# CIE4485
# Wastewater Treatment

Dr.ir. M.K. de Kreuk

15. WWTP 2030 and Resource Factory

# CT4485 Wastewater Treatment

## WWTP 2030 and Resource Factory

Dr. Ir. M.K. de Kreuk

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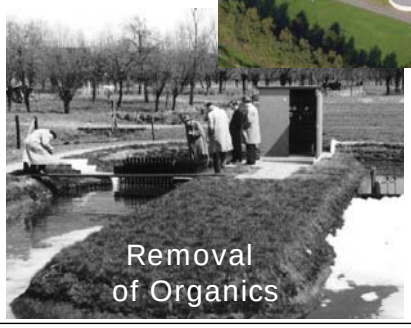
# Learning objectives

You should be able to:

- Think creative and innovative about chances for the wastewater treatment plant of the future....
- Select technologies and design treatment chains to fulfill the needs for the surrounding activities...
- In the Netherlands or for your own country
- Discuss about chances and defend choices you make



# Changed focus in the past 60 years


# And the future…

Which changes do you see for the future (2030)

Demography:

Economy:

Policy:

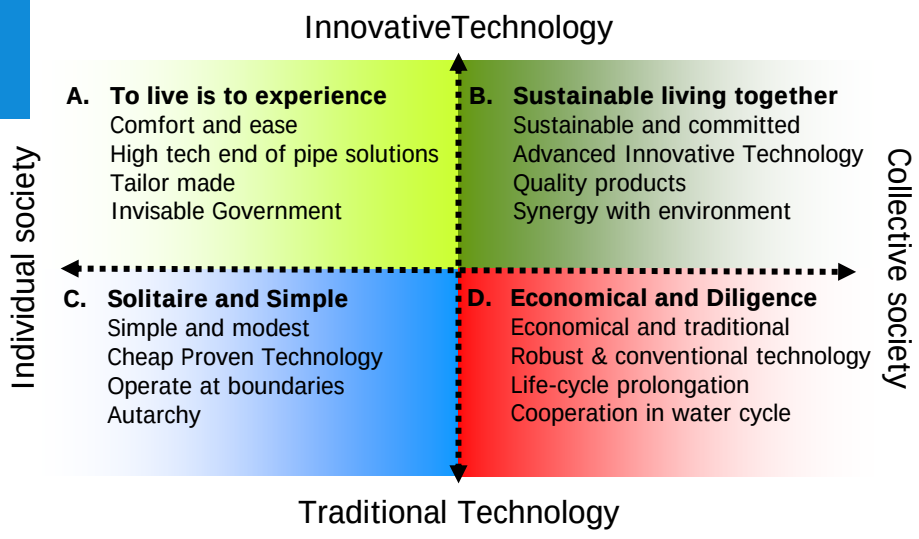
Ecology:

Social:

Technology:

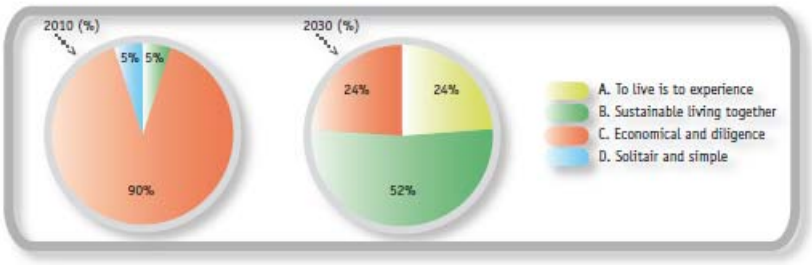


# Scenarios for the future



# Scenarios for the future

Opinion of water experts in 2010:



