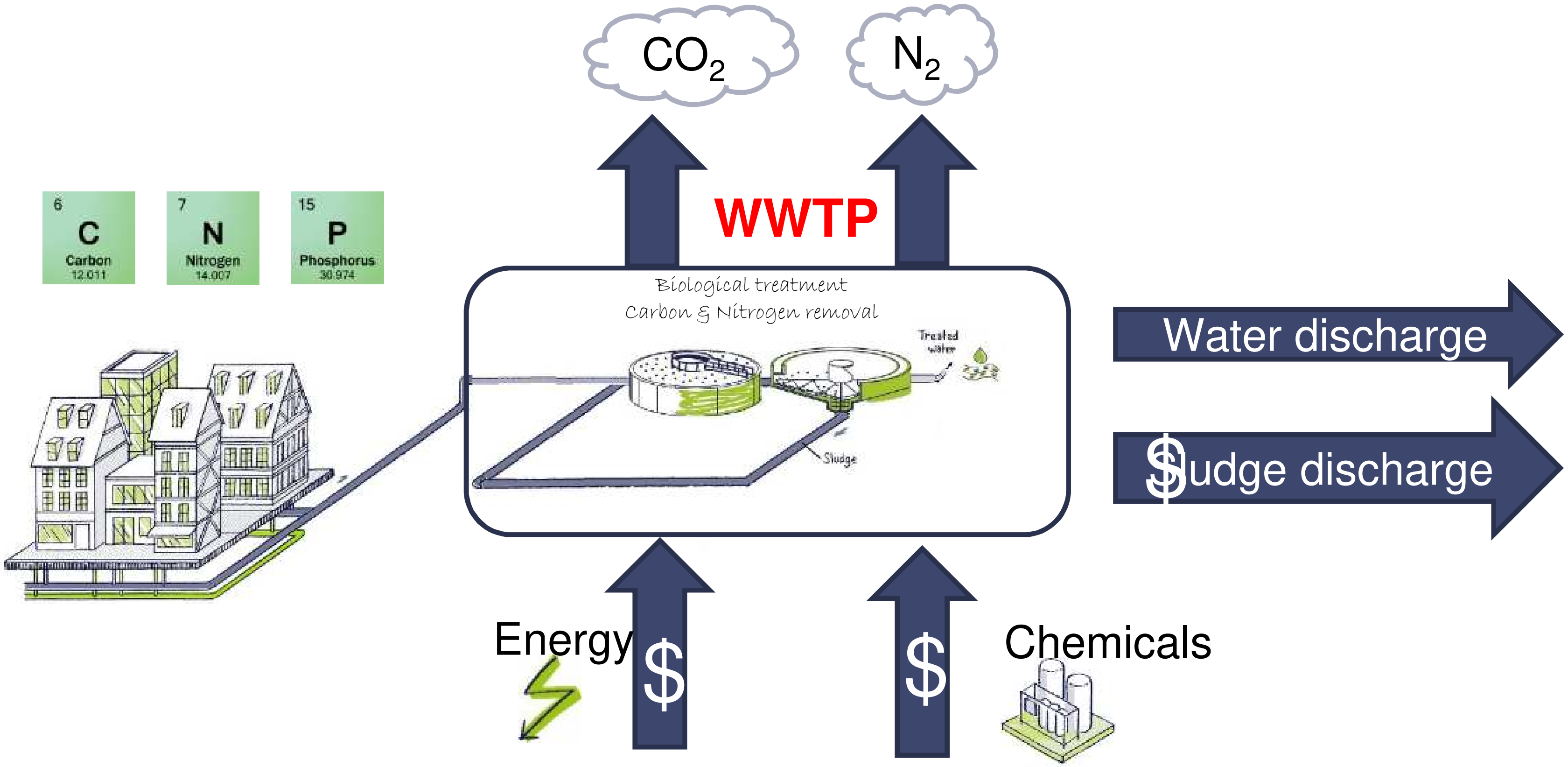
Economic sustainability of wastewater collection and treatment: cost of phosphorus removal and recovery

