Sustainable water use

Water cities in transition

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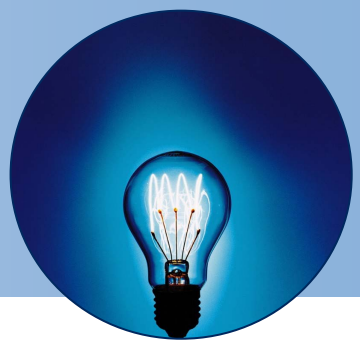
Introduction

- Sustainable dreams
- Examples
- Evaluation method
- Discussion

Juggling with Water

- Environment: *What is required?*
- Ambition: *What do we want?*
- Geography: *What is possible?*
- Infrastructure: *What exists, what can be avoided?*
- Synergy: *e.g. greenhouses, industry, energy supplyer*
- Local authorities: *cooperation how?*
- *…*



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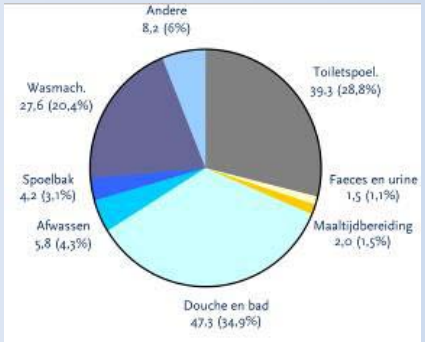
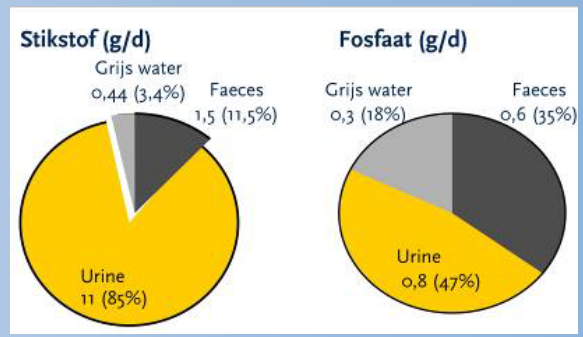
Chances

Separation at source seems logic…



Samenstelling dagelijkse hoeveelheid afvalwater



30 bottles per person per day!

… it is done

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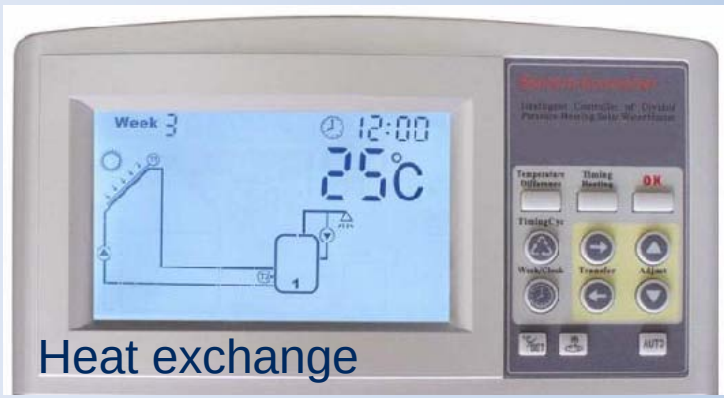
Sustainable dreams…

Sustainable laundry

Nutrient recovery



Heat exchange

Local treatment

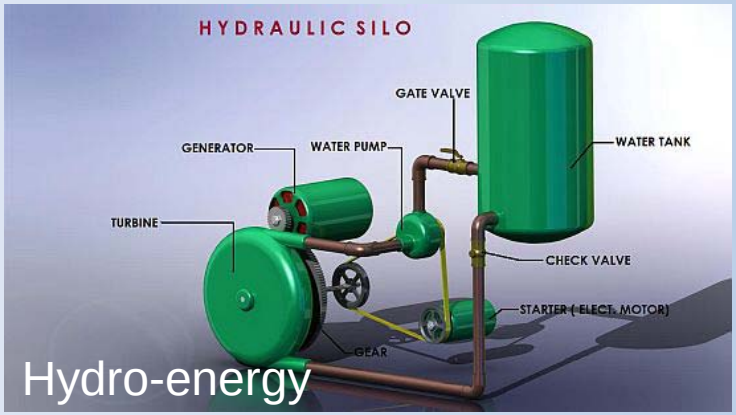
Constructed wetland

Sustainable dreams…

Eco-toilet

Sink positive™

Eco-shower



Hydro-energy

Water fitness:

use your energy to treat!

