



Sustainability evaluation of phosphorus removal techniques on municipal wastewater treatment plants

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SUSTAINABILITY AT KEMIRA



We share the worlds future ambition articulated in the UN Sustainable Development Goals (SDGs).

Background

A woman is swimming in the ocean, her arms outstretched and her head tilted back, smiling broadly. The water is a deep blue-green color with some ripples and small waves. The overall scene is bright and positive.

Many people consider

- Biological = 😊
- Chemical = ☹️

Need to remember biological processes are chemical processes

Chemical processes mimics the reactions in Nature

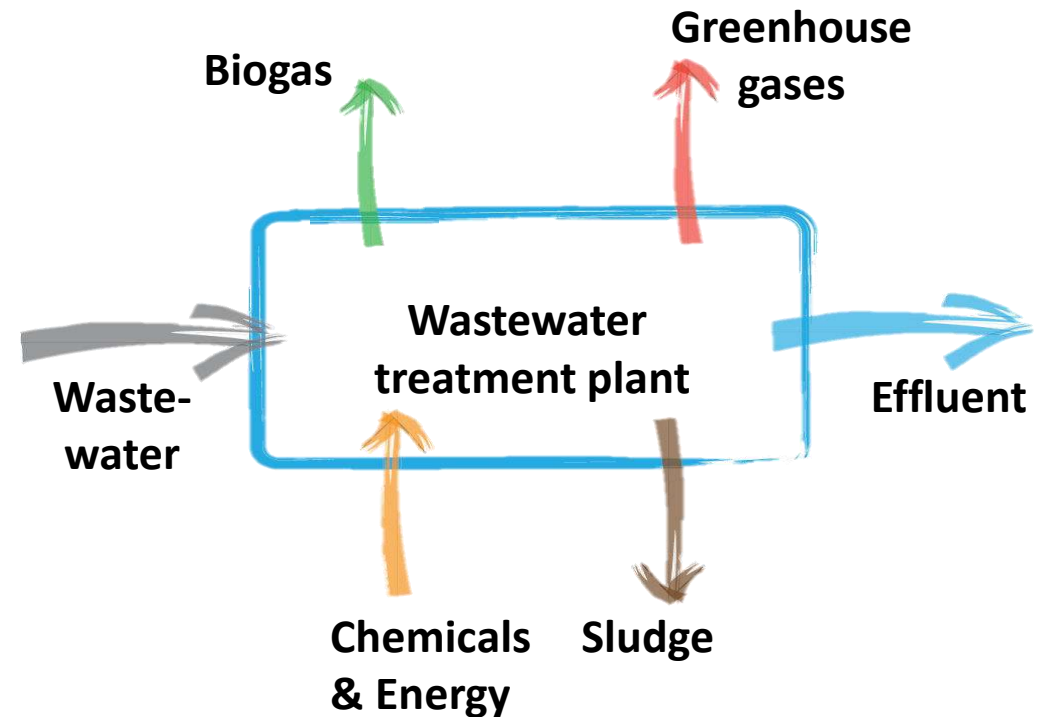
What is actually most environmentally friendly?

Scope of the study

Evaluate different WWTP processes from a LCA perspective

Incoming water quality and treatment results should be the same for all processes

All plants should have biogas production and the biogas should be used with the same purpose on all cases. Only sludge produced at the WWTP is used in the digester. Sludge is also used in the same way for all process solutions.



Effluent limits

Baseline:

TP 1 mg/L, TN 10 mg/L, BOD 25 mg/L

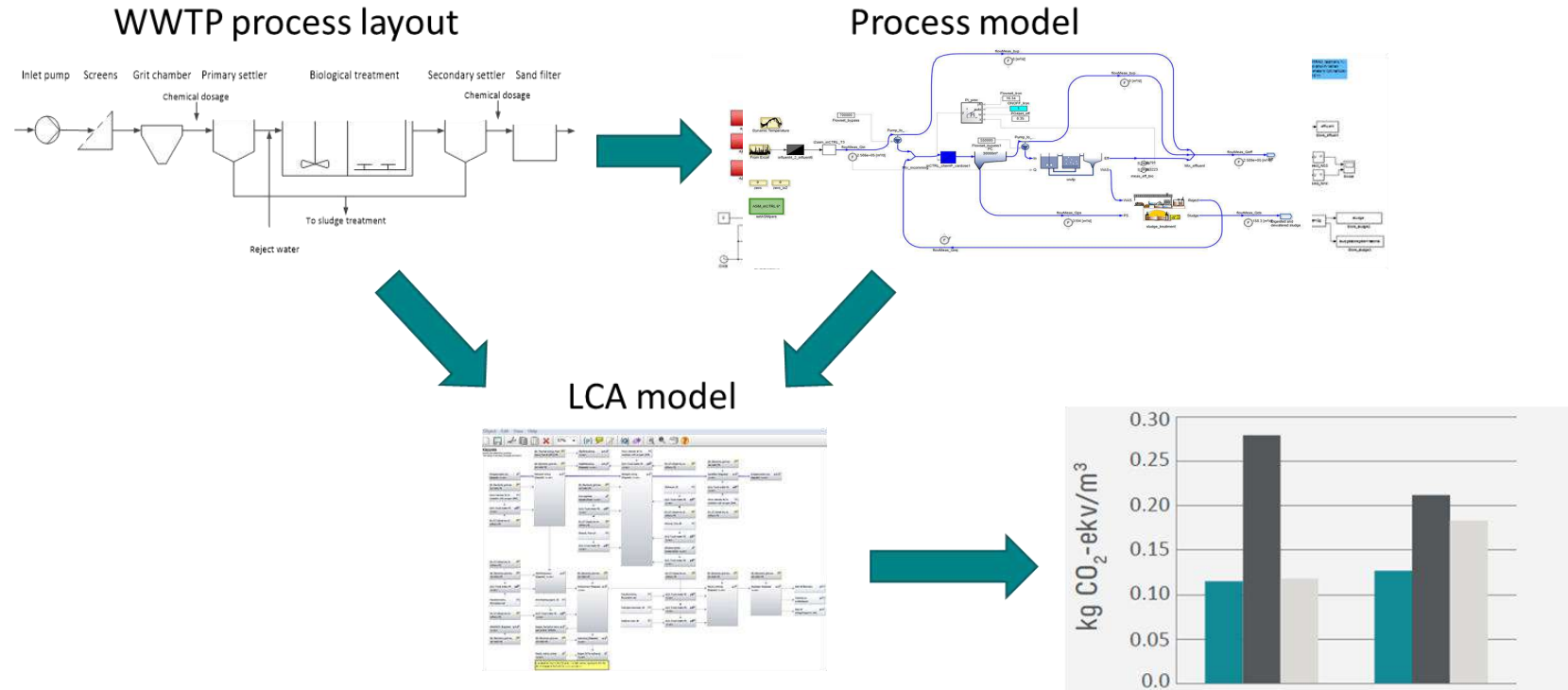
Stricter:

TP 0.3 mg/L, TN 10 mg/L, BOD 25 mg/L

Method

Using models/digital twins for generation of data into the LCA

This will achieve the scope of evaluate 3 different WWTP configurations that fulfils the same effluent standards as well as have the same quality of the incoming water



