

# HYDROHM

Electrify water

**URIDIS:  
electricity-driven water technology for safe  
and sustainable toilets without chemical  
additives**

Korneel Rabaey, Jolien De Paepe, Pieter Naert, Fabian De Wilde, Max Sabbe

# HYDROHM - electrify water

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HYDROHM (est'd 2020) is a spin-off of Ghent University and ESA MELiSSA programme

HYDROHM develops **innovative electrochemical water treatment processes and technologies**, with two pillars:

- 1) Only electricity as input, no chemicals
- 2) A better user experience

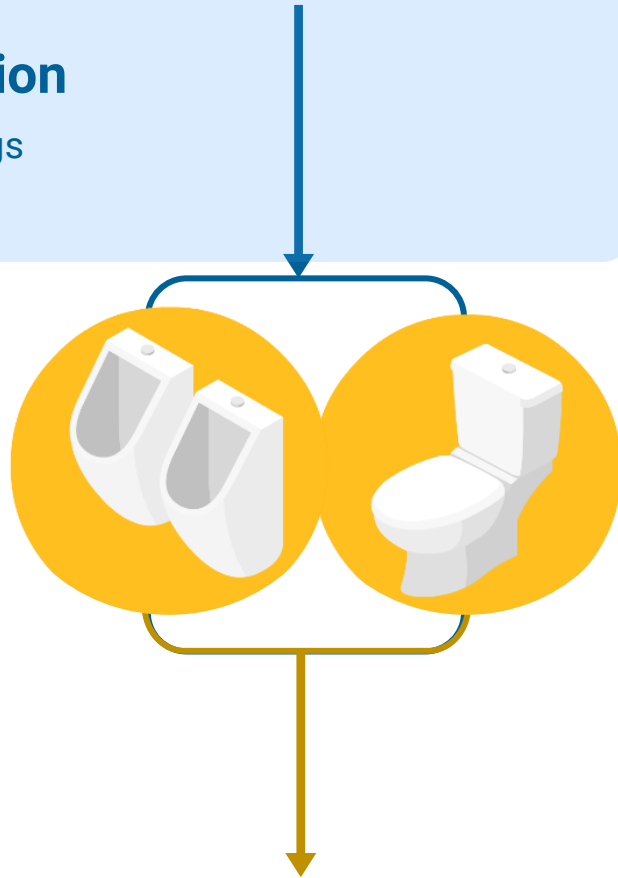


# Toilets of today

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## High water consumption

>70% in non-residential buildings



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## Hygiene risk

Spread of pathogens & frequent source of odour nuisance → results in high cleaning and maintenance cost



## *Flushing the Toilet May Fling Coronavirus Aerosols All Over*

A new study shows how turbulence from a toilet bowl can create a large plume that is potentially infectious to a bathroom's next visitor.



*NY Times, June 2020*

# Toilets of today

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## Valuable nutrients are lost

Urine is full of nutrients but they are lost → high nutrient load to wastewater treatment

# Toilets of the future: source separation

## High water consumption

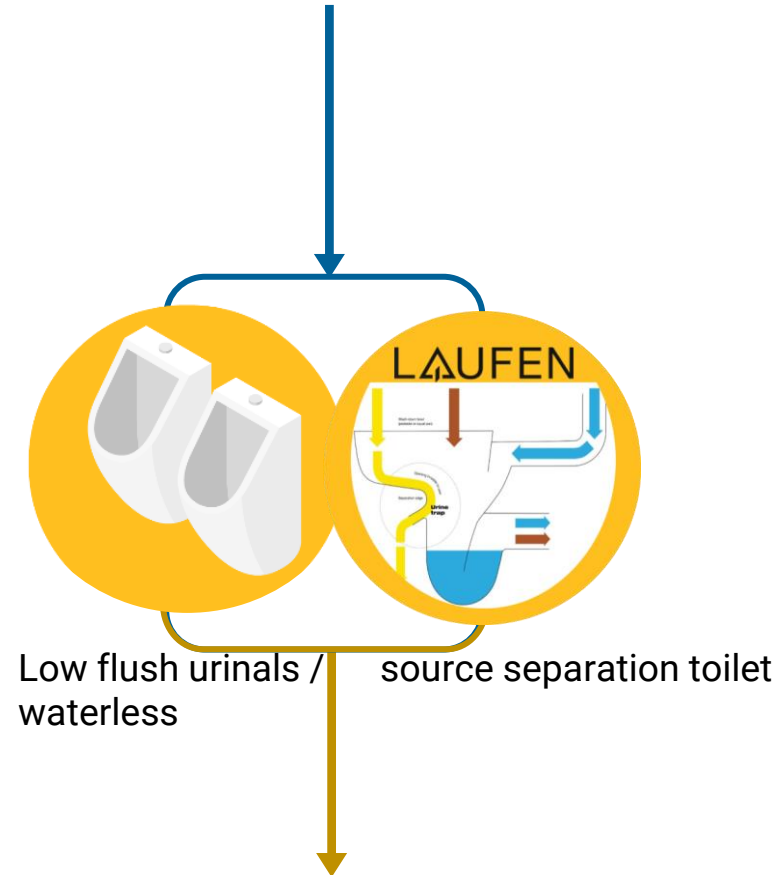
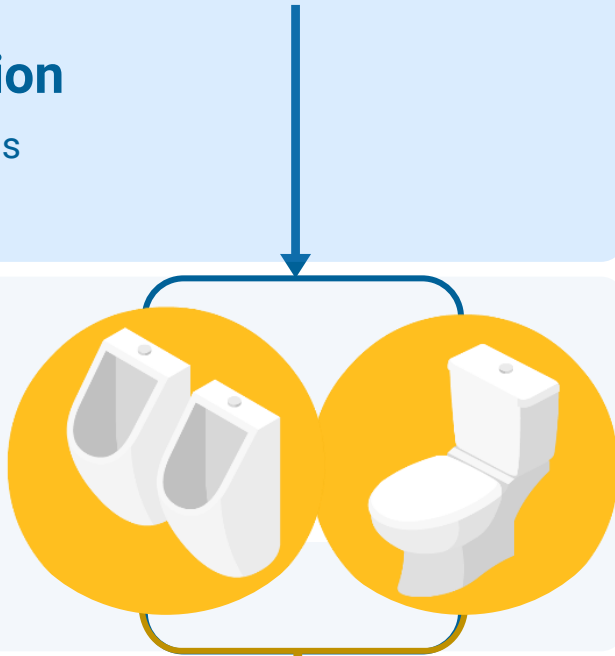
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## Hygiene risk

Spread of pathogens & frequent source of odour nuisance → results in high cleaning and maintenance cost

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# Toilets of the future: source separation

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## Hygiene risk

Spread of pathogens & frequent source of odour nuisance → results in high cleaning and maintenance cost

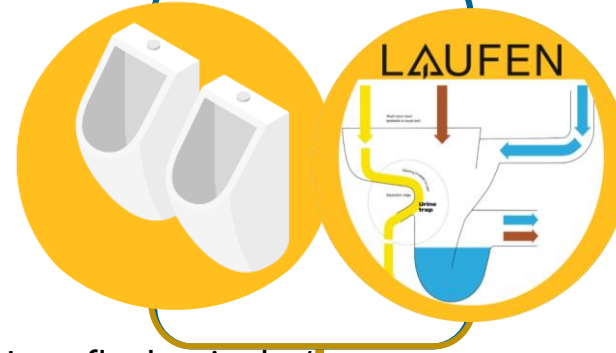


## Valuable nutrients are lost

Urine is full of nutrients but they are lost → high nutrient load to wastewater treatment

## Low water consumption

Lower flush volumes



Low flush urinals / waterless

source separation toilet

## Nutrient recovery

Urine is separately collected, which facilitates nutrient recovery

# Toilets of the future: source separation

## High water consumption

>70% in non-residential buildings

## Hygiene risk

Spread of pathogens & frequent source of odour nuisance → results in high cleaning and maintenance cost



## Valuable nutrients are lost

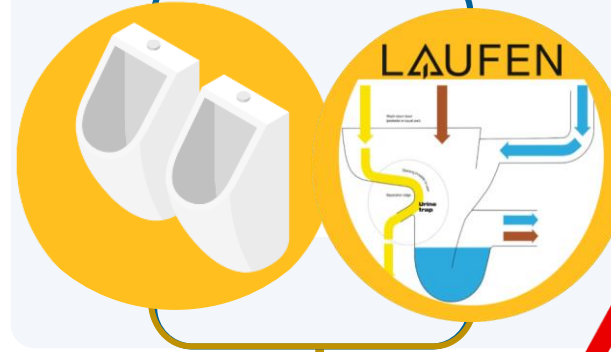
Urine is full of nutrients but they are lost → high nutrient load to wastewater treatment

## Low water consumption

Lower flush volumes

## Hygiene risk

Spread of pathogens & frequent source of odour nuisance → results in very high cleaning and maintenance cost



## Enables nutrient recovery

Urine is separately collected, which facilitates nutrient recovery



Urea hydrolysis

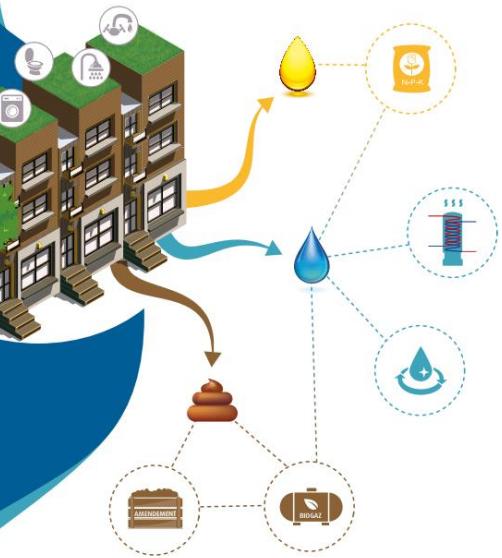
→scaling

→odour nuisance



# The importance of urine source separation

Source separation = separate collection of different waste streams for more efficient treatment.