Bruno BARILLON
Head of Department Treatment & Recovery Processes
SUEZ

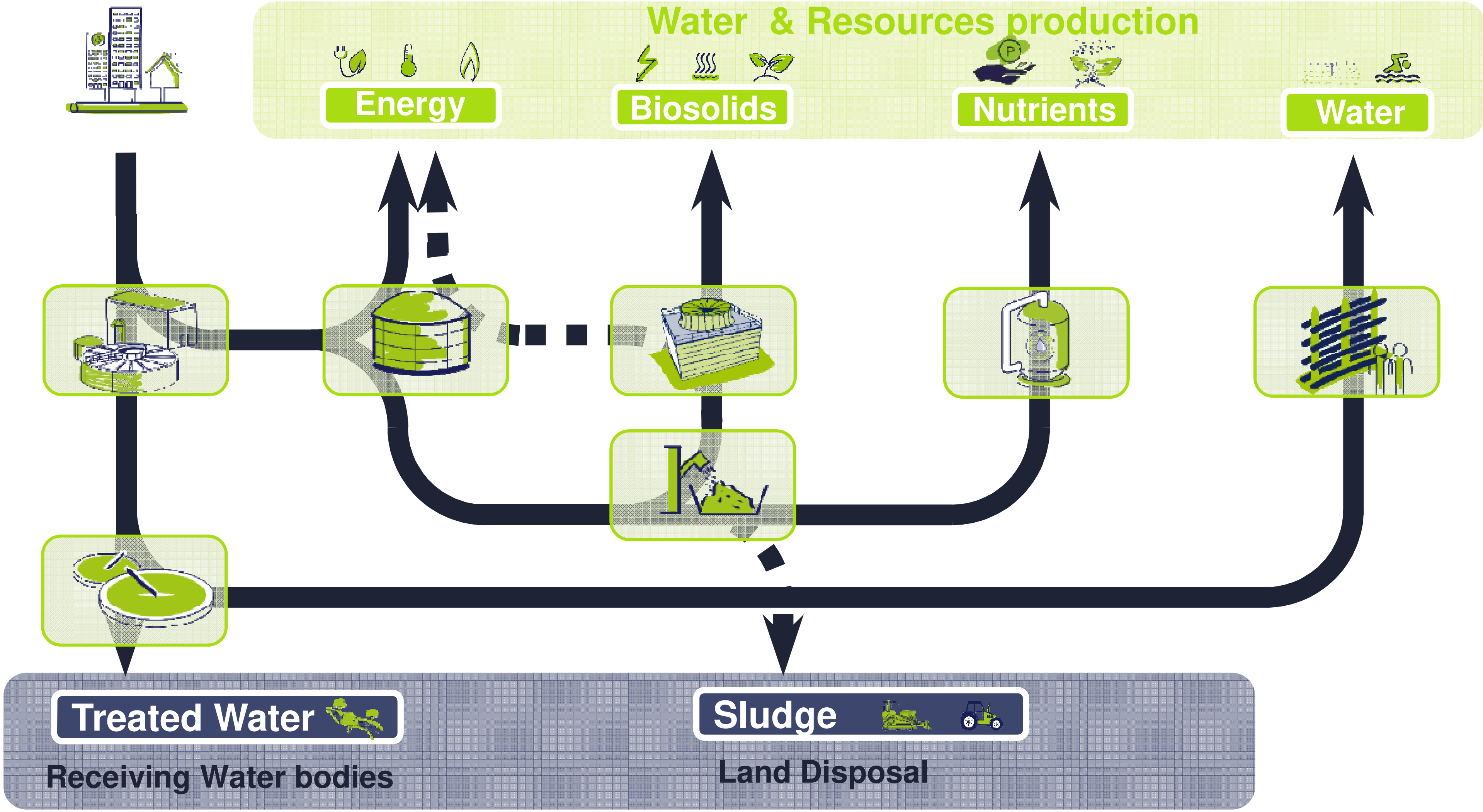
IFAT
Munich
17th May 2018

ready for the resource revolution

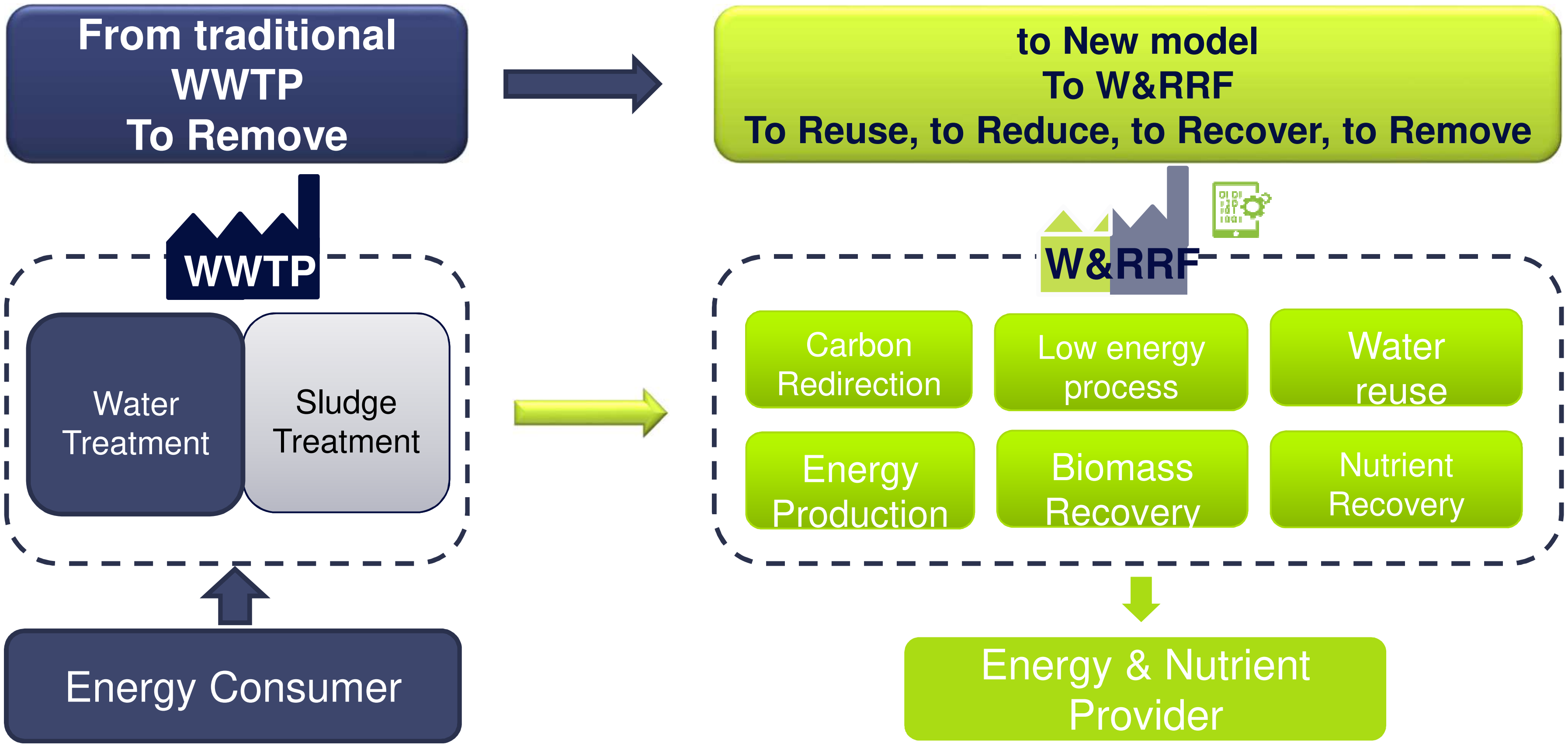
Wastewater treatment Plant
Carbon, Nitrogen & Phosphorus Removal



Current Model : WWTP


Water & Resources production
Energy
Biosolids
Nutrients
Water
Treated Water
Receiving Water bodies
Sludge
Land Disposal

Water And Resource Recovery Facility
From Energy consumer to Energy and Nutrient Provider



suez

context
facts and figures about phosphorous

today, a nutrient

- essential to life (creation of DNA, cell membranes…)
- non-substitutable
- intensively used as an additive in food industry and agriculture

