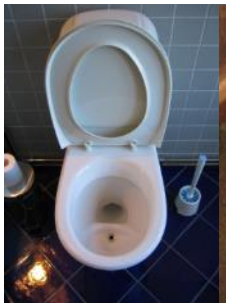




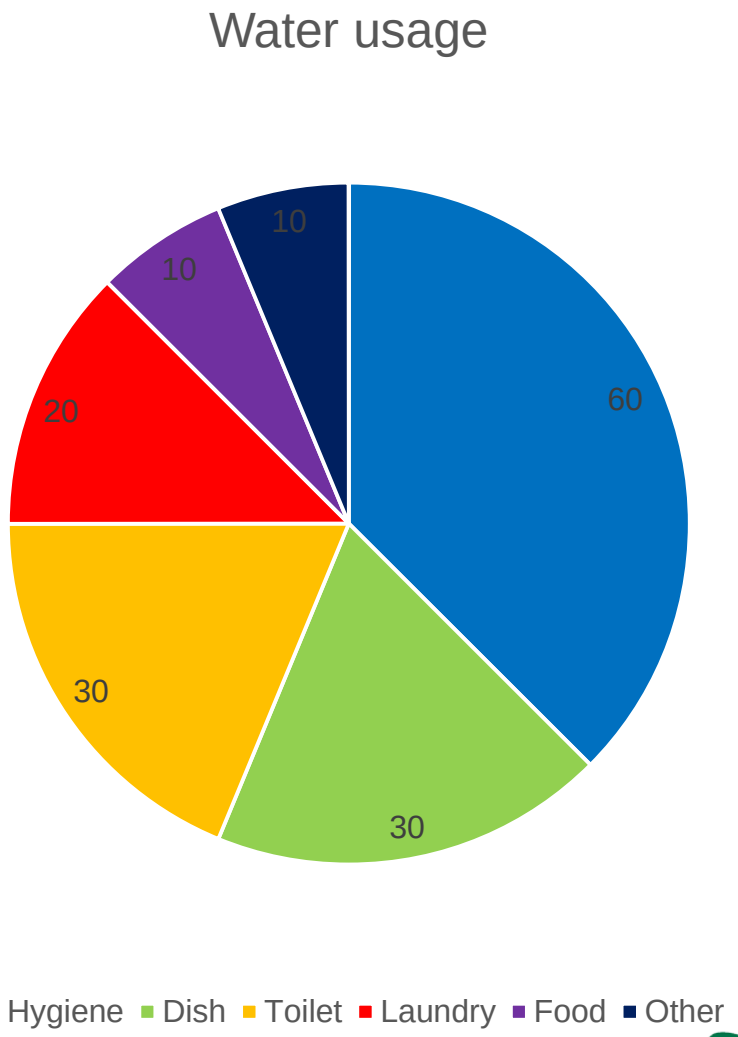
The future in sanitation is off the grid

Dr Björn Vinnerås
Assoc Prof Environmental Engineering

Swedish University of Agricultural Sciences

Situation today

- 160L per person & day
  - Personal hygiene 60L
  - Laundry 20L
  - Dishwashing 30L
  - Toilet flush 30L
  - Drinking & Food 10L
  - Other 10L



Waste hierarchy

Waste hierarchy

Where does wastewater management fit?

behaviour

ial

Recycle 3 Recycling and reprocessing materials

Recover 4 Recovering energy

Landfill 5 Targeting **zero landfill**

The waste hierarchy

The waste hierarchy

Water saving

Reduce	1	Changing our behaviour
Reuse	2	Reusing material
Recycle	3	Recycling and reprocessing materials
Recover	4	Recovering energy
Landfill	5	Targeting **zero landfill**
WWTP	6	Wastewater untreated

