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De waarde van water: de weg naar een toekomstbestendige afvalwaterzuiveringen

Jouke Dykstra - Sjoerd Kerstens
12 oktober 2023

11-10-2023

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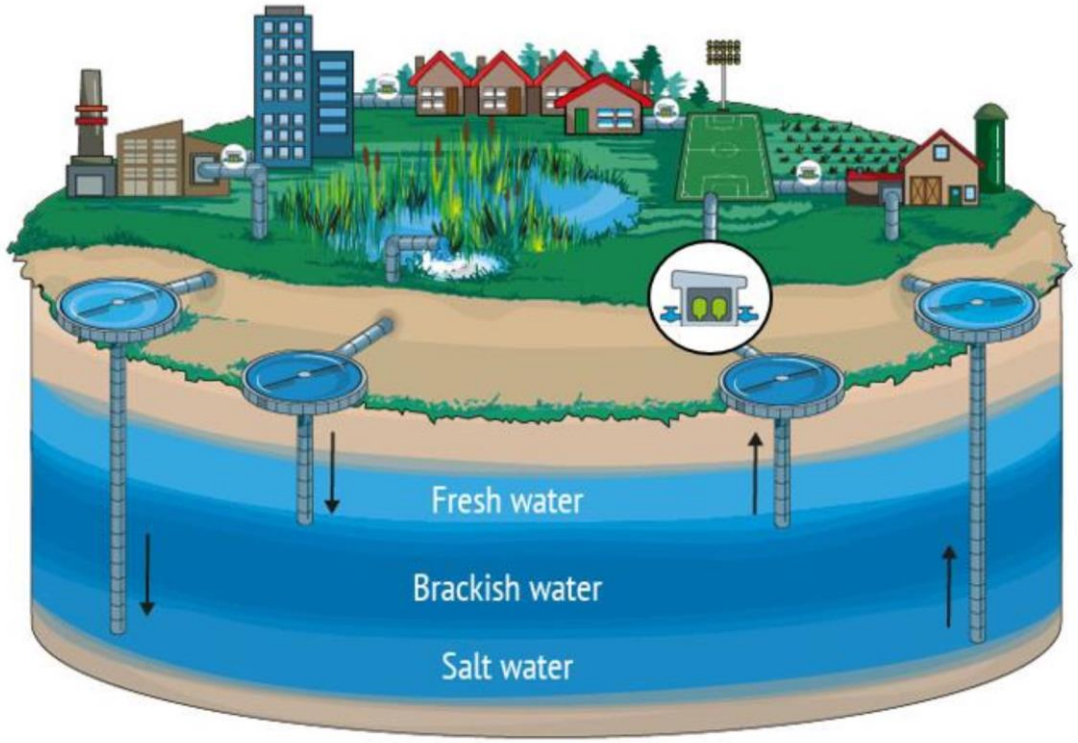
Sjoerd Kerstens (RHDHV)

Jouke Dykstra (WUR)

Why chemical and physical technologies?

- Decentralized implementation: treatment to match supply and demand
- Water treatment fit for purpose
- Flexible use,
  no start-up time



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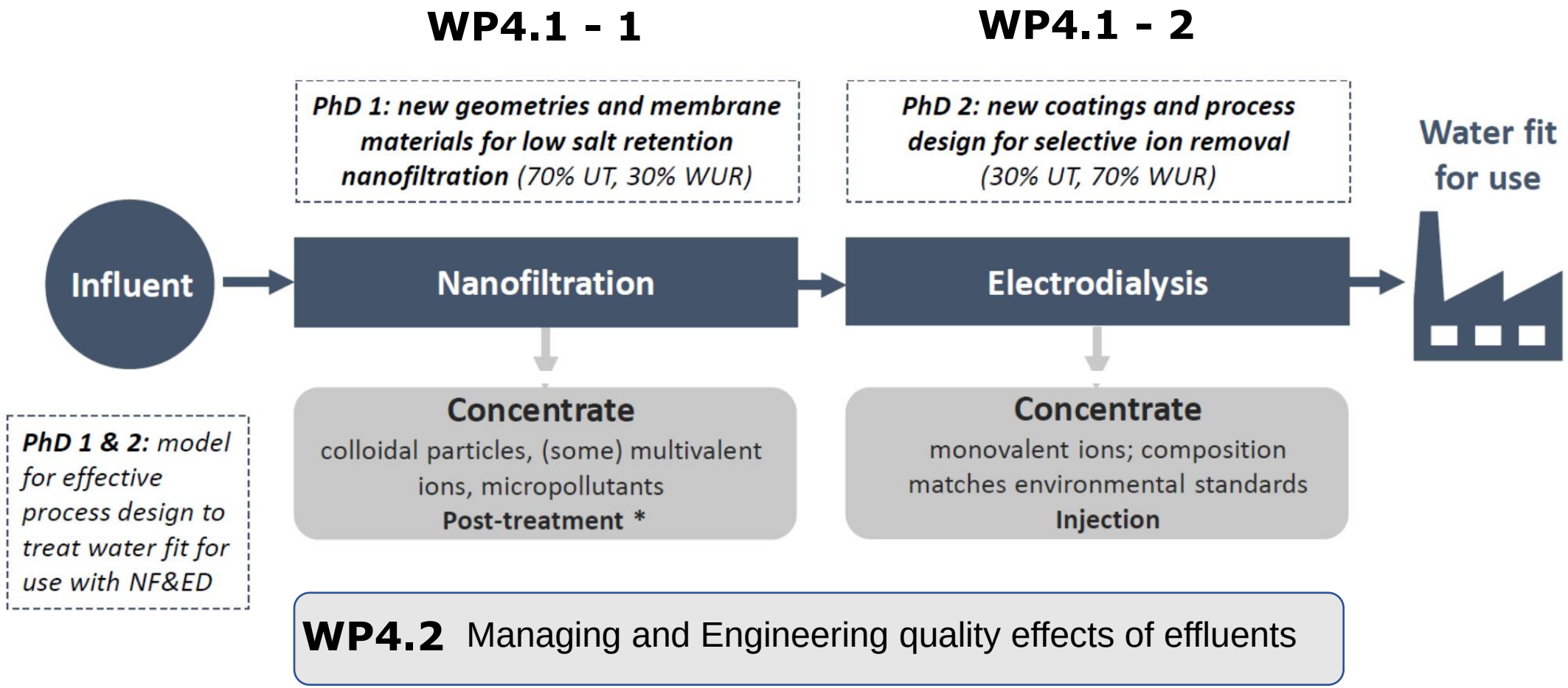
Overview WP4