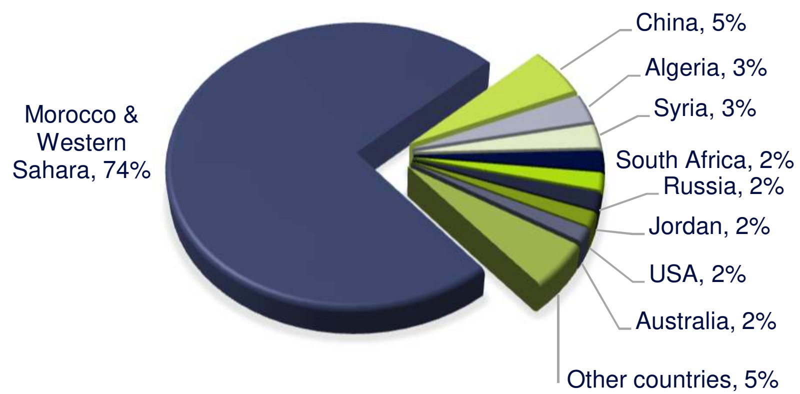
tomorrow, a geopolitical issue?

- depletion foreseen by the end of 21st century
- reserves unequally distributed throughout the world:

  95 % of the reserves located in **only 9 countries**

- complicated geopolitical situation in some countries
- Europe has ***no*** phosphate reserves

Phosphate reserves distribution worldwide (Total: 67 Mt)



Source: U.S. Geological Survey, Mineral Commodity Summaries, January 2015

solution
phosphorus recovery

considering that:

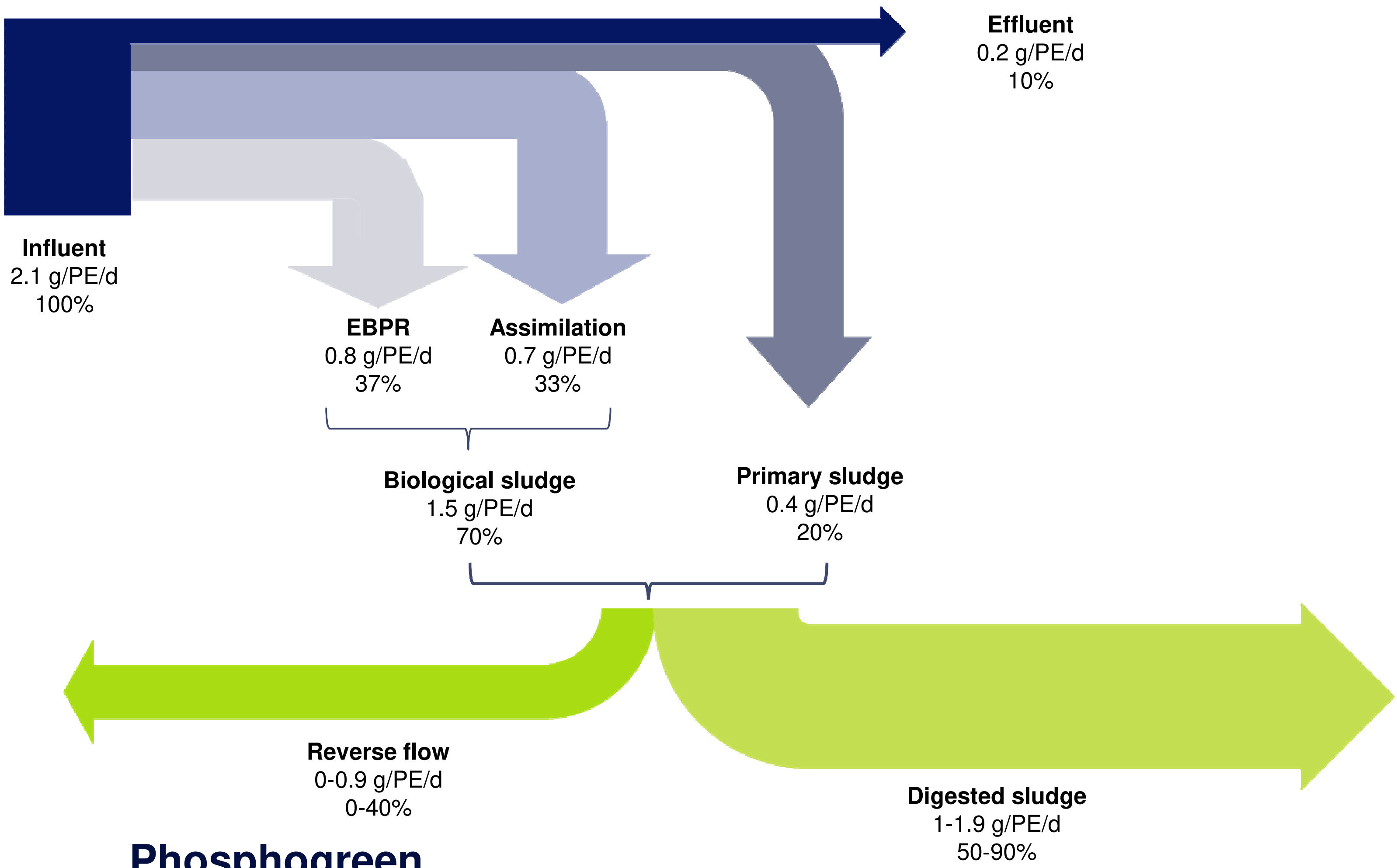
- **20%** of current world demand of phosphorus could be covered by recovery from wastewater
- **80%** of phosphorus extracted from phosphate ores is intended for fertilizers