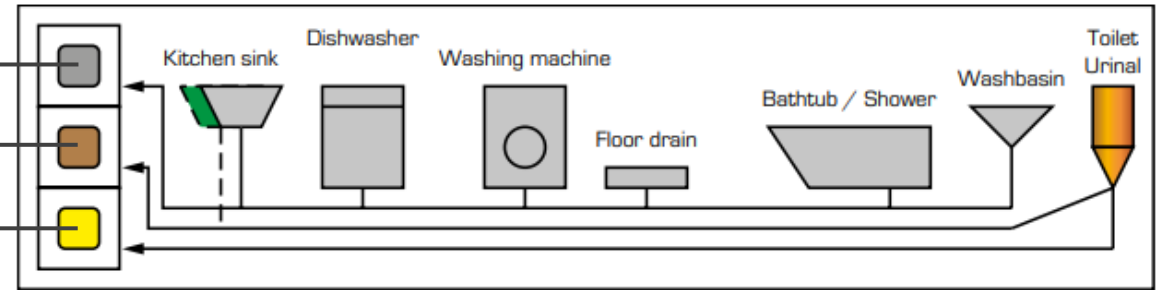


Light contamination, potential for reuse ←

Rich in organics, easy to treat ←

Rich in nutrients and salt ←

COMPREHENSIVE SOURCE-SEPARATION



**'Peeycling' payoff: Urine diversion shows multiple environmental benefits when used at city scale**

Highly relevant for urine due to high nutrient load:

- allows capacity increase of urban water treatment plants
- substantially reduces energy demand of water treatment and GHG emissions
- reduces sewer corrosion



## State-of-the-art urine treatment in Space (ISS)

Water recovery from urine by:

1. **stabilisation with  $H_2SO_4/H_3PO_4$  and  $CrO_3$  (toxic!) to prevent urea hydrolysis and microbial growth**
2. vapour compression distillation
3. filtration, catalytic reactor, ion exchange

- x toxic chemicals
- x brine: toxic, no nutrient recovery
- x scaling minimizes water recovery efficiency

### ISS Water Recovery and Management System



## Urine treatment in regenerative life support systems

Water/nutrient/ $N_2$  recovery from urine by:

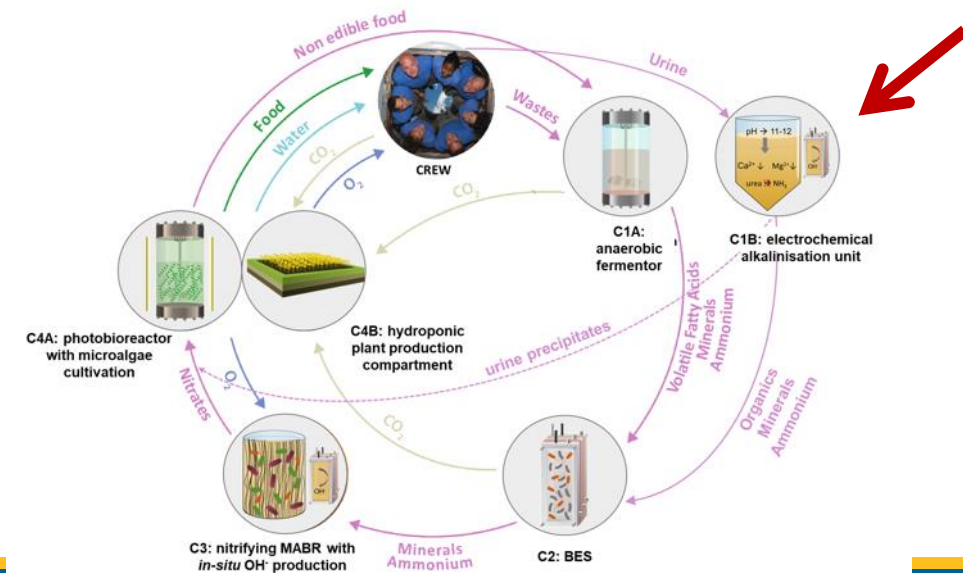
### Stabilisation through alkalisation and biological treatment

Followed by

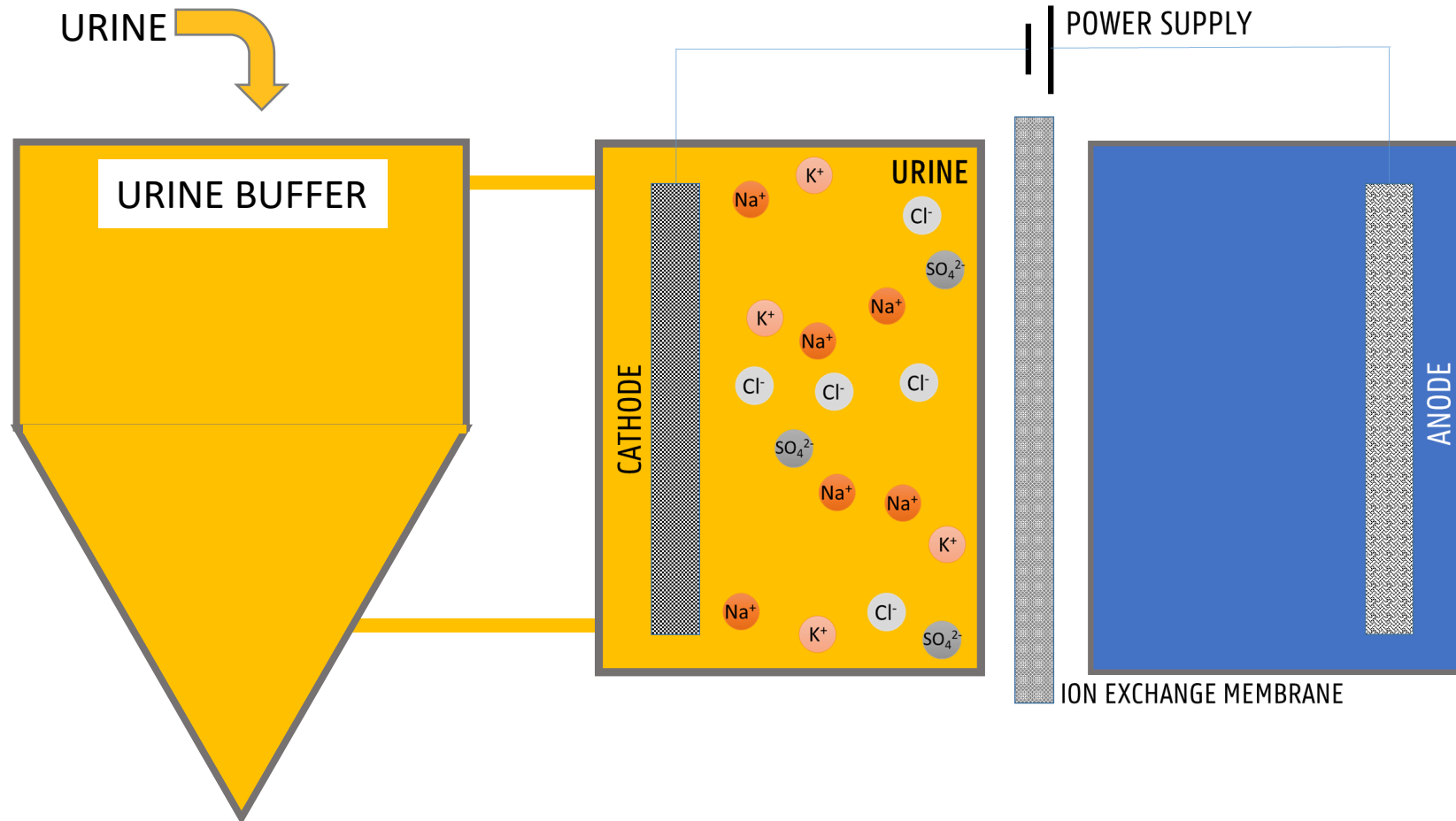
- water recovery (e.g., using membrane technology or distillation)
- water and  $N_2$  recovery
- integration in MELiSSA (microalgae – plants)