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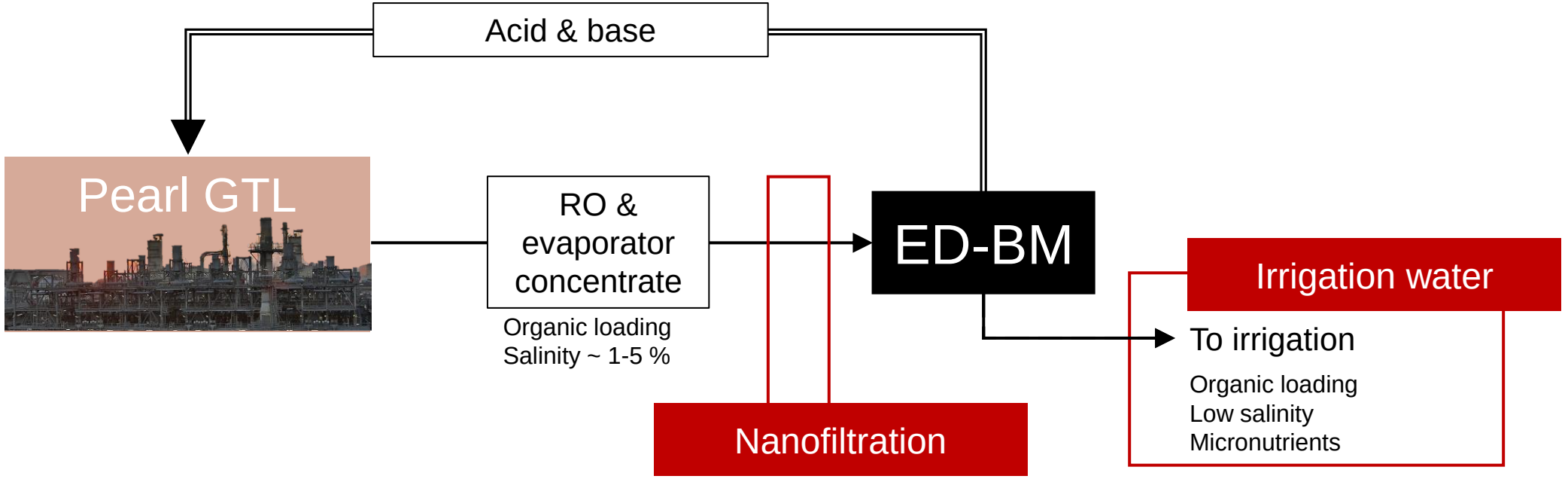
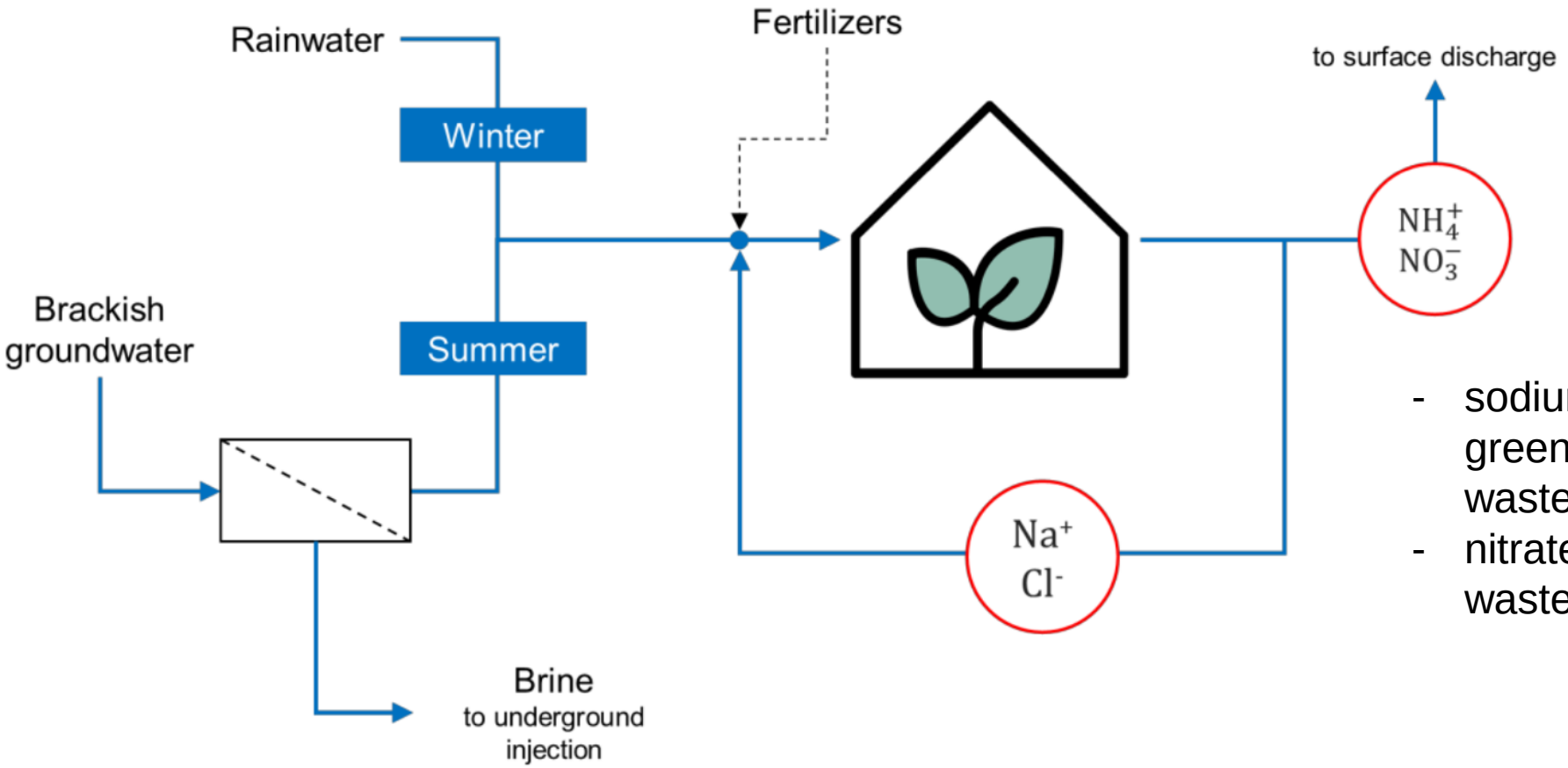
Case study: production acids & bases at Shell, Qatar