the solution is:

to convert phosphorus present in wastewater into a valuable fertilizer

to help our clients take a step forward towards sustainable development and circular economy

Fate of phosphorus in a WWTP



Phosphogreen

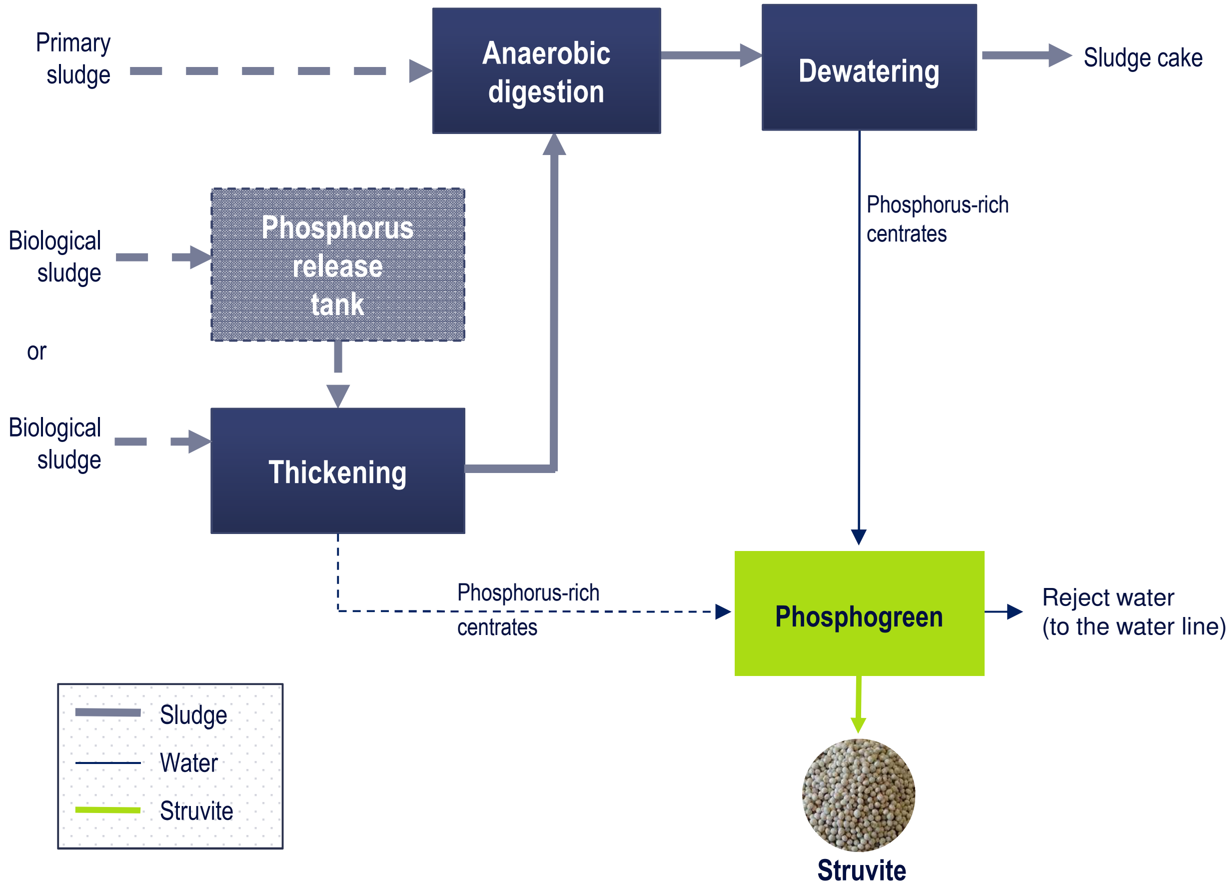
treatment line

Phosphogreen

position in the treatment line