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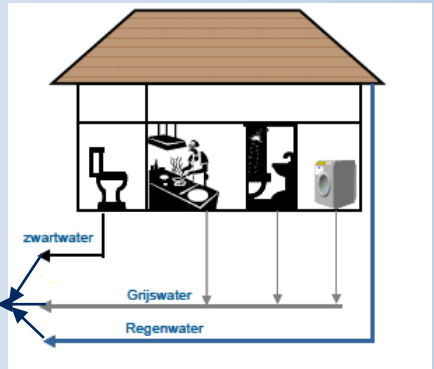
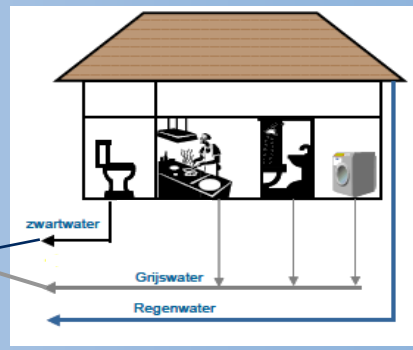
Collection, how?

Historic concept



Wastewater

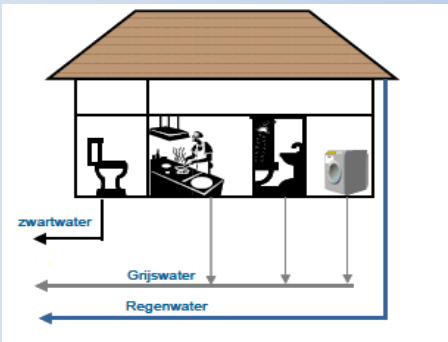
Present concept



Domestic wastewater

Storm water

Black/grey water concept

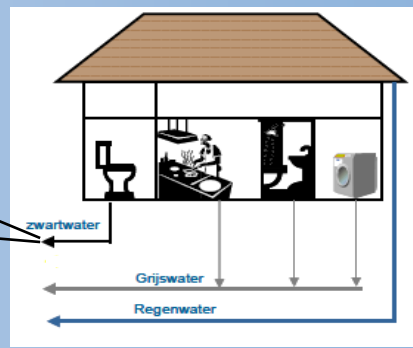


Black water (urine+feces)

Grey water

Storm water

Complete separation at source



Yellow water (urine)

Brown water (feces)