WWTP modelling



Design

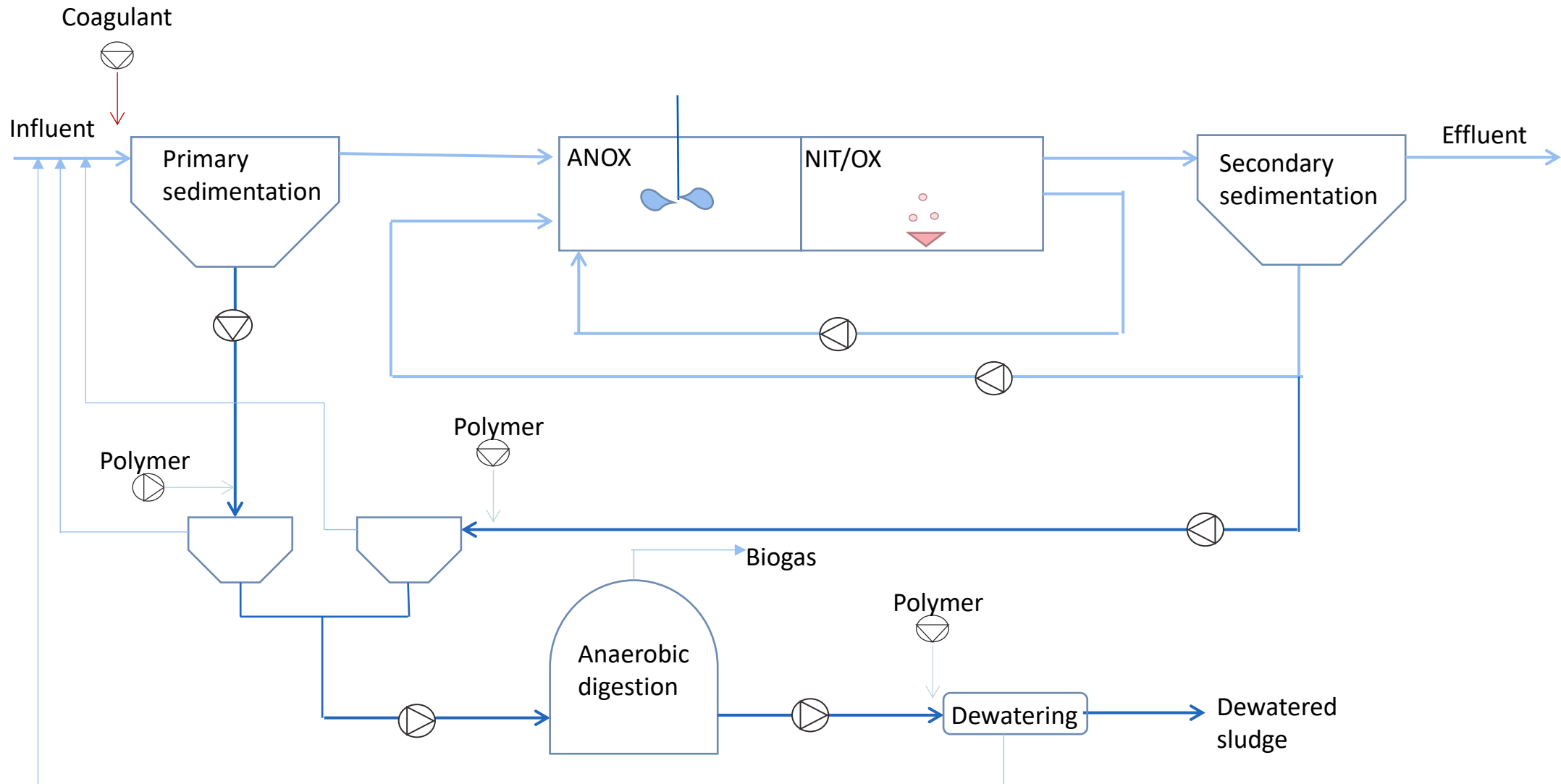


Effluent limits

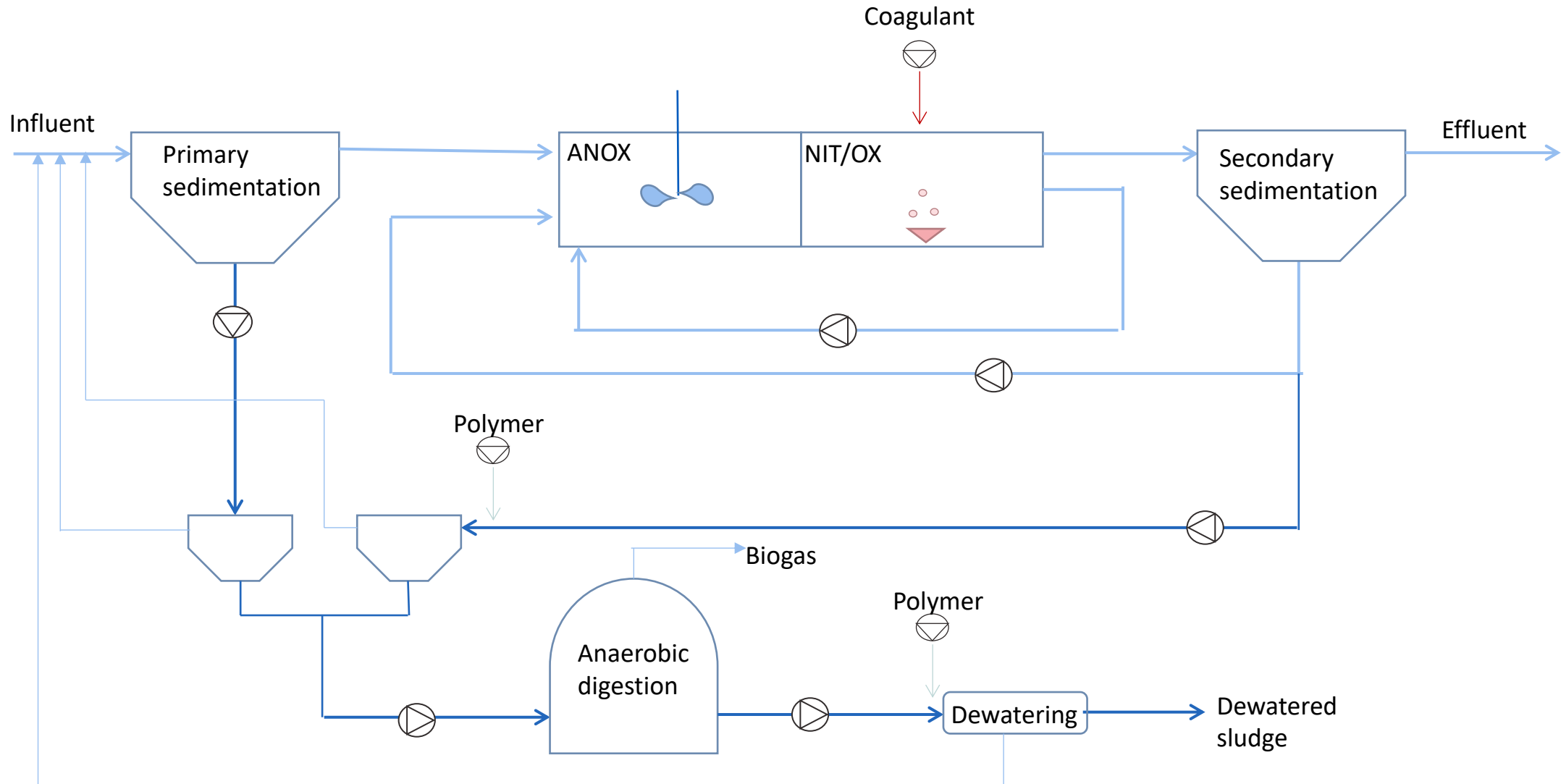


SIMBA#

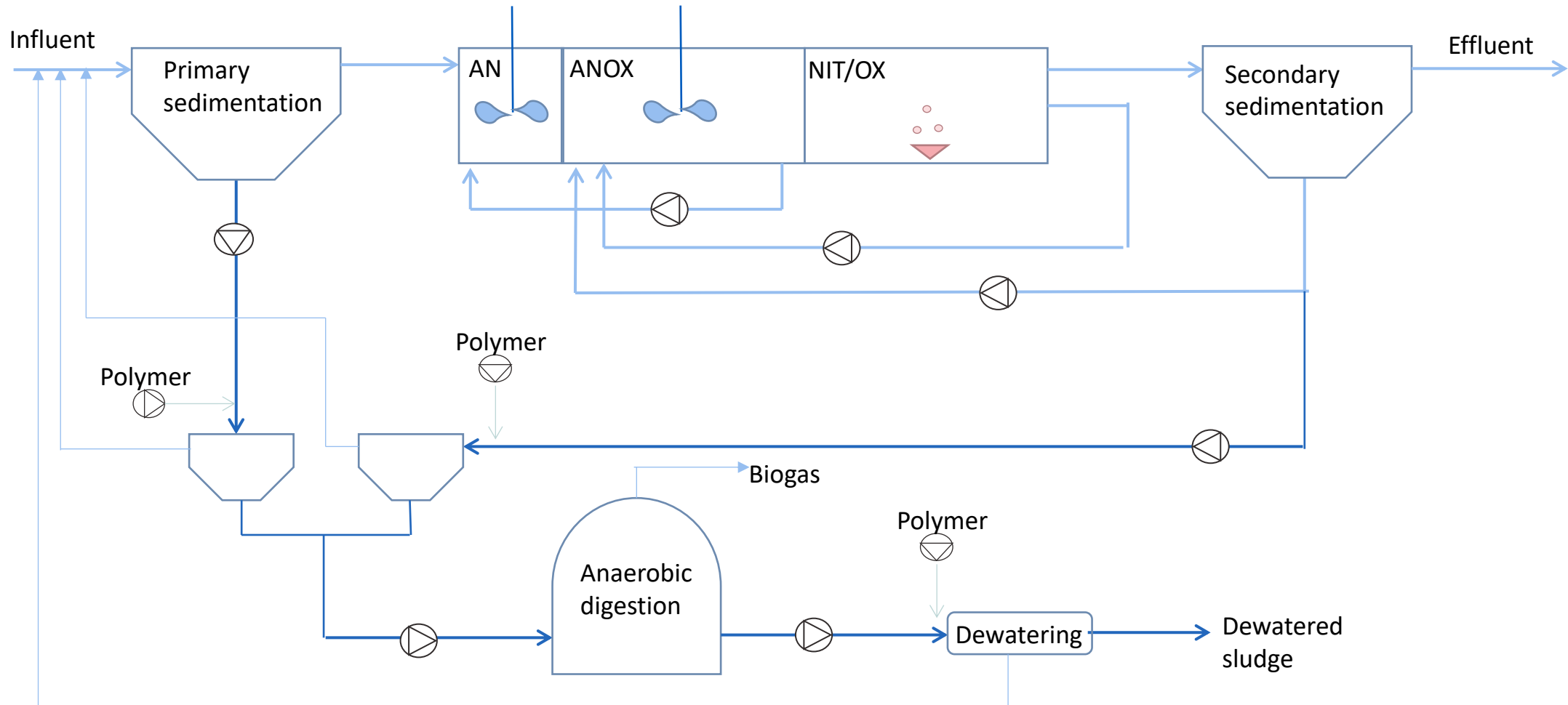
Pre-precipitation



Simultaneous precipitation



Biological P removal



Volumes for the different process solutions

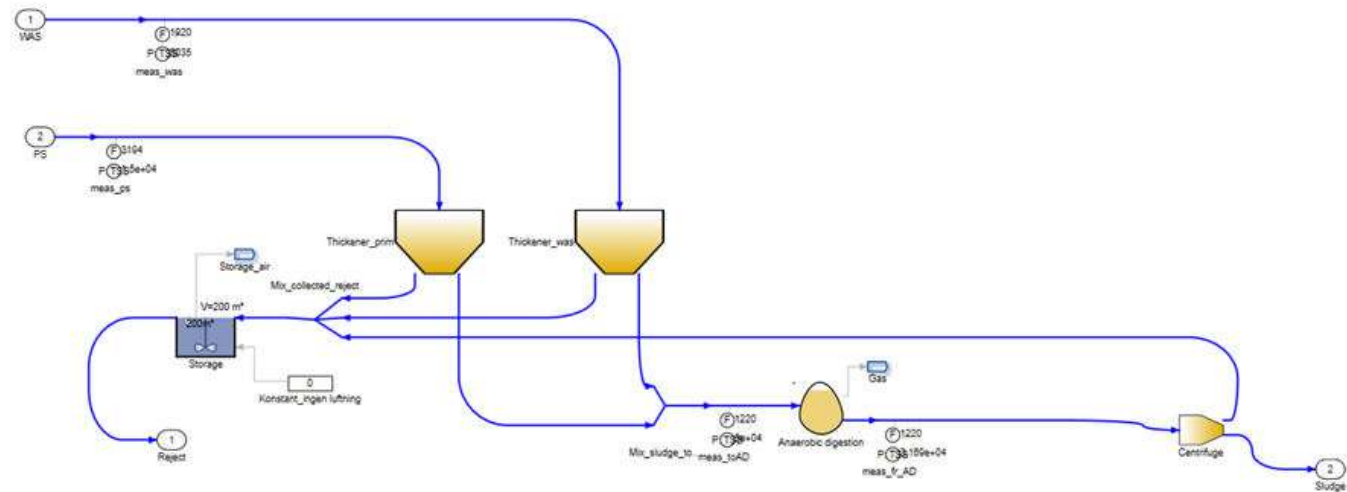