application field

- WWTP capacity > 40,000 PE
- Bio-P removal
- Anaerobic digestion
- Phosphorus in digested sludge centrates ≥ 70 mg/L



suez

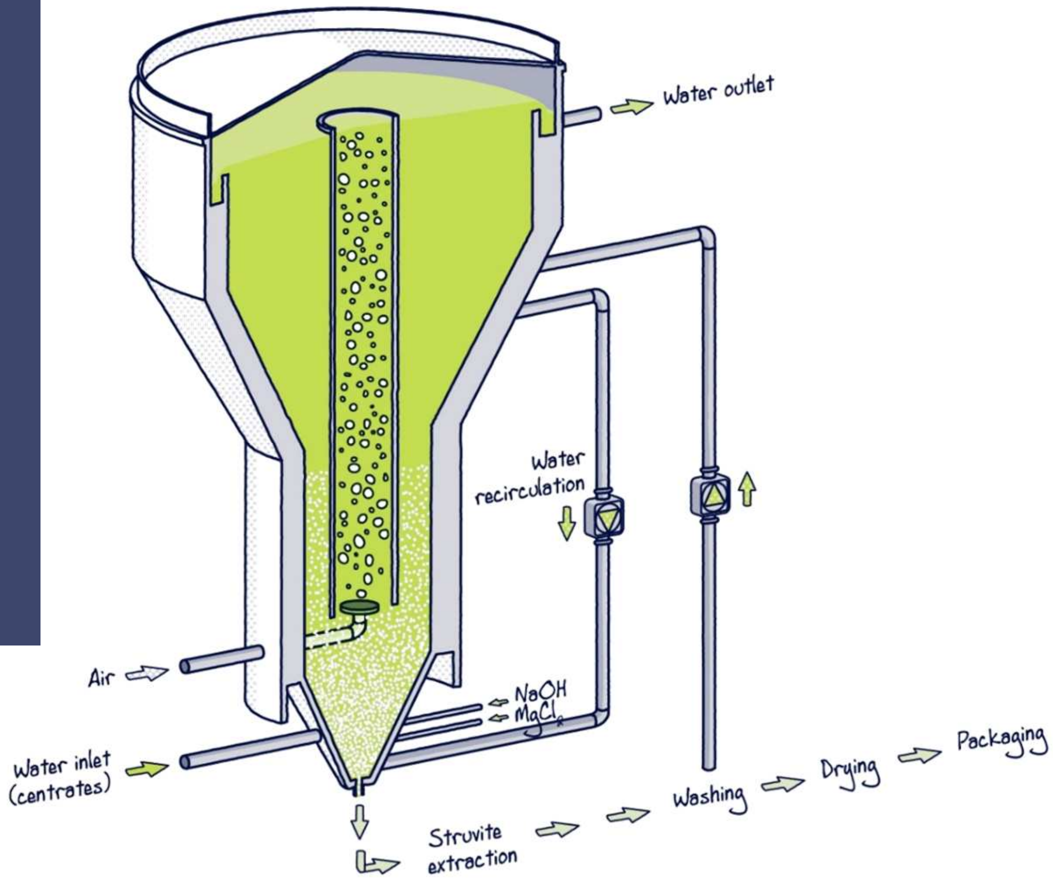
technology

Phosphogreen

process overview

Recovers phosphorus from municipal or industrial effluents in the form of **struvite ($MgNH_4PO_4$, 6 H_2O)**