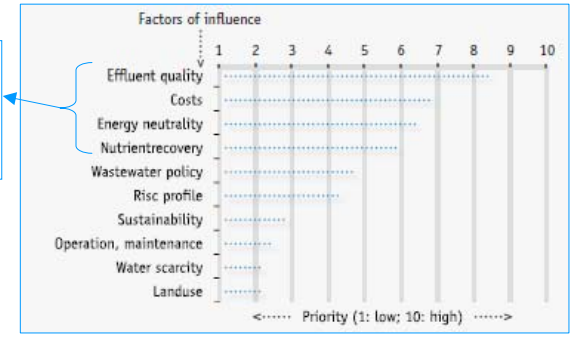



# Break….

# Starting point for the roadmap

Central systems, with the predictable changes in composition of the sewage and effluent quality in 2030 will be improved

Effluent Quality
Costs
Energy neutrality
Nutrient recovery

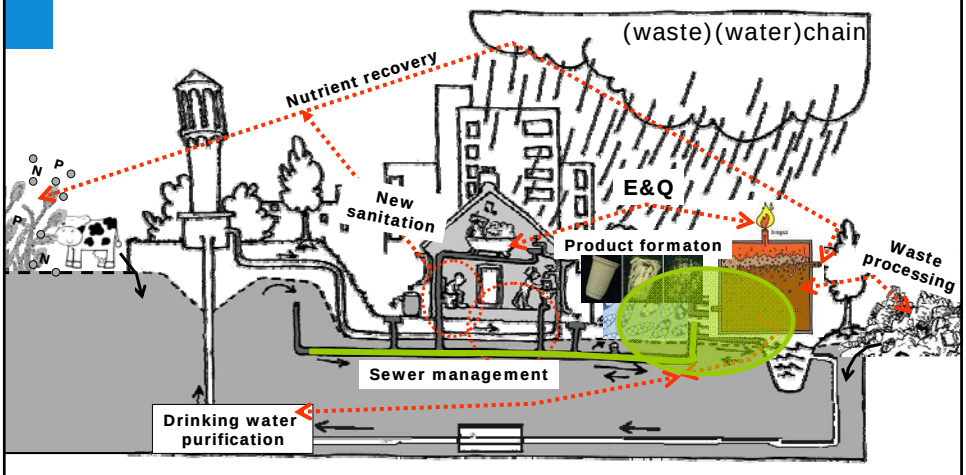



"a water cycle organisation that primary focusses on production of resources, energy and water with an economic value" (Roadmap)