- ✓ no chemical input
- ✓ no toxic brine
- ✓ nutrient recovery

### Modified MELiSSA loop, including urine treatment



# URIDIS™ technology: how it works



**UAB**

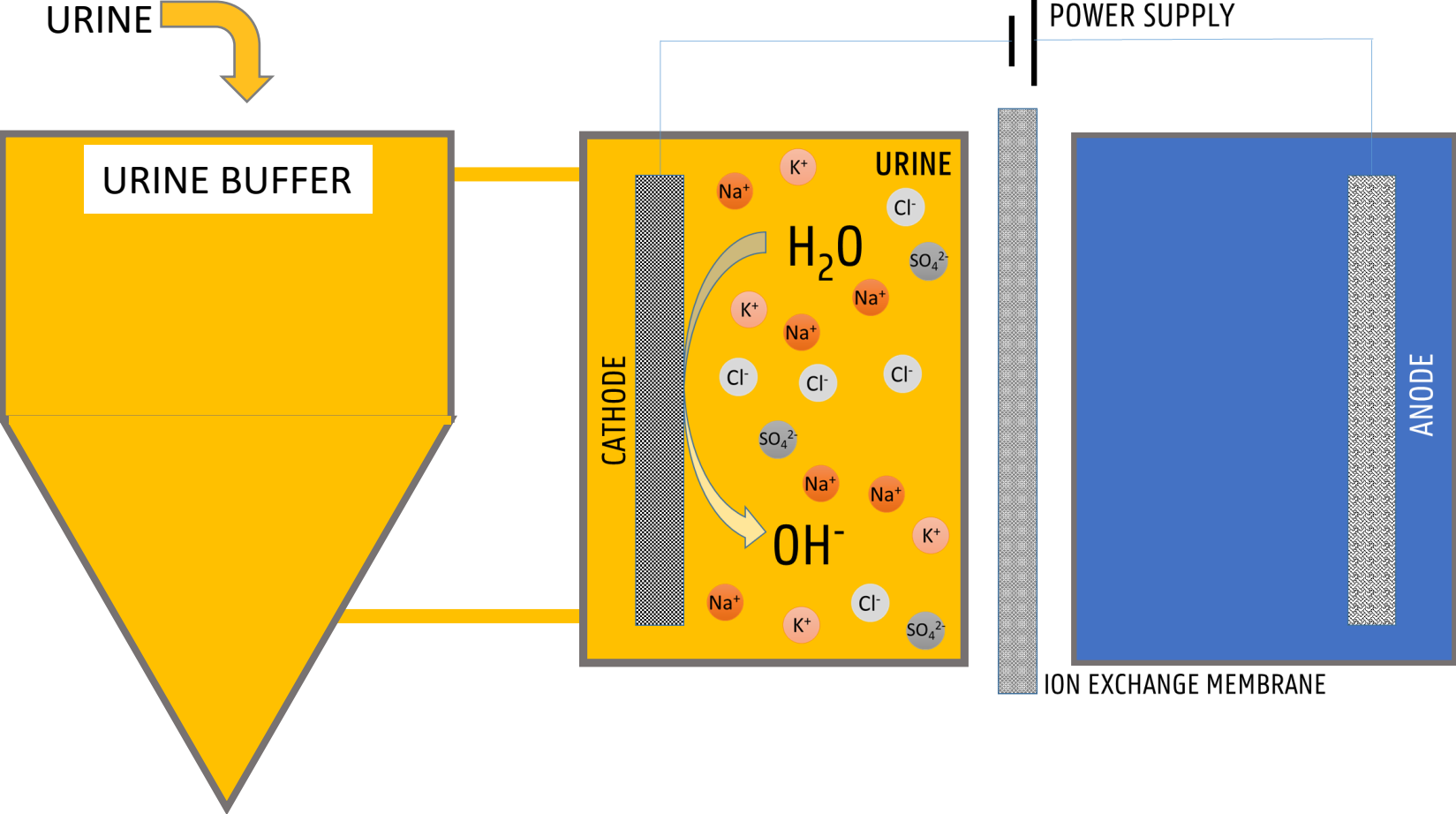


UNIVERSITEIT  
GENT

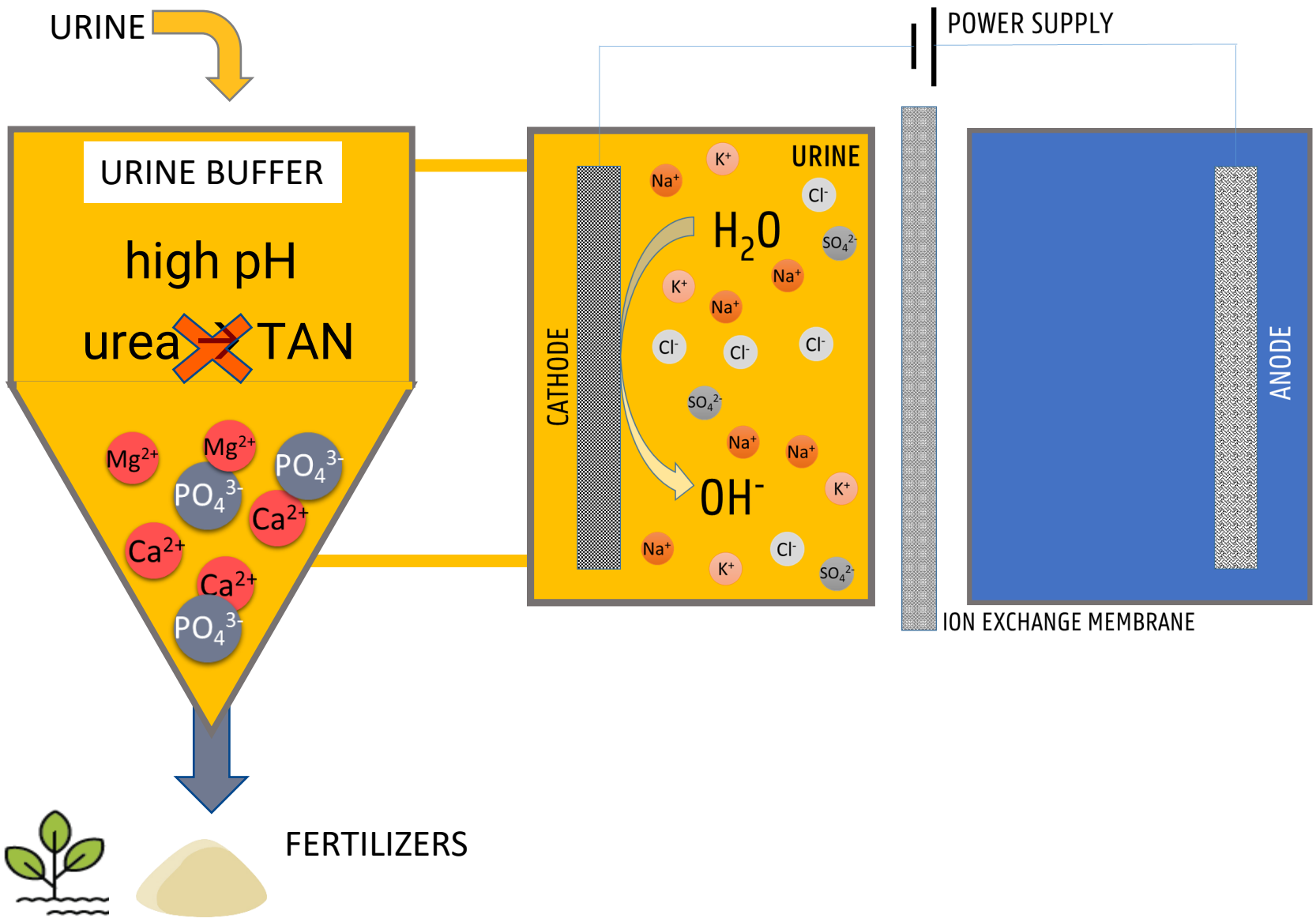