The waste hierarchy

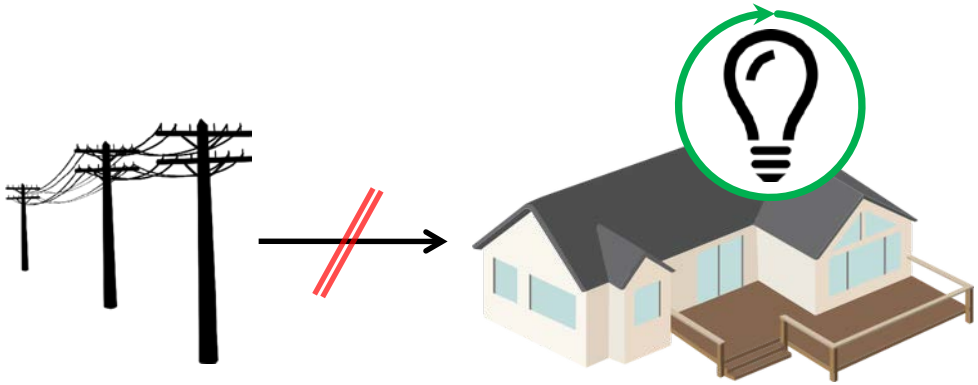
Water saving

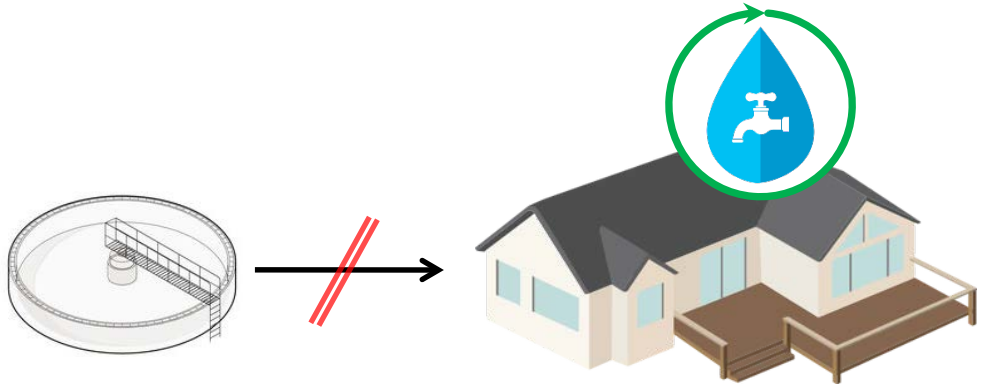
Sludge management

Reduce	1	Changing our behaviour
Reuse	2	Reusing material
Recycle	3	Recycling and reprocessing materials
Recover	4	Recovering energy
Landfill	5	Targeting **zero landfill**
WWTP	6	Wastewater untreated

Disconnect from grid?

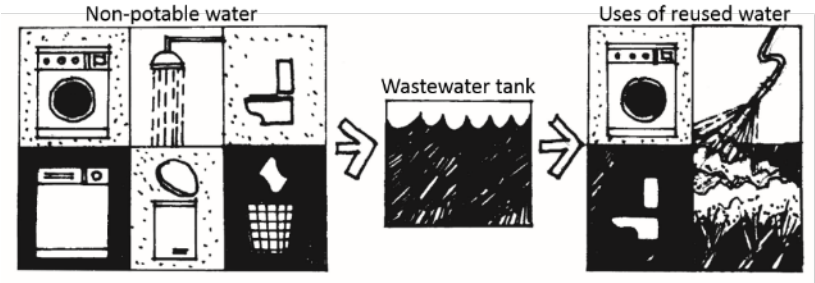
- Telephone is disconnected
- Low / zero energy housing
- Low / zero water housing?





Off grid houses exist – still linear

- Eco house – Kathmandu
- Sustainable house – Sydney
- Rainwater fed systems
- Water treatment and reuse for irrigation or ground water recharge
- **Challenge**
  - Wastewater management