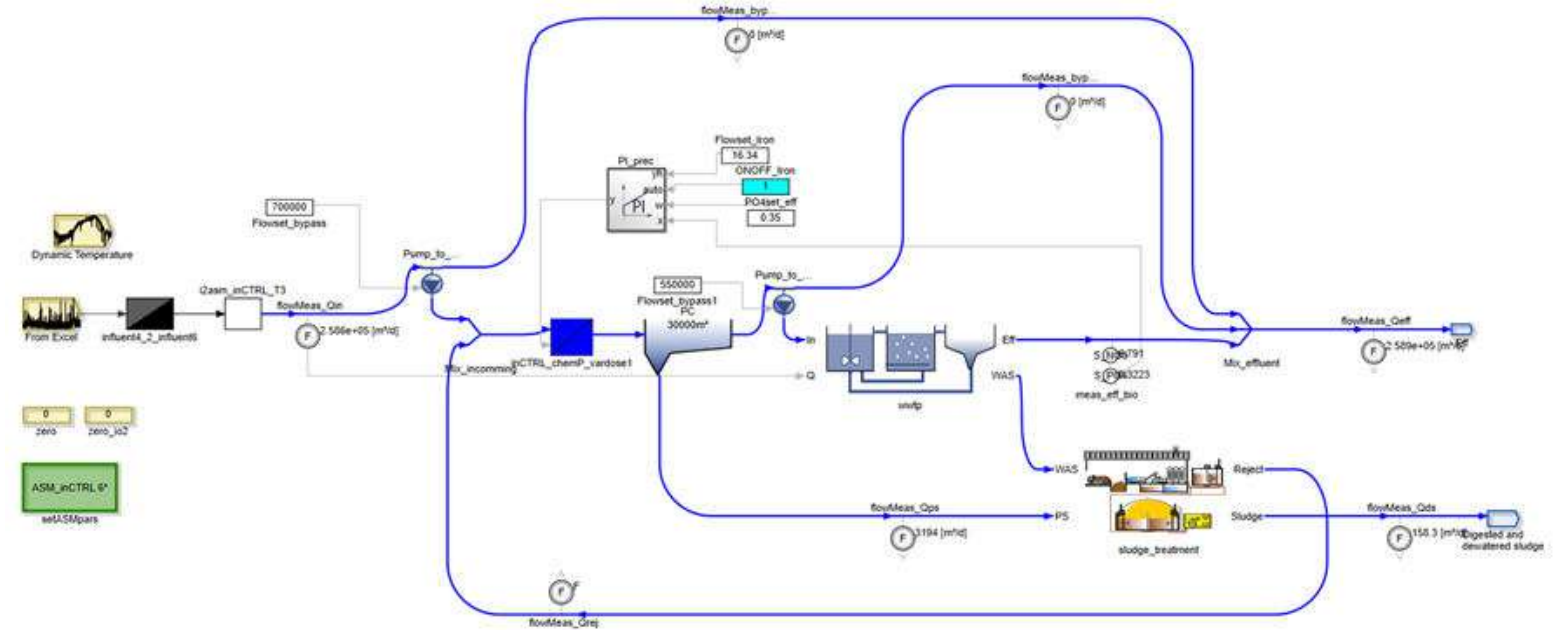
Total volumes, m ³	Pre-precipitation	Simultaneous precipitation	Bio-P
Primary Sedimentation	30 000	30 000	30 000
AN	N/A	N/A	47 000
ANOX	56 000	56 000	60 000
NIT/OX	30 240	54 000	54 000
Secondary Sedimentation	75 000	75 000	75 000
Anaerobic digester	32 000	28 500	31 000
Total volumes	223 240	243 500	297 000

