg mineral nitrogen fertilizer requires 38 MJ = 10.5kWh of energy.
(Refsgaard 1997)

It is enough plant nutrients in domestic sewage and organic household waste to grow food for the world population.
(Wolgast 1991)

Design
of ecological sanitation systems

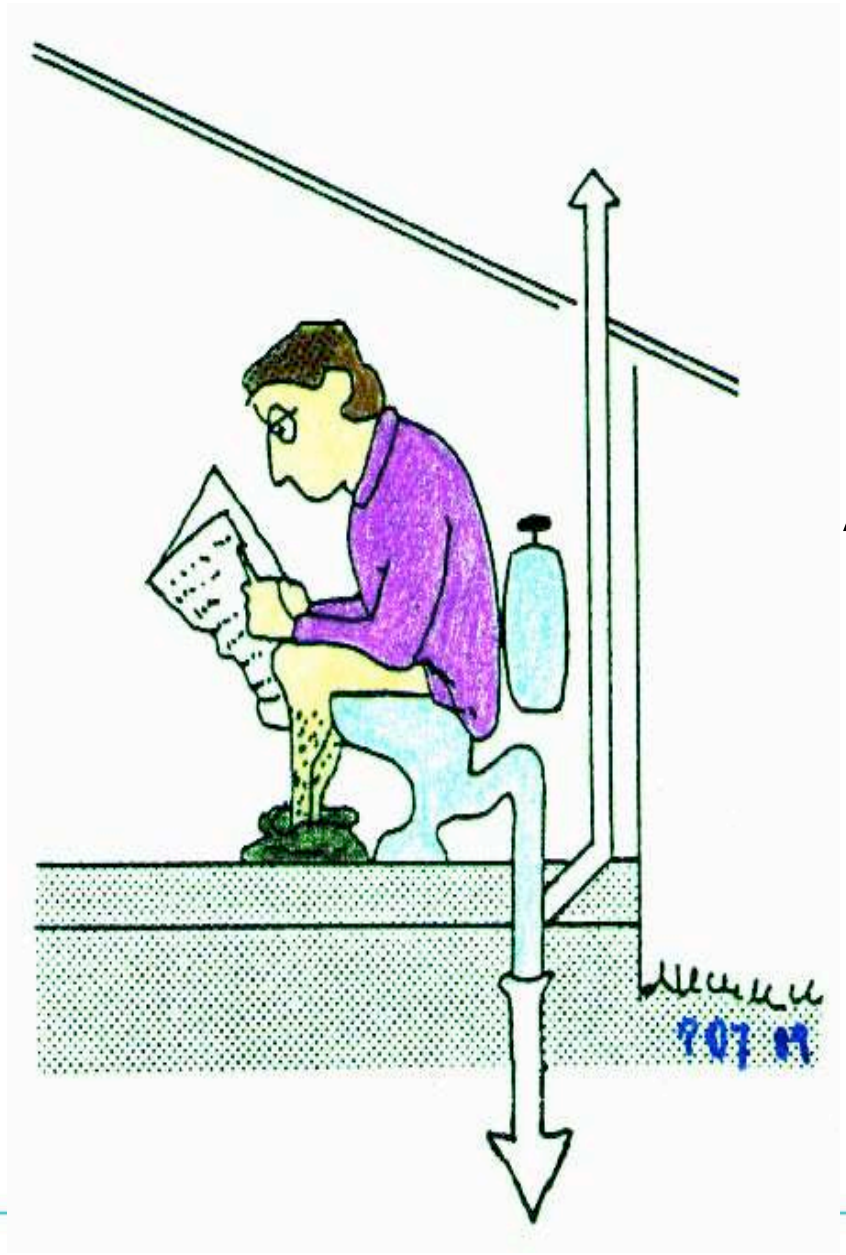
- System approach
- Decentralized systems
- **Recycling and resource saving**



The toilet!

Contribution from the toilet

* 90 % of N
* 80 % of P
* 80 % of K
* 40-75 % of org. matter
* Majority of the pathogens



An ordinary toilet
uses 6 - 20 litres/flush

Future toilet types
(comercially available today)

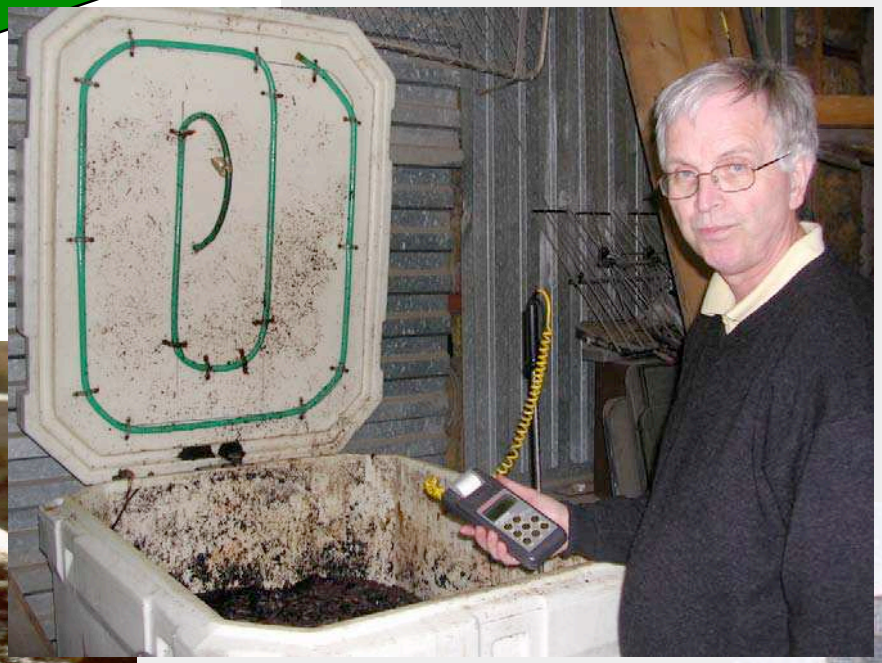
- Composting /dry sanitation 0 - 0.1 liter/visit
- Urine diverting 0.1 - 4.0 liter/visit
- Water saving (vacuum&gravity) 0.5 - 1.5 liter/visit

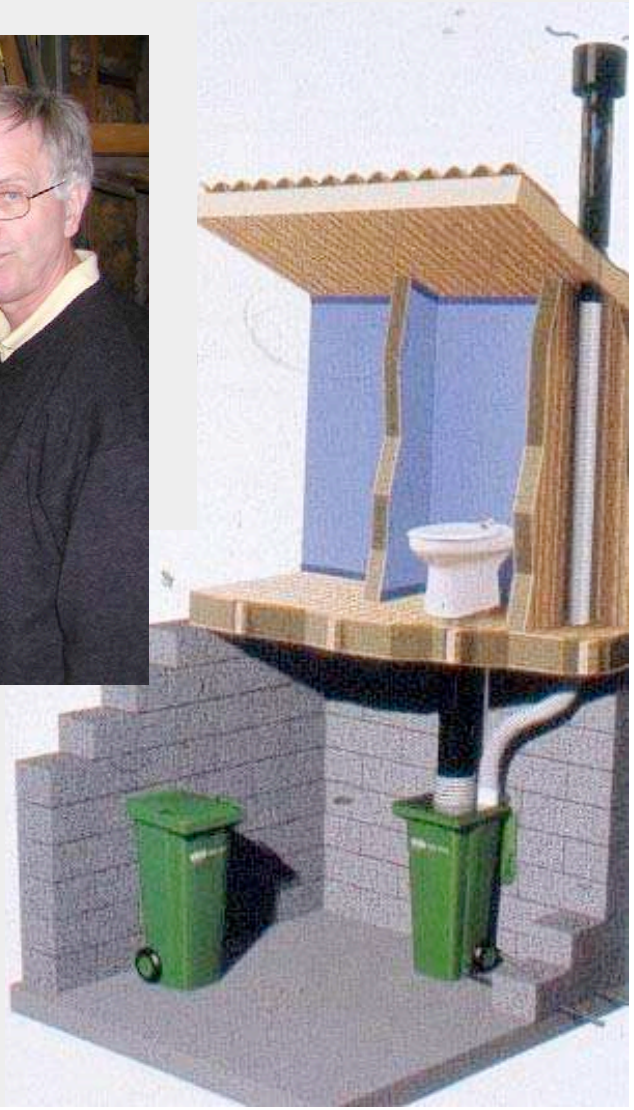
Composting toilet at roadside facility - Sweden

