

Sortering ved kilden. Et globalt perspektiv på spildevandshåndtering

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Wastewater treatment: A never ending story

Mechanical treatment
Biological treatment
Chemical treatment
Filtration

primary treatment
secondary treatment
tertiary treatment
quartenary treatment

Nitrification

Denitrification

Biological phosphorus removal

Micropollutants, ozonation, activated carbon

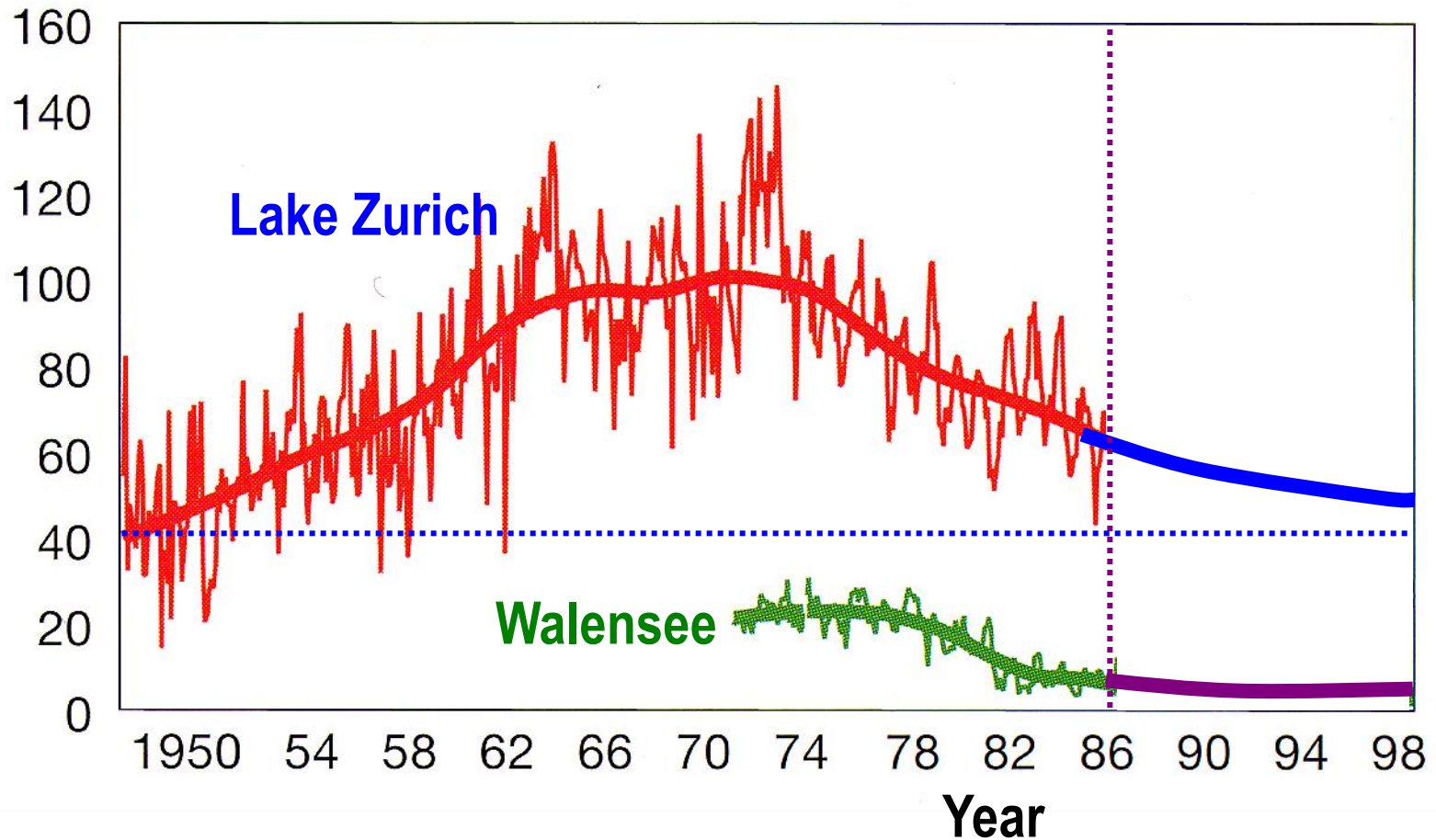
Resistance to antibiotics, virus ...