SIMBA#

Model adjustments and calibration for all 3 different configurations

Dynamic inflow profile drives the model

Runs for 1 year with real time data



LCA



System borders



Functional unit

1 m³ treated water that fulfils the effluent standards



Impact categories

Global Warming Potential (GWP)

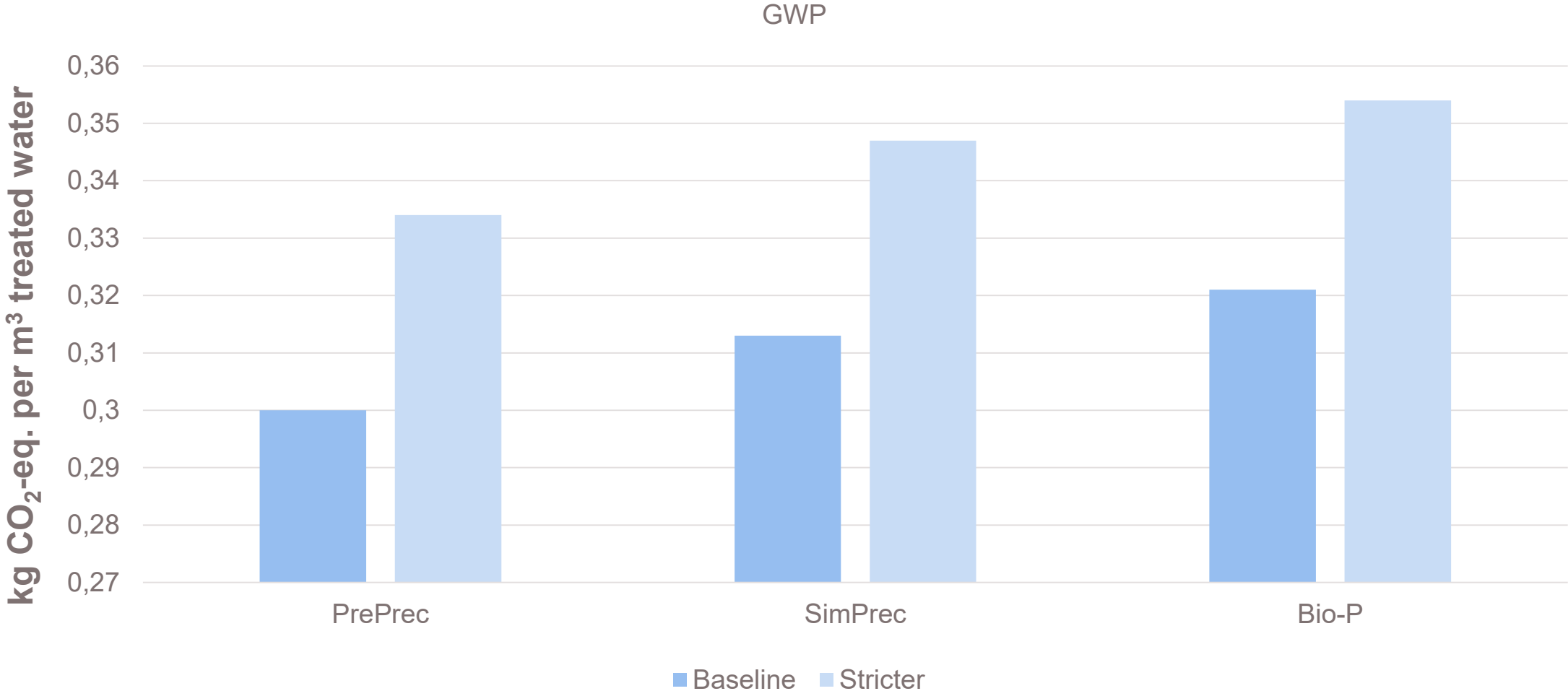
Eutrophication Potential (EP)

Acidification Potential (AP)

