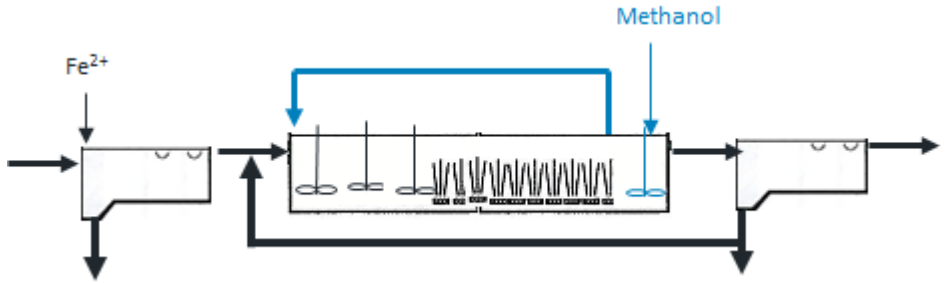
How to improve wastewater treatment with increased recovery of plant nutrients in urban areas?

David Gustavsson

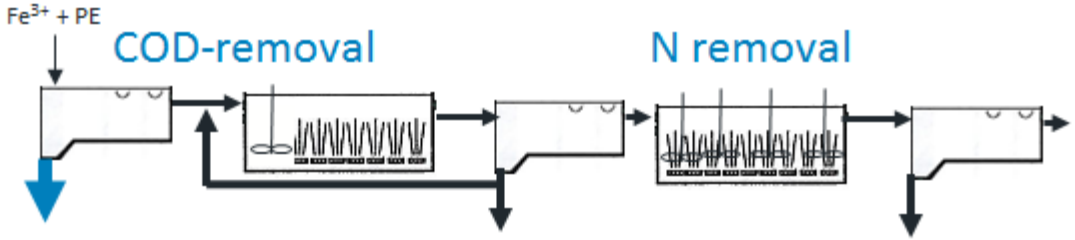
Research Leader

Wastewater treatment

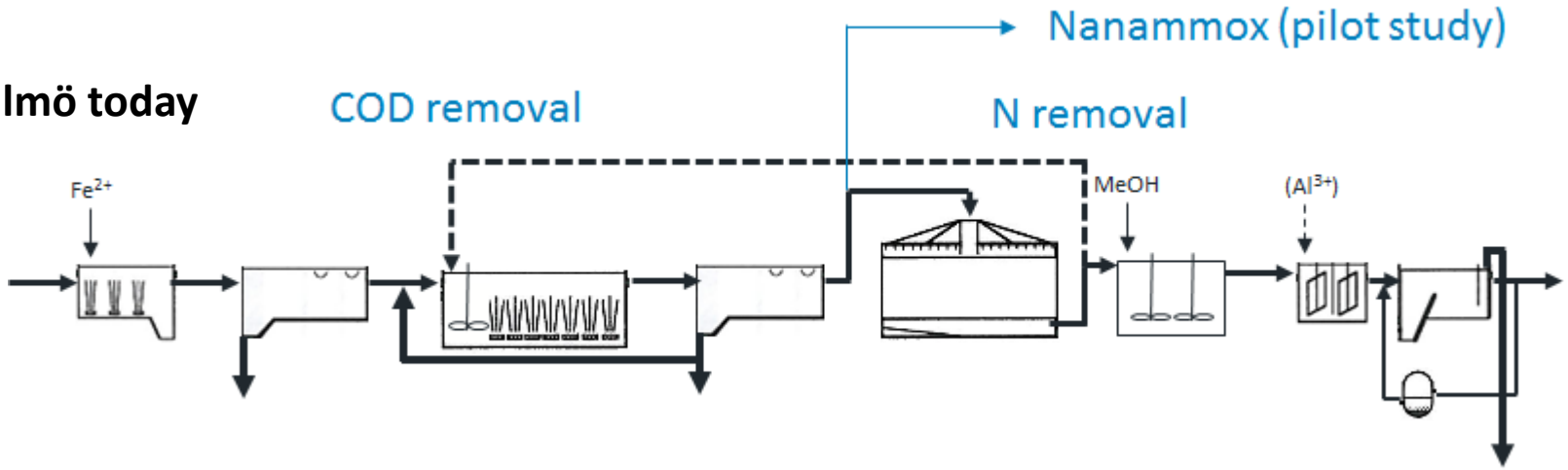