Elected the best roadside facility In Sweden 2002

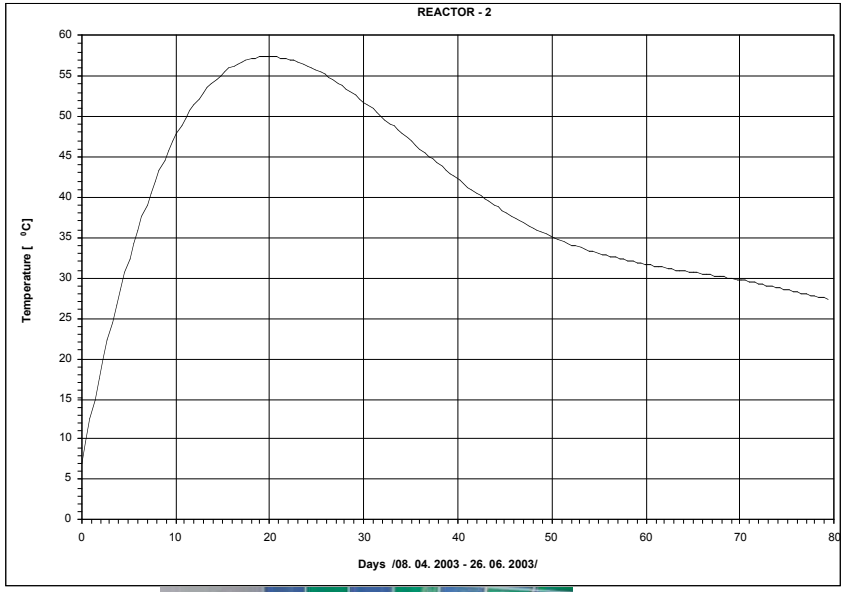
Norwegian University of

Secondary composting





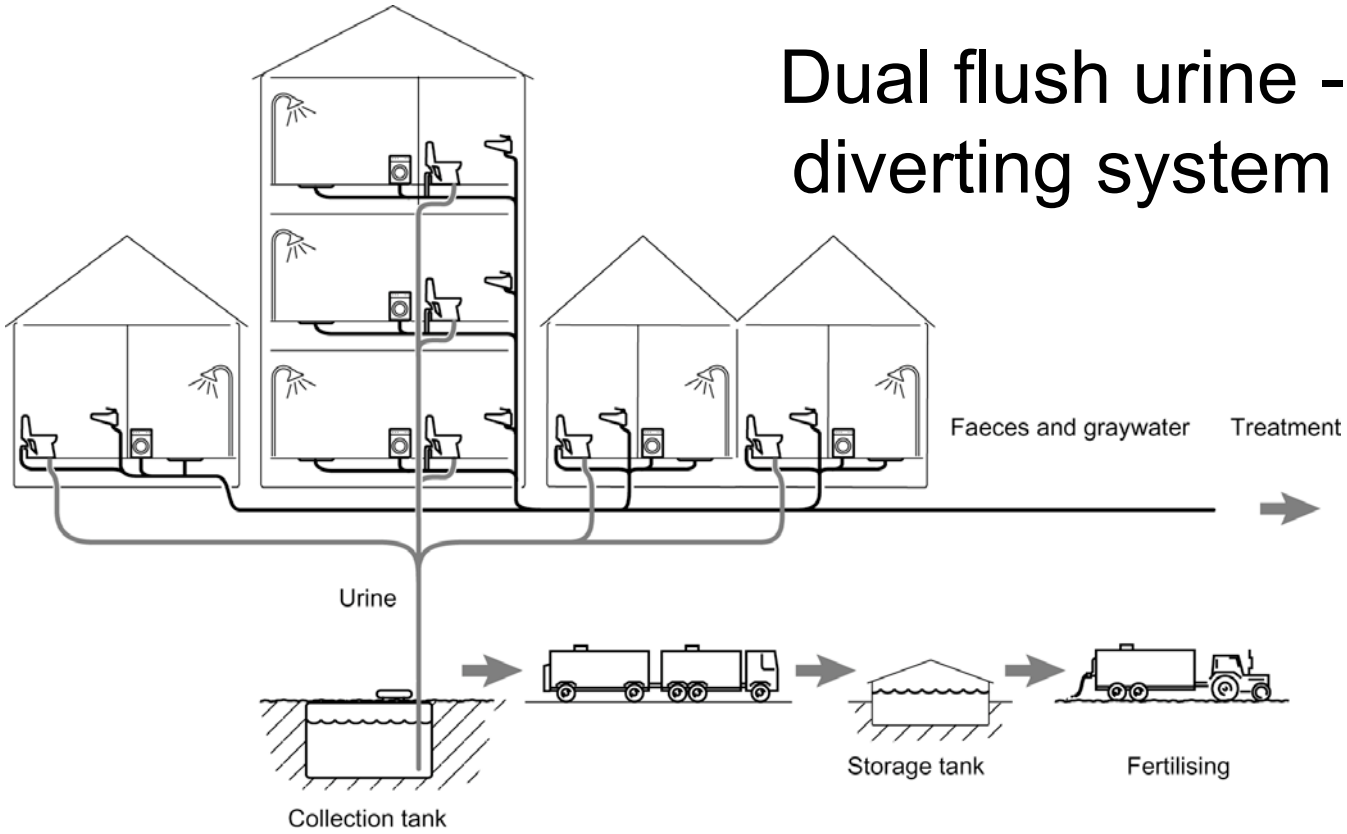
Dry sanitation - hygiene



- International research show that dry sanitation may give an equal or higher reduction of pathogens and a high reduction in risk of exposure.

(Stenström 2001)

Dual flush urine - diverting system



- Urine flushed with 1-2 dl
- Faeces - flushed with 2-4 liters

(Jønsson et al. 1998)