Grey water

Storm water

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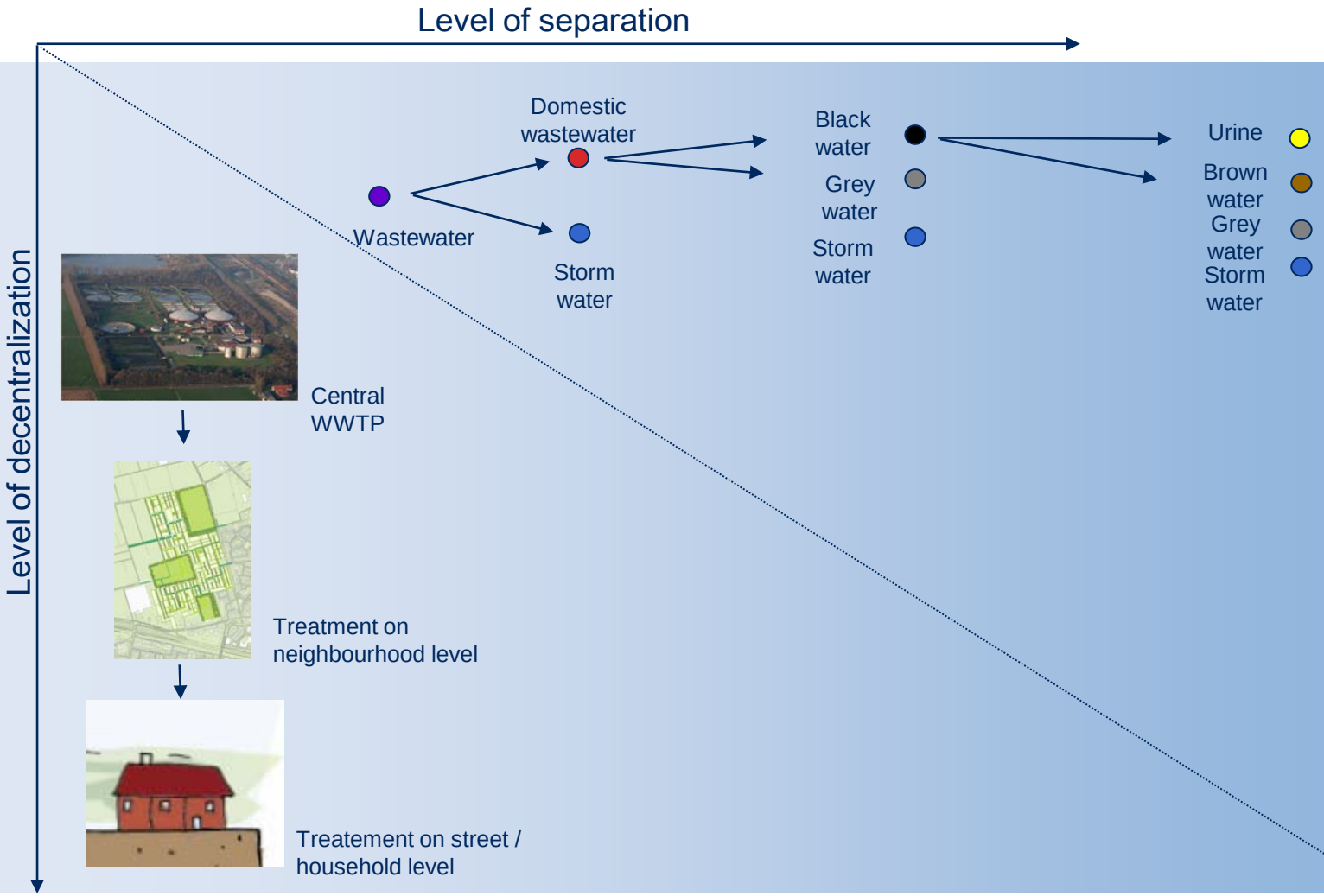
Solutions



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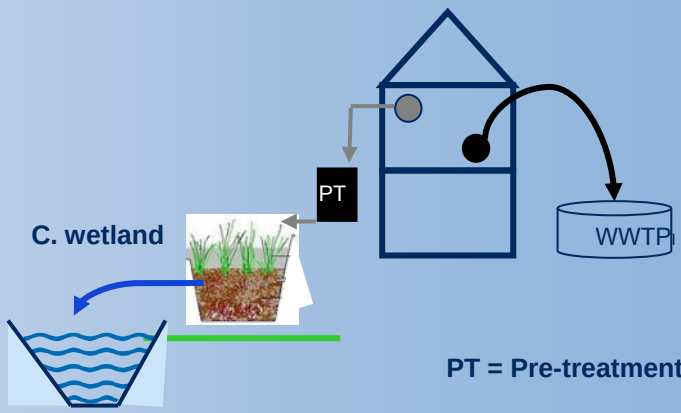
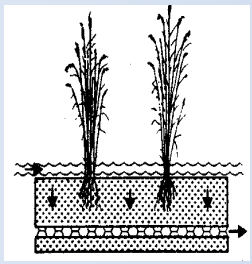
Example 1: Grey water treatment