Nanoparticles ...

Resource recovery, phosphorus, energy, water

Phosphorus – a success story!

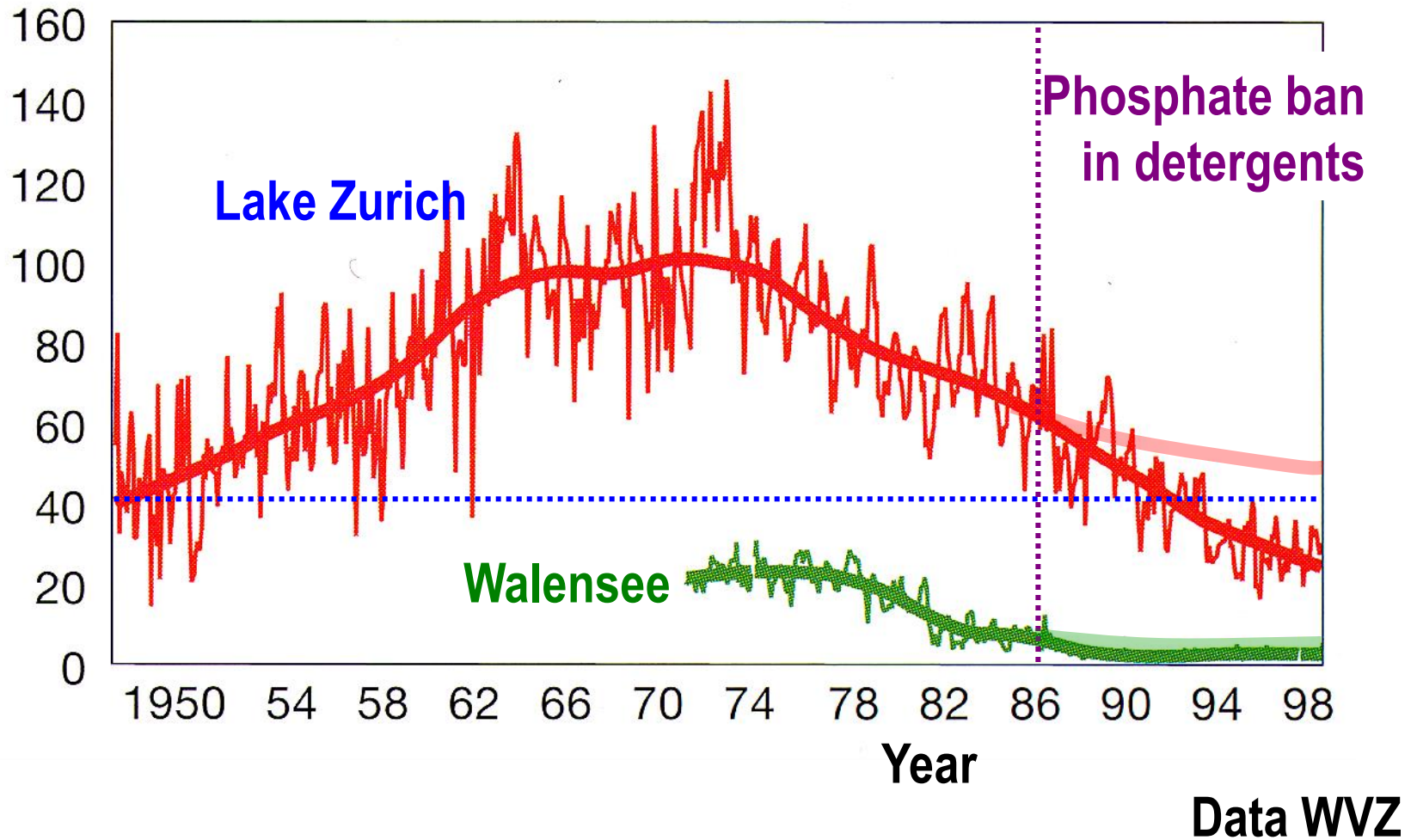
$\mu\text{g/l}$ Phosphate Phosphorus, 1948 - 1998