Case study: closing water cycles greenhouses



- sodium removal for greenhouse wastewater recycling
- nitrate removal for wastewater disposal

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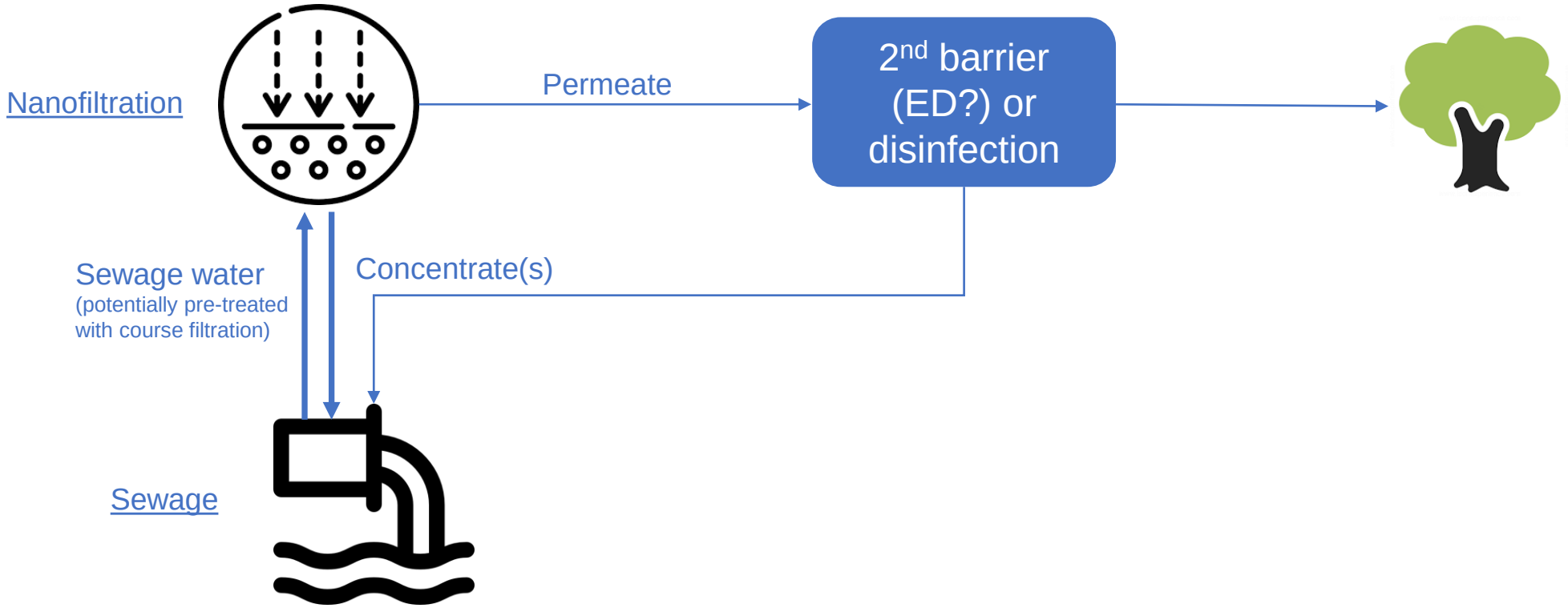
Case study: water mining from sewage



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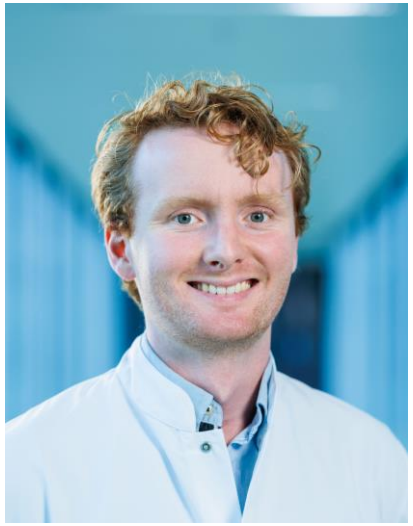
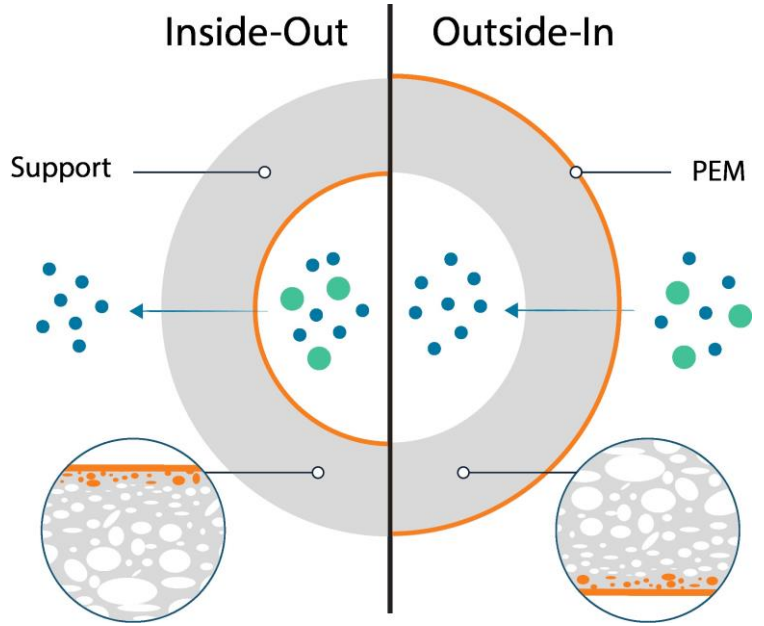
WP4.1 – Nanofiltration: Outside-In Polyelectrolyte multilayer membranes