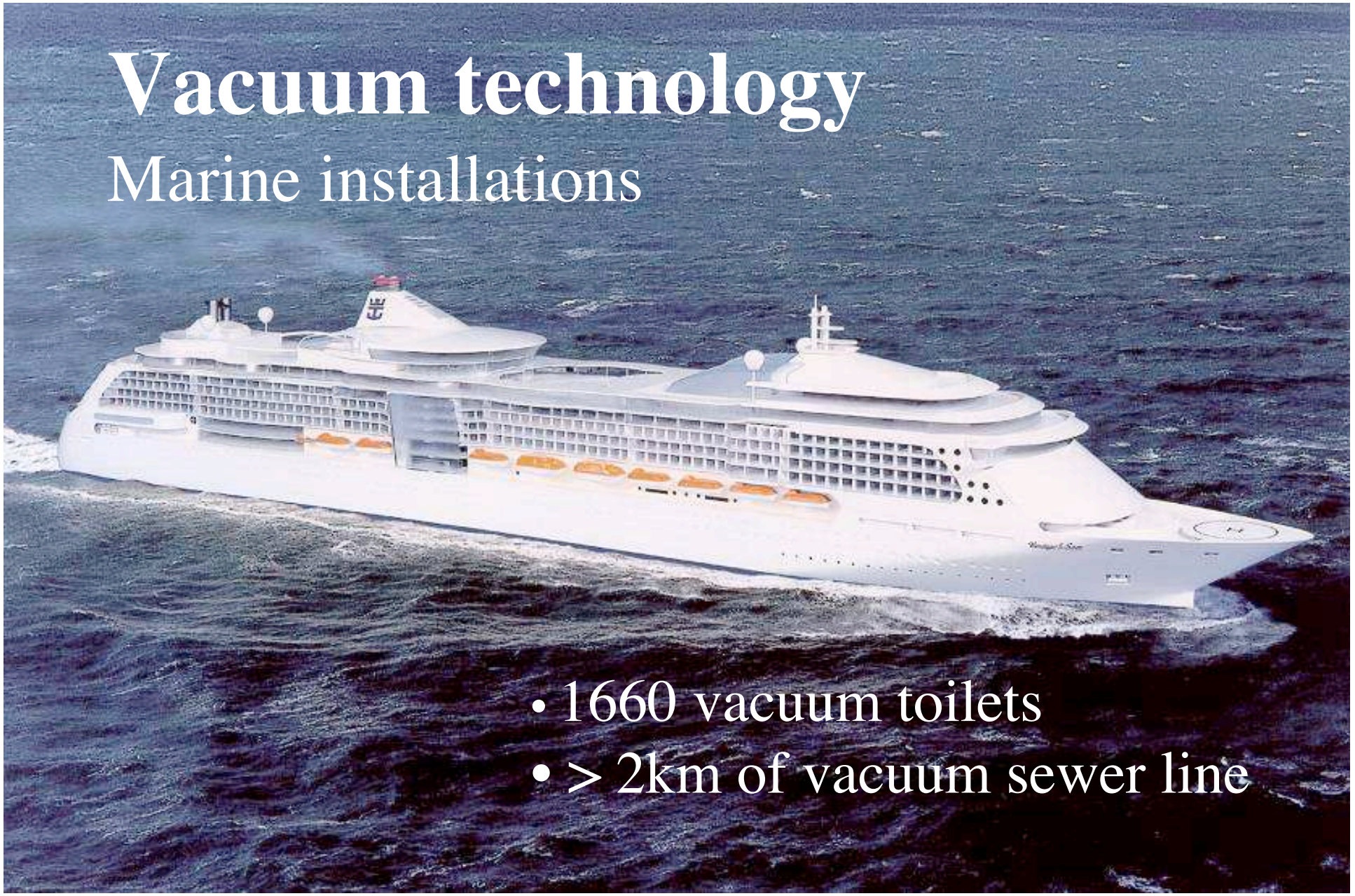
Low flush toilets

Vacuum
0.5 - 1.5 liters/flush

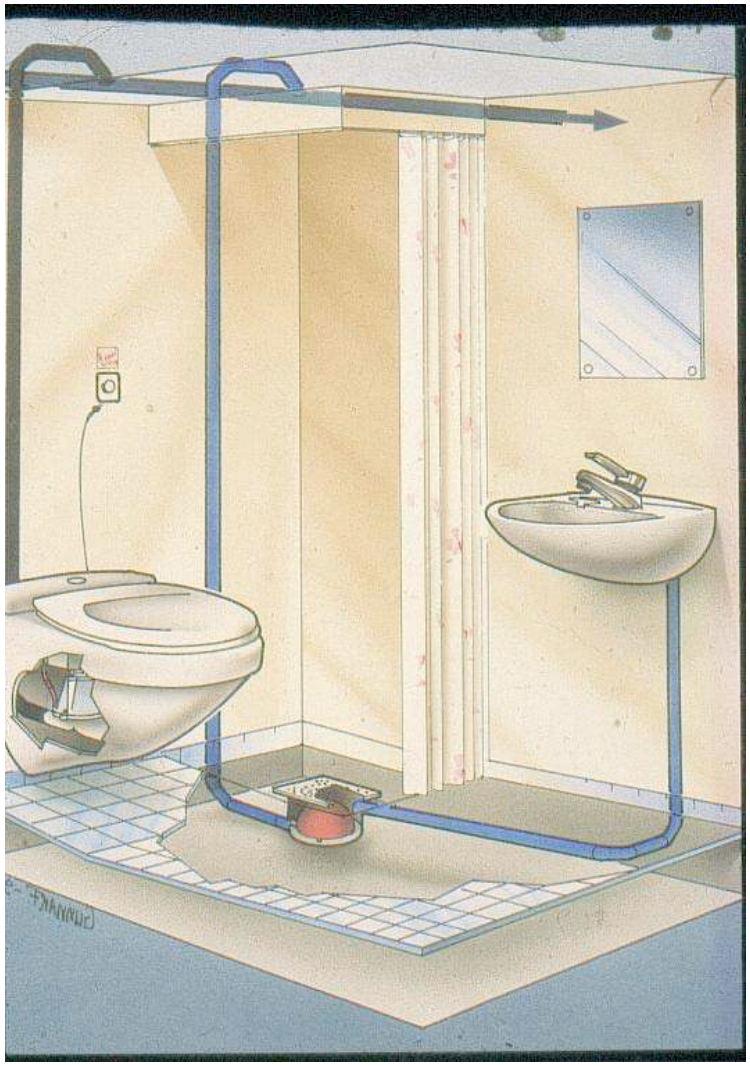
Gravity
1 liter/flush

Vacuum technology

Marine installations

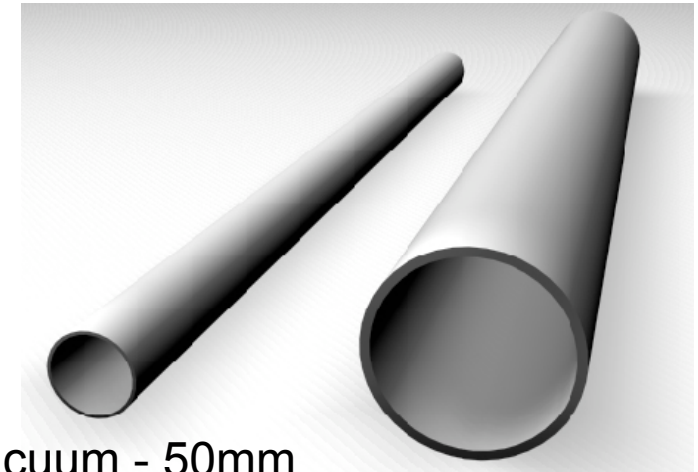


- 1660 vacuum toilets
- > 2km of vacuum sewer line



Vacuum toilets

- Small diameter pipes
- Piping independent of inclination



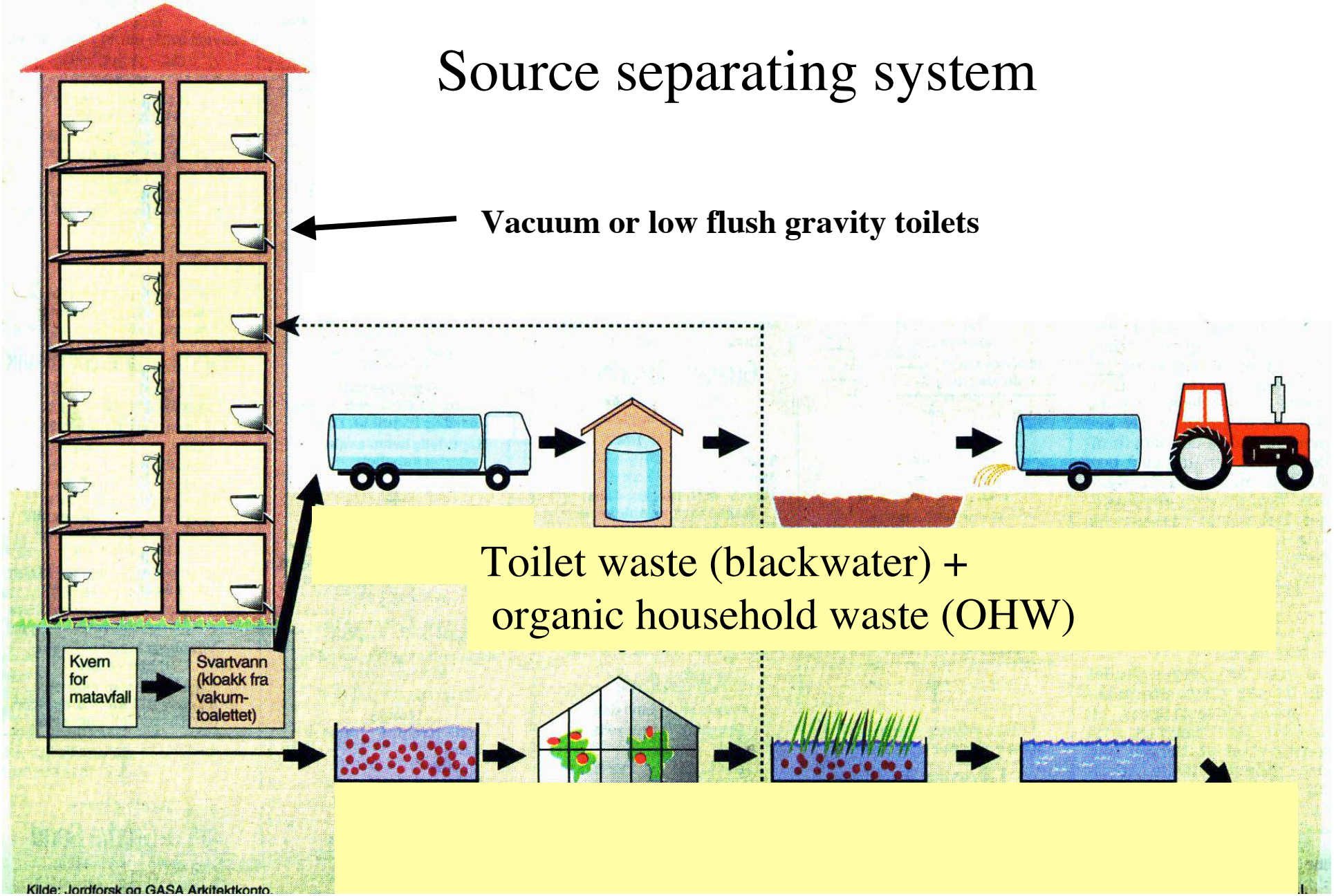
Vacuum - 50mm

Gravity - 110mm

Vacuum toilets - energy use

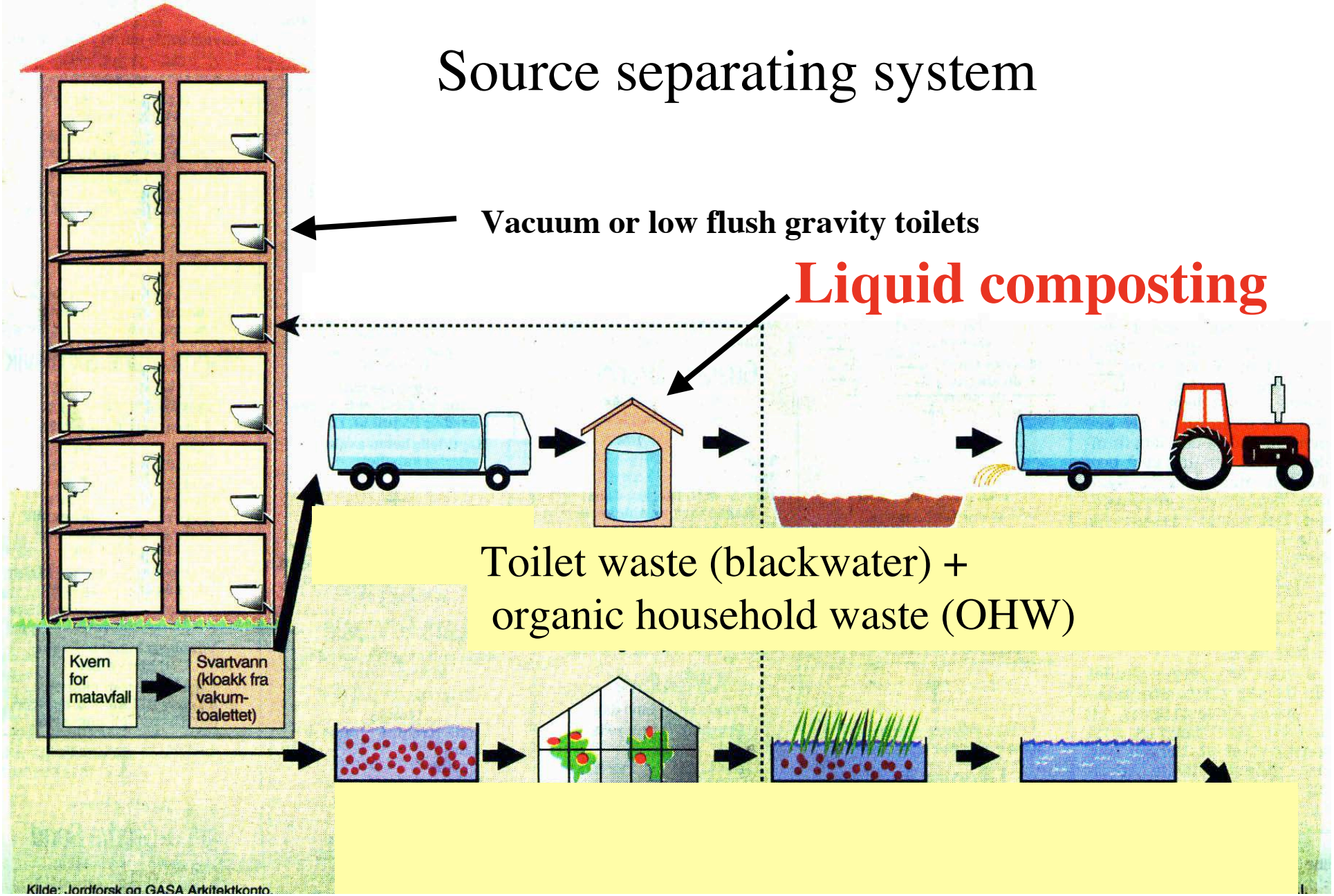
4 KWh/person and year

Source separating system



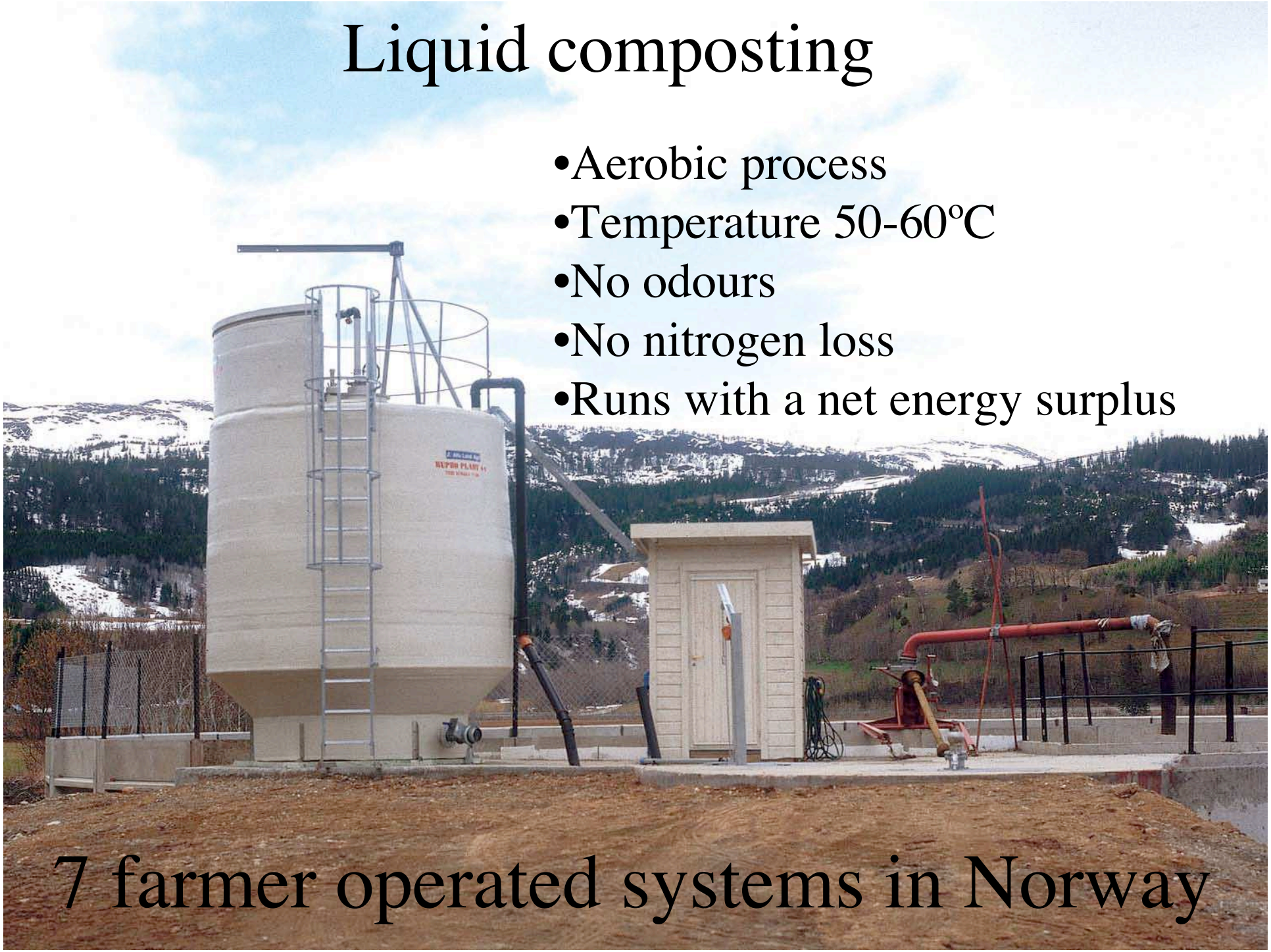
Toilet waste (blackwater) +
organic household waste (OHW)