MELISSA FOUNDATION

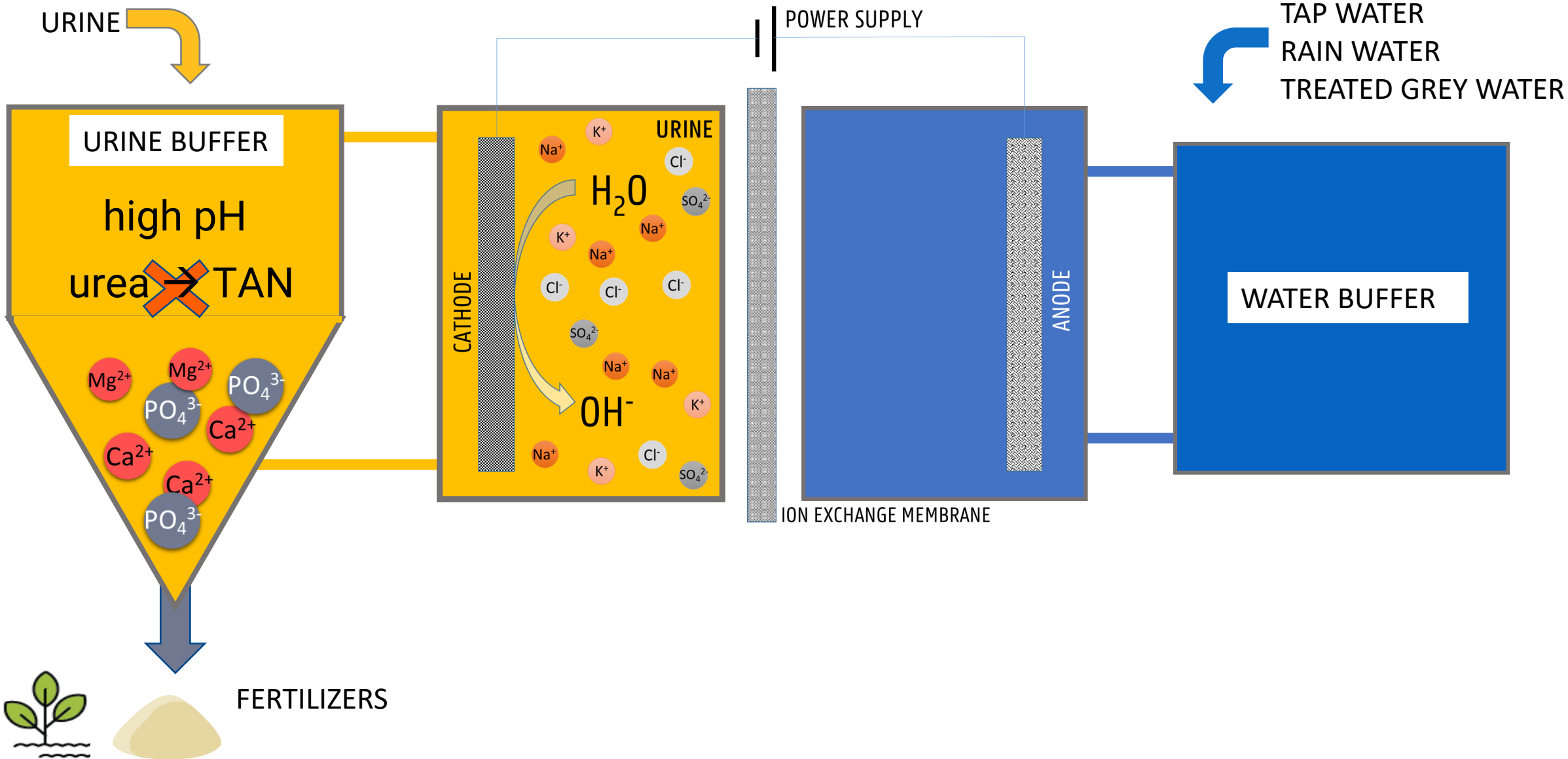
# URIDIS™ technology: how it works



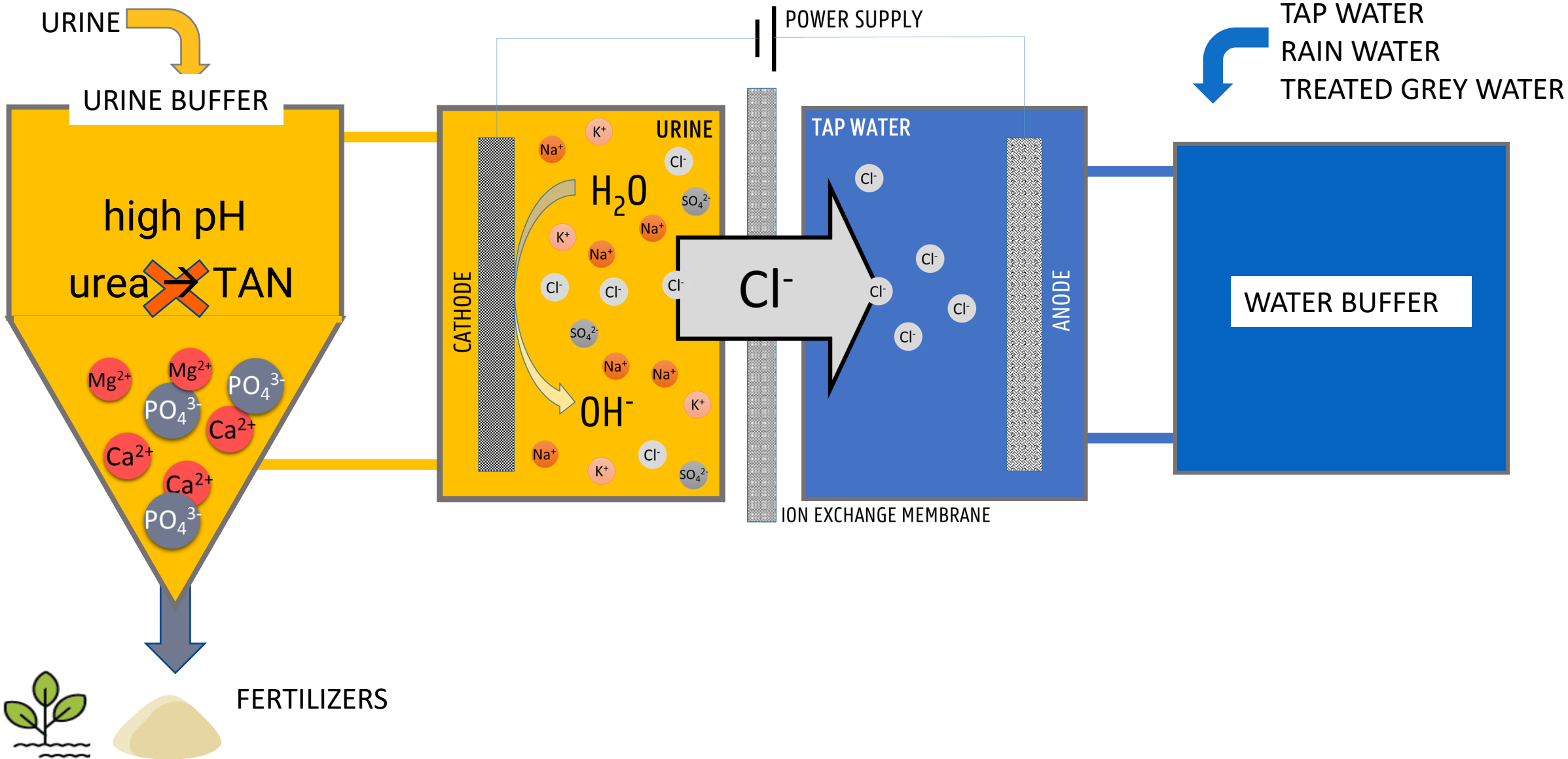
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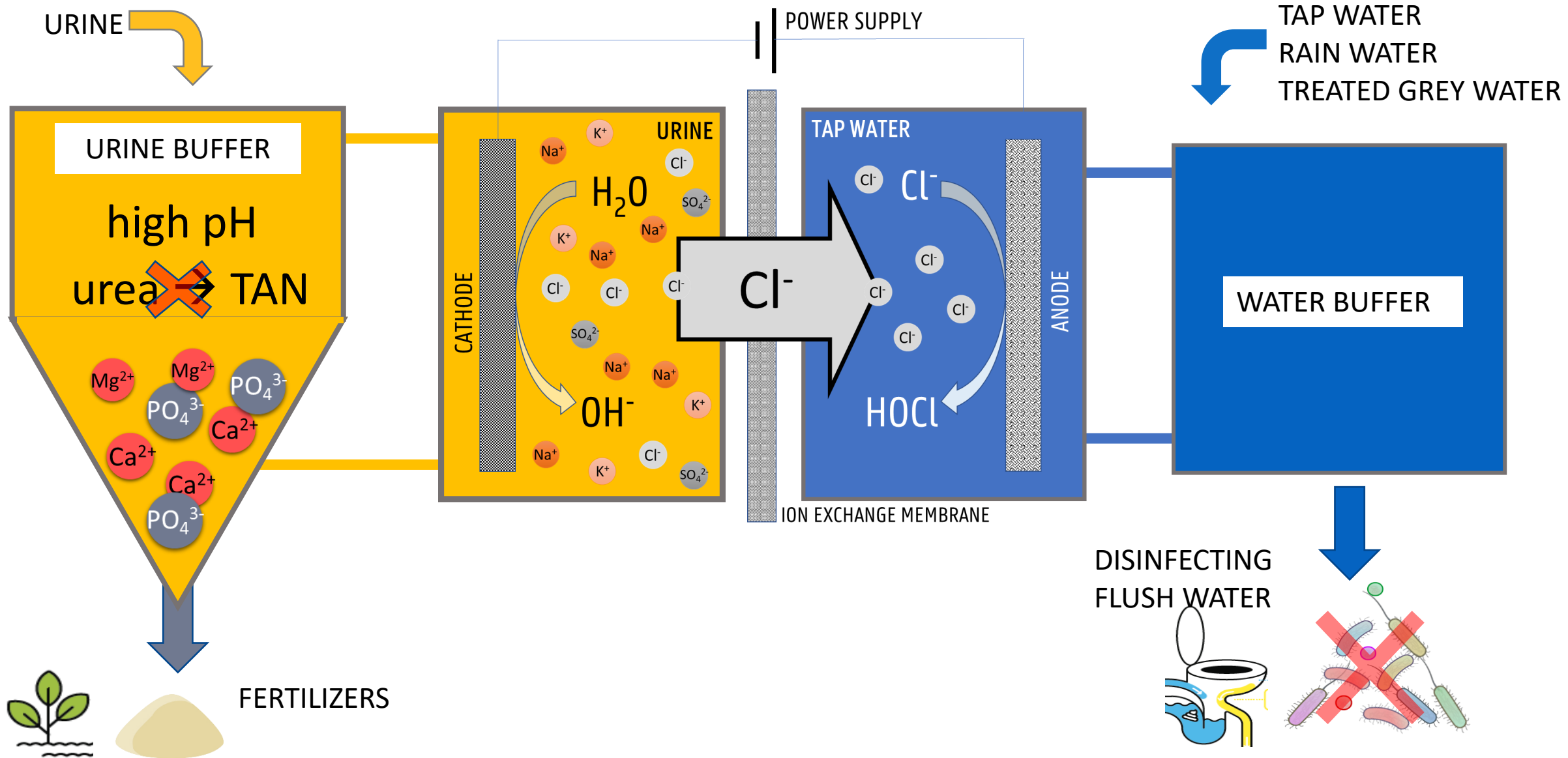
# URIDIS™ technology: how it works