- Black water to WWTP
- Grey water local treatment
- Constructed wetlands, but…

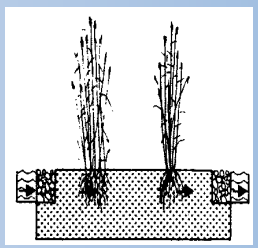
- Aim1: feeding surface water
- Aim2: efficient treatment on WWTP



Vertical flow



Horizontal flow



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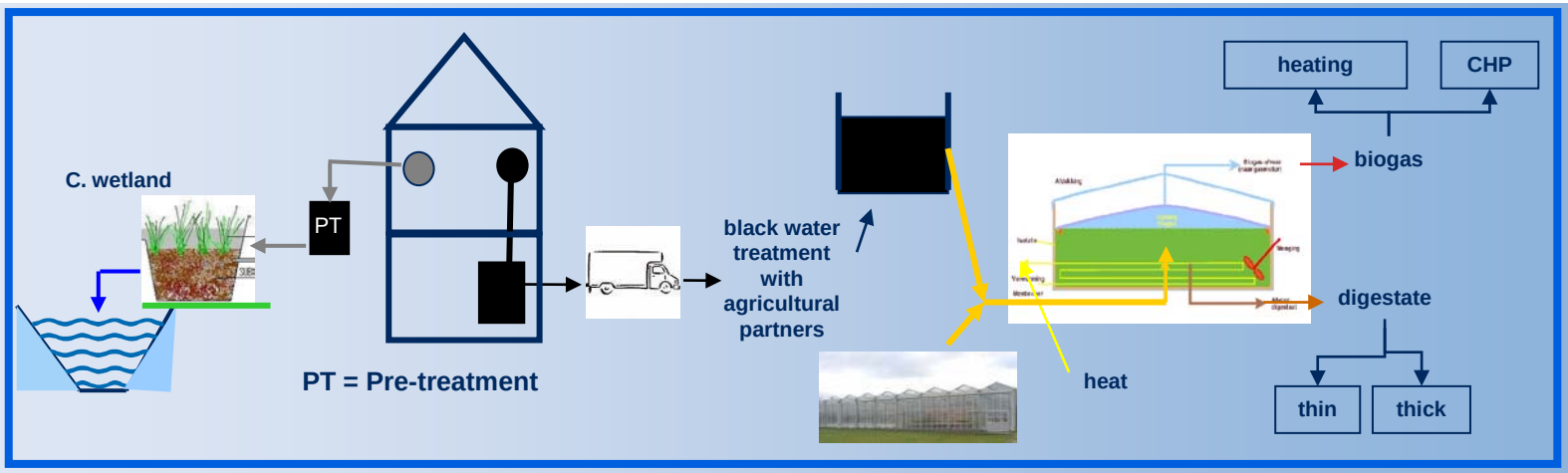
Example 2: Black + grey water treatment



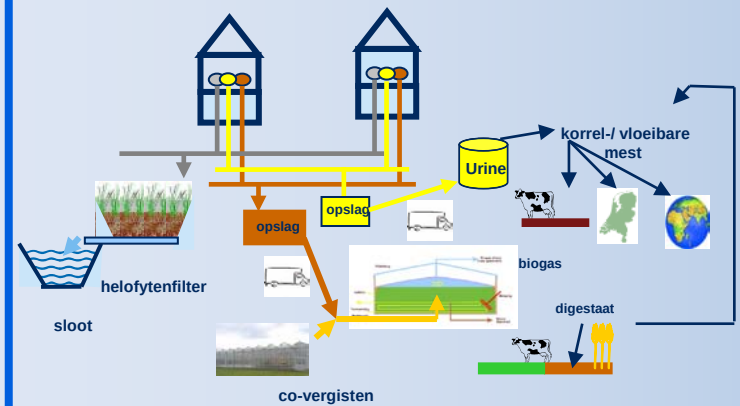
IBA

DESAH (Sneek)

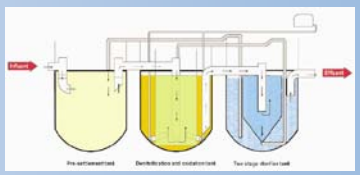
Shredder for kitchen waste (Roediger)