# Changes in the next (60) jaar?



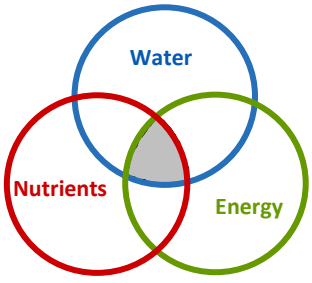
# Themes for the coming years



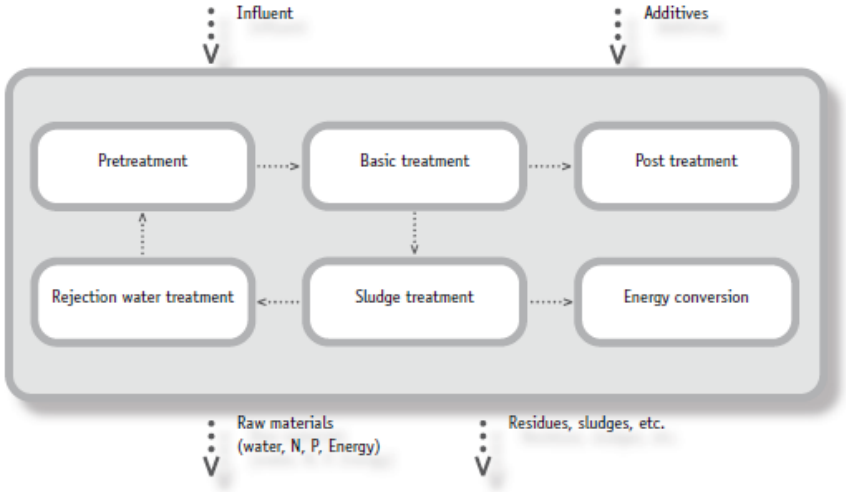

Sustainable living together



# Roadmap 2030 – "Source Factory"

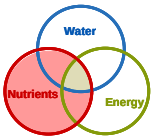


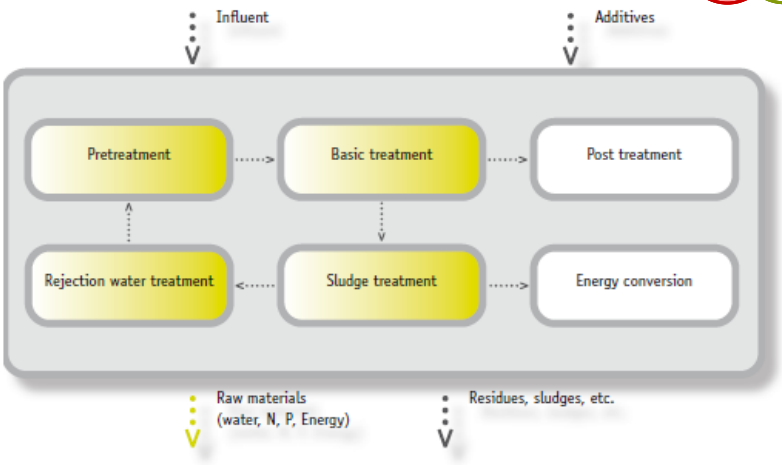

# Scheme of various process steps in a WWTP



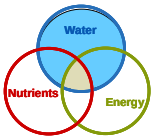


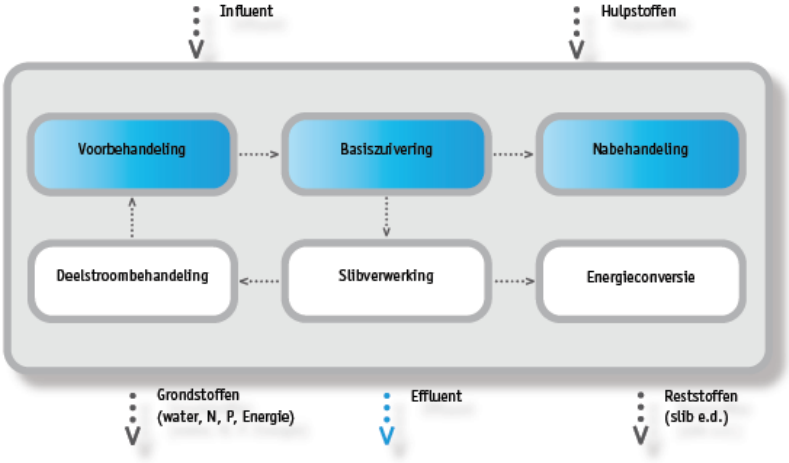

# Nutrient factory



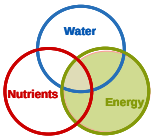
# Water factory

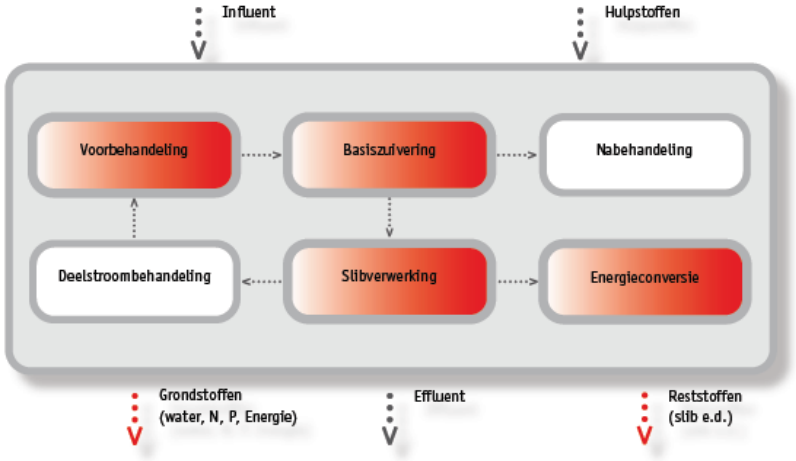





# Energy Factory



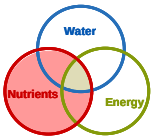