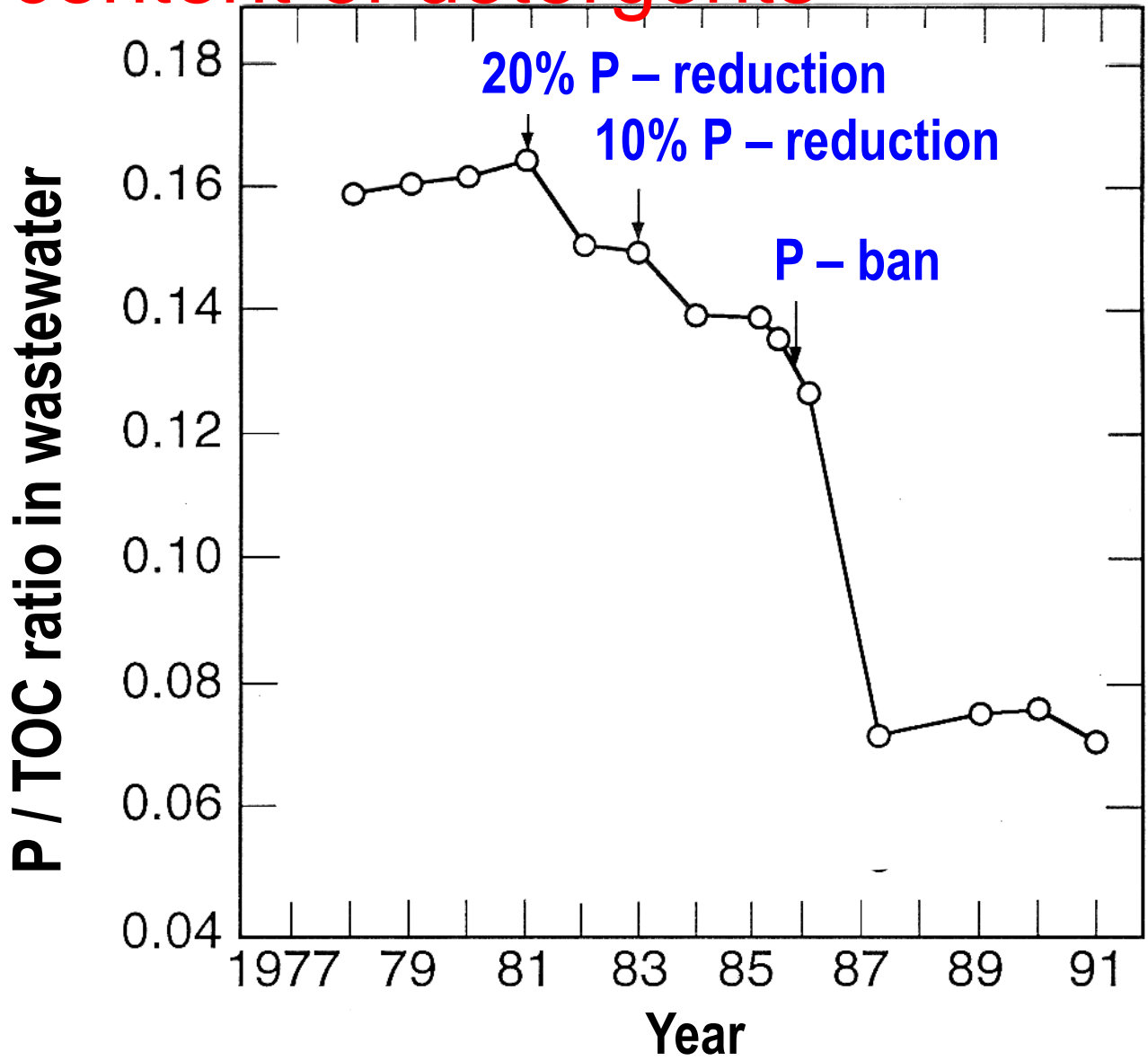
Data WVZ

Phosphorus – a success story!