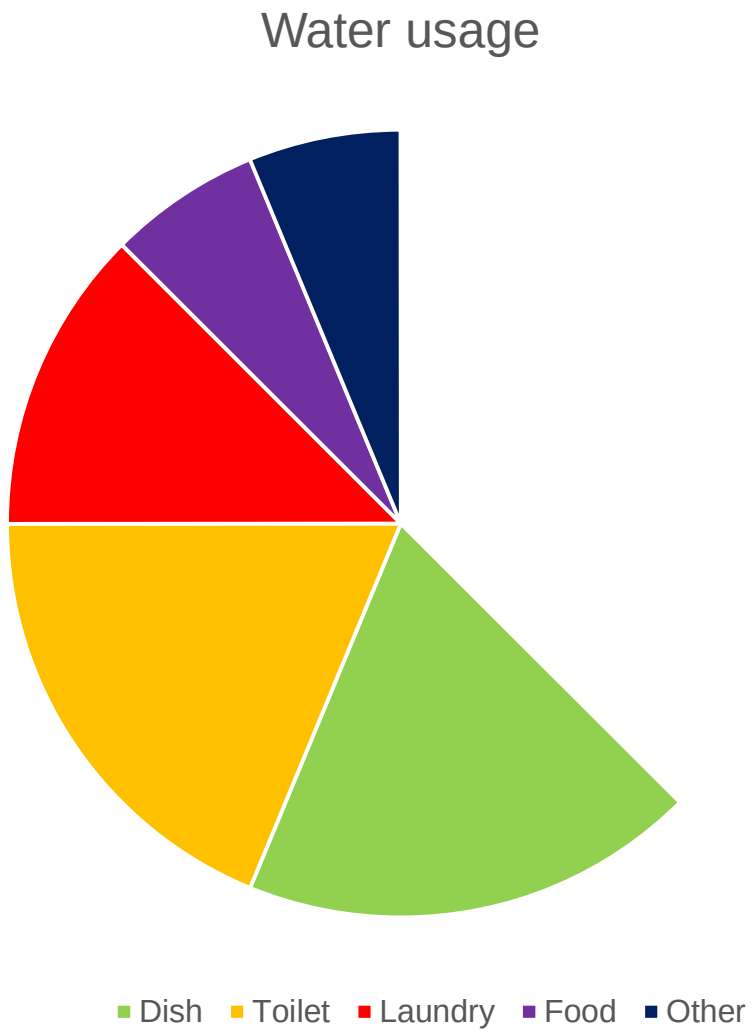


Internal water recycling

- Blue diversion water wall
- Orbital systems
  - 5L water/shower
  - 12L flow/min
- 60L water for personal hygiene is reduced to zero

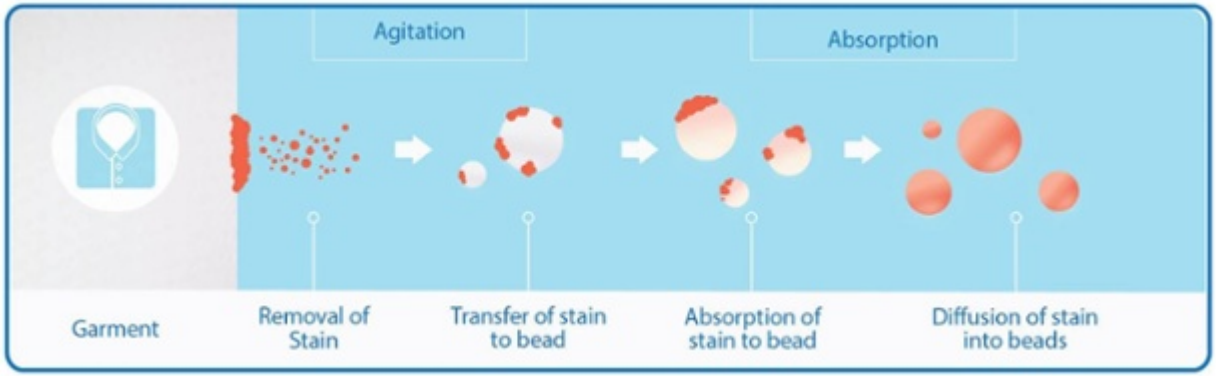
Situation today

- 100L per person & day
  - Personal hygiene 0L
  - Laundry 20L
  - Dishwashing 30L
  - Toilet flush 30L
  - Drinking & Food 10L
  - Other 10L



Laundry

- Deionised water washing- no detergents
  - Easier to treat water
  - Circular system
- Steaming of clothes
  - LG system
- Xero polymer beads
  - Small amount of water