Advantages outside-In over inside-out:

- Increase in active surface area per module → up to 5x
- Smaller fibres can be fabricated → Increase in mechanical strength leading to new possible applications
- New module designs possible limiting concentration polarization → better (micro)pollutant retentions



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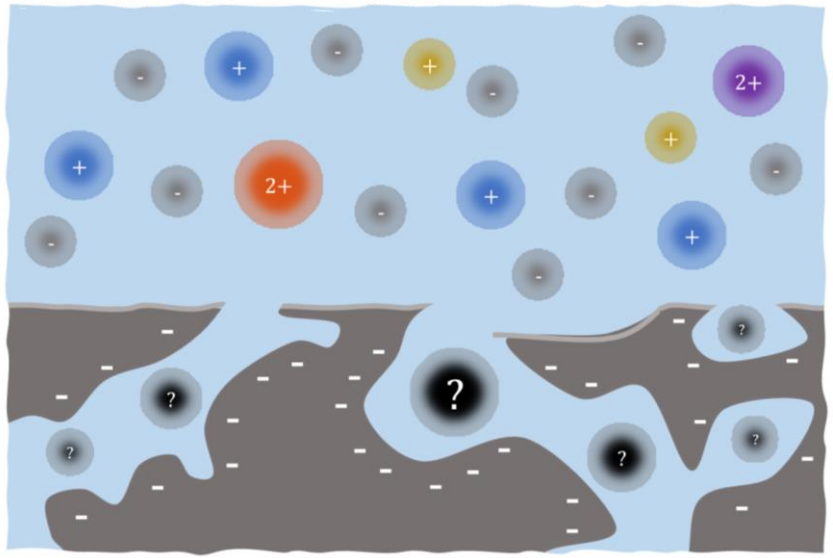
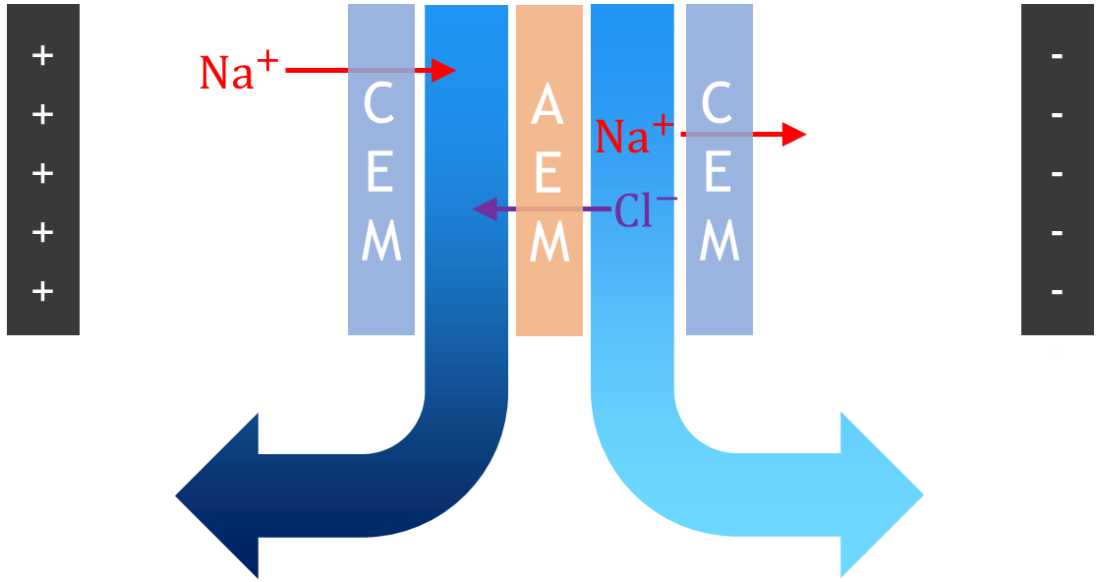
WP4.1 – electrodialysis for selective-ion separations

- We investigated the ion equilibrium and transport across ion-exchange membranes.
- Multivalent ions, e.g. Ca^{2+}, dominate the equilibrium over the monovalent ones, e.g. Na^{+}.
- General affinity inside cation-exchange membranes:

  $Ca^{2+} > Mg^{2+} > K^{+} > Na^{+}$

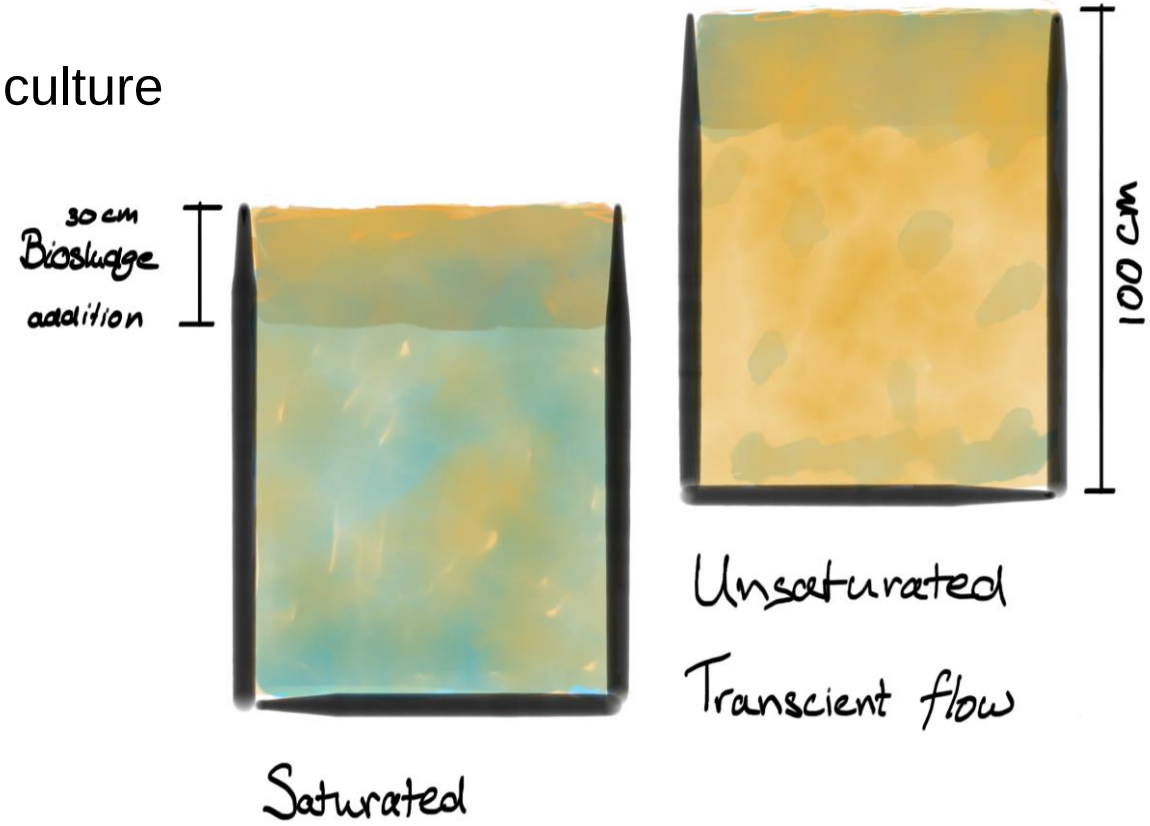




WP4.2 – assessing the fate of contaminants of emerging concern (CECs) in effluents during irrigation

- Creating a contaminant transport prediction model that is suitable for extreme dry climates
- Contribute to safe reuse of effluents in agriculture

- Modelling leaching of metals from industrial biosludge used as fertilizer in arid/desert climate
- Model can be used for prediction of sandy soils in desert climate, still optimization needed



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Enhancing Society Together

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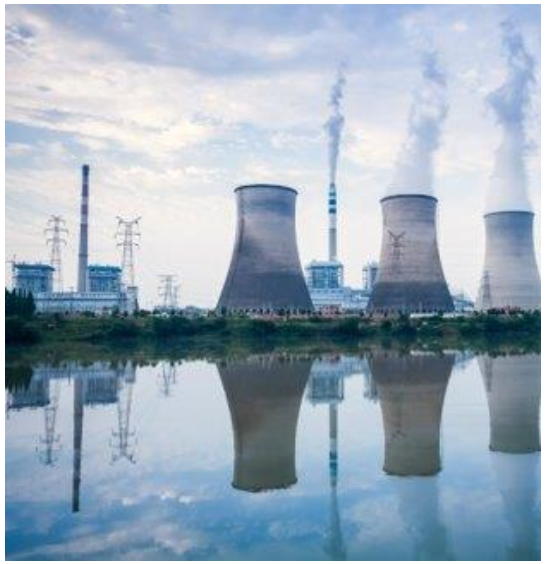
From reducing impact towards positive impact