Source separating system



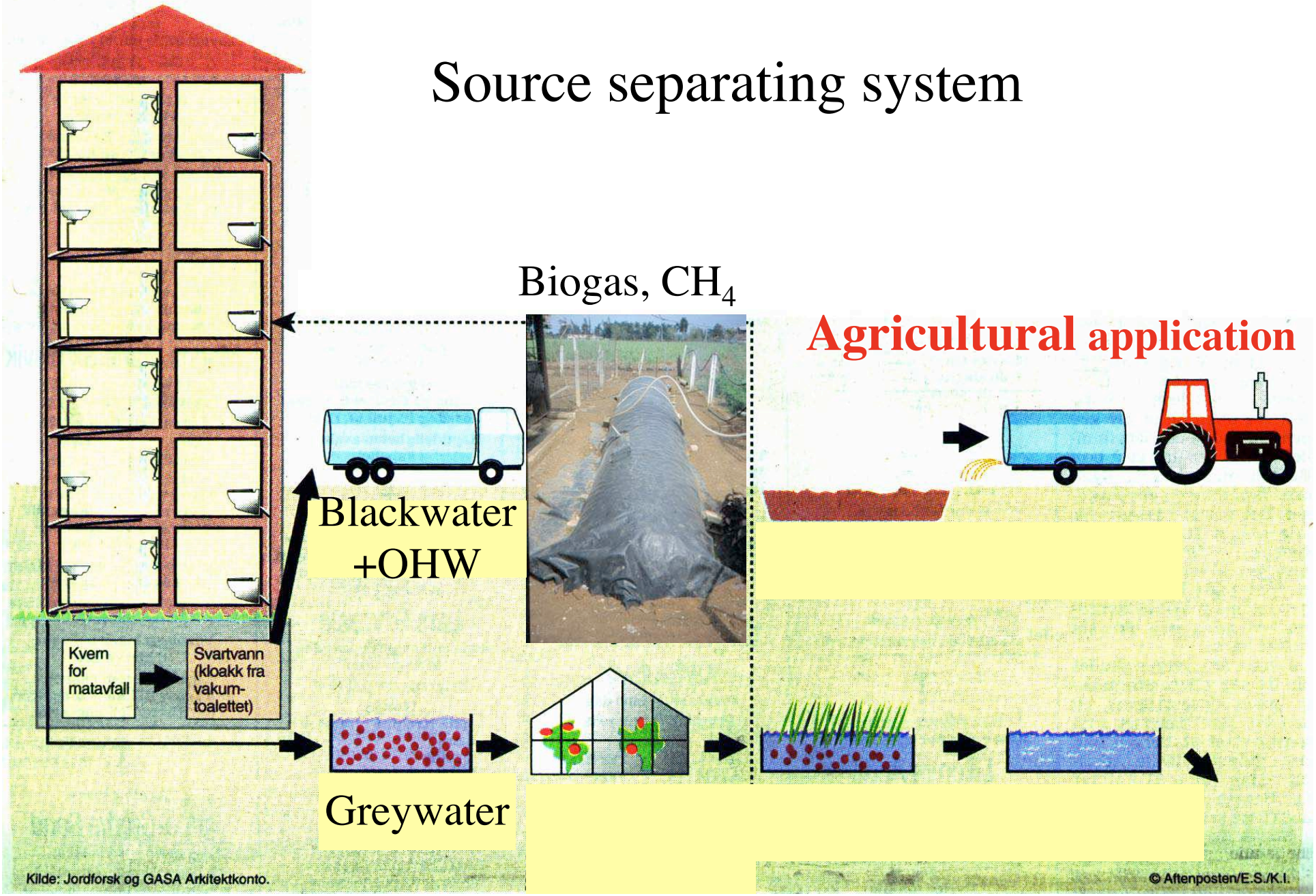
Liquid composting

- Aerobic process
- Temperature 50-60ºC
- No odours
- No nitrogen loss
- Runs with a net energy surplus