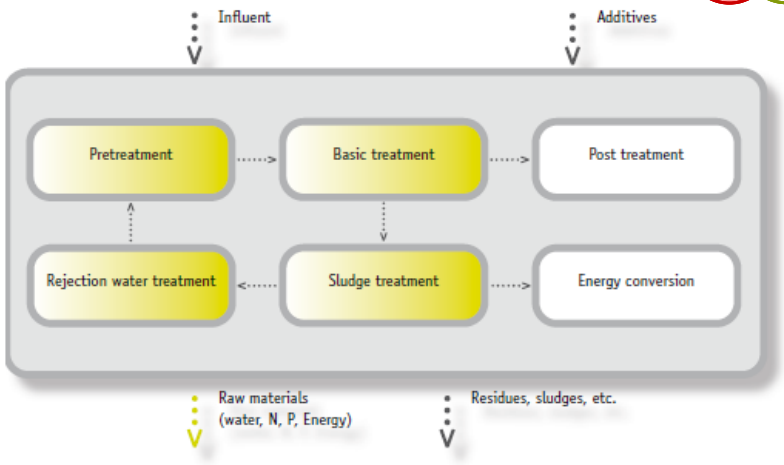
# Assignment

Which technologies can be used per “factory”;
put them in a process scheme (design)
to recover your target product
AND treat the wastewater to good effluent standards.



# Nutrient factory



# Why again?

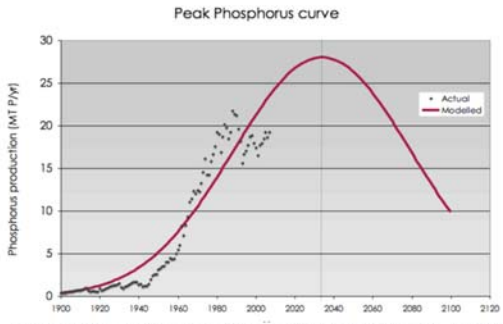
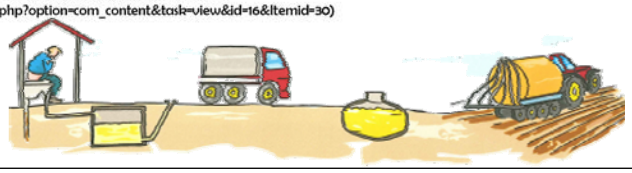
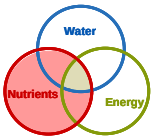



Figure 1: Peak phosphorus curve, illustrating that, in a similar way to oil, global phosphorus production is also likely to peak (Source: http://phosphorusfutures.net/index.php?option=com_content&task=view&id=16&Itemid=30)