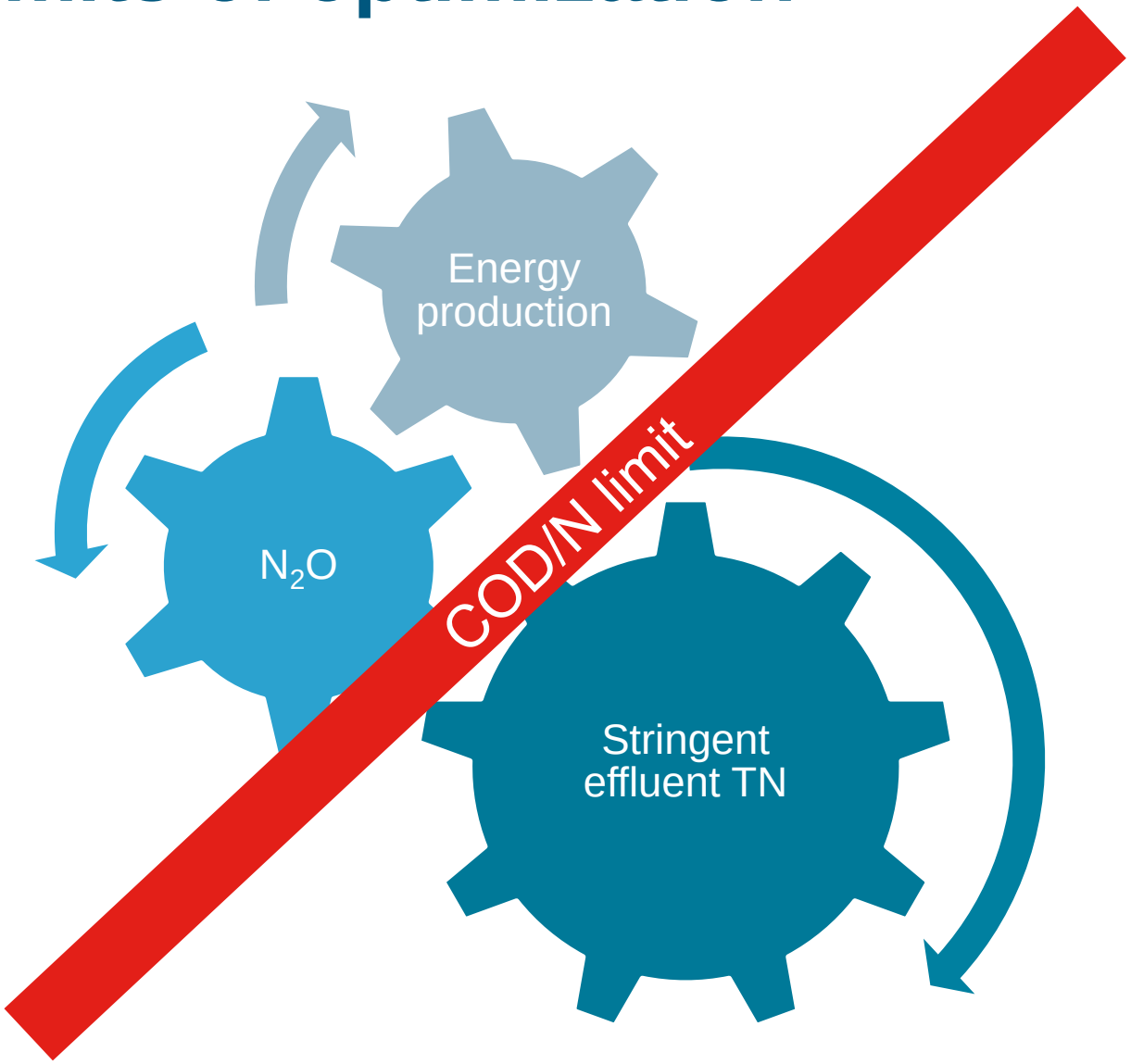


Energy saving, GHG reduction

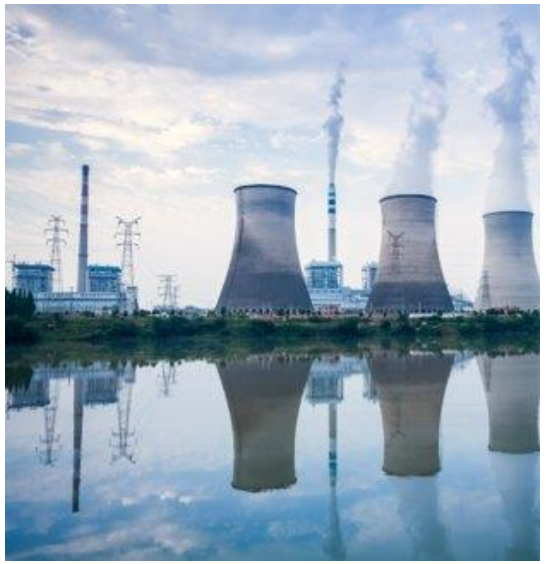
Space saving

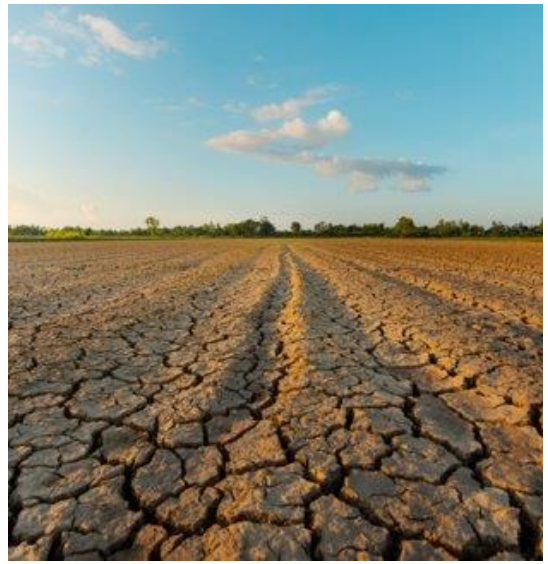
Reduce

Reaching the limits of optimization



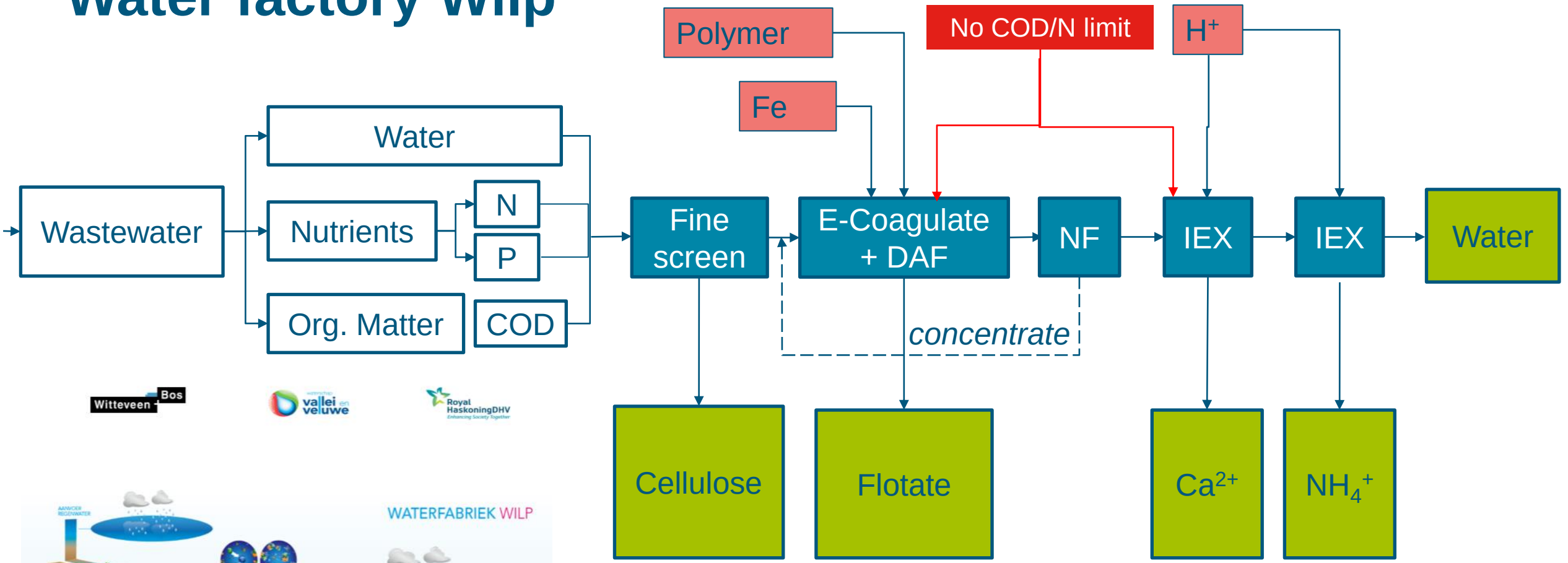
Shifting from less negative to positive





Enhance	Energy production, CO_2 uptake, fossil fuel-based products replacements	Space creation	N&P fertilizer, N to energy, protein (feed)	Water source to combat drought, for agriculture, nature, industry
↕	↕	↕	↕	↕
Reduce	Energy saving, GHG reduction	Space saving	Reduction of N&P discharge	Reduce water consumption

Water factory Wilp



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Outcome

- Excellent removal of TSS, N and P
- Poor removal of COD and insufficient of BOD
- CEC compliant with Guidelines of Ministry of I&W (IPMV)