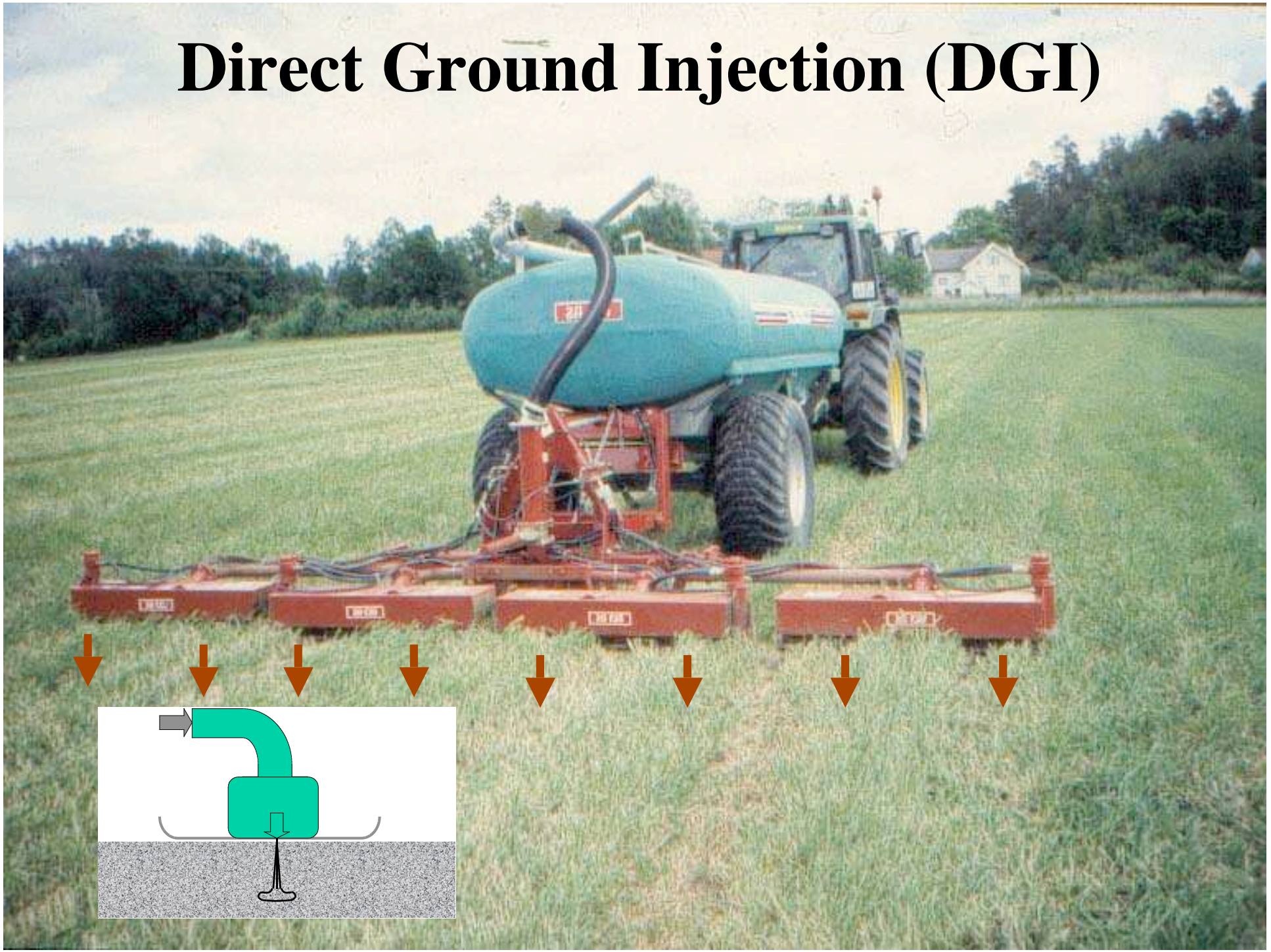


7 farmer operated systems in Norway

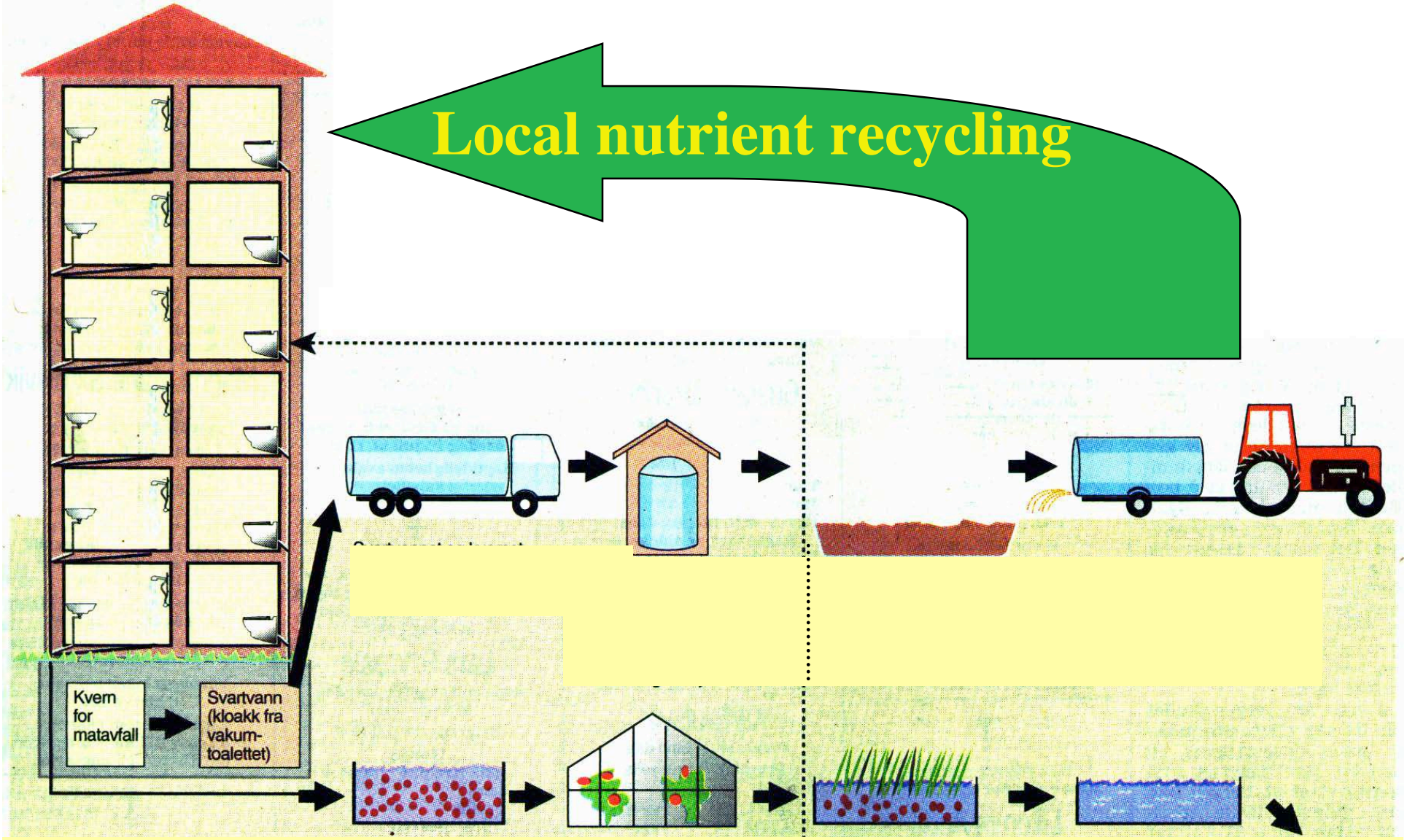
Source separating system



Direct Ground Injection (DGI)

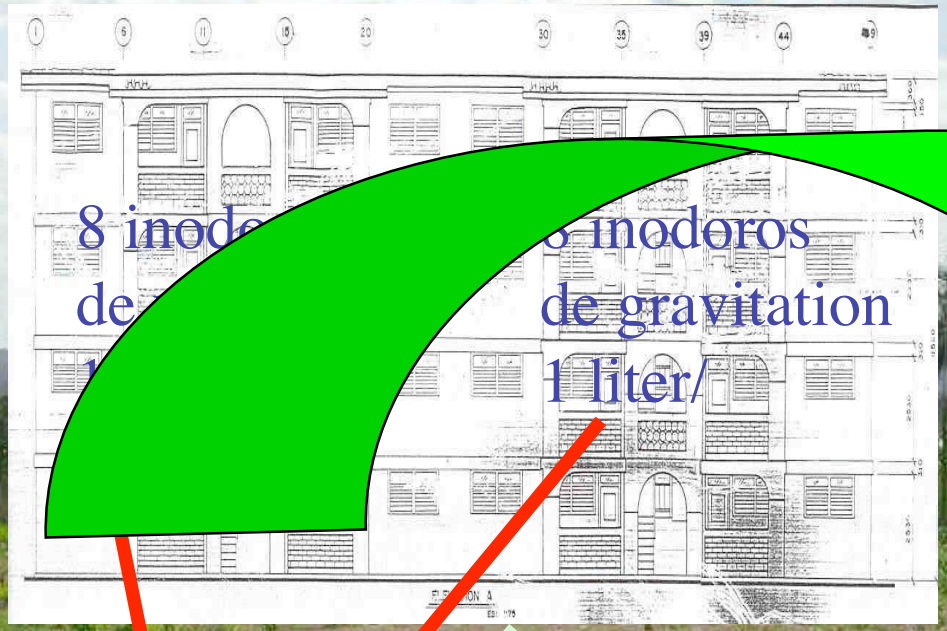


Local nutrient recycling



”Zero emission house”

16 viviendas

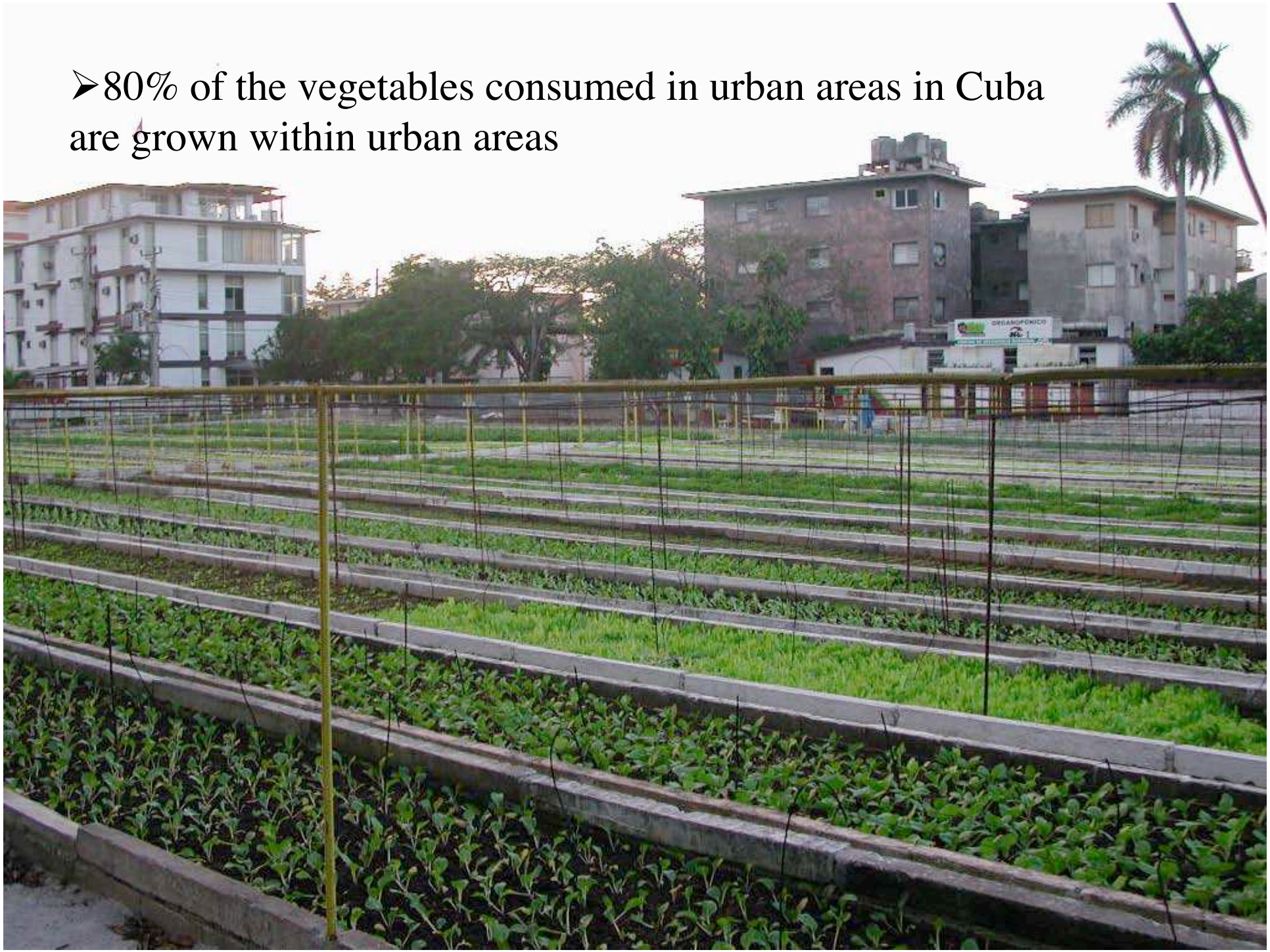


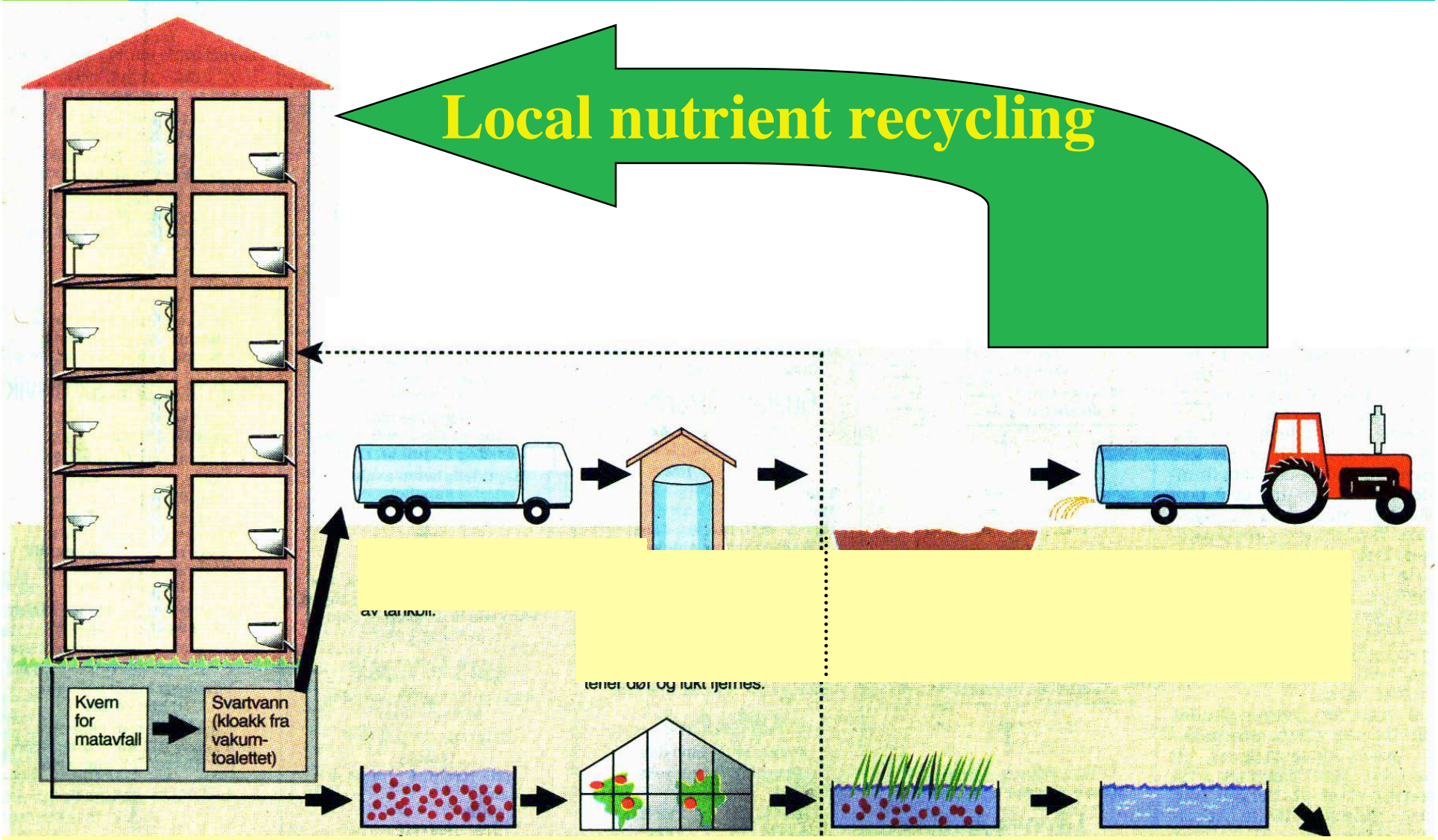
8 inode… … inodoros
de… de gravitation
1… 1 liter/