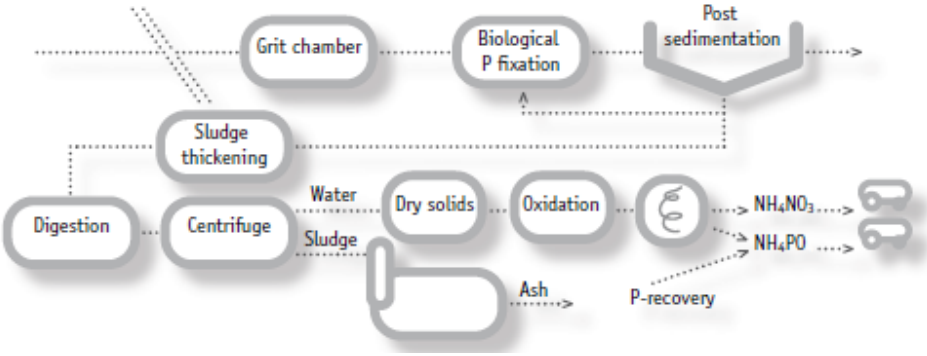


# Nutrient factory

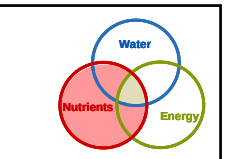


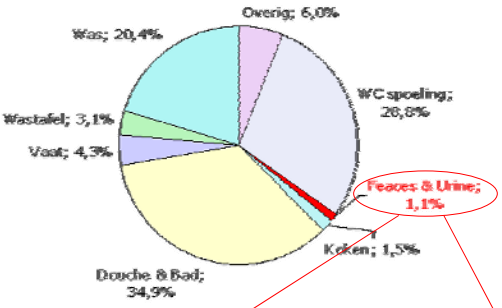

Important characteristics for WWTP configuration

- Separate nutrients and COD
- Concentrate nutrients

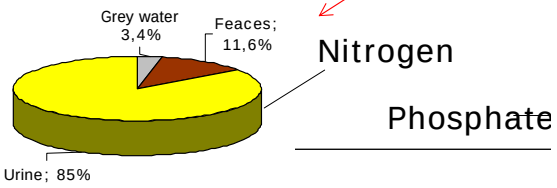


# Decentralised recovery

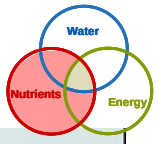


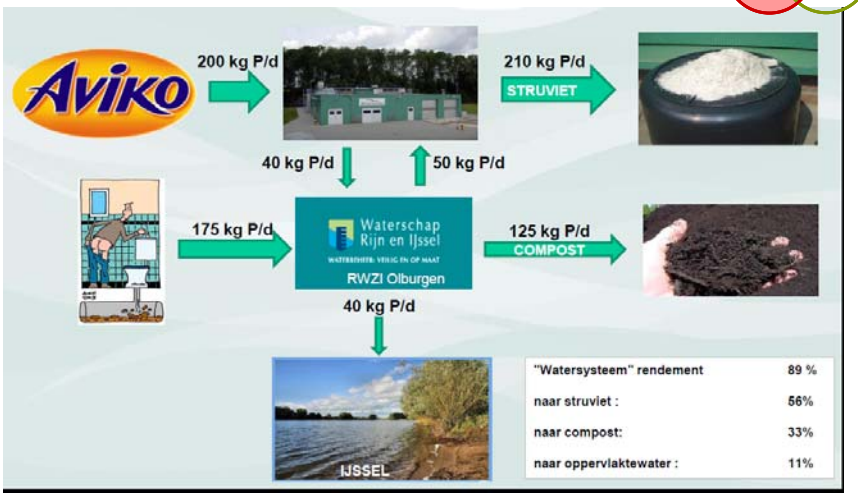





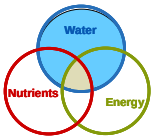


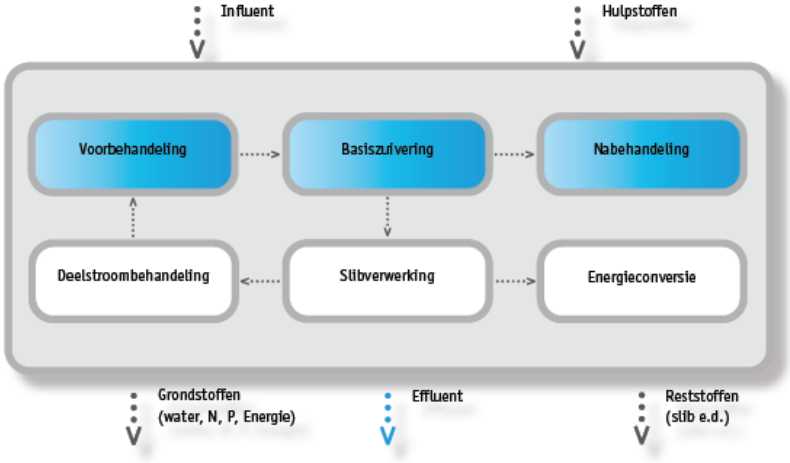

# Centralised recovery



# Water factory






# Why Water reuse?

Why:

- Draught;
- Salt;
- Effluent relatively clean compared to other sources.