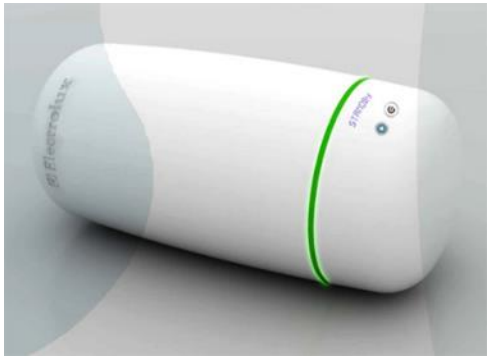


Future sanitation

- 80L per person & day
  - Personal hygiene 0L
  - Laundry 0L
  - Dishwashing 30L
  - Toilet flush 30L
  - Drinking & Food 10L
  - Other 10L

Dishwashing

- Water used as carrier
- CO_2 is an alternative
- Sand + air
  - Patented method
    - US20140102485 A1
- Sound + air
  - Ultrasonic cleaning
  - Ecocleaner – Electrolux lab 2010



Future sanitation

- 50L per person & day
  - Personal hygiene 0L
  - Laundry 0L
  - Dishwashing 0L
  - Toilet flush 30L
  - Drinking & Food 10L
  - Other 10L

Toilet – can we go dry from wet?

- Benefits of a flush toilet
  - Flush & forget
  - Someone else problem
  - Instant local information of some misuse - blockages
  - No feed back of other missusage - pollutants

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Toilet – a dry system?

- Solid waste route?
- Infrastructure available
  - Solid waste management
- Cassette system
- Information of misuse
- Excreta
  - No visual contact
  - No physical contact

Toilet – faecal management

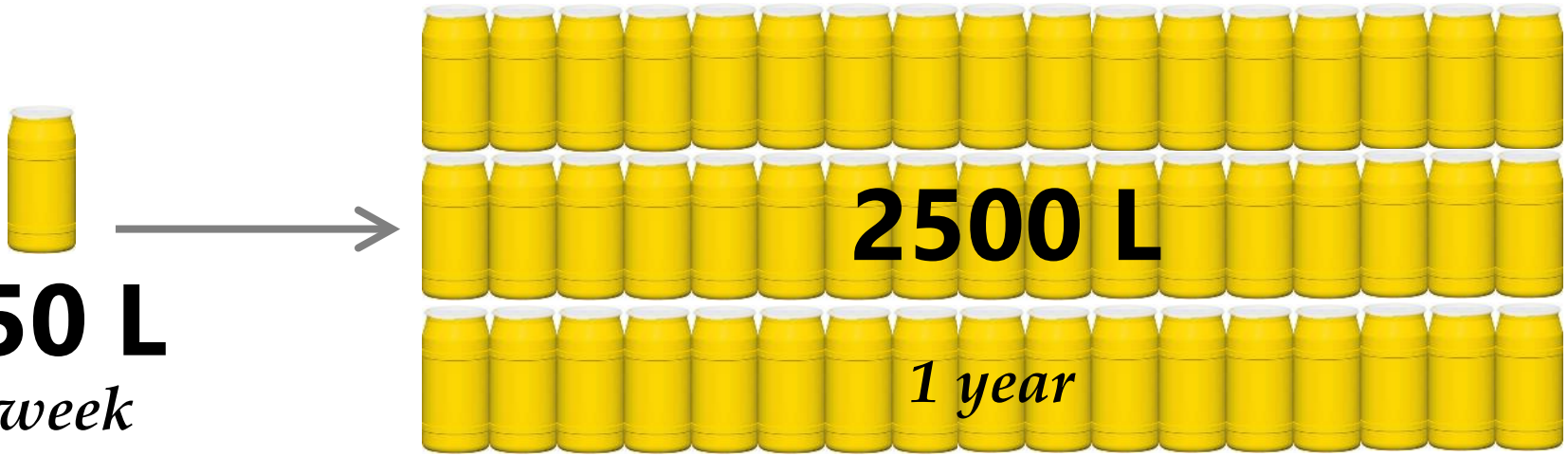
- Faeces annually / person
  - 50 kg wet weight
  - 10 kg dry weight
  - 2 kg ash
- Toilet paper / person
  - 5 kg dry weight
  - 0.5 kg ash
- Family of 4
  - 0.16 kg day
  - 1 kg / week