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# URIDIS™ technology: how it works





# Demonstration project 'The Place To Pee'

First deployment of the URIDIS technology on scale, by coupling a URIDIS installation system to a temporary public toilet at 'De Blaarmeersen'

- Goals:

- 1) Technical:

- Test control system to deliver stable output at variable input of urine
- Evaluate effect at toilet level
- Assess maintenance need of the URIDIS system, and identify attention points for optimization trajectory

- 2) Outreach:

- Communication campaign in collaboration with Stad Gent, Laufen, Farys



LAUFEN



# Demonstration project 'The Place To Pee'

Summer 2021: URIDIS system coupled to a public toilet at 'De Blaarmeersen' (recreational area in Gent)



- Urine of 3500 visitors treated
- Positive feedback on the Save! toilet
- Positive feedback on disinfecting flush water



LAUFEN





**THE PLACE TO PEE**

## Circulair toilet in Gent recycleert urine

Lees voor

Het circulaire toilet 'The Place To Pee' in Gent recycleert dankzij een innovatieve technologie je plasje. Lees hier hoe het werkt.

## July design news: toilets, iceberg hotels and quilts

**The Guardian**

## Circulair toilet recycleert urine van bezoekers Blaarmeersen



(06-07-2021) Deze zomer recycleert het toilet 'The Place To Pee' het plasje van bezoekers in de Blaarmeersen. Dankzij innovatieve technologie wordt de urine verwerkt tot ontsmettend spoelwater en tot meststoffen voor de landbouw.

Nog tot en met eind september kunnen bezoekers hun plasje achterlaten in het circulaire toilet 'The Place To Pee', naast het centrale strandgebouw in de Blaarmeersen. De urine vloeit niet automatisch naar het riool, maar wordt via een innovatieve technologie, initieel ontworpen voor toepassingen in de ruimtevaart, gescheiden en verwerkt.

"Urine laten wegspoelen is zonde. Urine bevat waardevolle stoffen die ook de waterzuivering belasten. Bovendien verbruikt het spoelen van toiletten ook veel water. Daarom bedacht Hydrohm, spin-off van de UGent, de innovatieve Uridis-technologie. Via



## GENT Nieuw toilet in Blaarmeersen recycleert plasjes van bezoekers

In de Blaarmeersen werden nieuwe toiletten gezet die de plasjes van bezoekers hergebruiken. De opgevangen urine wordt gebruikt als spoelwater en meststoffen voor de landbouw.

Tot eind september kunnen bezoekers hun plasje achterlaten in de nieuwe 'circulaire toiletten' naast het centrale strandgebouw in de Blaarmeersen. Daar stroomt het niet automatisch door naar het riool, maar wordt het apart

opgevangen en verwerkt. «Urine laten wegspoelen is zonde», zegt Pieter Naert van Hydrohm, een bedrijf verbonden aan de UGent. «Urine bevat waardevolle stoffen die ook de waterzuivering belasten. Bovendien verbruikt het spoelen van toiletten veel water. Daarom bedacht Hydrohm een innovatieve technologie waardoor we fosfor en stikstof uit de urine kunnen halen, om te gebruiken als meststoffen in de landbouw. Daarboven kunnen we ontsmettend spoelwater, water en groene stroom halen uit de urine.»

### Waterbesparend

Het toilet ziet er hetzelfde als andere toiletten, maar de impact is gewoon groter. De nieuwe technologie zorgt voor waterbesparing, een properder toilet en afvalwater en meer waardevolle

## Naar het toilet in de Blaarmeersen? Je plasje wordt gerecycleerd

GENT

Deze zomer kun je in een container op het strandgedeelte van de Blaarmeersen een nuttig plasje doen. Via een proefproject met nieuwe technologie wordt urine van bezoekers gerecycleerd tot ontsmettend water om de toiletten te spoelen en tot meststoffen voor de landbouw.

De strandzone van de Blaarmeersen heeft er tijdelijk een container met openbare toiletten bij. Op het eerste gezicht is er niets bijzonders aan de wc-potten en toch zit er een hele nieuwe technologie achter. De urine van bezoekers wordt er immers apart opgevangen en hergebruikt. Dat gebeurt in een installatie die opgesteld staat in een tweede container naast de



In de ogenschijnlijk gewone containertoiletten op de Blaarmeersen wordt van de plasjes iets nuttigs gemaakt.

toiletten.

«Via een innovatieve zuive-

ringstechnologie halen we fosfor en stikstof uit de urine, om

als meststoffen te gebruiken in de landbouw», zegt Piet Naert van Hydrohm, gelinkt aan de UGent. «Daarnaast produceren we ook ontsmettend spoelwater uit urine, water en groene elektriciteit. Zo zorgen we voor waterbesparing, properder afvalwater en hygiënische toiletten.»

### Toekomstmuziek

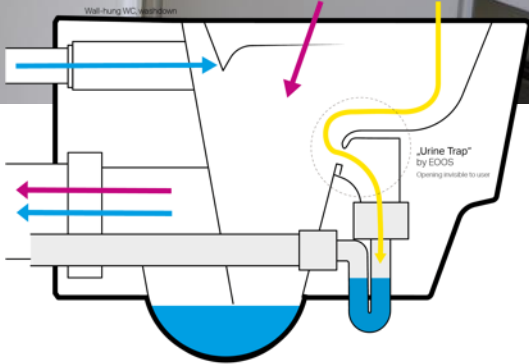
In de toekomst kan de technologie worden gebruikt voor publieke toiletten in stations, kantoorgebouwen of op evenementen.

De toiletten op de Blaarmeersen zijn onderdeel van een proefproject en staan er tot eind september. Stad Gent geeft via een fonds voor innovatieve projecten 38.500 euro steun aan het initiatief. (fl)