Conventional



Future



Malmö today

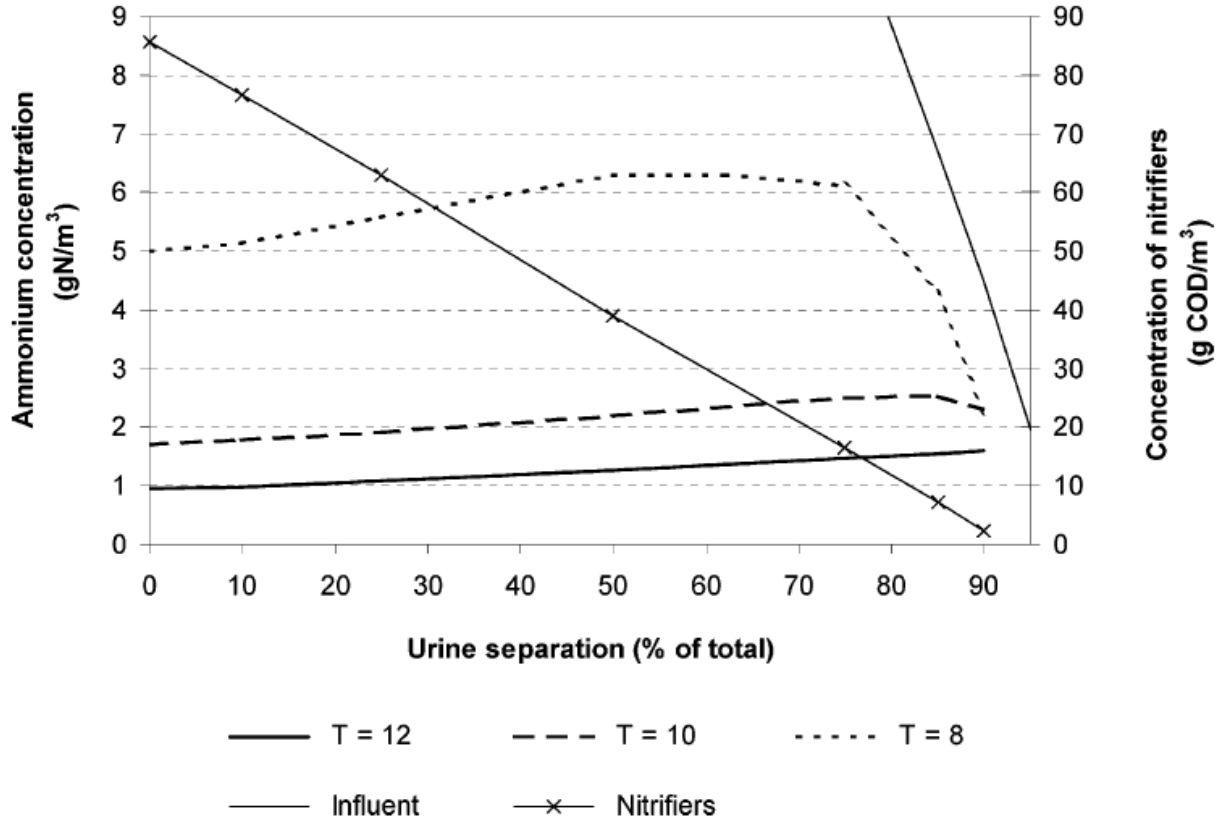


”Sustainable” cities

Winner of Nordic Built Cities Challenges 2016 – Sege Park

Sharing for Affordable and Climate Smart Living

Effect of urine collection



Wilsenach & van Loosdrecht (2004)