$\mu\text{g/l}$ Phosphate Phosphorus, 1948 - 1998



Phosphate content of detergents



IWA Leading Edge Conference 2017

1. Resource recovery

2. Technologies for control of micropollutants and pathogens of emerging concern
3. Advanced anaerobic technologies
4. Advanced treatment materials and multifunctional membranes
5. Applying advanced microbiology/genetics tools
6. Innovative biofilm and granular processes
7. Green-blue-infrastructure to enhance urban water management.

Resources in domestic wastewater

Water	m³/p/year	Gm³/year
Domestic	65	500
Industrial	110	820
Nutrients	kg/p/year	Mt/year
Nitrogen (N)	4	27
Phosphorus (P)*	1	5
Energy	kWh/p/year	TWh/year
Heat in warm water**	800	-
Organic matter	145	1100
Nutrients	35	270

* only from metabolism (without detergents)

** typical European value

Larsen et al., Science, 2016

Resources in domestic wastewater

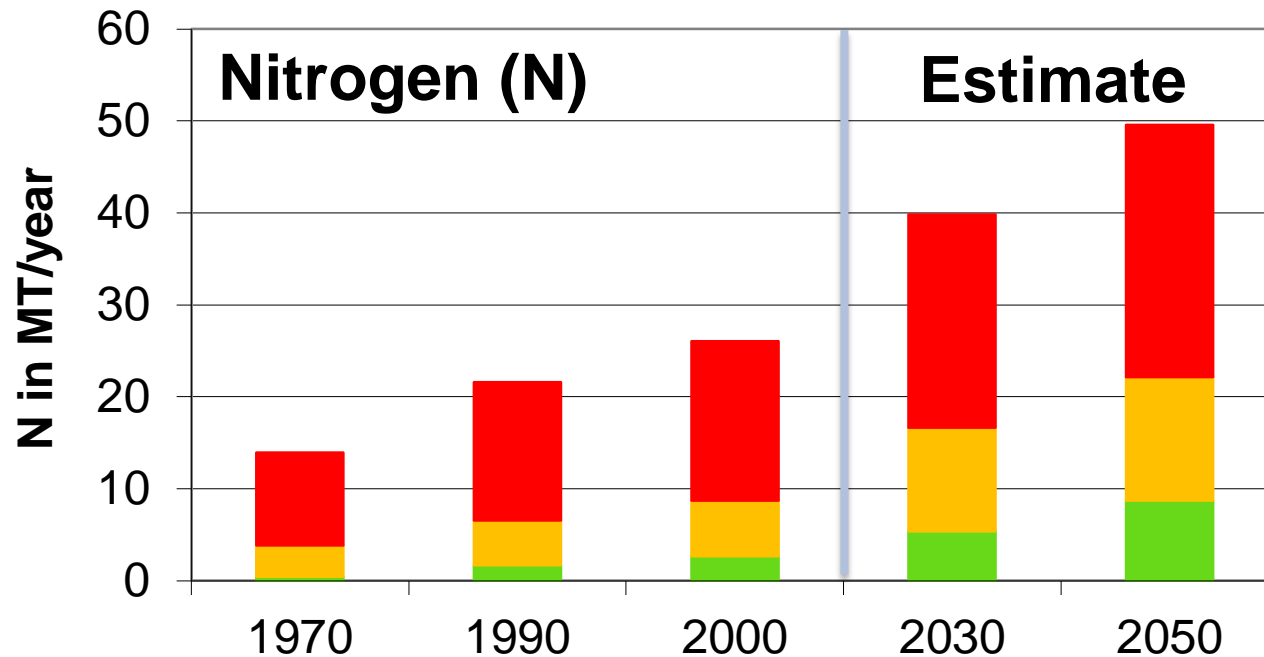