Biogas

Greywater

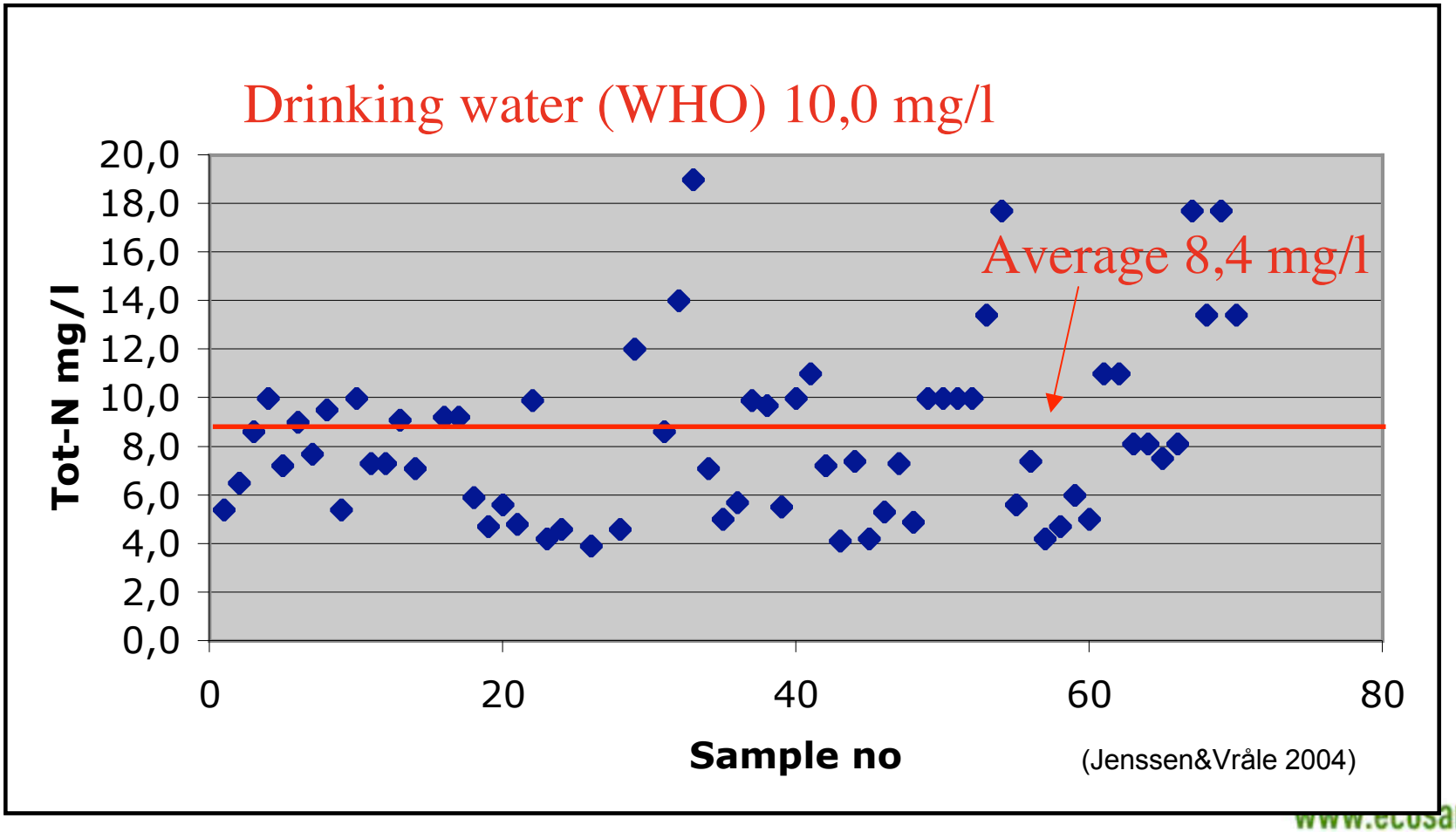
Wetland


➢80% of the vegetables consumed in urban areas in Cuba are grown within urban areas



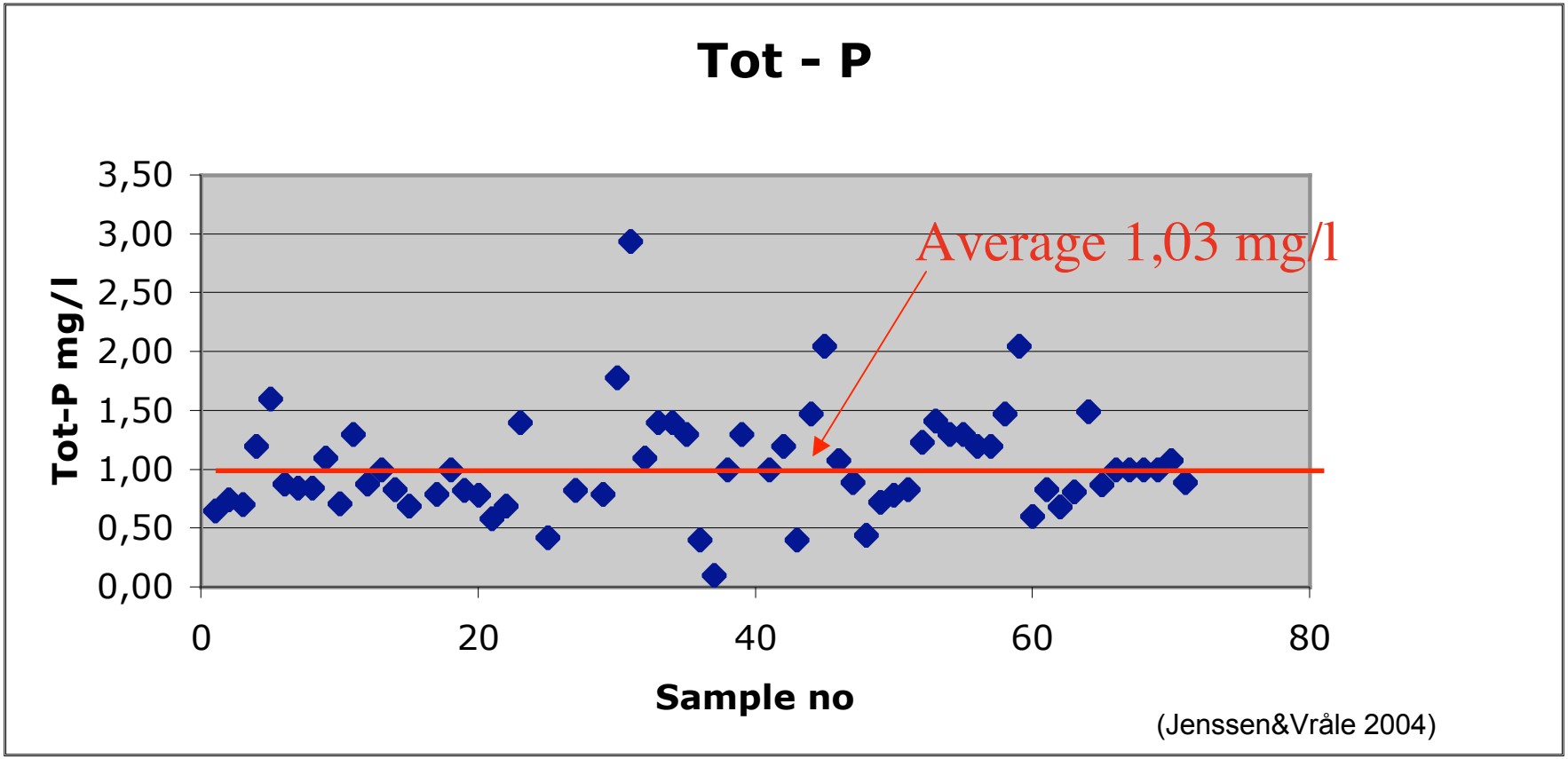
Greywater treatment

Total nitrogen concentrations in untreated greywater (mg/l)



(Jenssen&Vråle 2004)

Total phosphorus concentrations in untreated greywater (mg/l)