# Toilet container



**LAUFEN**  
Save! Toilet



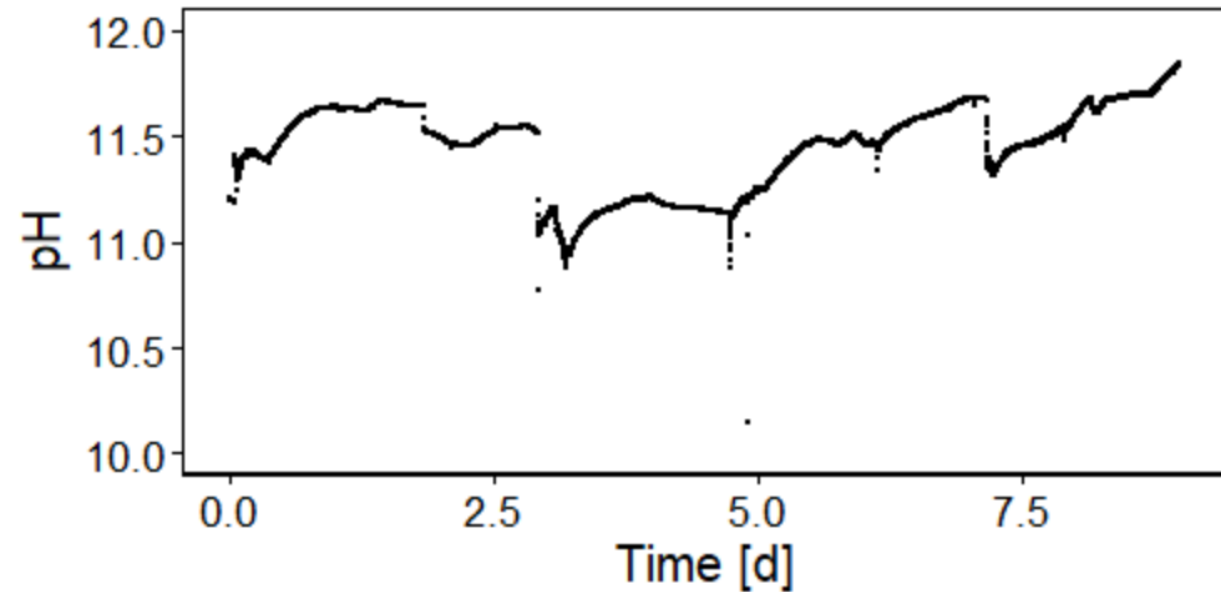
# Technology container





# System performance

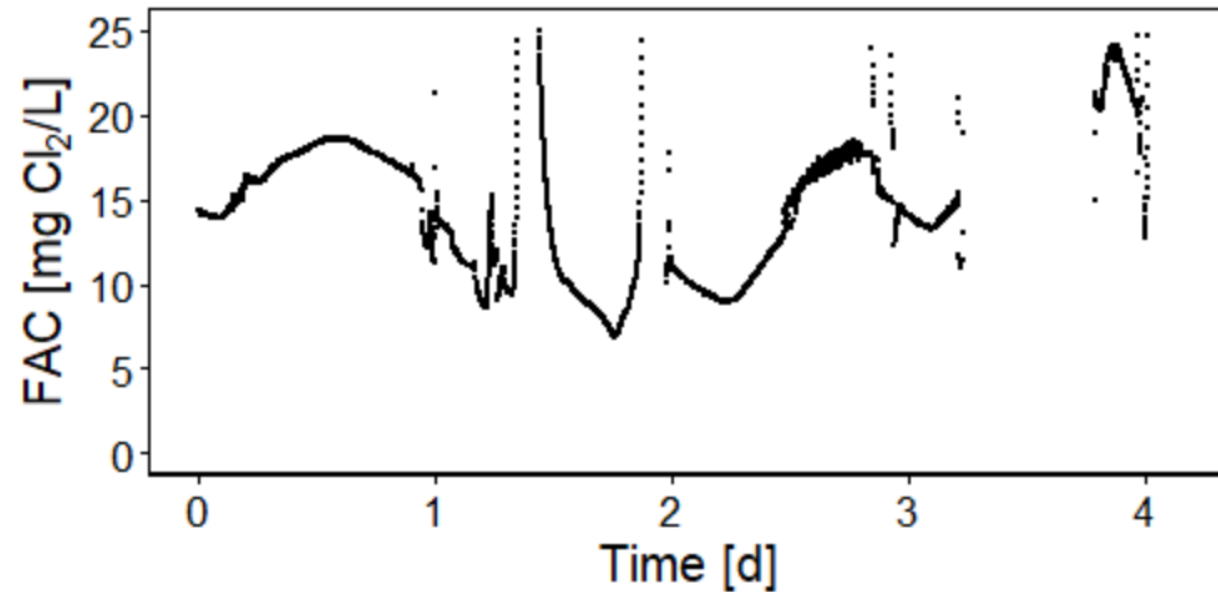
pH urine tank



pH depends on

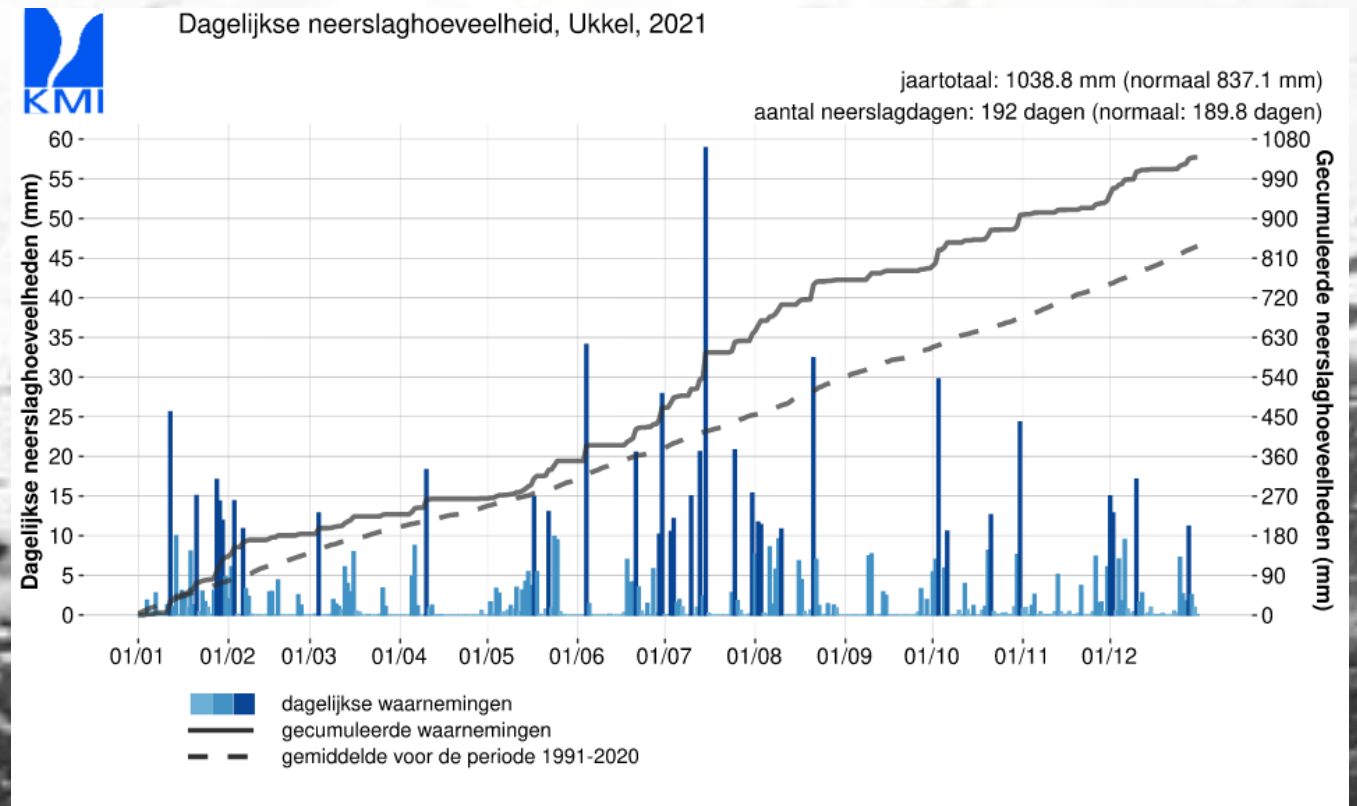
- Urine input
- Current of PS (<FAC concentration)

FAC disinfectant tank



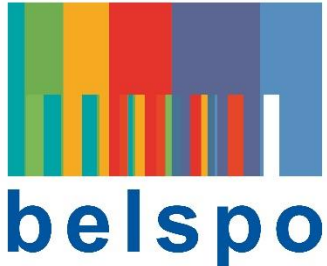
FAC (free active chlorine) depends on

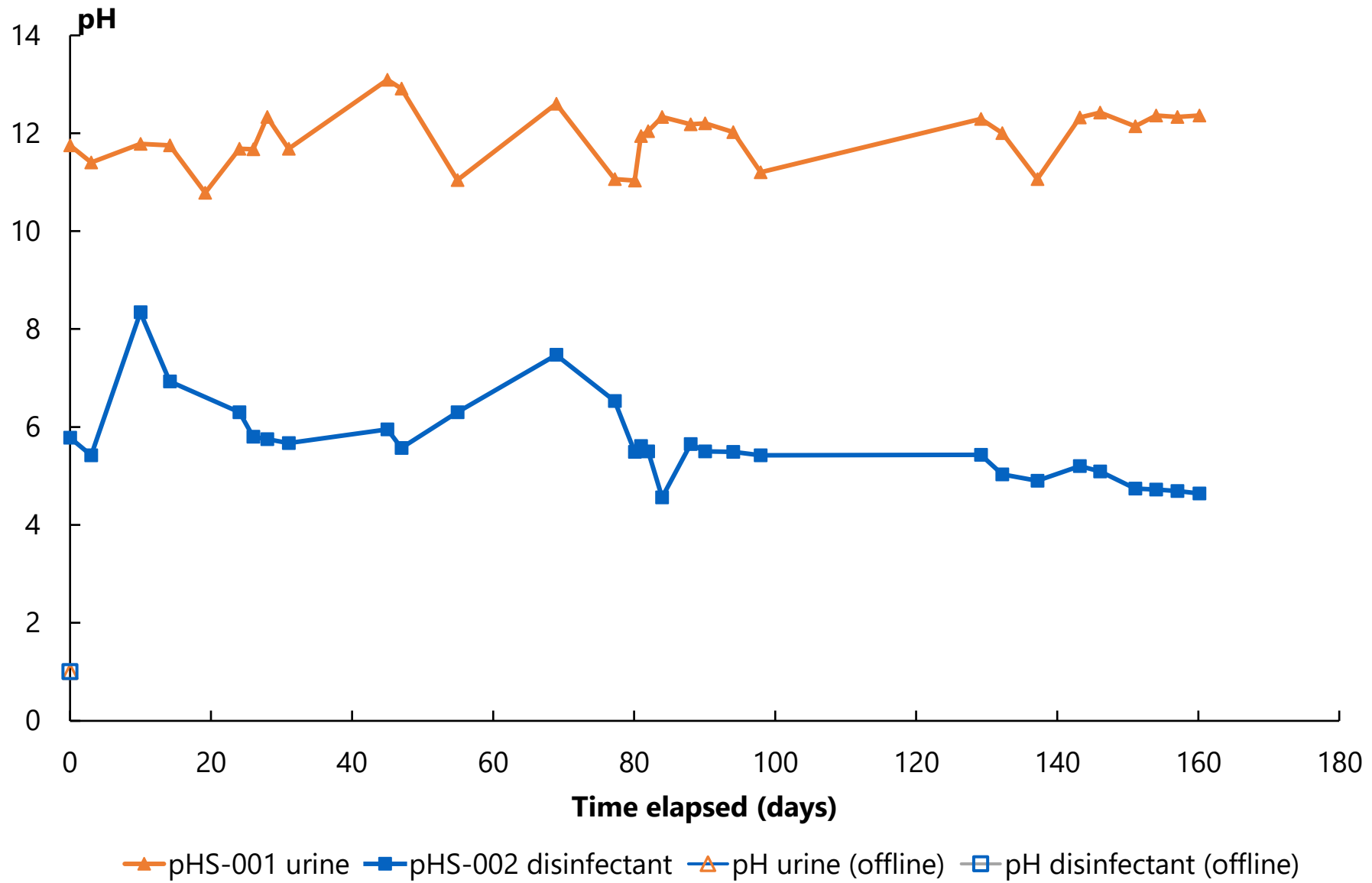
- Flush water demand
- Current of PS (<FAC concentration)