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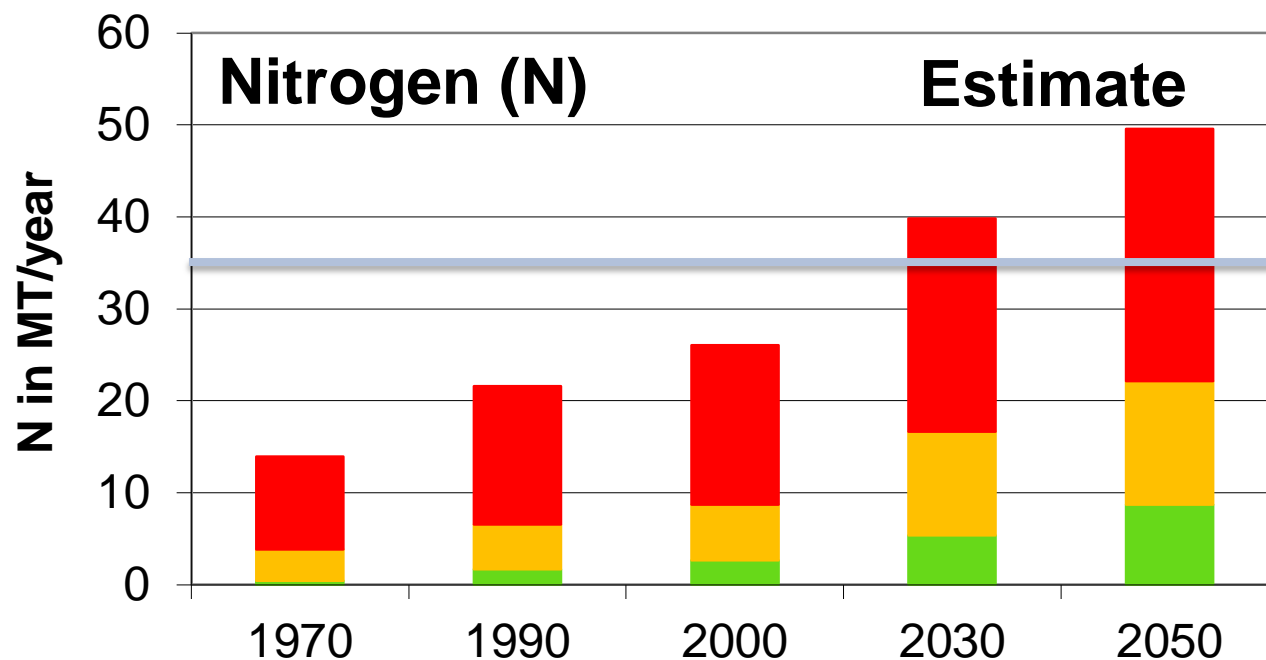
Larsen et al., Science, 2016

Global wastewater nitrogen



- Not connected to treatment plants
- Emissions from treatment plants
- Removed in treatment plants

Global wastewater nitrogen



'safe operating boundary' for **production** of N

Rockström et al.,
2009, Nature

- Not connected to treatment plants
- Emissions from treatment plants
- Removed in treatment plants

Can we recycle N from wastewater?



‘Side effects’ on treatment plants:

- No nitrification, denitrification, more sludge production
- Very little P-elimination required, if any
- 2/3 of pharmaceuticals from metabolism are in urine

Would we still want to centralize?

Technology for nutrient recovery from urine



Is urine source separation serious?

2015

Paris—Le SIAAP a annoncé le projet de mise en place d'une collecte d'urine sur un bâtiment en cours de construction à Achères et qui accueillera 300 exploitants.