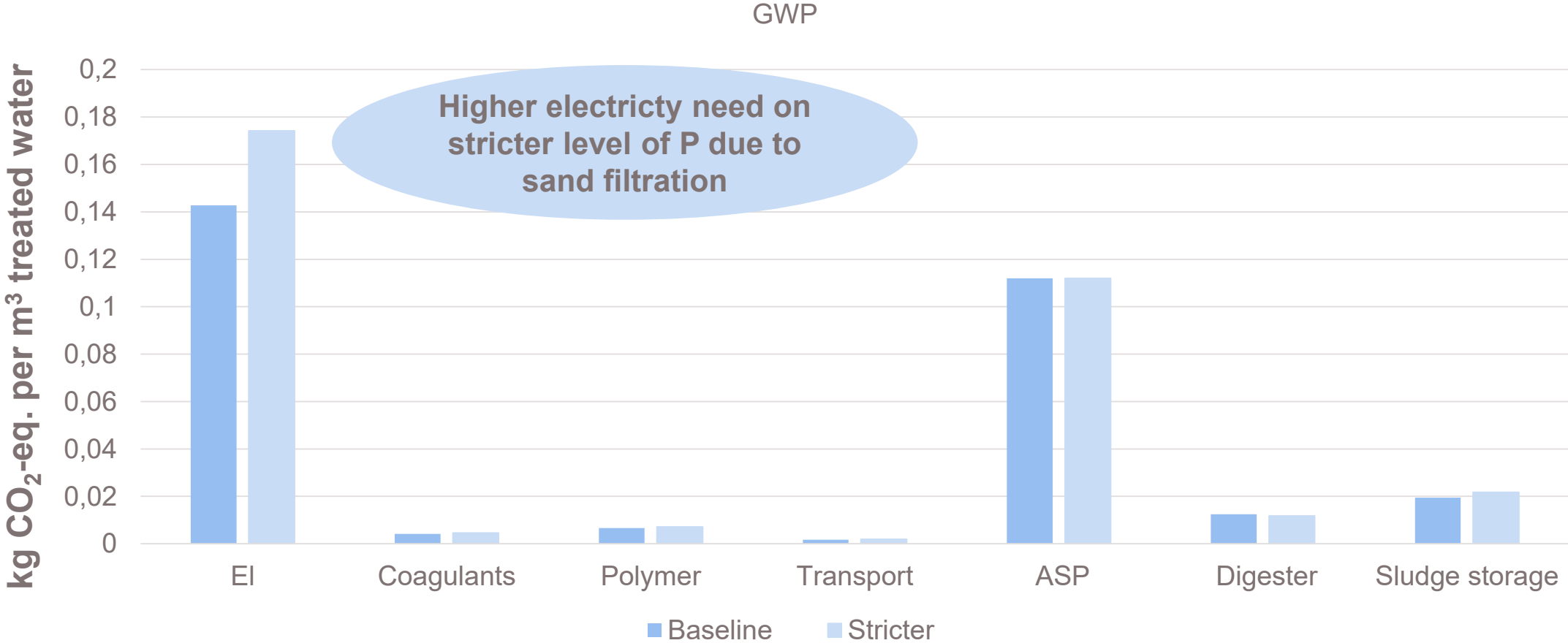
Abiotic Depletion (ADP Fossil)

Abiotic Depletion (ADP Elements)

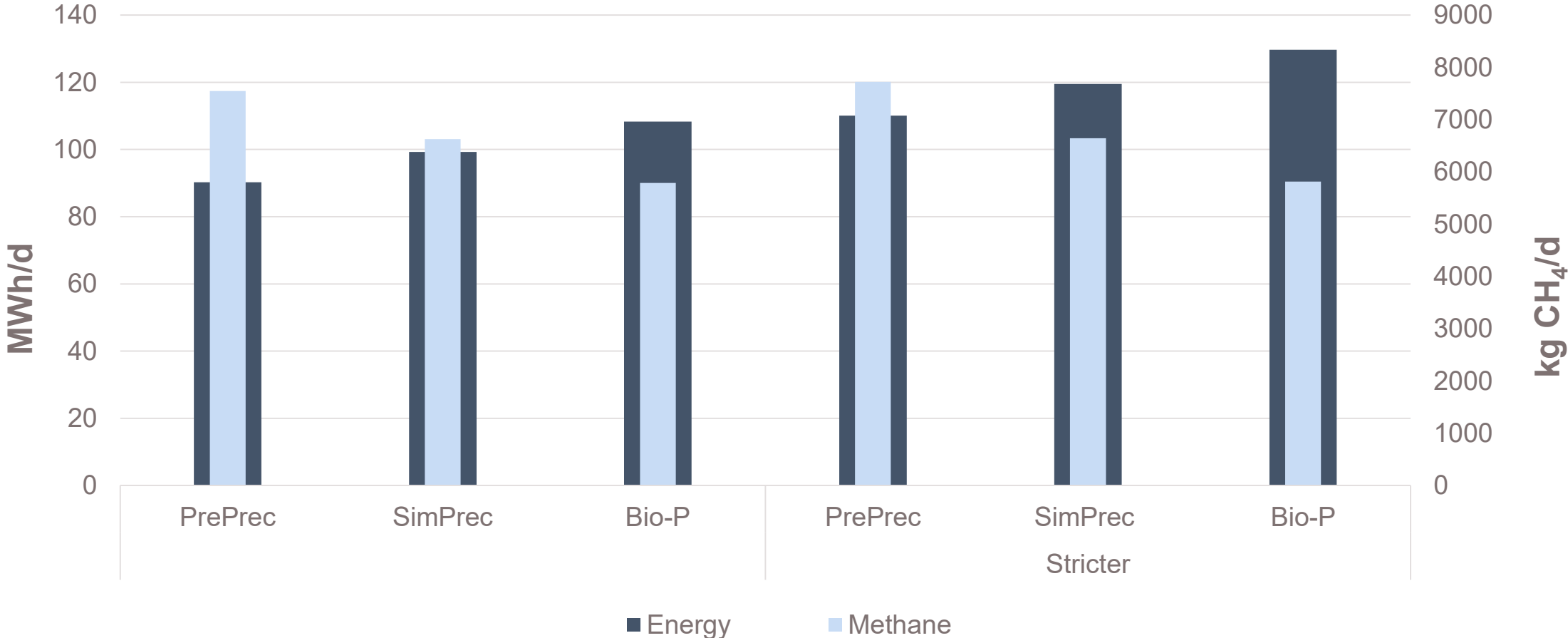
Different configurations –footprint only