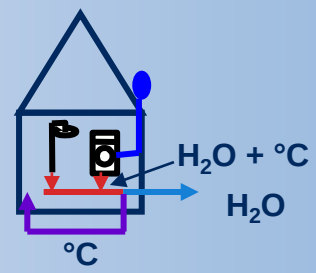
Example 3: Separation at source

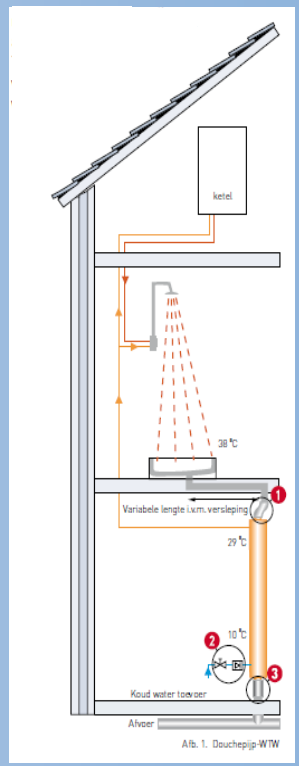
- wastewater divided in:
  - urine → struvite
  - brown → codigestion
  - gey → water + heath



Individual urine treatment







Heat recovery from the shower

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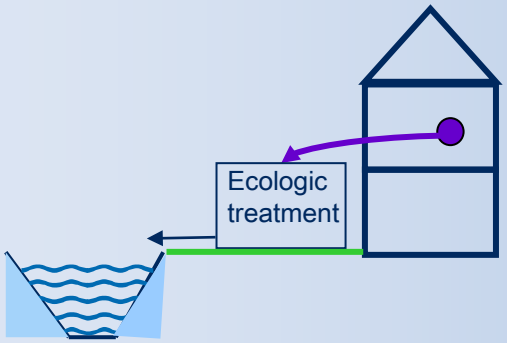
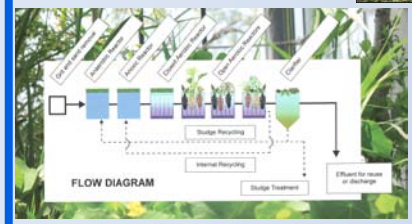
Example 4: Combined local treatment: ecologic wastewater treatment



Organica Technology

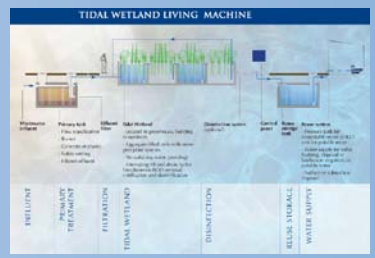
Living Machine ®
by Worrell Water Technologies

Organica treatment plant



Flow diagram volgens
Organica Technology

Living Machine® in
Noorder Dierenpark Emmen



Flow diagram from
Worrell Water Technologies

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Example 5: College toilets

In Windesheim College (Zwolle, NL) 125 urine separation have been put in place. The urine is used for research by students. All the urine is treated separately

Example 6: Buon Ma Thuot effluent reuse

The Government of Vietnam jointly agreed on the establishment of a Sector Programme Support (SPS) for the Water Sector in Vietnam.

The Buôn Ma Thuôt Wastewater Sub-Component is one of the interventions contained within the SPS and includes: Detailed Design and Construction Supervision (DCS) component including the rehabilitation of the sewerage system,new wastewater treatment plant,house connections and rehabilitation and extension of the stormwater collection system.

The treated effluent is used for irrigation of coffee plantations

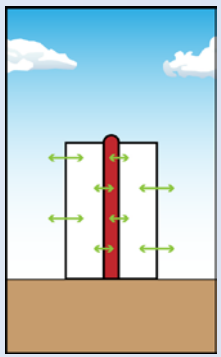
Example 7: DOW Chemicals effluent reuse

Since 2001 DOW has outsourced the supply of proces water, water for cooling tower, demineralised water and ultra-pure water to third parties.