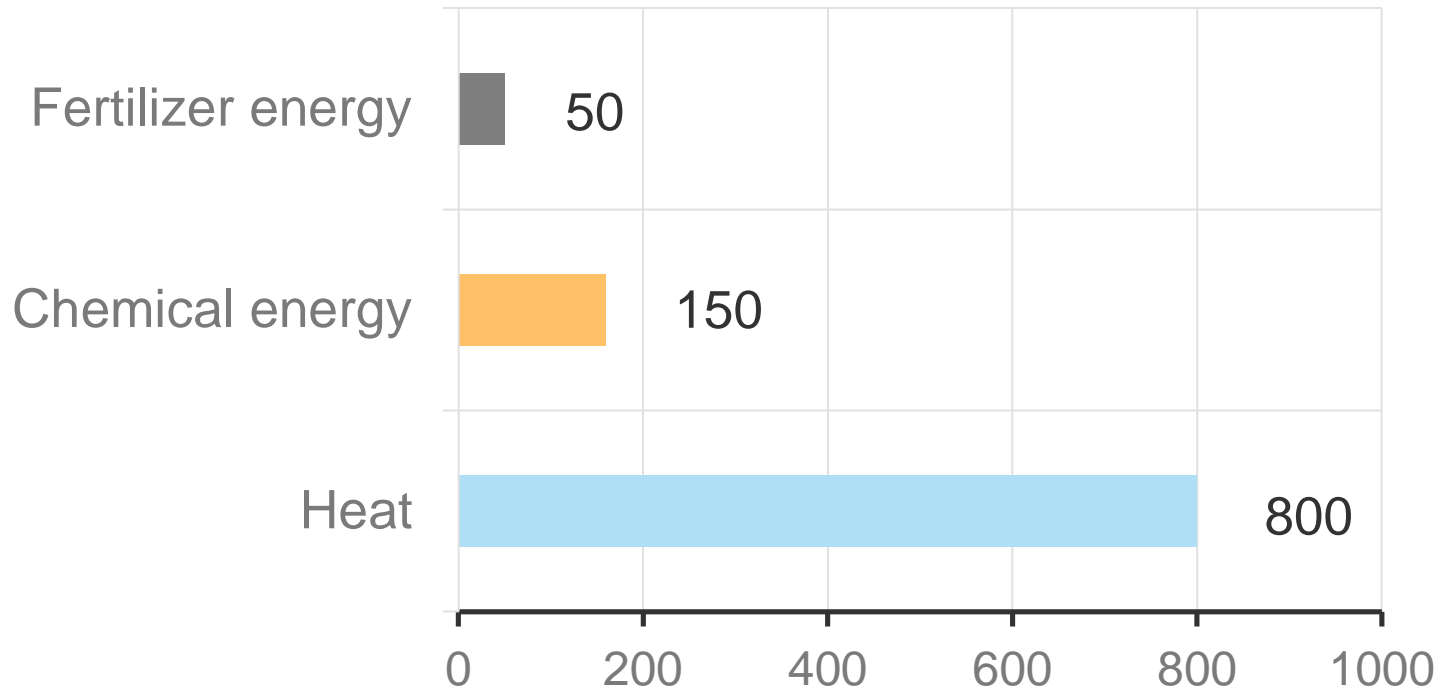
Sept 08, 2016

ANN ARBOR—Converting human urine into a safe fertilizer for agricultural crops is the goal of a new \$3 million grant from the National Science Foundation.