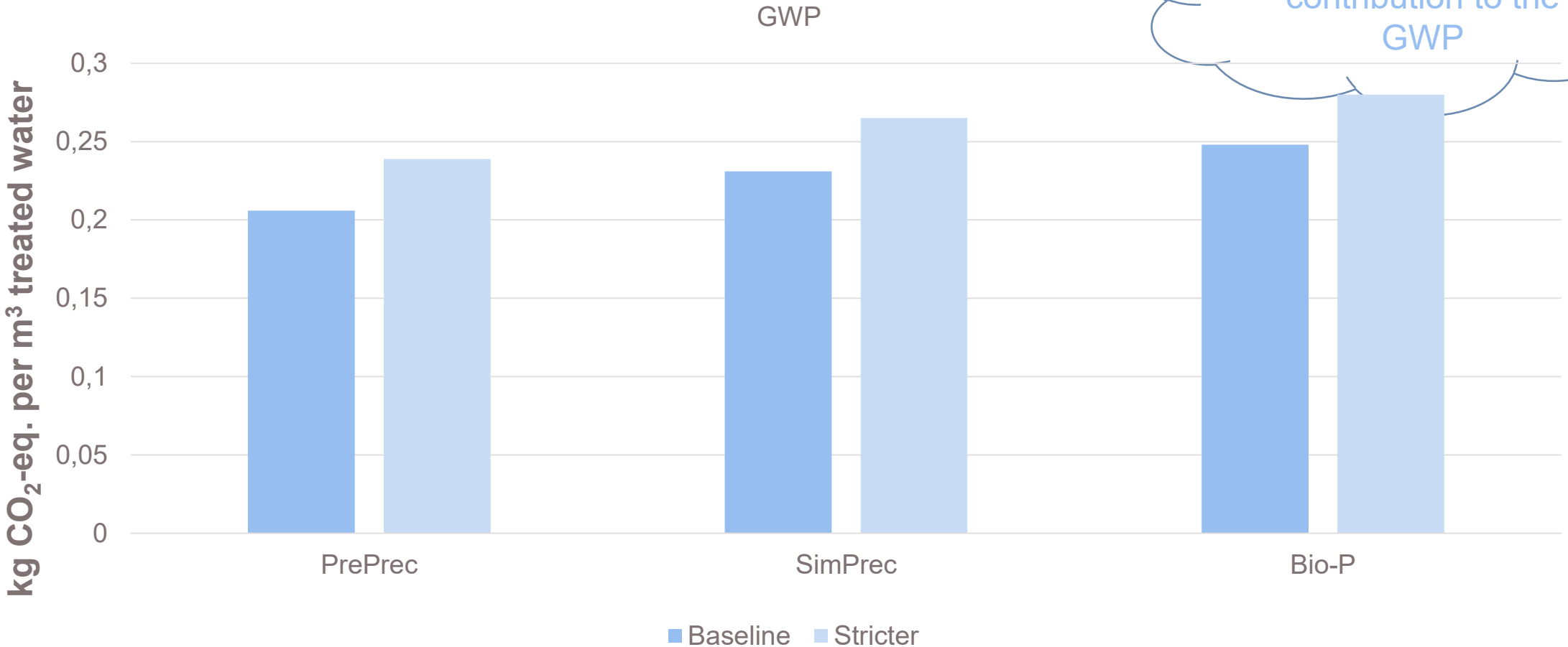
Pre-precipitation – at 2 different phosphorus demands