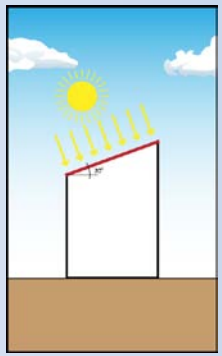
In 2005 it was decided to prepare part of the required demineralised water from effluent from a nearby municipal WWTP. Grontmij supported the technological design, produced the basic engineering and tender documents, supervised the construction and supported the start-up.

Example 8: sustainable buildings China

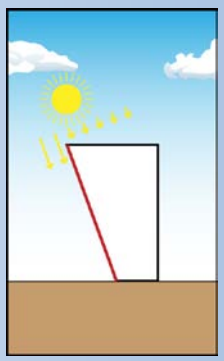
Design principles
主要设计



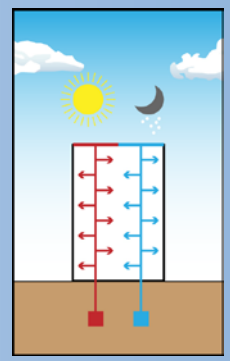
Atrium
中庭



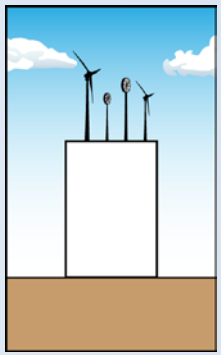
Ideal PV roof
理想**PV**屋顶



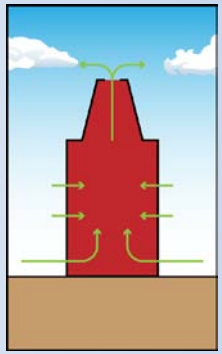
Shadow façade
遮阳面



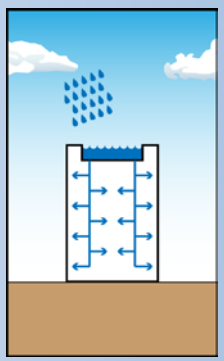
Energy roof
能源屋顶



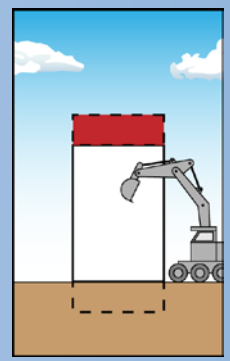
Wind energy
风能



Natural ventilation
自然通风



Rain water use
雨水利用



Ground source balance
地源冷热能平衡

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Sustainable design

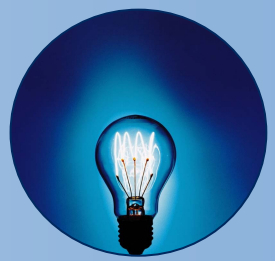
Water development

Integrated Planning

Water Safety Requirements → Surface Water Scheme → (Waste) Water Chain Approach → Water Systems Design → Procedures → Project Realisation

Area scheme → Area development → Area design → Procedures → Sale of lots

Area development



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Evaluation method: Green LCC

Life cycle costs (euro) ; time frame 100 year

	0 Energy factory WWTP	1 Living Machine	2 Grey	3 Grey & Black	4 Separation
NPV Capital costs	-2.349.400	-3.565.600	-3.685.300	-5.096.300	-5.885.100
NPV Maintenance costs	-168.300	-272.200	-281.300	-491.700	-607.900
NPV Operational costs	-2.002.900	-1.971.000	-2.127.000	-1.575.700	-1.595.500
NPV Drinking water savings	0	0	0	417.400	368.100
NPV Energy prod./savings	100.800	0	100.800	46.500	0
NPV Nutrient recovery	0	0	0	85.700	51.400
LCC	**-4.419.900**	**-5.808.700**	**-5.992.800**	**-6.614.200**	**-7.669.000**