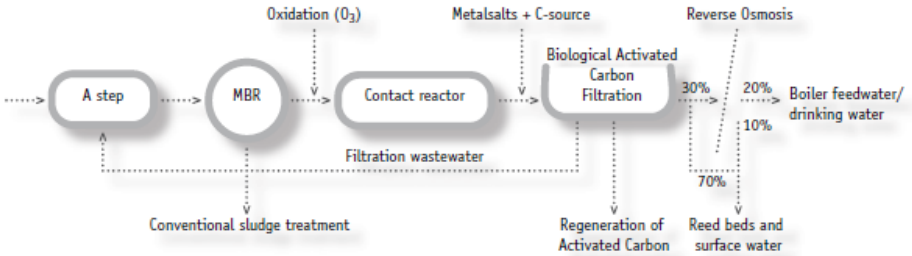
What :

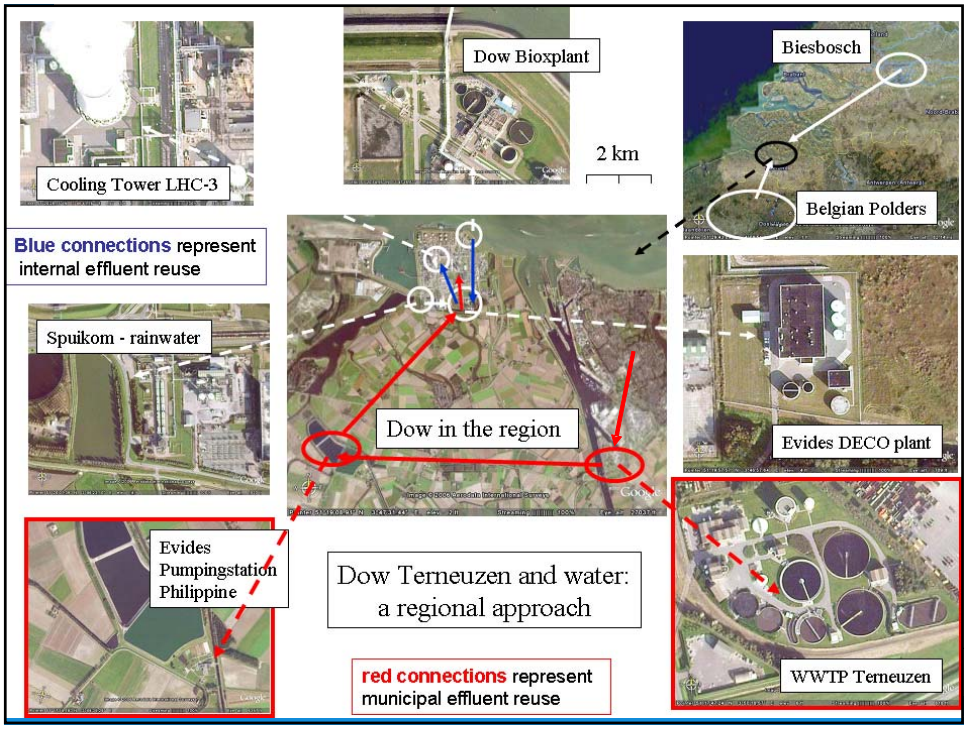
- Cooling water
- Proces water
- Irrigation water
- Drinking water??

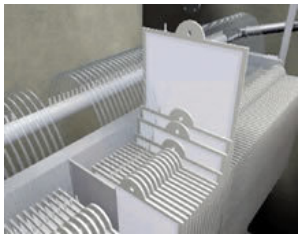
# Water factory

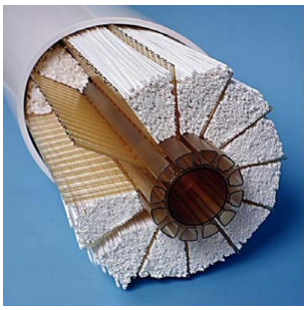
Important characteristics for WWTP configuration

- Physical removal of COD
- Biological removal of N
- Biological and chemical/physical removal of P
- Biological processes based on activated sludge and attached growth (membrane, activated carbon).