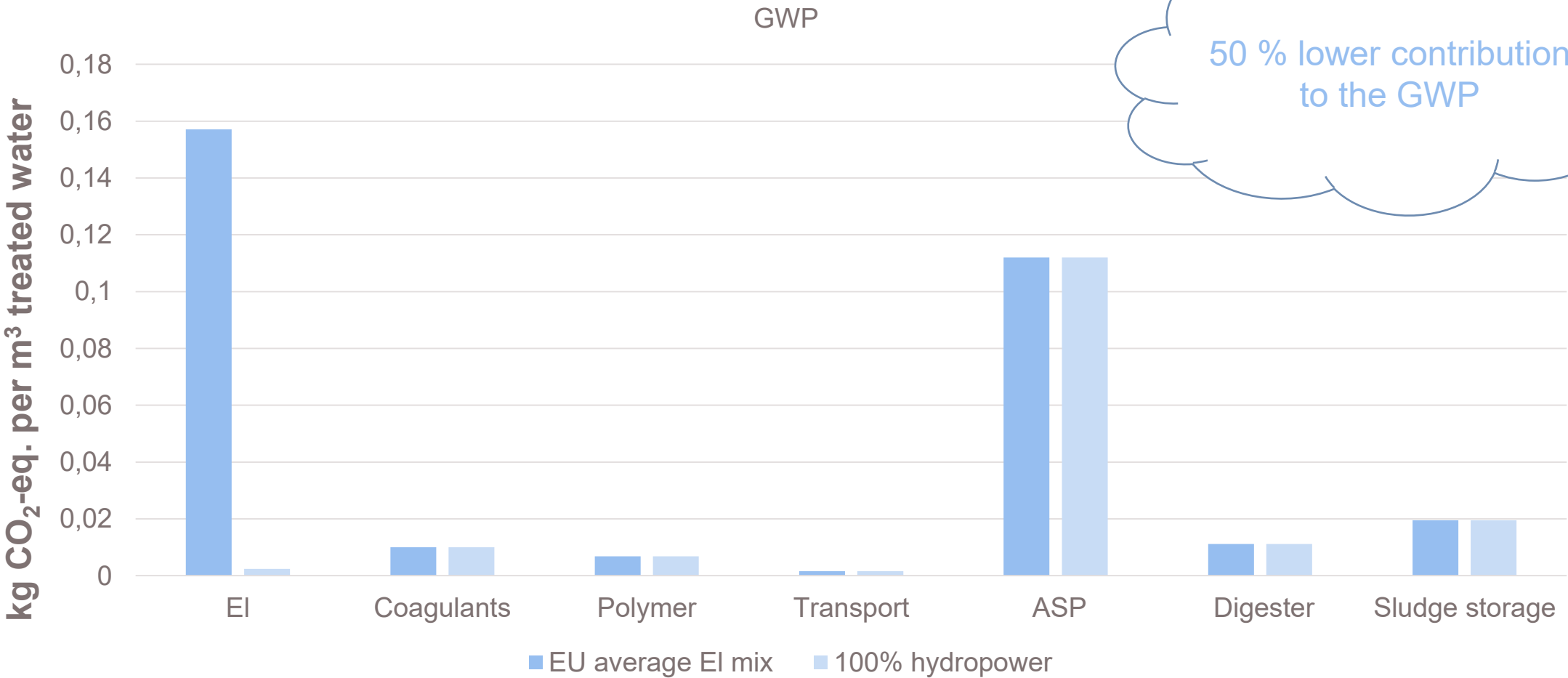
Energy use and methane production



If the biogas would replace natural gas

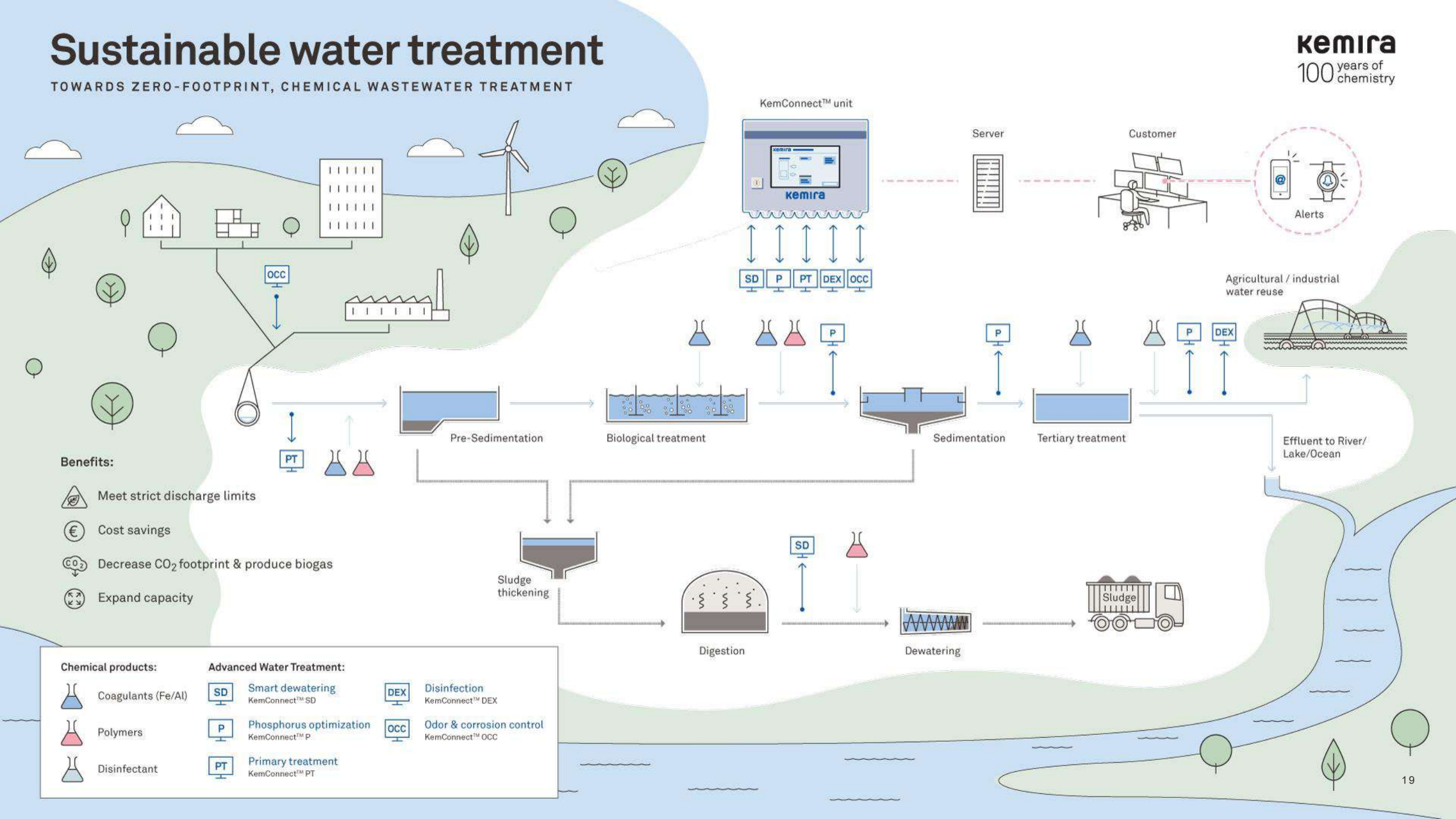


Pre-precipitation - Sensitivity analysis, Energy source



Sustainable water treatment

TOWARDS ZERO-FOOTPRINT, CHEMICAL WASTEWATER TREATMENT



Benefits:

- Meet strict discharge limits
- Cost savings
- Decrease CO₂ footprint & produce biogas
- Expand capacity

Chemical products:

- Coagulants (Fe/Al)
- Polymers
- Disinfectant

Advanced Water Treatment:

- SD** Smart dewatering
KemConnect™ SD
- P** Phosphorus optimization
KemConnect™ P
- PT** Primary treatment
KemConnect™ PT
- DEX** Disinfection
KemConnect™ DEX
- OCC** Odor & corrosion control
KemConnect™ OCC

KemConnect PT

- KemConnect PT controls the level of
 - Suspended Solids
 - Phosphorus
 - COD/TOC
 - and can link the levels to nitrogen
- Target is to:
 - Maximize energy production and capacity in biological treatment
 - Minimize energy consumption and optimize the chemical need
 - Optimizing the nitrogen and phosphorus removal