NEST Water Hub: All about source separation



Energy content of domestic wastewater (kWh/p/year, primary energy, at household level)

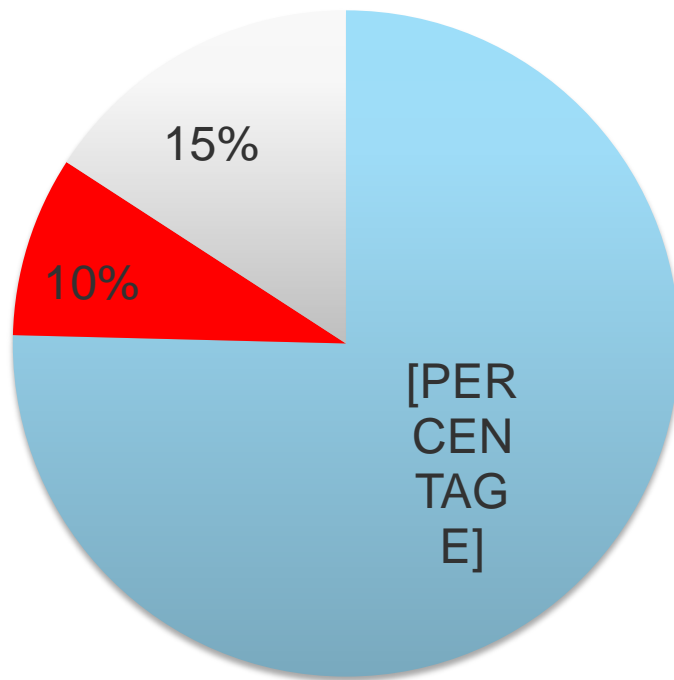


Electricity demand WWTP in Denmark: 20-40 kWh_e/p/year

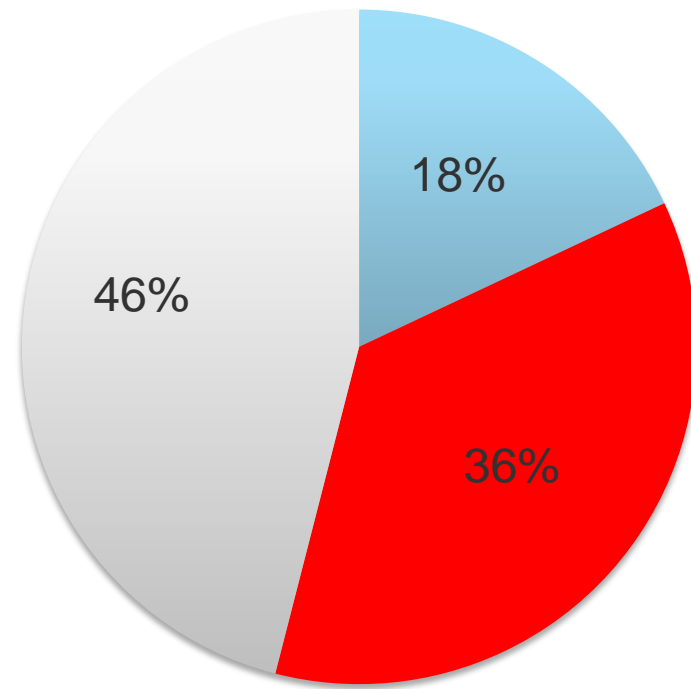
Increased importance of warm water

Low-energy houses: Experience for 4-person household (<http://www.isover.dk>)

Average Denmark



Low-energy household



Room heating

Warm water

Appliances

Energy can also be recovered in the household

Joulia: the shower with energy recovery from wastewater (joulia.com)



Typical potential of energy saving:
100-300 kWh/person/year



The use of heat pumps in households

Meggers und Leibundgut (2011) Energy and Buildings

**warm water
(shower, bath,
washing
machine,
dishwasher)**

**cold water
(toilet)**

Well suited for heat pumps

«In this way, the production of warm water with photovoltaics can be more efficient than solar heating of warm water»