Membrane technology suitable for water reuse:

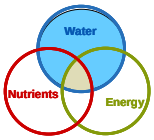
- Compact system;
- Fouling;
- High Energy Consumption;
- Not all components are degraded or filtered, so post treatment needed

| Technique | MWCO** (Da) |
|---|---|
| Microfiltration | $>10^5$ |
| Ultrafiltration* | $10^3 – 10^5$ |
| Nanofiltration | $10^2 – 10^4$ |
| Reverse Osmosis | $10^2$ |

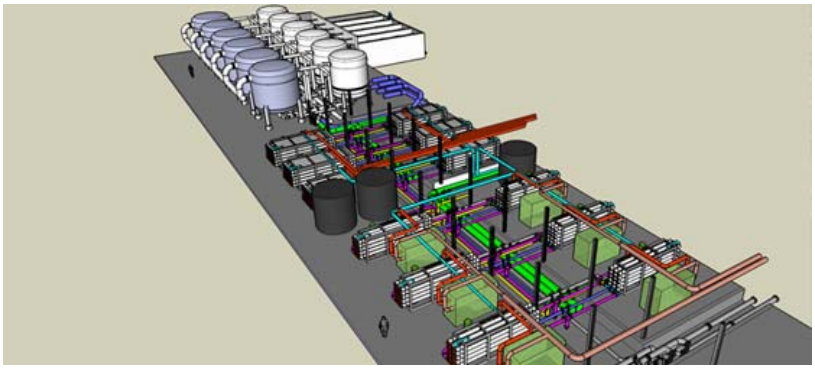
* Pore size 1 – 100 nM
** Moleculair Weight cut off



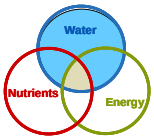
# Dutch examples




- Boiler feed water: UF, biological activatedcarbonfiltration, 2 phase RO, polishing by electro deionisation;



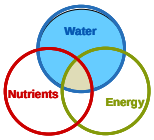
# Dutch examples




- Boiler feed water: UF, biological activatedcarbonfiltration, 2 phase RO, plishing by electro deionisation;
- Recreation water: Rapid sand filter followed by a reed bed filter;



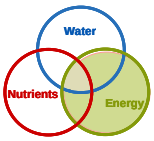
# Dutch examples

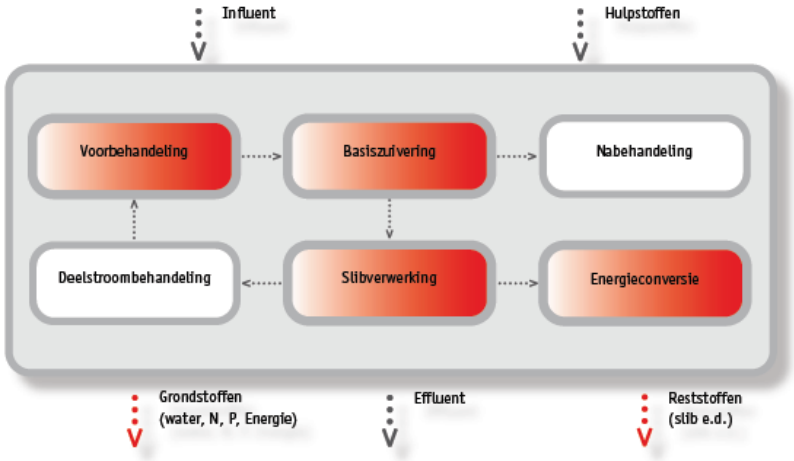



- Boiler feed water: UF, biological activatedcarbonfiltration, 2 phase RO, plishing by electro deionisation;
- Recreation water: Rapid sand filter followed by a reed bed filter;
- Agricultural use (via discharge at surface water): supply pond, parallel reed bed canals, discharge canal and aquatic plant ponds.