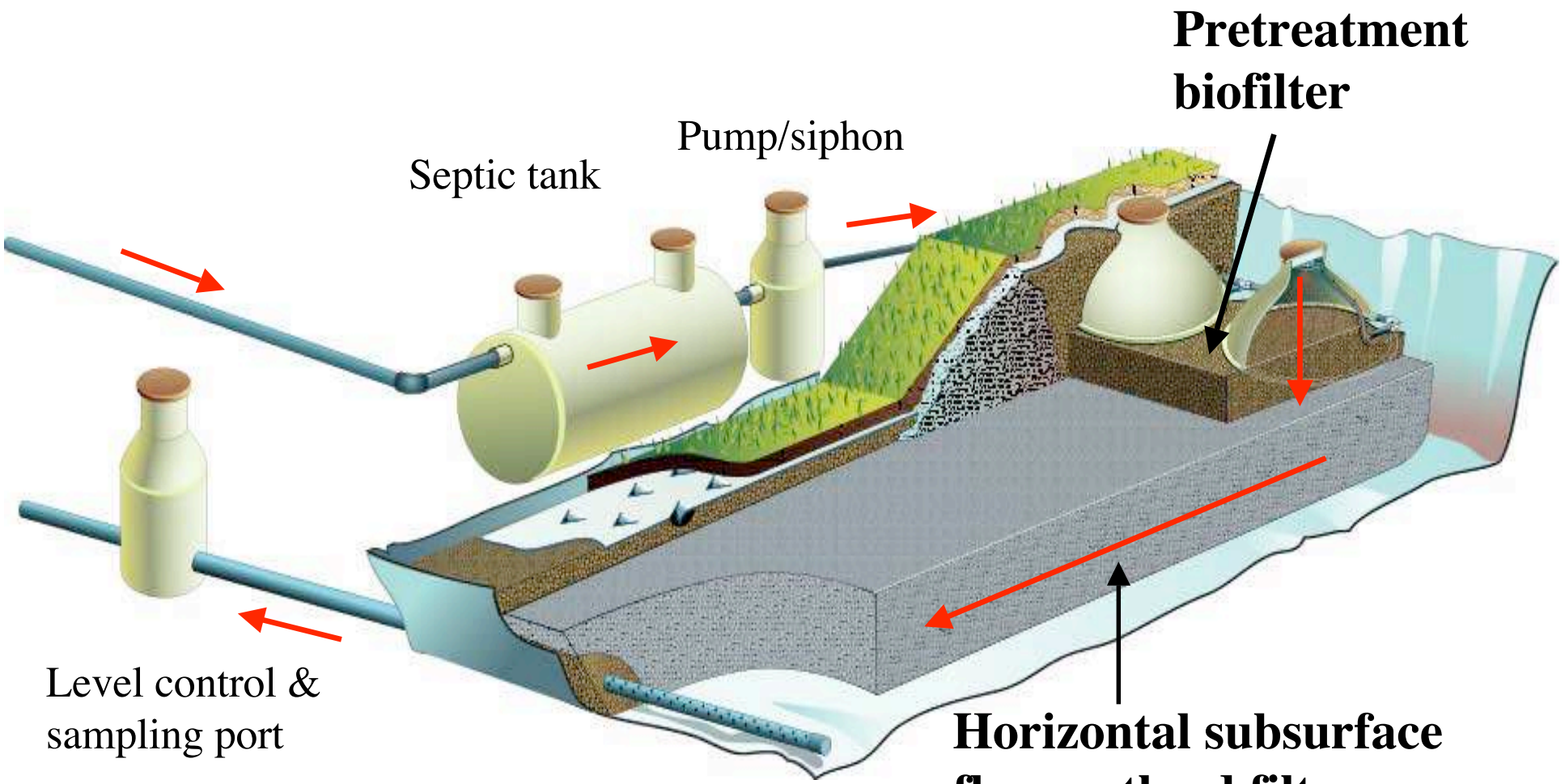
(Jenssen&Vråle 2004)

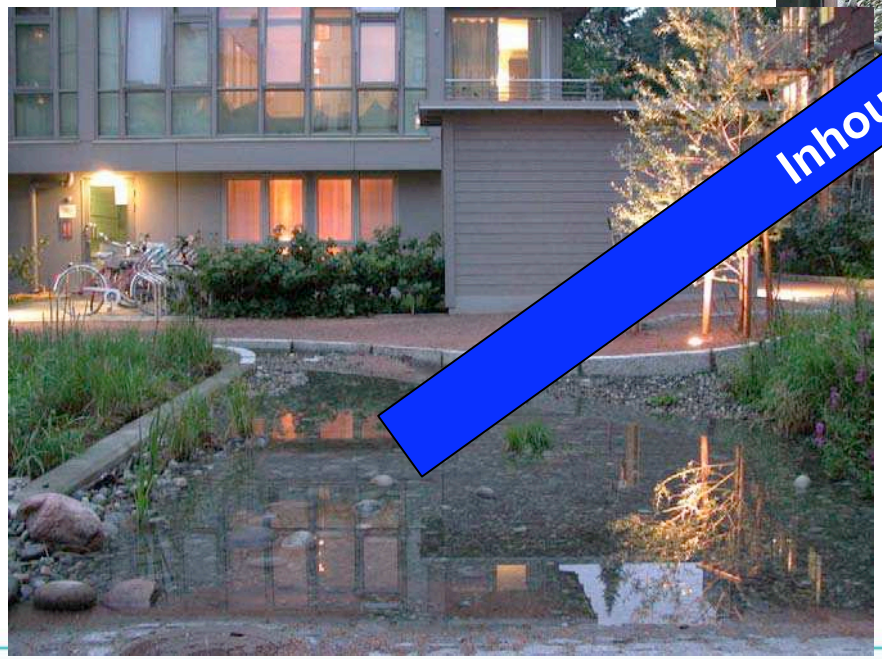
Compact systems

Rotating biological contactors

Greywater treatment in OSLO

Greywater treatment





Inhouse use ?

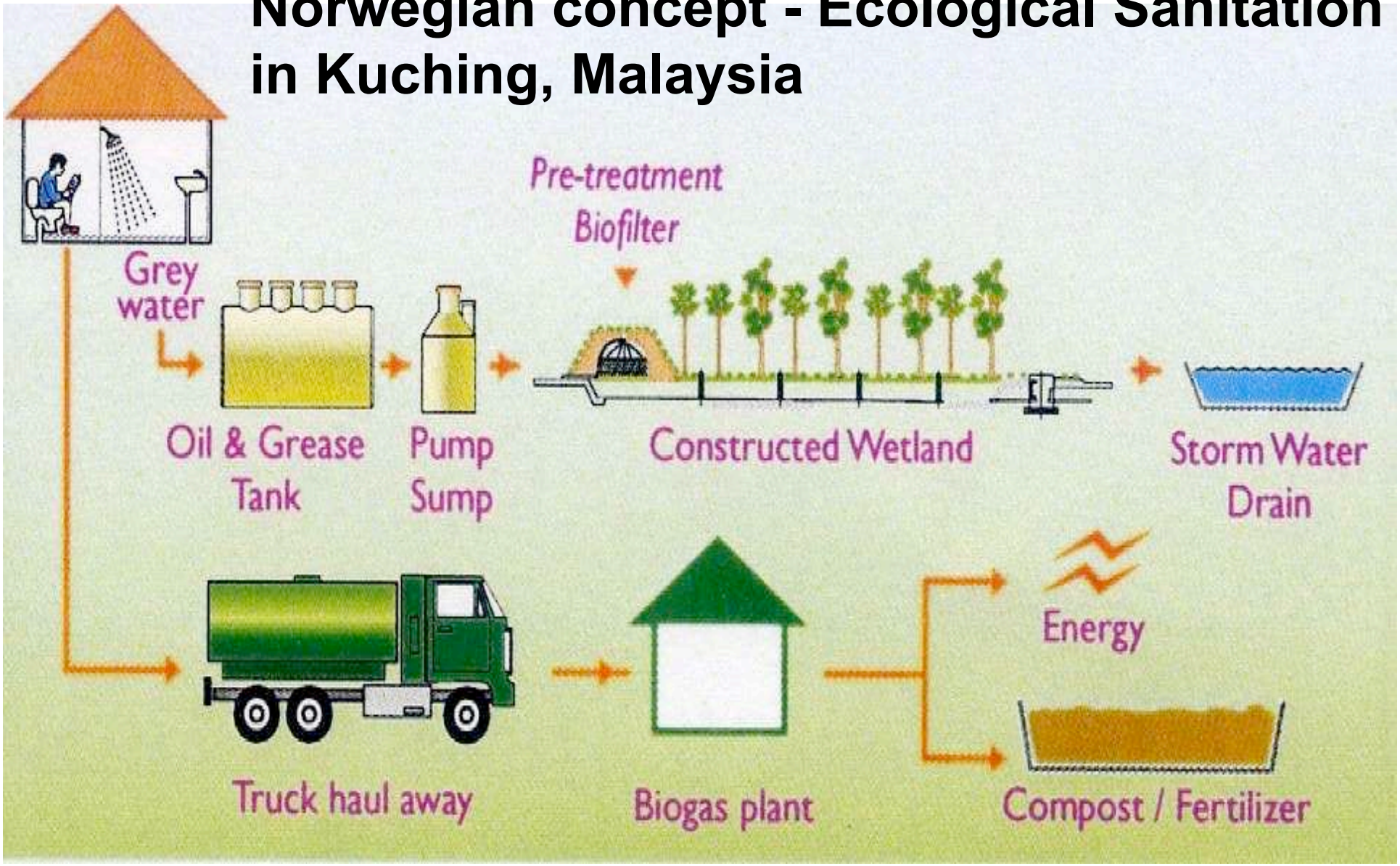
Greywater treatment at Klosterenga Oslo

Effluent values:

Fecal coliforms:	0
Total-N:	2,5 mg/l
Total-P:	0,02 mg/l

Kuching
Sarawak Malaysia

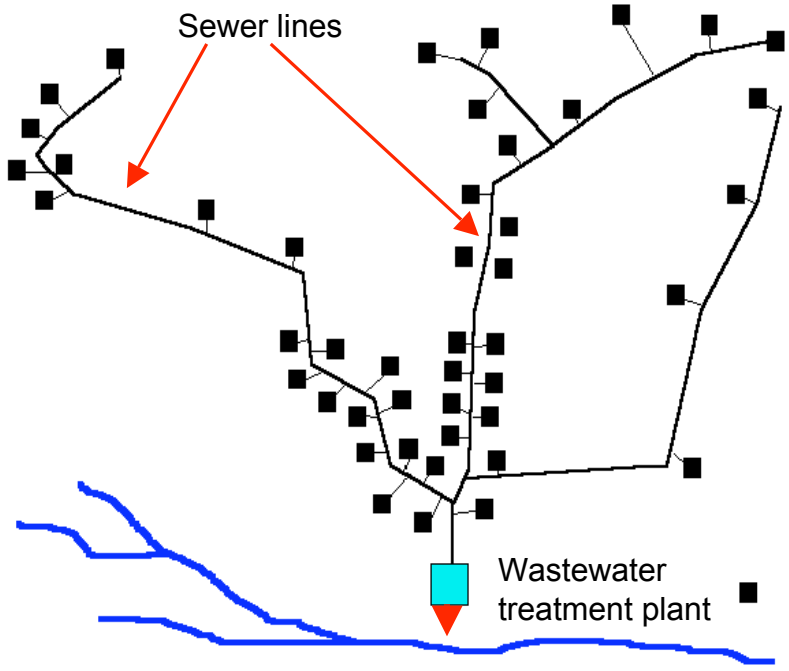
Norwegian concept - Ecological Sanitation in Kuching, Malaysia