Less suited for heat pumps

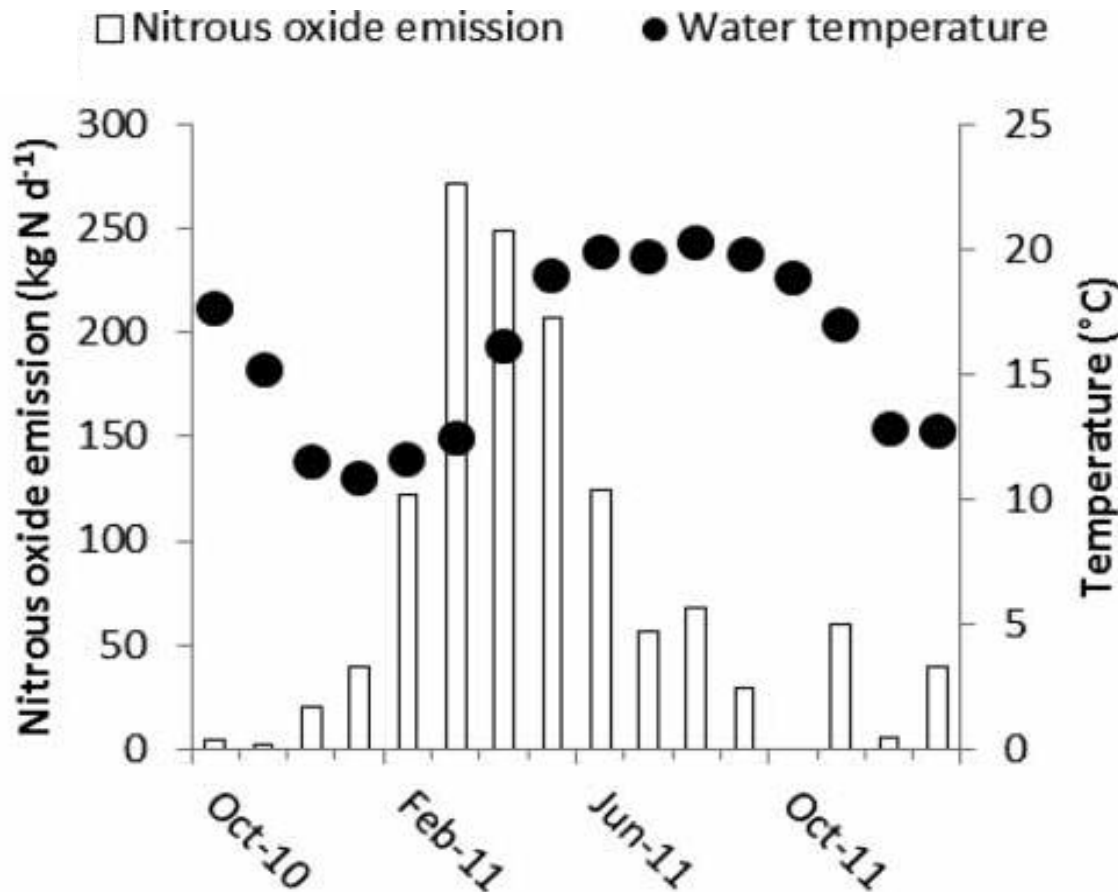
Well-treated greywater will lead to less maintenance!

In Switzerland, wastewater may leave the parcel at 5°C

What happens on the treatment plant when the temperature gets very low?

- Nitrification is more difficult at low temperatures
- Mainstream anammox may get less interesting
- We may experience higher emissions of N₂O

N₂O emissions may be temperature-dependent



**On this plant > 80 %
of GHG emissions
stem from N₂O
(2.8% of incoming N)**

**5% of N as N₂O
corresponds to
100 kg CO₂/p/a**

**Swiss goal (total):
1000 kg CO₂/p/a**

Take-home messages

- Some wastewater resources are best recovered at the household level.
- In this presentation, the recovery of nitrogen and heat energy from wastewater was discussed
- Nitrogen recovery from urine simplifies WWTP and help keep the world within 'safe boundaries'
- Cooling of wastewater in the household could be a problem for treatment plants – during summer, it would be an advantage for the surface waters
- With urine separation, wastewater temperature does not play a role

Thank you for your attention

For more information about wastewater treatment in buildings:

www.novaquatis.eawag.ch

www.eawag.ch/vuna

www.bluediversiontoilet.com