Assimilation

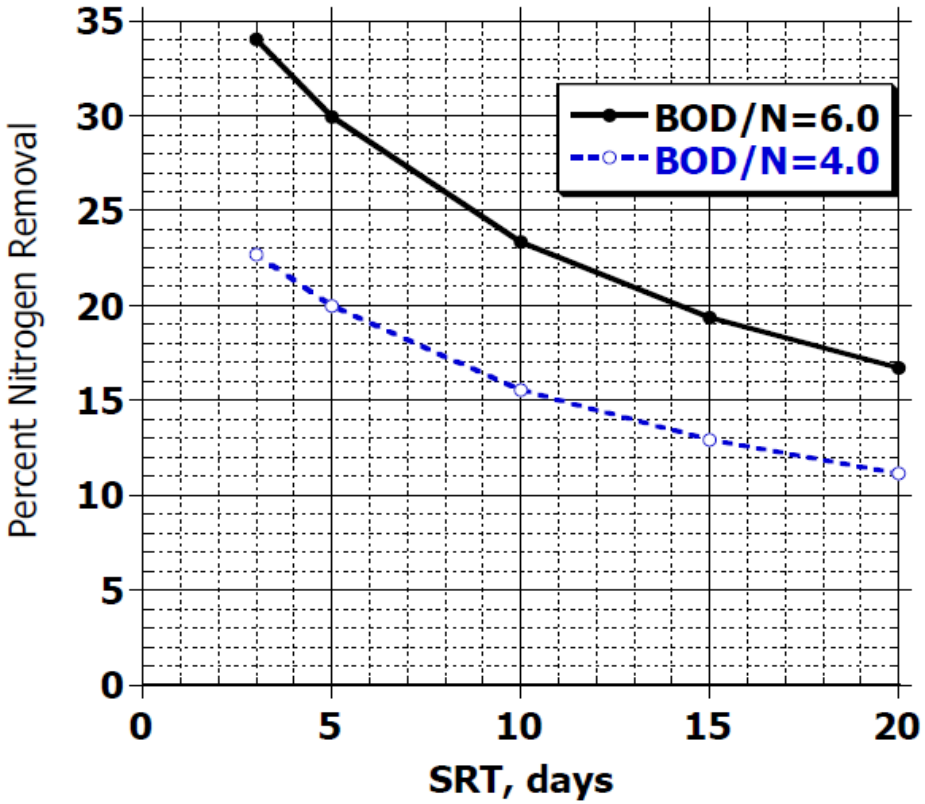


Figure 4-1. Percent nitrogen removal due to biomass synthesis as a function of SRT and influent BOD/N ratio.

EPA (2010)

Nitrogen 20 %, phosphorus 50 % & potassium 55 % in added mineral fertilisers can be substituted.

DN.se **DEBATT.**

FÖRSTASIDAN | STHLM | EKONOMI | SPORT | KULTUR & NÖJE | LEDARE | DEBATT | BOSTAD | MOTOR | RESOR

Debatt - hem Stockholmsdebatt

”Återvinn fler näringsämnen än fosfor i avloppsvattnet”

Publicerad 2012-07-28 00:50

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Elisabeth Kvarnström, Tekn Dr, Vectura, sakkunnig hos Naturvå
avlopp 2001–02

Value

Stock

GHG

Fakta. Fler näringsämnen än fosfor i avloppet

● De olika växtnäringsämnena har jämförts avseende ekonomiskt värde *, samt minskade tillverkningsutsläpp av växthusgaser om mineralgödseln ersätts av toalettavlopp eller avloppsslam.

	Kväve	Fosfor	Kalium	Svavel	Totalt	
Värde (milj kr/år)						
Toalettavlopp	413	79	140	6	638	Toilet waste
Avloppsslam	28	98	12	4	143	WWTP sludge
Resursens ändlighet (antal år)						
Reserv vid nuvarande användning	64**	372	257	<72		
Potentiellt minskade växthusgasutsläpp (ton CO2-ekv/år)						
Toalettavfall	196500	2500	4500	-	203500	Toilet waste
Avloppsslam	13500	3000	500	-	17000	WWTP sludge

* Beräknat från USGS, 2012 (Mineral Commodity Summaries. United States Geological Survey) samt BP, 2012 (BP Statistical Review of World Energy June 2012). ** Naturgas