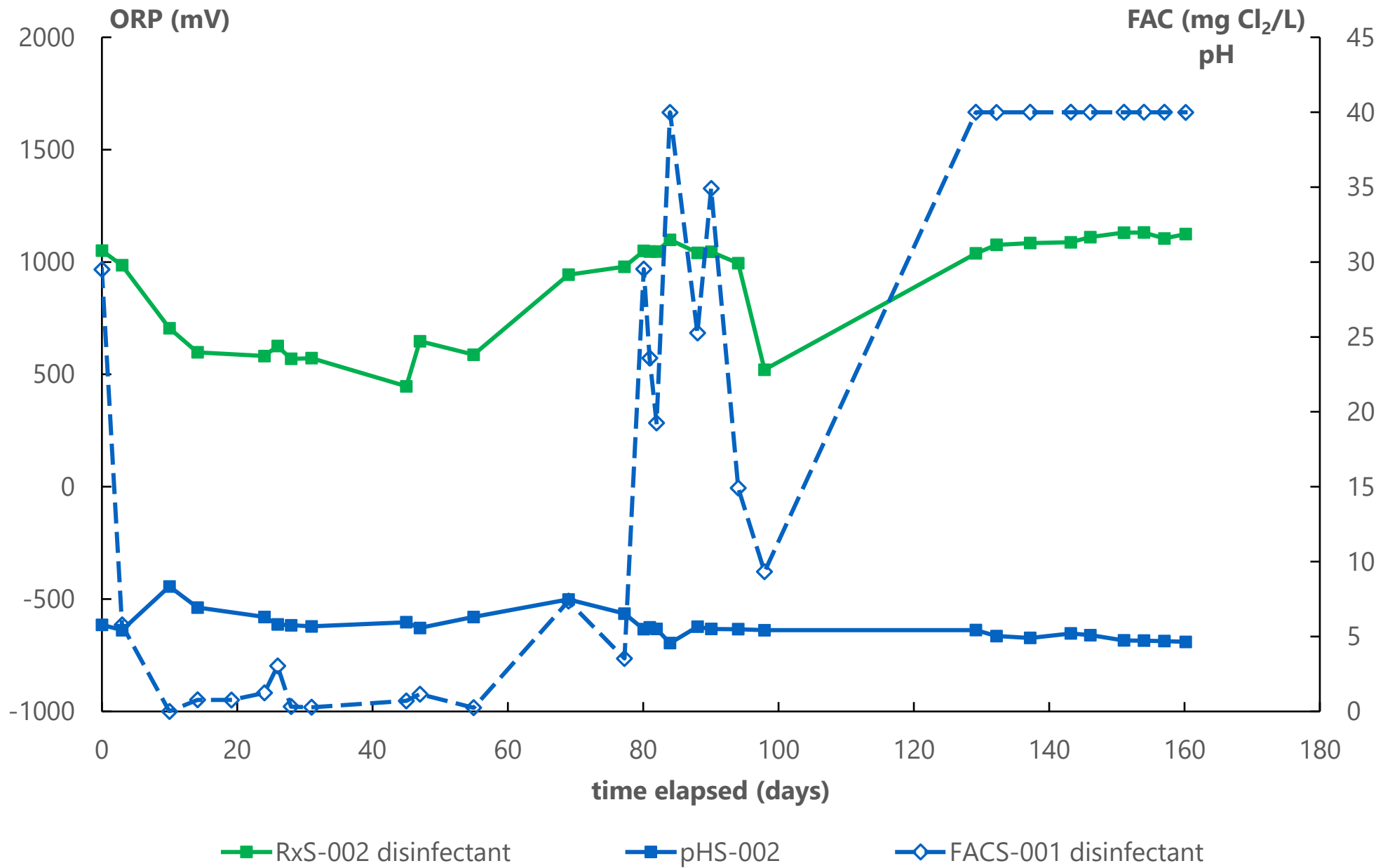




# New demonstration project: 2 schools in Deinze and Eeklo

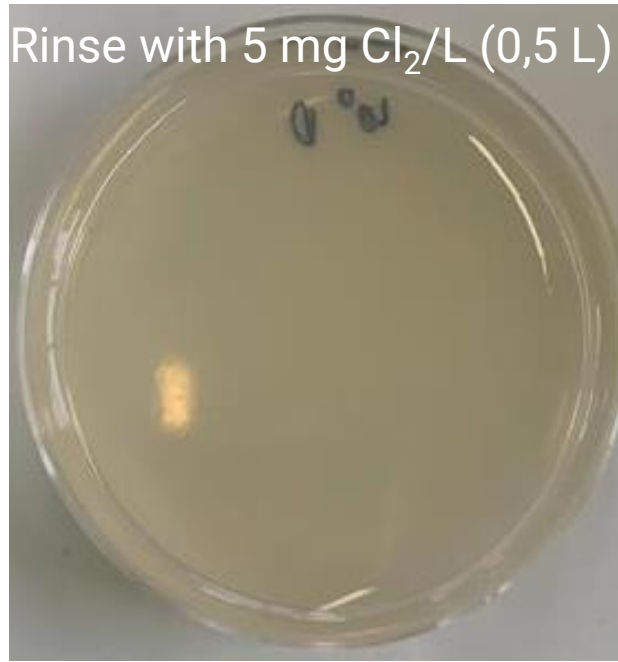
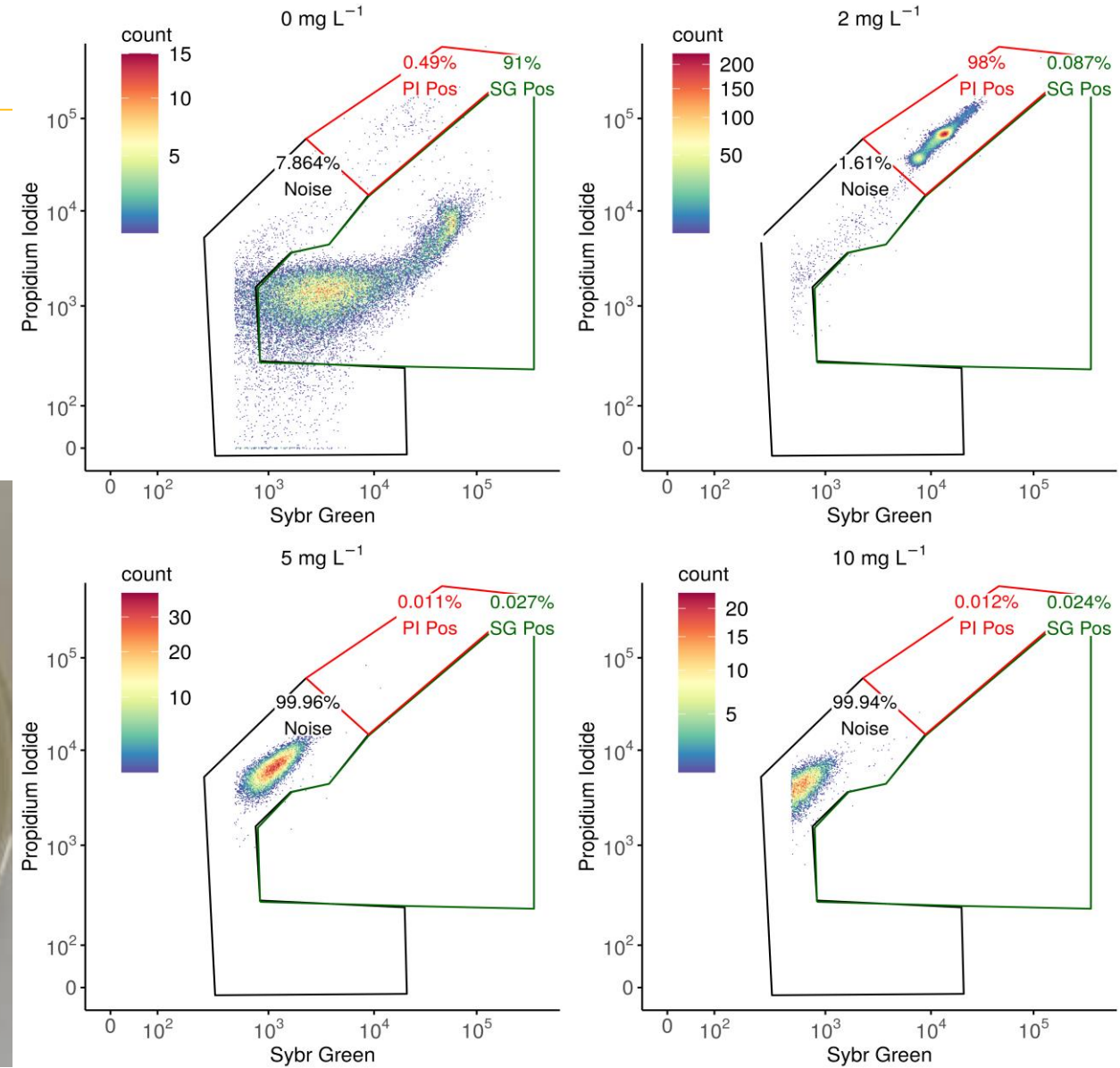