Bristol stool chart

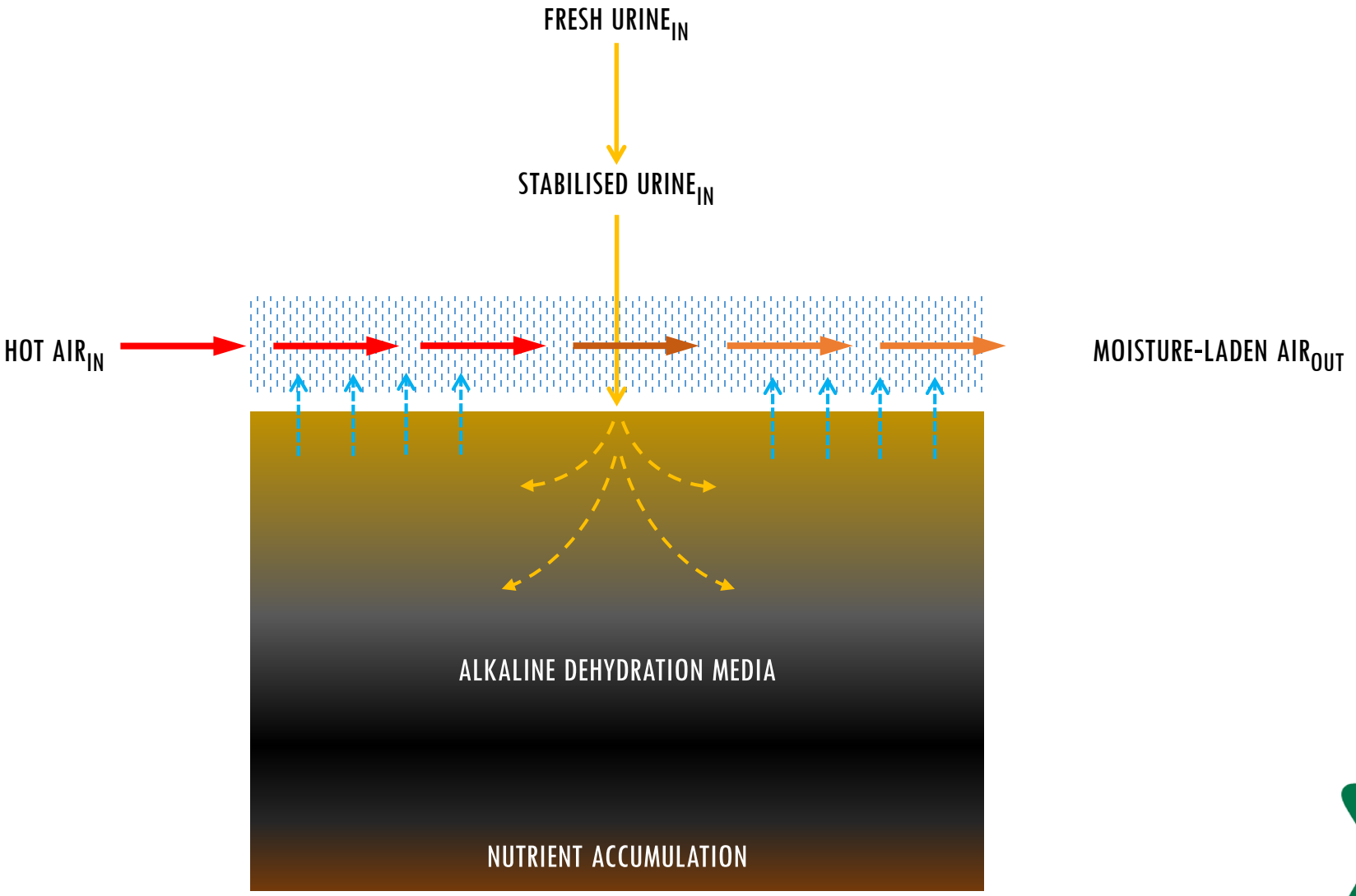
Type 1		Separate hard lumps, like nuts (hard to pass)
Type 2		Sausage-shaped but lumpy
Type 3		Like a sausage but with cracks on its surface
Type 4		Like a sausage or snake, smooth and soft
Type 5		Soft blobs with clear-cut edges (passed easily)
Type 6		Fluffy pieces with ragged edges, a mushy stool
Type 7		Watery, no solid pieces, **Entirely liquid**