Spångberg *et al*. (2014) - LCA

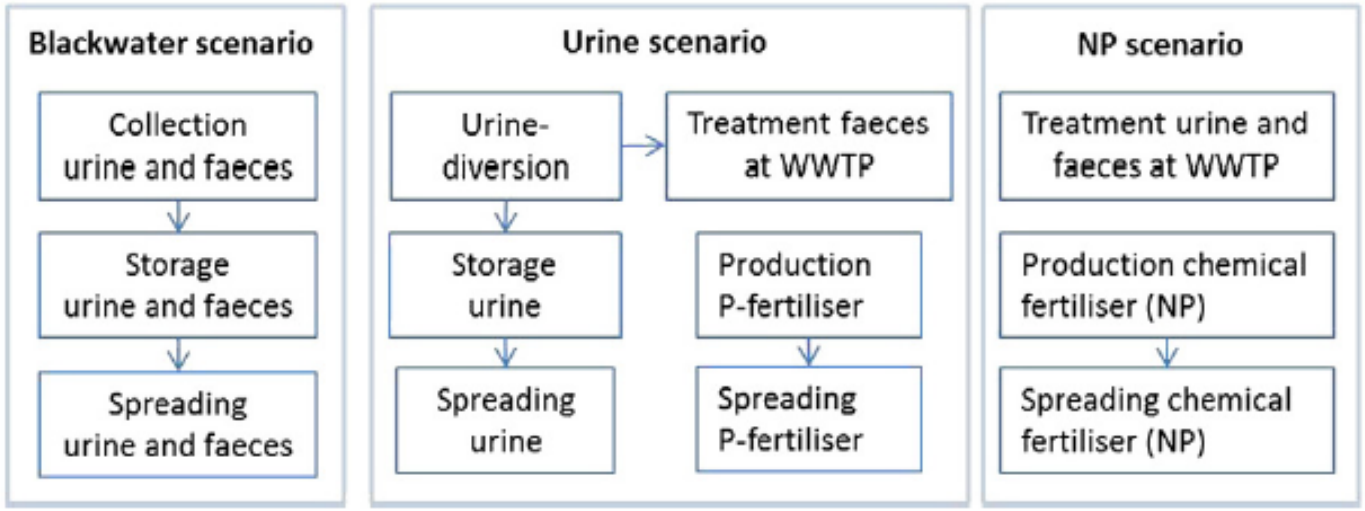