Parameter	Unit	Requirement (EFD)	Average	Maximum
TSS	mg/l	< 3	0,0	<5
P-total	mg/l	< 0,15	0,01	0,05
N-total	mg/l	<4,8	0,87	1,27
COD	mg/l	<125	74,2	79
BOD	mg/l	<20	30	53

Influent Flotate DAF effluent NF filtrate IEX filtrate

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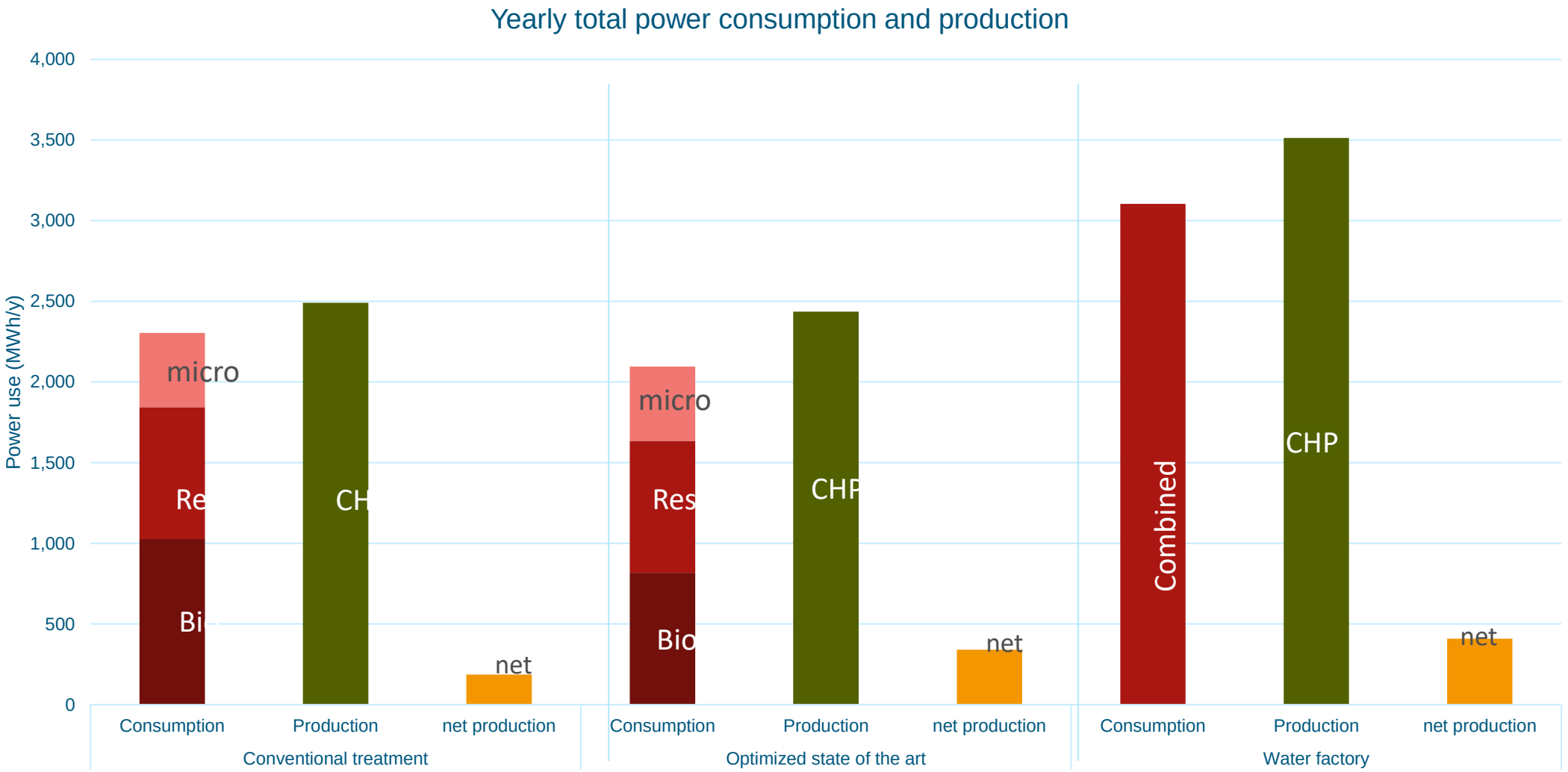
Energy consumption & production (100,000 PE)