Toilet – urine system requirement

- Family of 4



Alkaline dehydration



Effect of drying

Liquid Urine

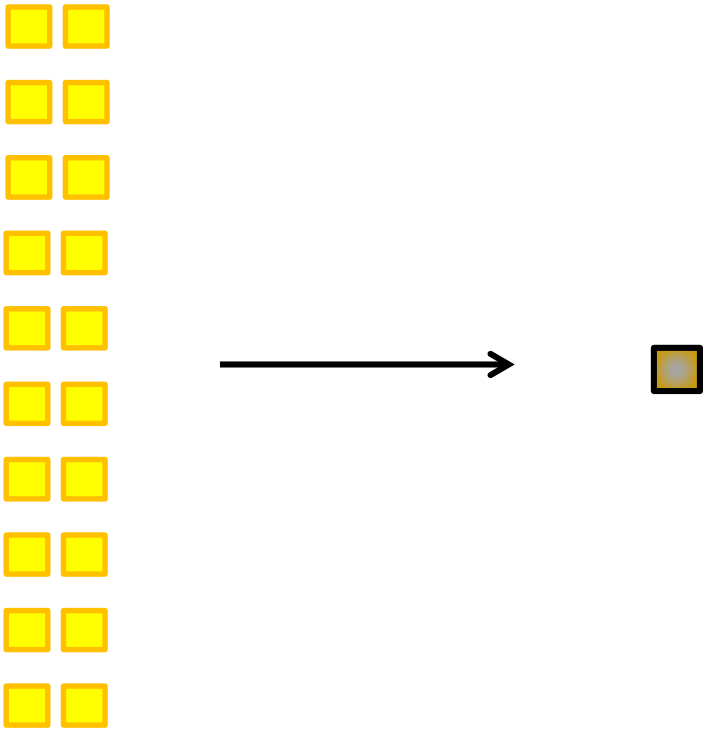
20 kg

0.6% N

Dried Urine

1 kg

>15% N



95 %

VOLUME REDUCTION

25 times

NUTRIENT CONCENTRATION

>80% N RECOVERY

100% P RECOVERY

100% K RECOVERY

Drying potential

Drying Media	50 °C	65 °C
75% Bran/ 25% Ash	18% ± 1.1%	16% ± 0.3%
75% Biochar/ 25% Lime	3% ± 0.2%	16% ± 1.2%
75% Soil/ 25% Lime	11% ± 1.9%	9% ± 0.3%
100% Lime	13% ± 0.9%	13% ± 0.8%
100% Ash	15% ± 0.6%	14% ± 0.4%

Drying potential

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100% Lime	13% ± 0.9%	13% ± 0.8%
100% Ash	15% ± 0.6%	14% ± 0.4%

Toilet - urine

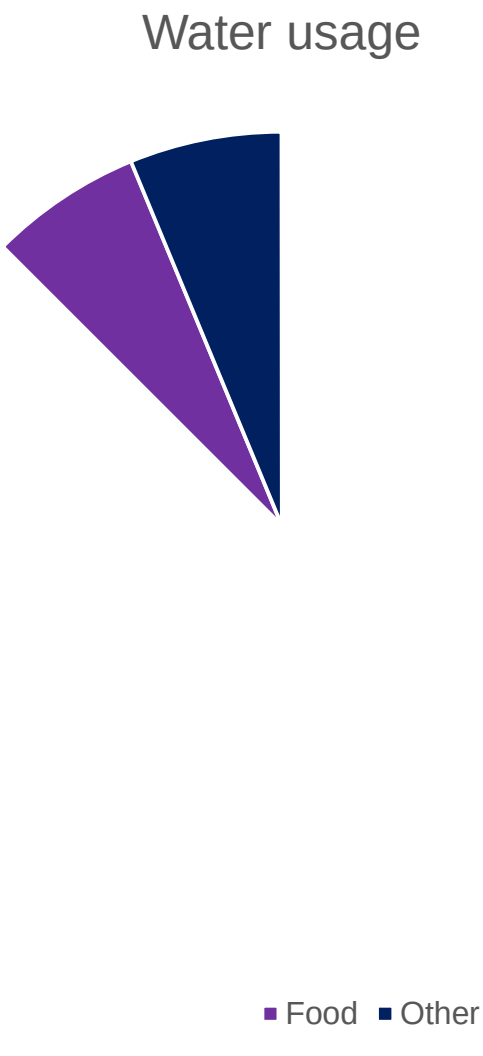
- 95% volume reduction
- 90% Nitrogen recovery
- Valuable product
  - 15%N
  - 1.5% P
  - 5% K
- Final product
  Pellets
- Commercial NPK fertiliser
  - 20-50% replacement