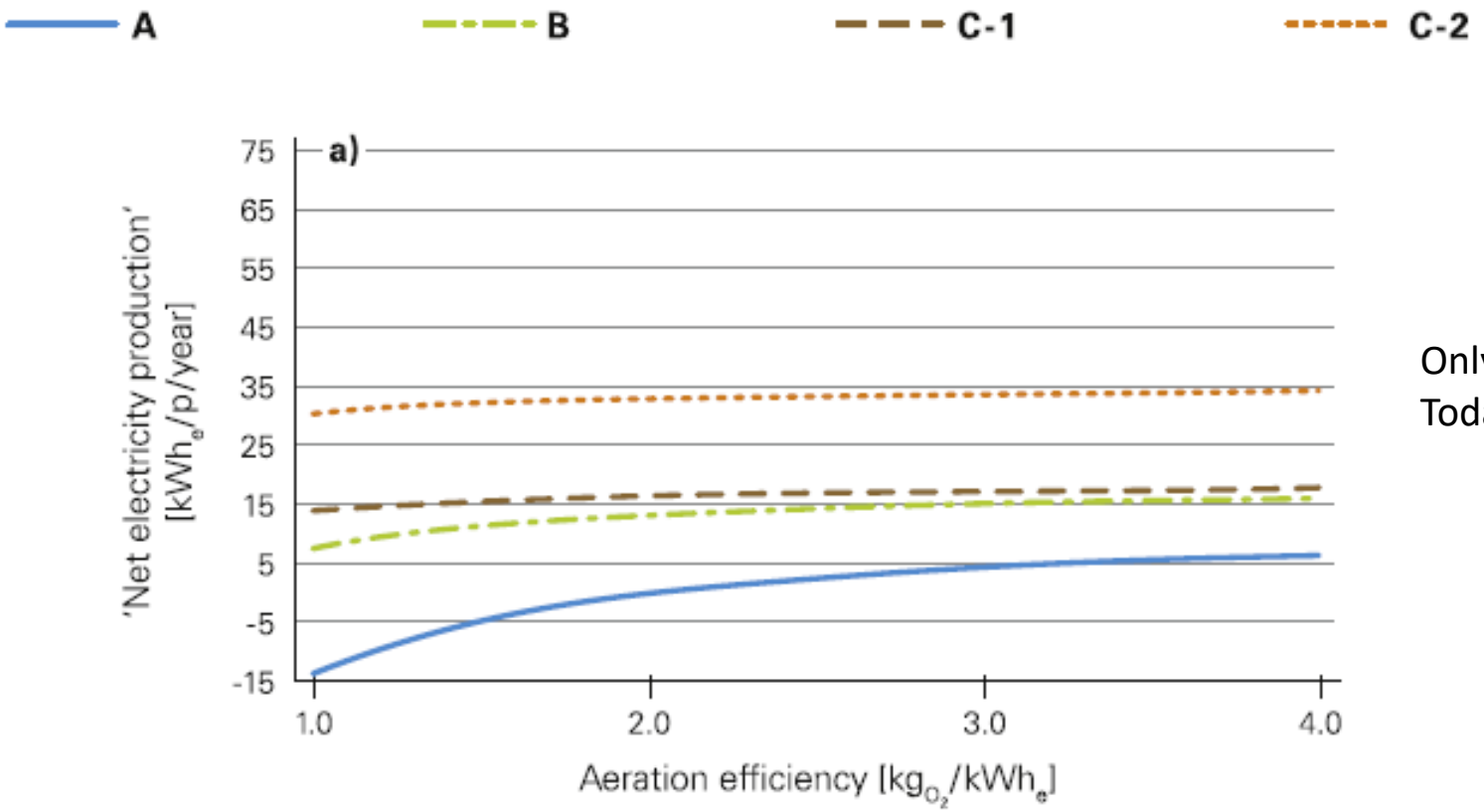