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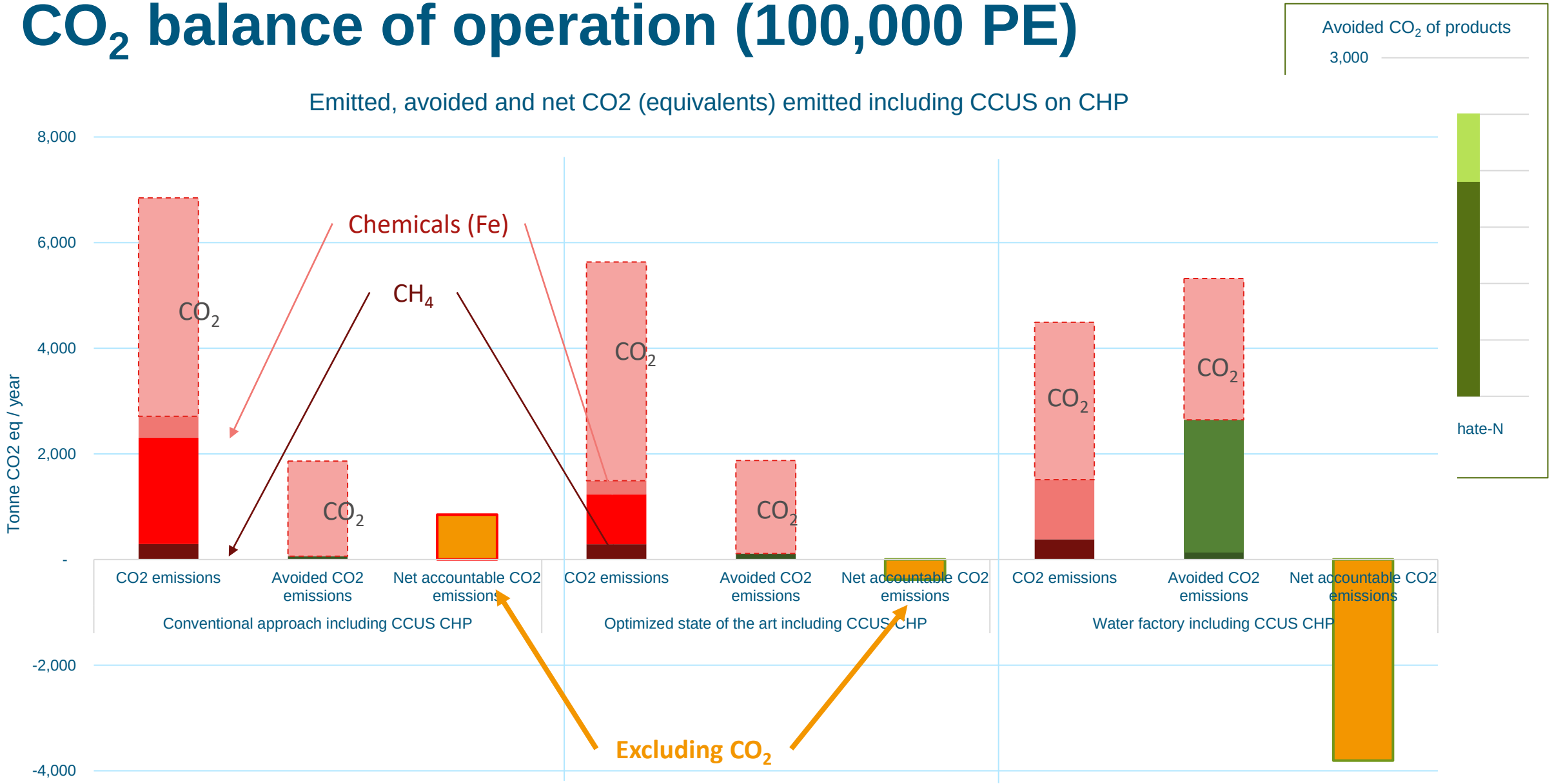
CO_2 balance of operation (100,000 PE)



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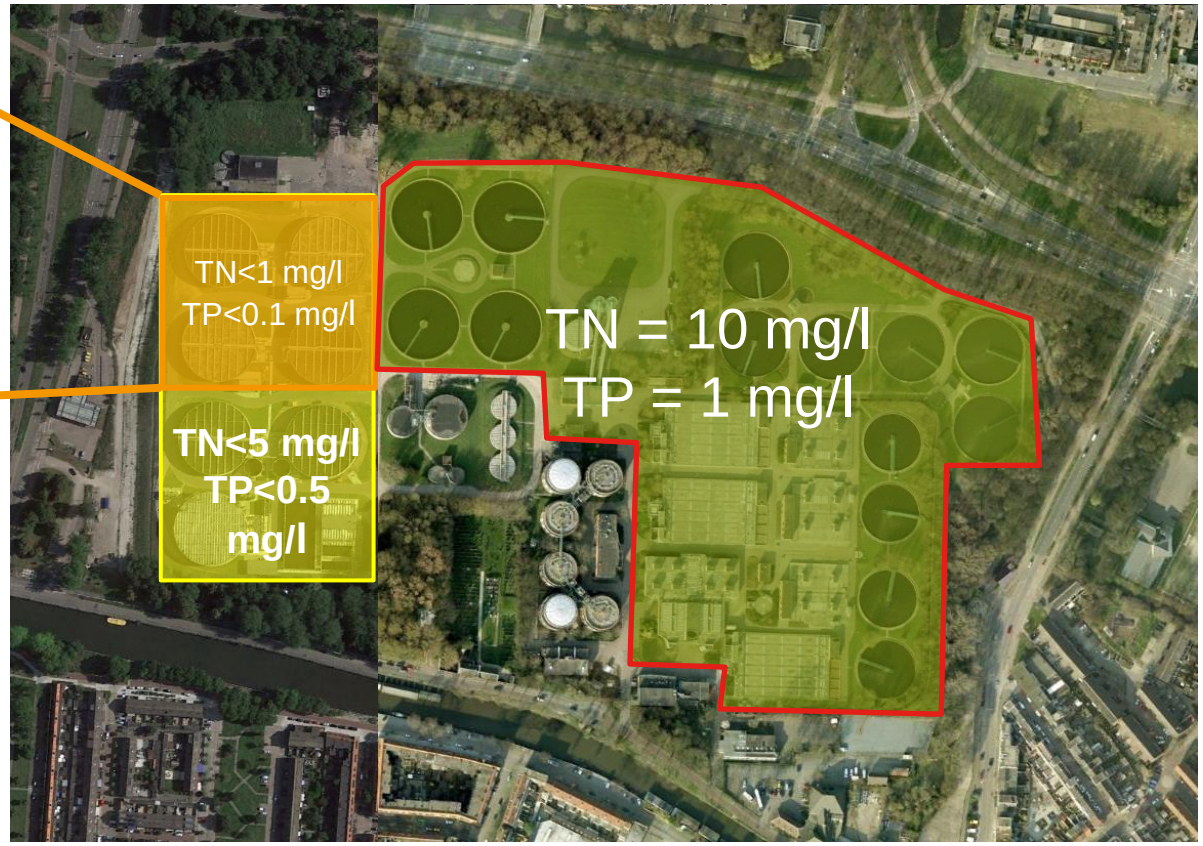
Space creation in a bird view

Stowa, 2023

- Coarse screen
- Fine screen
- Electro coagulation
- Flocculation
- Dissolved Air Flotation
- Buffer
- Nano filtration
- Ion exchange (1)
- Ion exchange (2)
- pH correction
- PE-preparation
- Chemicals



Conclusions

- Future societal challenges require new approaches in WWT
- Boundaries are reached in optimizing effluent levels, energy and GHG, space
- New approaches will involve more chemical/physical processes
- These processes produce a high-water quality, are climate positive and free up space
- Identified bottlenecks in this technology development are:
  - COD and BOD soluble in effluent
  - High Fe and other chemical usage

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