The new UD system

- Urine diversion
  - Flush – no flush
- Placed in toilet room
  - No extra piping
  - 0.25m^2 for family of 4
- Final design not determined

Future sanitation

- 20L per person & day
  - Personal hygiene 0L
  - Laundry 0L
  - Dishwashing 0L
  - Toilet flush 0L
  - Drinking & Food 10L
  - Other 10L

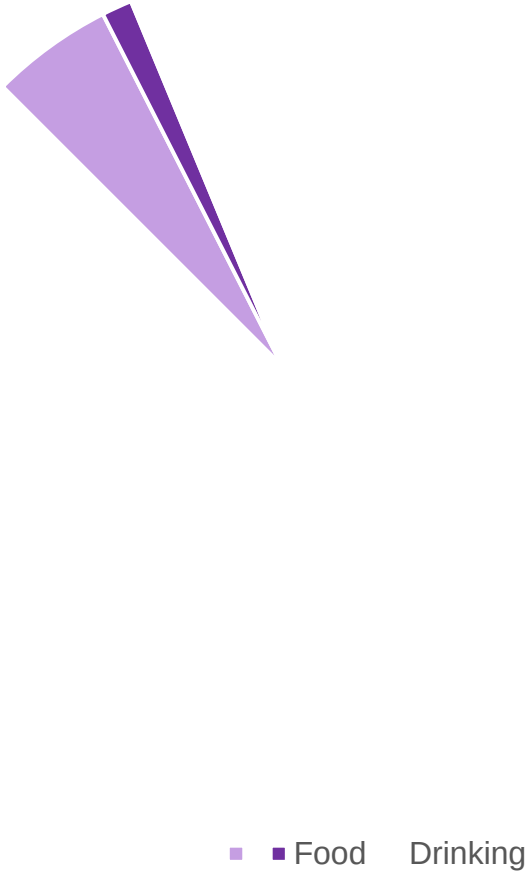


Future sanitation

- 10L per person & day
  - Personal hygiene 0L
  - Laundry 0L
  - Dishwashing 0L
  - Toilet flush 0L
  - Drinking & Food 10L
  - Other 0L

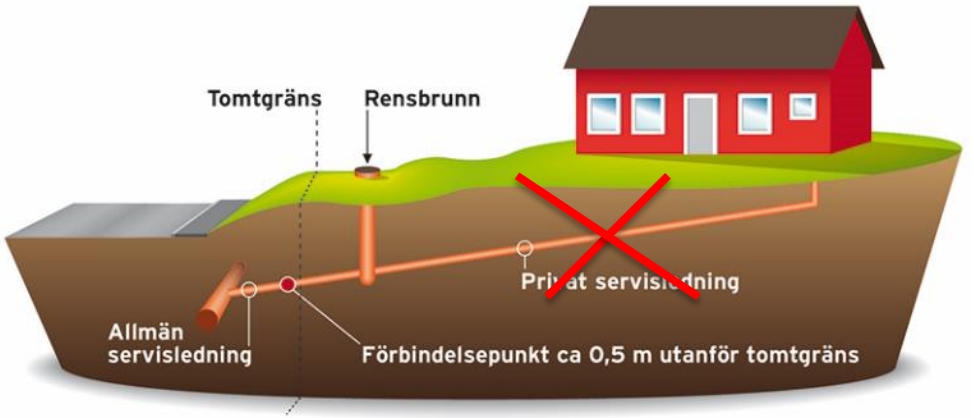
Future sanitation

- 10L per person & day
  - Personal hygiene 0L
  - Laundry 0L
  - Dishwashing 0L
  - Toilet flush 0L
  - Drinking & Food 10L
    - Drinking 1-2L
  - Other 0L