Fig. 1. System boundaries for the three scenarios studied. All three scenarios produced the functional unit (P-fertiliser = phosphate rock).

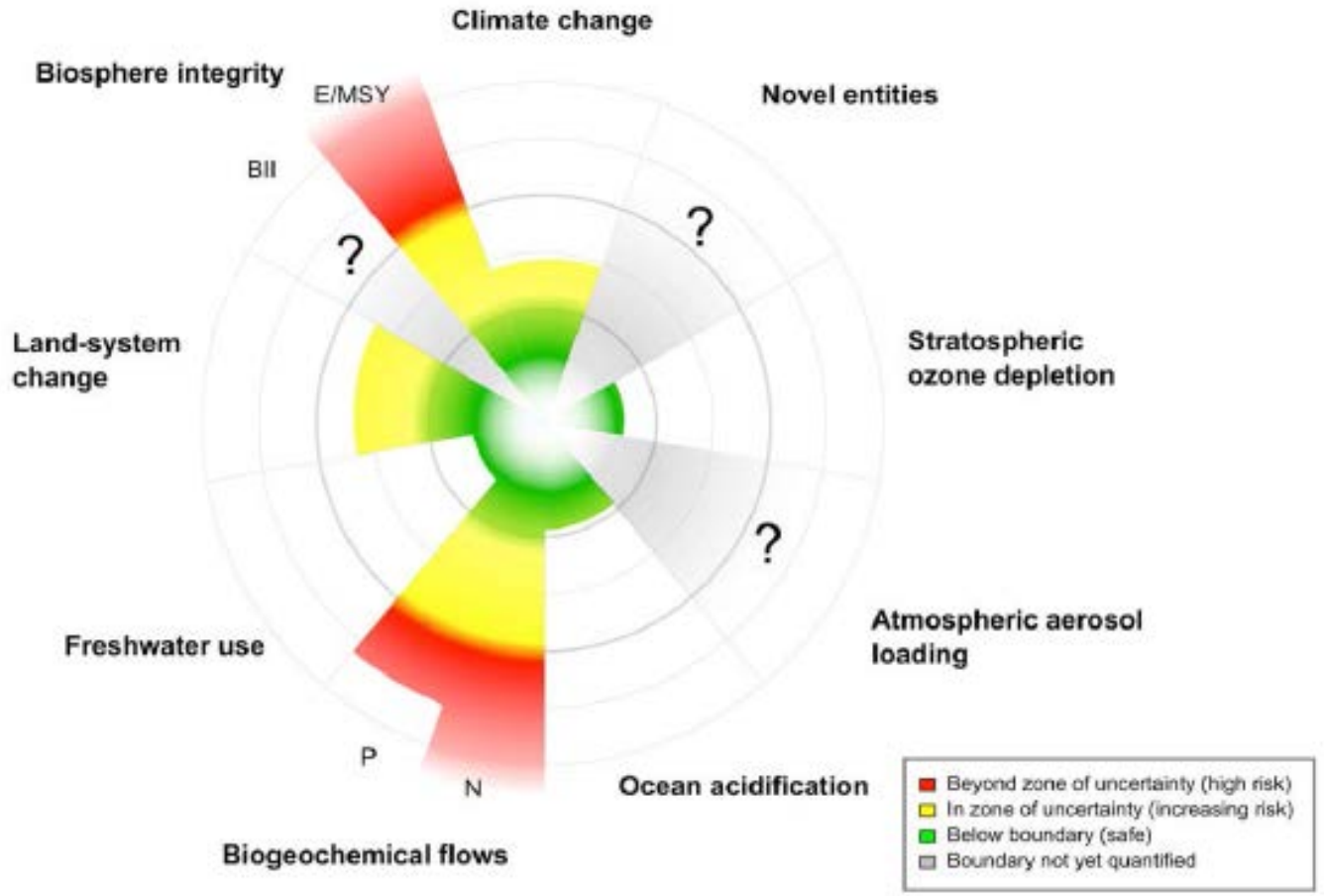
Larsen (2015) – energy comparison



Only aeration and electricity production from sludge.
Today´s standard for electricity production.

A – Conventional treatment
B – Separate COD and N removal (anammox)
C – Urine nutrient recovery (1/2 = with/without embedded fertiliser energy)

Planetary boundaries



Steffen et al. *(2015)*

Sustainability strategy (2015) for the housing area Sege Park in Malmö

”Sege Park is an experimental workshop for sustainability”

”Sege Park shall be a test bed for urine separation.”…”The aim is that at least one building is included in the study…”

VASYD

Malmö stad

Uricycle - vision

We will put forward a new urine separation system, which enables the creation of new dry fertilisers, which can decrease the dependency of import of mineral fertilisers to secure a resilient food supply.

Main argument for urine separation

- Decreased need of upgrading and decreased operational costs at existing centralised WWTP.
- Increased nutrient recovery from human excreta.
- Decreased water use/decreased climate impact of wastewater handling system.

Main challenges urine separation

- Lack of attactive and comfortable urine separation toilets with low maintenance needs,

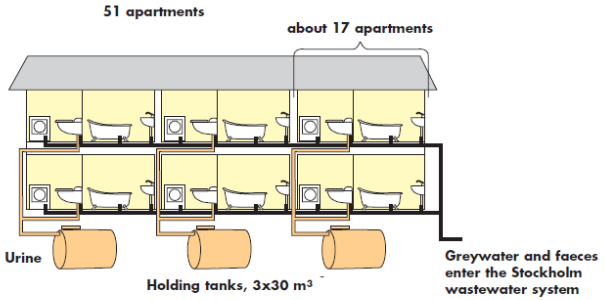


Figure 5. Diagram of the Palsternackan wastewater treatment system. Illustration: Kim Gutekunst