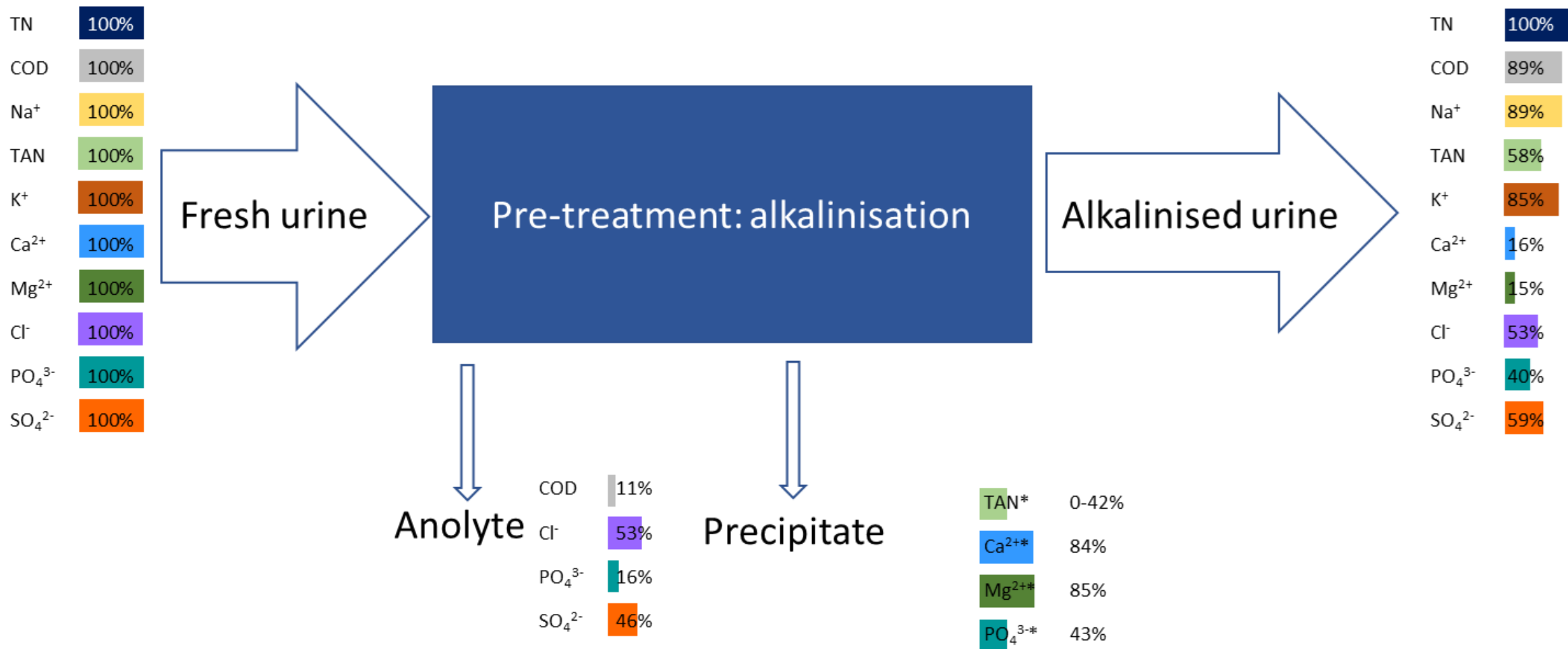




# Use of disinfecting flush water

- >3 log reduction in *E. coli* culture (initial concentration:  $10^7$  cells/mL) at 2, 5 and 10 mg  $\text{Cl}_2/\text{L}$





SaRY, poster Coene

# Challenges ahead

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1. Create robust N conversion
  1. Nitrification for C4 in space, for recovery / injection on earth
  2. Recovery as ammonia
2. Optimize system control – towards dynamic controllers
3. Optimize P separation
4. Water recovery – towards an integrated solution on earth

# HYDROHM

Electrify water



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Visit us at [www.hydrohm.com](http://www.hydrohm.com)

# ELECTRIFIED WASTEWATER RECYCLING

## Using space technology to make hygienic and sustainable toilets



know.space

URIDIS innovative electrochemical water treatment technology, developed under ESA's MELiSSA project (to build a closed life support system) is being used by Belgian company HYDROHM to treat urine on Earth, saving water and recovering valuable nutrients

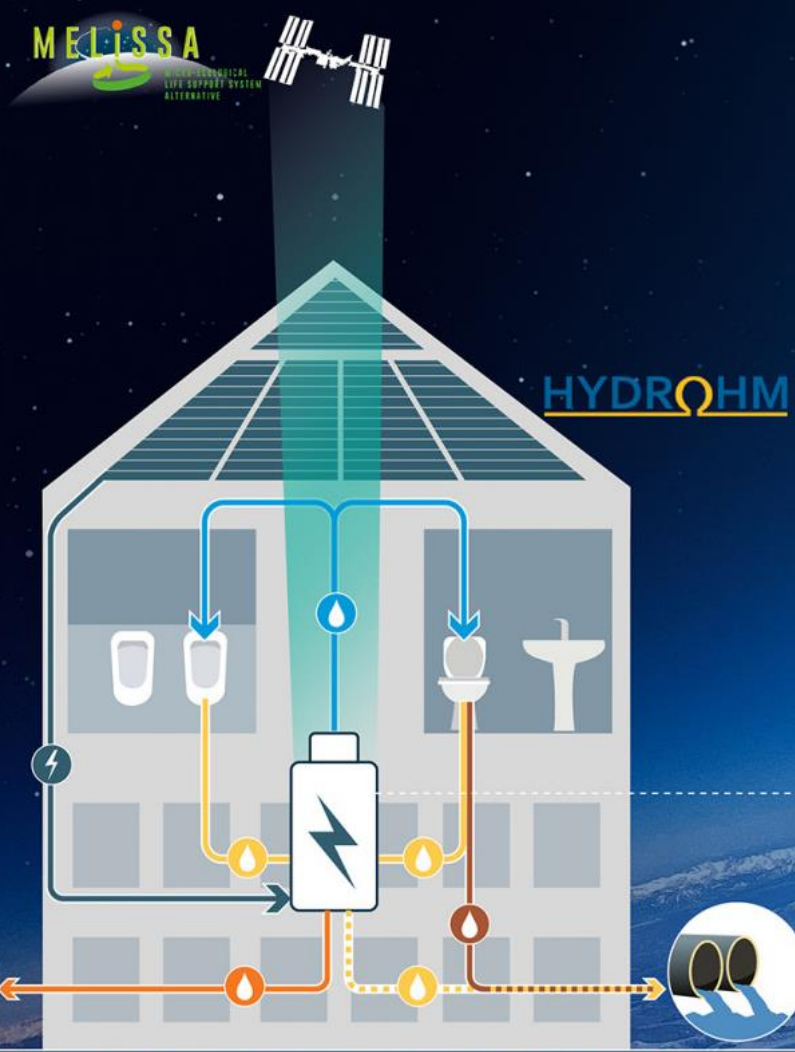
**Up to 60% water savings**  
(traditional toilets use up to 13 litres per flush)

Improved **toilet hygiene** due to disinfecting nature of treated flush water

Successful **Ghent University spin-off** company created with potential for rapid growth

Reduced treatment load, saving up to **~40% less energy** & up to **~50% less GHG emissions**

**Nutrients recovered** from human urine could replace **1/4 of global fertiliser production**



**Sustainable** using green energy, and no heavy chemicals

**Cost recouped in just 7 years** for high usage toilets (e.g. offices or hospitals)

Helps customers to promote a **sustainable brand image** in a practical and visible manner

### APPLICATION USE CASES



Graphic by Spatial Design Hub

Commercial in confidence