The future – off the grid sanitation

- We will always need water
  - 2-10 L with same standards as today
- Service level
  - not specific wastewater products
- Key to go off grid!
  - Internal circulation
  - Dry sanitation
  - Same service level as today

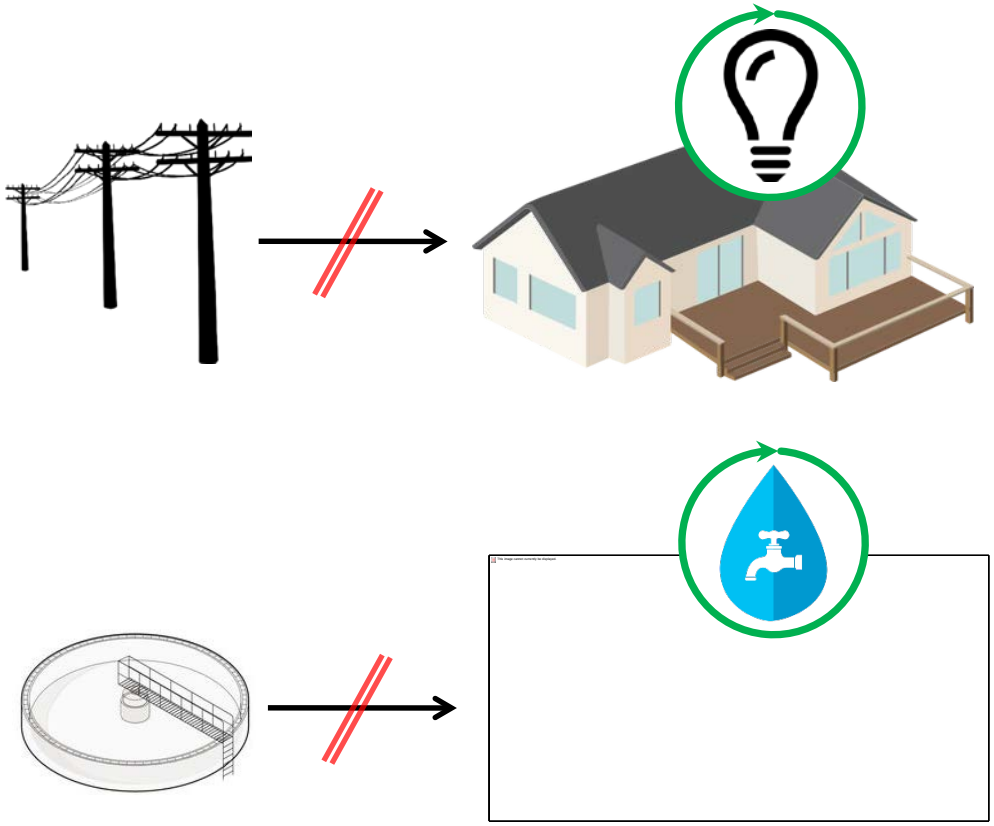


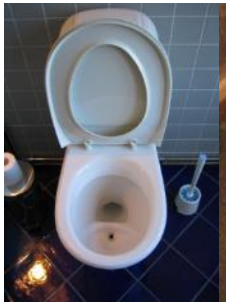
Where do we get the water from?

- Rain water
  - Uppsala 500mm per year
  - 7m^2 per person
- Condensed water
  - Ventilation / AC
  - Refrigerator
  - Condensed urine water
- Bottled water

Added benefits

- Polluter pays
- Less corruption
- Build anywhere
- Flexible in size
  - Household
  - community
- Climate resilient







No need for network connections, neither electricity nor water, nor wastewater

Next generation of housing is off the grid

Swedish University of Agricultural Sciences