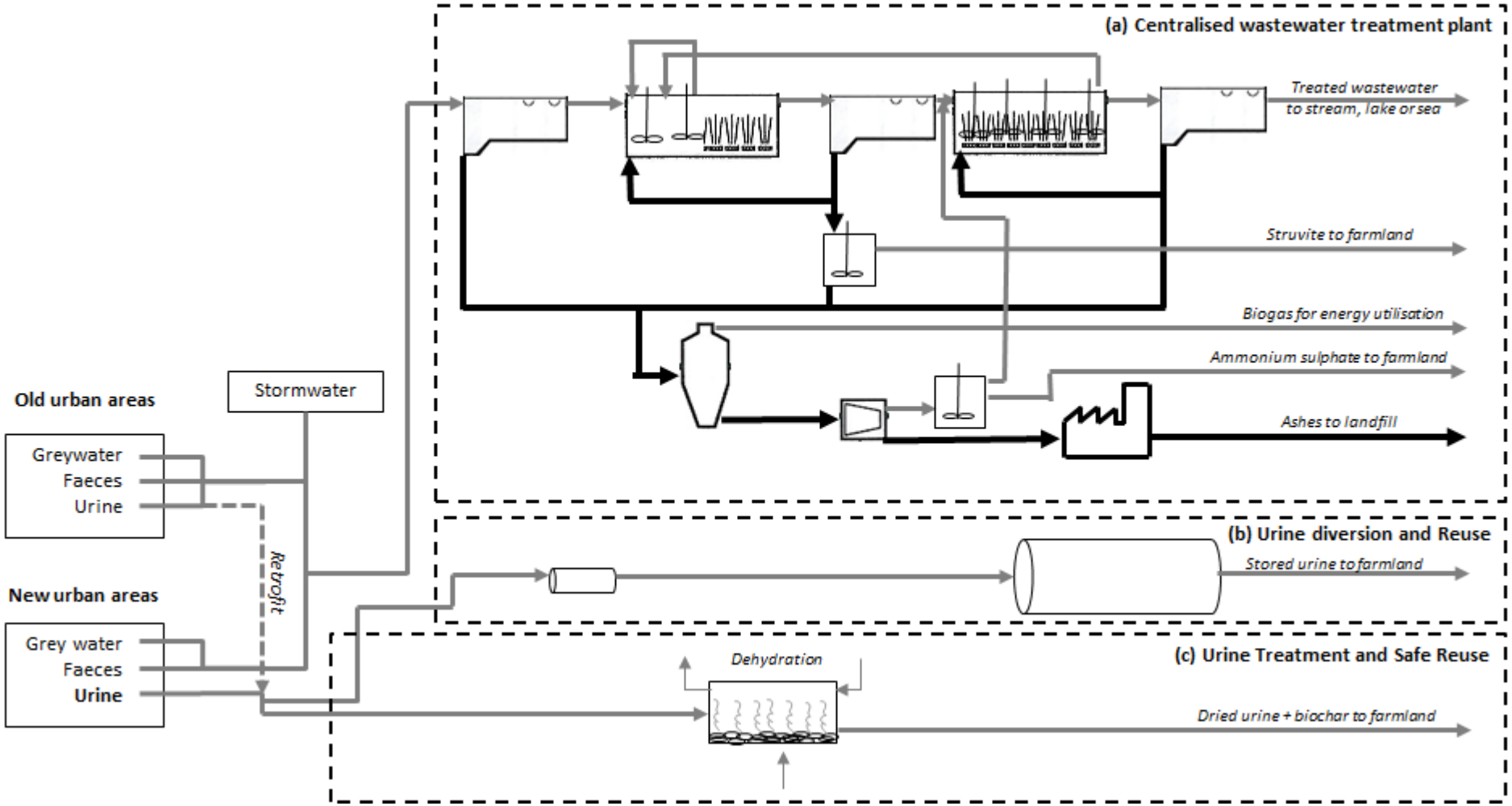
- Space efficient , local solutions

- Low energy methods for volume reduction for minimising the transports to agriculture