N.B.: *- Costs for acquiring land are excluded.*

Sensativity analysis

Results sensativity analysis

	0 Energy factory	1 Living Machine	2 Grey	3 Grey + Black	4 Separation
standaard	1	2	3	4	5
Investment +25%	1	2	3	4	5
Investement -25%	1	2	4	3	5
Interest rate 4%	1	2	3	4	5
interest rate 7%	1	2	3	4	5
Shorter depreciation term (30/10/5)	1	2	3	4	5
Longer depreciation term (60/20/15)	1	2	4	3	5
50 year life cycle (tot 2060)	1	2	3	4	5
75 year life cycle (tot 2035)	1	2	3	4	5
Electricity price (5x)	1	3	2	4	5
Electricity price (10x)	1	3	2	5	4
Drinking water price (2x)	1	2	3	4	5
Drinking water price (5x)	1	3	4	2	5

Multi criteria analysis (1)

	0 Energy Factory	1 Living Machine	2 Grey	3 Grey + Black	4 Separation
Finances					
LCC (€, NPV)	-4.418.600	-5.809.200	-5.991.500	-6.391.000	-7.670.100
Opex (€)	-9.820	-15.870	-16.400	-28.670	-35.450
Investment (M€)	1,2	1,8	1,9	2,3	2,5
Sustainability					
Energy use (GJ)	277	103	252	340	87
Energy production (GJ)	353	0	353	59	0
Resource recovery (kg/year)	None, but possible	none	none	N=9000 P=1200	N=6700 P=690
Crop potential	none	crop	Green nature	Green nature	Green nature
Drink water savings (m³/year)	0	0	0	21.900	19.300
Material / system design	One pipe	One pipe	Two pipes	Two pipes	Three pipes, local treatment units
Surface water quality	As present	Local Discharge	Poor effluent quality	Poor effluent grey water, effluent black water	Poor effluent grey water, effluent black / yellow water
Spatial use	None	0,5 ha	±1ha	±1, 5ha + 500m²	1,5 ha + local units

Multi criteria analysis (2)

	1 Energy Factory	2 Living Machine	3 Grey	4 Grey + Black	5 Seaparation
Public / organisation					
Toilet + sewerage	As present	Cleaning materials	Functioning	Vacuum toilets	No-mix toilets, gents need to sit
Treatment	As present	Discharge near by	Human health, odour	odour	Many local units
Impact on buildings	none	none	Separate pipes	Separate pipes, flexible	Three pipes, no-mix toilets
Public awareness	Hardly any	large, 'employment'	aware	Large, but people are not involved with treatment	large
Multi functionality	none	Cooperation with other initatives	Hardly any	'municipal waste collection'	'municipal waste collection' '
Impact on operational organizations	none	big	Operation c. wetlands	Operation c. wetlands	Many separate units
Regulations/ licenses	No additional	Wm, Waterwet (één unit)	Waterwet	Wm, Waterwet, Public safety	Wm, Waterwet (many units)
Possibility for cooperation with local industries	none	Possibly water	e.g. greenhouses, water	Greenhouses, water+heat+energy	Possibly water
Innovation					
Level of innovation	Not yet full scale operational	Not yet in urban area (NL)	operational	Small scale available	Not in urban areas, but already in hospitals

Remarks

- Wastewater treatment can be sustainable!
- Sustainabilty has many faces, which are often not the same:
  - Energiy use / production
  - Water use
  - Environmental impact
  - Resource recovery

- Chances with other initiatives
- Compare the LCC's and environmental/social valuation
- New solutions: new operations!

Theorems

1. A non-potable water system deserves a 2nd chance in NL.
2. Local treatment is too dangerous.
3. Systems can be changed, but not people.
4. Vacuum collection is the future.
5. Fertilizers made from wastewater should be used in food production.
6. Effluent reuse yes! But not for potable use…
7. Effluent reuse will fail, since it causes interdependency between parties.
8. Harvesting storm water on household level should be obligatory.
9. In the future everything will be organized on household level, in stead of centralized networks.
10. Drinking water production and supply is a governmental responsibility.

Thank you!

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