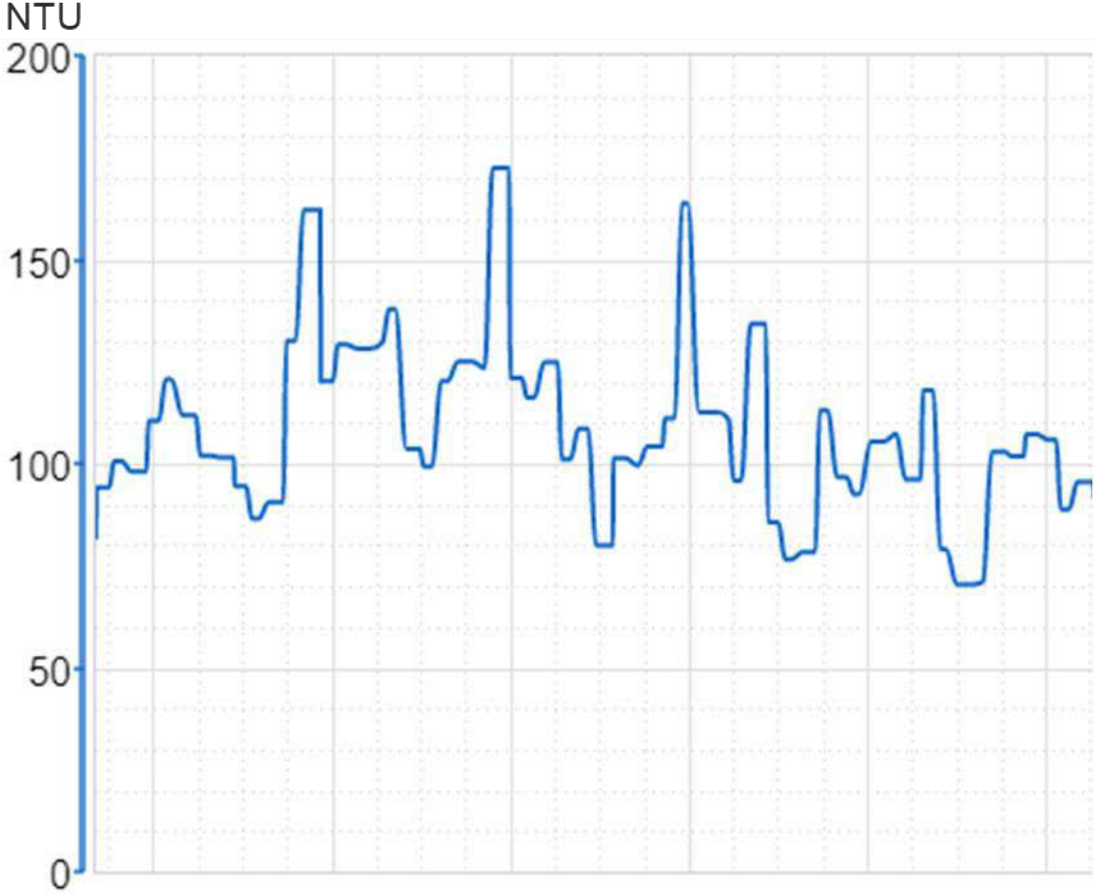


Case study from Finland

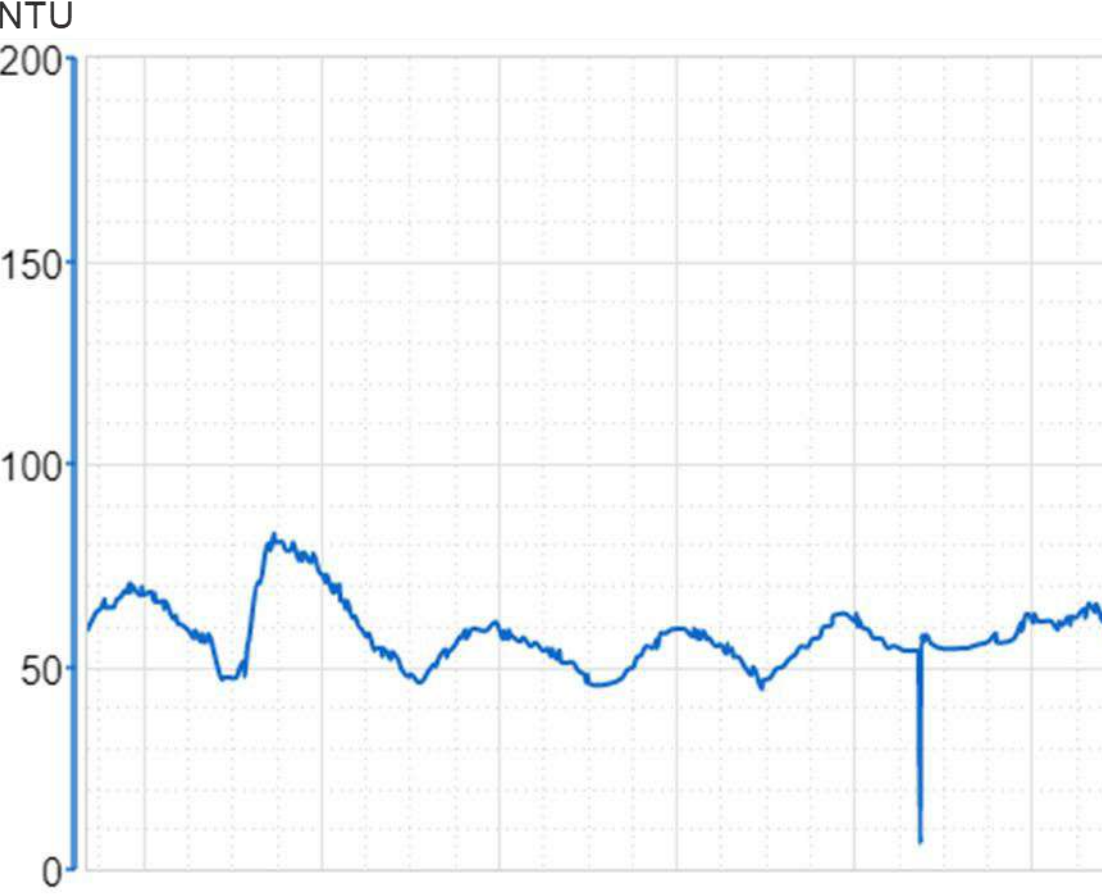
Municipal plant with load from dairy
20 000 m³/d
350 mg BOD₇/l
Sometimes over-loaded
Difficulties with nitrification
Has both pre and simultaneous precipitation



KemConnect full-scale clarification performance stabilization clearly visible

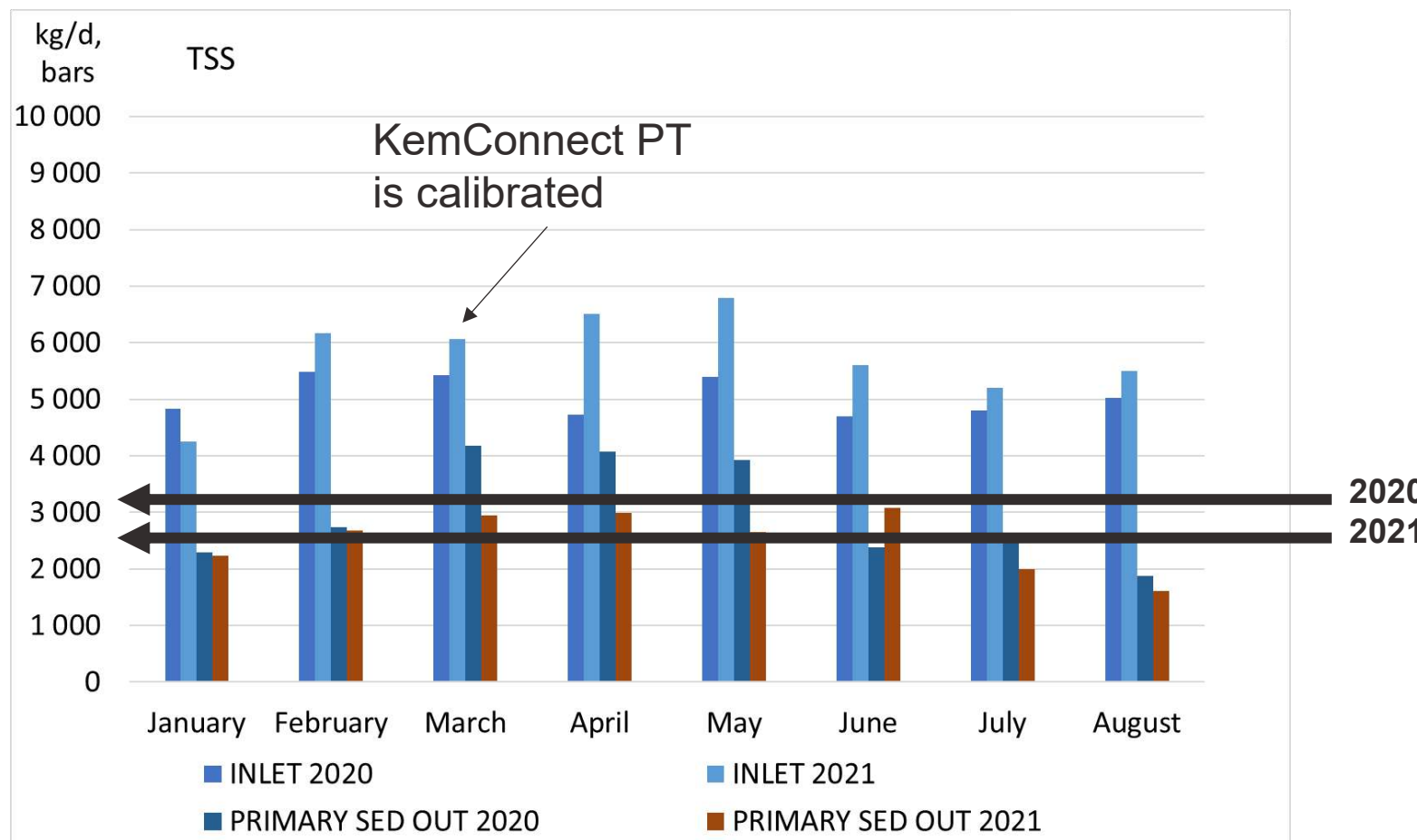


Week period
without KemConnect optimization



Week period
with KemConnect optimization

Organic load to biology controlled by KemConnect technology



- Biology load reduced by 20% even if influent load increased by 20%
- Significantly higher nitrification level achieved particularly at the cold period
- In average 60% increase in nitrification level
- 14% more biogas
- Savings in carbon footprint - >300 ton CO₂-eqv./year

Conclusions



Pre-treatment reduce the WWTP volumes



Chemical pre-treatment clearly gives a lower GWP than the other configurations



Pre precipitation generates most biogas



Energy source important factor for several impact categories



With KemConnect is it possible to make the WWTP more sustainable

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