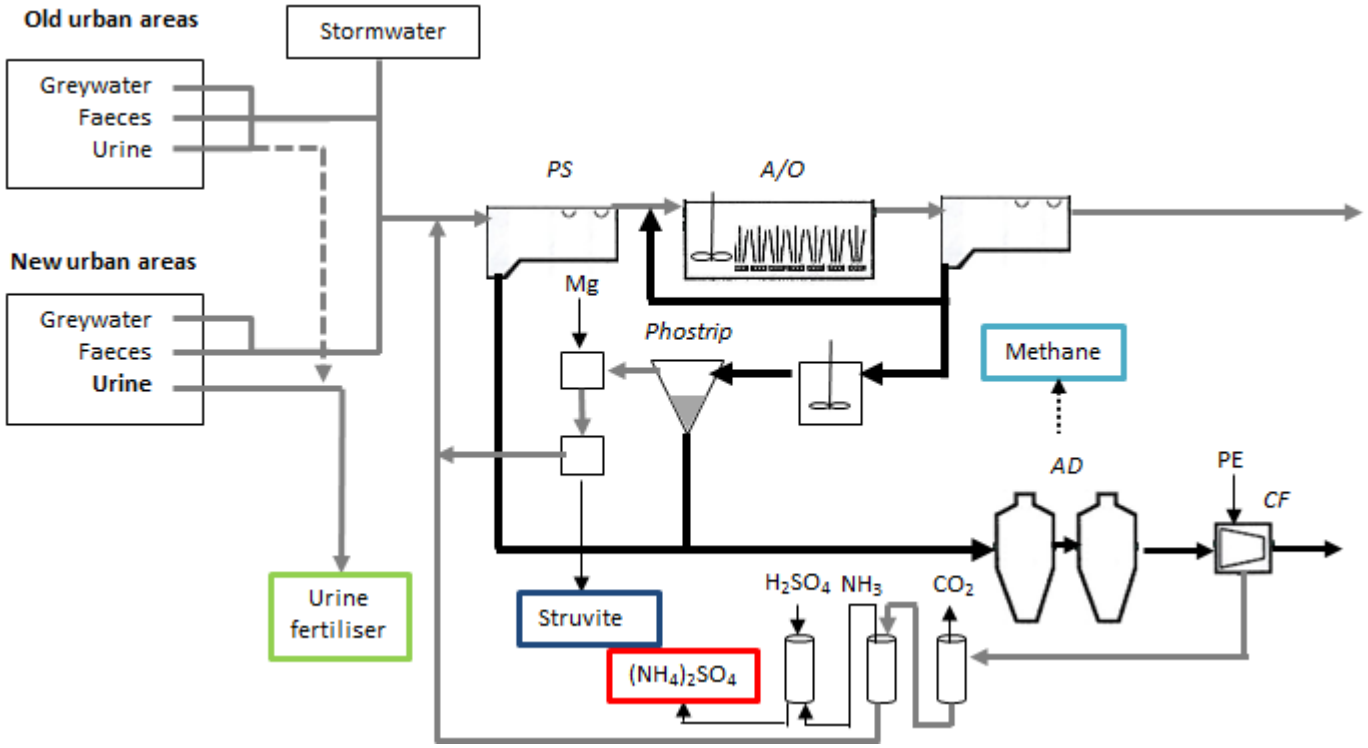
So… how to improve wastewater treatment with increased recovery of plant nutrients in urban areas?

- Urine separation – nutrient recovery in a separate stream.
- Favor N removal by assimilation by lowering SRT (separate COD and N removal stages) and increasing BOD/N ratio.
- More N in sludge – N recovery can become more attractive.
- Increasing BOD/P ratio initially also favors biological phosphorus removal (struvite production).
- More biogas production due to less denitrification and less aerobic hydrolysis (short SRT).
- Less aeration energy needed due to less aerobic hydrolysis and less nitrification.

Vision


(a) Centralised wastewater treatment plant
Treated wastewater to stream, lake or sea
Struvite to farmland
Biogas for energy utilisation
Ammonium sulphate to farmland
Ashes to landfill
Old urban areas
Stormwater
Greywater
Faeces
Urine
Retrofit
New urban areas
Grey water
Faeces
Urine
(b) Urine diversion and Reuse
Stored urine to farmland
(c) Urine Treatment and Safe Reuse
Dehydration
Dried urine + biochar to farmland

Ongoing MSc thesis – Effect of urine collection on nutrient recovery at WWTP



sweden water research

UPPSALA UNIVERSITET

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LUND UNIVERSITY

Thank you for your attention!

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