Combination with nutrient factory: struvite recovery from human urine and cattle manure
Micro pollutants removed via ozonation and activated carbon filter

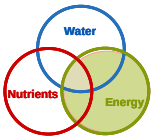
# Energy Factory





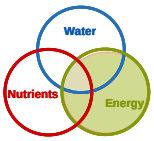

# Energy factory

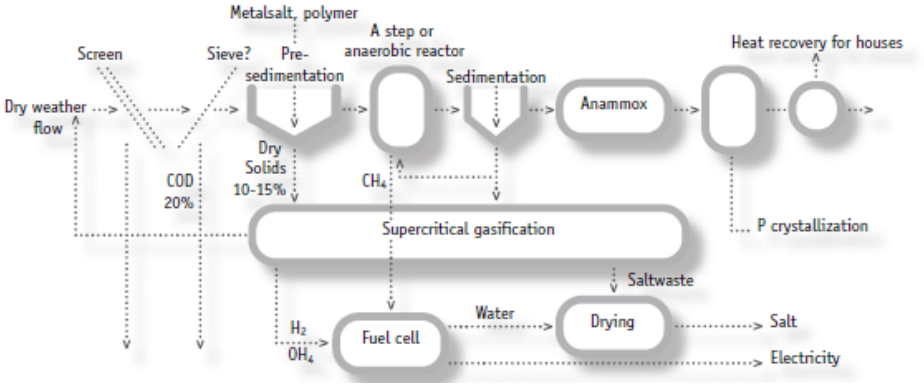



Important characteristics for WWTP configuration

- Separation of COD instead of aerobic degradation (optimization biogas production and energy consumption at aeration)
- Energy: economic removal of N, P and residual COD (anammox)
- Maximal recovery of sludge caloric content

# Energy factory







13 Waterboards
12 WWTPs studied

Almost all can treat their water energy neutral

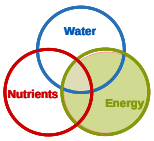
Energy reduction for waterboards: 2%-25%
Costs: -0,08 to 0,70 €/i.e.

Business case:
-1,36 to 0,55 €/i.e.

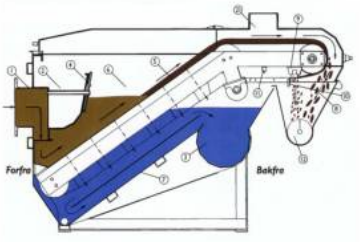
ENERGIE FABRIEK =

**Total energy Yield** **± 5800 households**

# Fine sieve




- 170,000 ton/year paper fibres
- 0.5 mm holes
- 30-40% SS, easy to increase
- Reuse of paper, energy recovery (biogas)



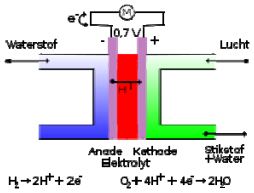



# Other measures in sludge treatment

- Sludge desintegration (5 bar, 150°C)

  (More biogas with higher methane content, easier to dewater sludge)
- Fuel Cell
- Supercritical gasification

  (Without $O_2$, high pressure (200-400 bar), high temperature (500-700°C) conversion of biomass to CH4, CO, N2 and H2)
- More efficient use of energy and low-value heat from CHP

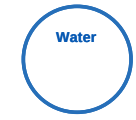


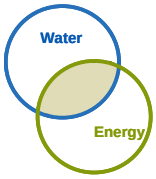
# Development of anammox technology at low temperatures

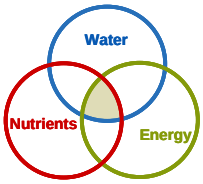


# Projects at GT

- Irrigation in greenhouses
  - Pilot at Harnaschpolder with filtration methods;
- Sewermining
  - Production of high quality process water from sewer, preferably energy neutral
- Anaerobic Membranes
  - uncoupling HRT and SRT, resulting in high quality nutrient rich, pathogen free effluent;
  - Fouling, shear and costs



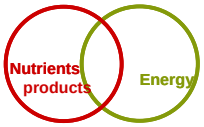



# And also at EBT-TNW…

- Cold Anammox (BT);


- Nereda
  - Low energy use
  - Alginate production/extraction (BT)
  - Increased digestion of biomass (GT)




- VFA production of biowaste/wastewater
  - Bioplastic production (BT)
  - Increased hydrolyses (GT)
  - VFA production from waste streams (GT/BT)