Preliminary Assessment of Investment Cost

Conventional Centralized Sewage System	3,000 Million MYR
Ecological Sanitation	1,000 Million MYR

Investment cost
of centralized sewer systems



- Collection system **80%**
- Treatment **20%**

In the US:

- 37% of all new developments are serviced by onsite or decentralised systems
- over 50% of onsite/cluster systems are in cities and their suburbs

(USEPA 2000)

Biogas plant


Pilot project Hui Sing Garden
Greywater treatment

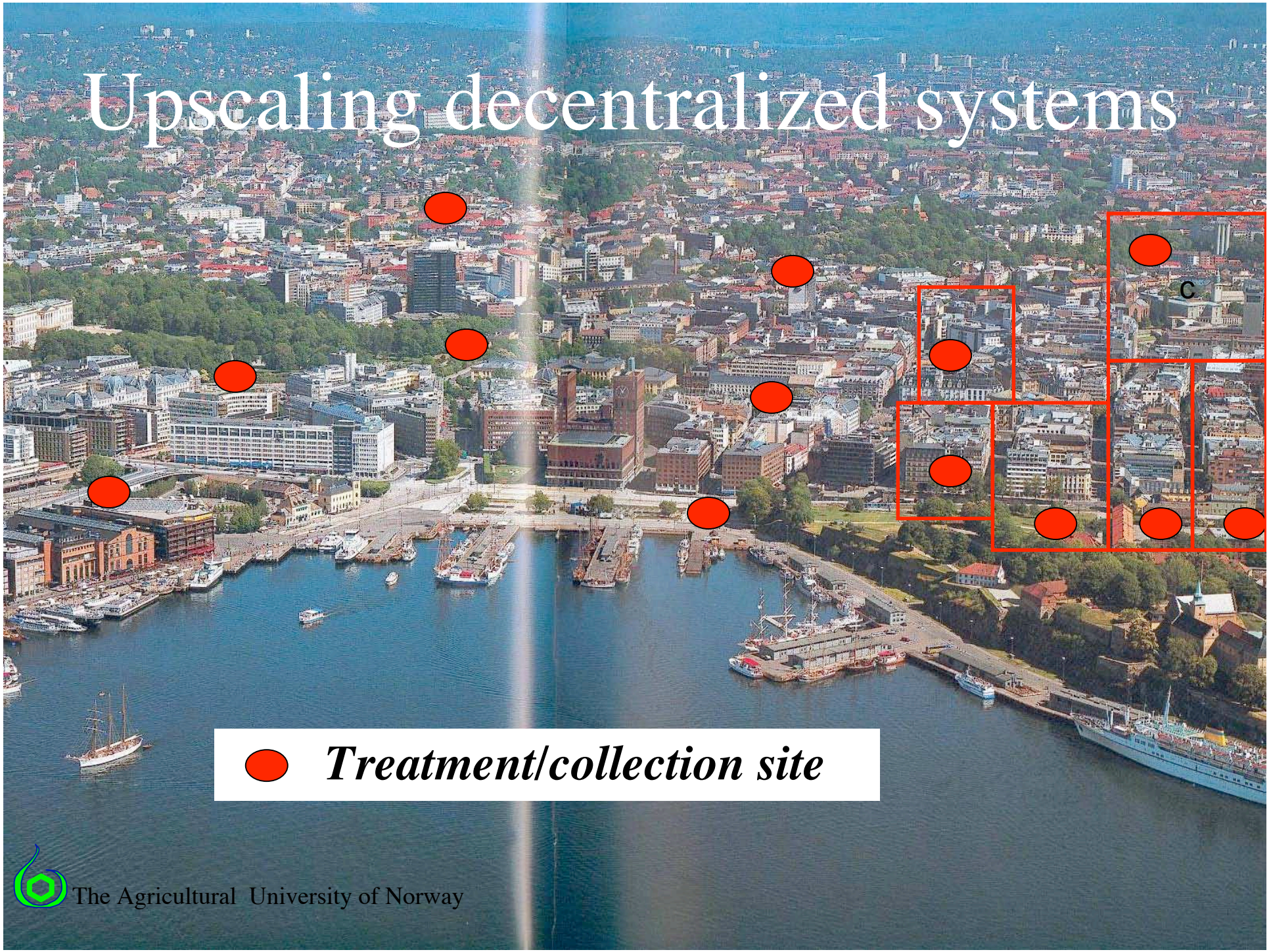

1st chamber of oil and grease trap
Pump sump
Final discharge

Greywater treatment - Hui Sing Garden

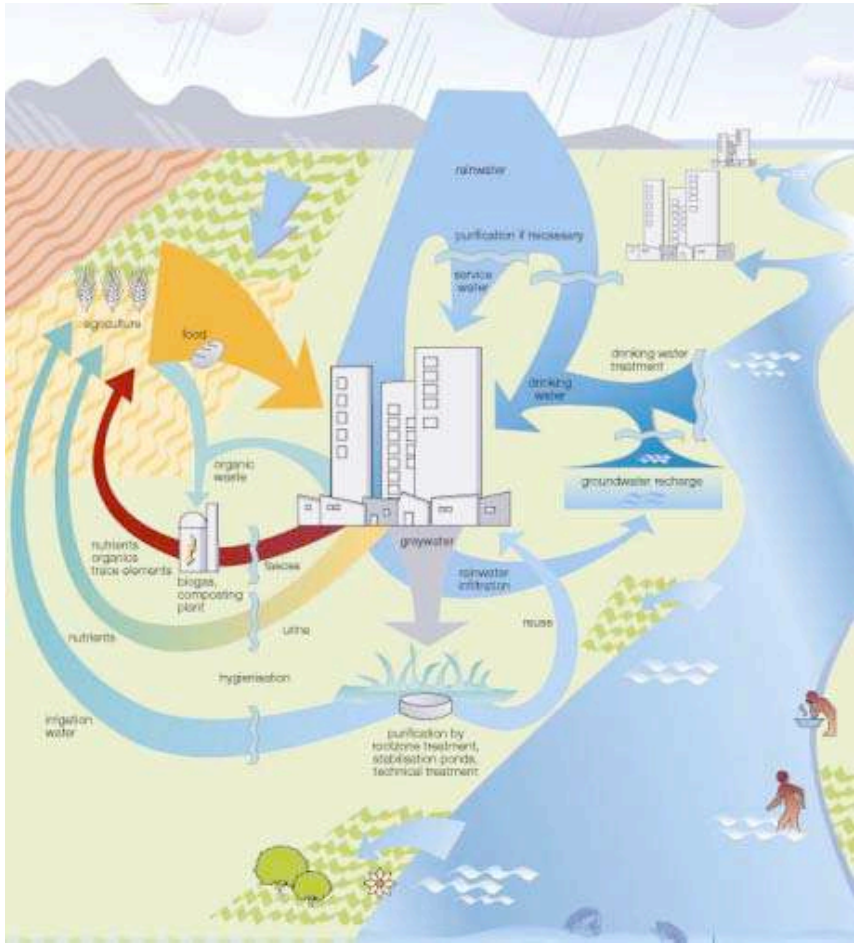
- Preliminary results:

BOD	< 2 mg/l
Total N	2.2 mg/l
Total P	1.9
Faecal coliforms	50/100ml

Upscaling decentralized systems

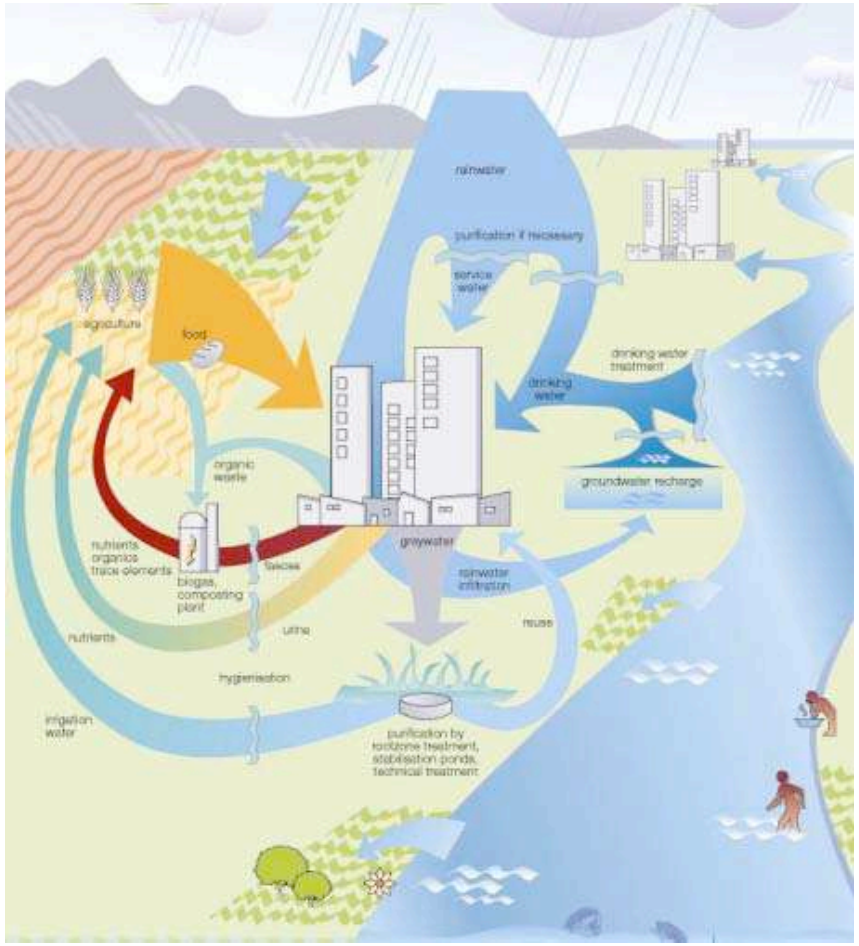


Ecological sanitation leads to



- **Improved health** by diverting blackwater from the water cycle
- **Affordable solutions** with low investment and maintenance costs
- **Increased food security** by better fertilizer availability
- **Substantial water savings** by using water saving toilets and reuse of greywater

Ecological sanitation leads to



- **Bioenergy production** by integrated solutions for wastewater and organic waste
- **Economic development** by generation of local business opportunities
- **Stakeholder involvement** and system acceptance

Conclusion

Leapfrog the conventional centralized sewers
Go straight to modern sanitation based on ecological principles