- **fluidized bed reactor** with recirculation
- **addition of $MgCl_2$** for precipitation
- airlift system for **CO_2 stripping (pH ↗)**
- **addition of NaOH** if pH needs to be further adjusted
- **struvite** pellets harvested from the bottom of the reactor, washed, dried and **packaged to be sold**



technology

phosphorus recovery yield

- Phosphogreen reactors have a phosphorus recovery yield of **80%**
- depending on the sludge treatment line, this leads to a global phosphorus recovery yield on the WWTP between **15** and **45%**

production of a recycled fertilizer

- Struvite produced by Phosphogreen reactors is a recycled fertilizer
- It is for example sold under the name Phosphocare in Denmark by fertilizer company Kongerslev
- It is a **fertilizer approved by the Danish EPA** even though it is not water soluble
- It has a **better slow release fertilizing effect** compared to chemical fertilizer. Plant roots gets « on demand » the phosphorus need
- **Reach registration in 2014**

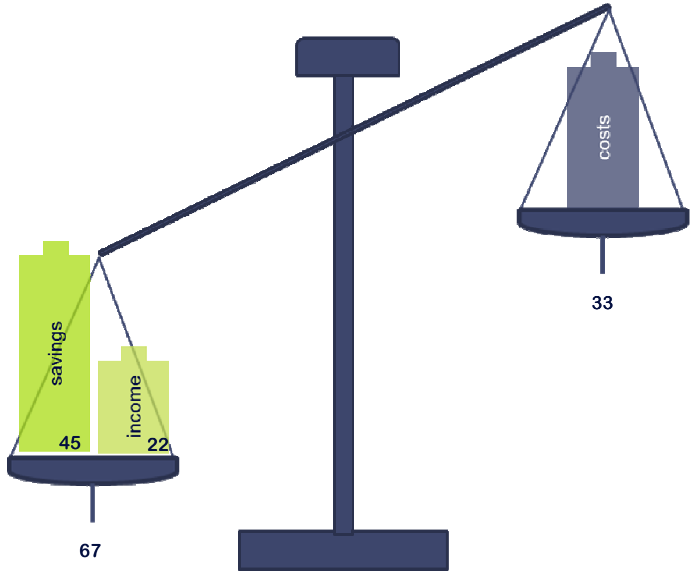
Struvite analysis
from different Sites

economics: costs, savings & income

- Saving and incomes accounts for **2 times** the process' OPEX
- Return on investment between **5 to 10 years**
- Phosphogreen' struvite is sold locally or to fertilizer companies (at **350 €/T** in Denmark) generating a revenue for the WWTP

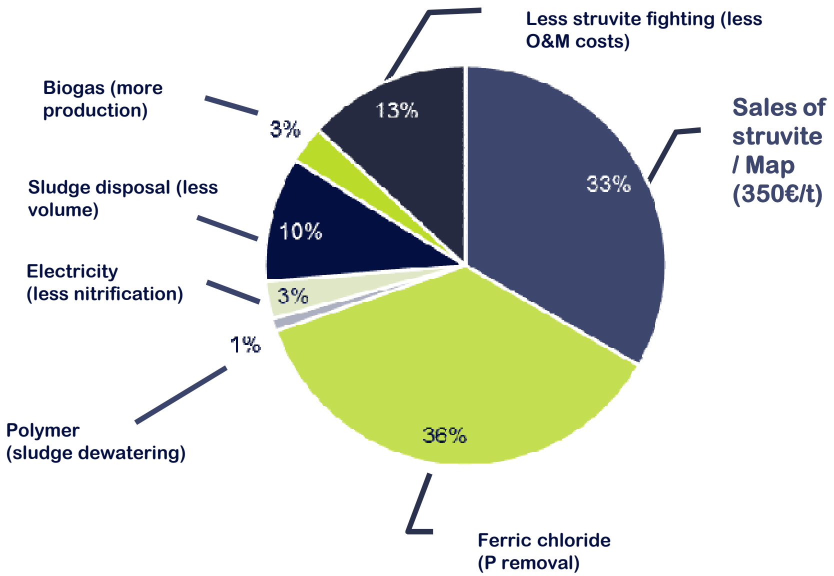
a cost saving solution

economics:
costs, savings & income

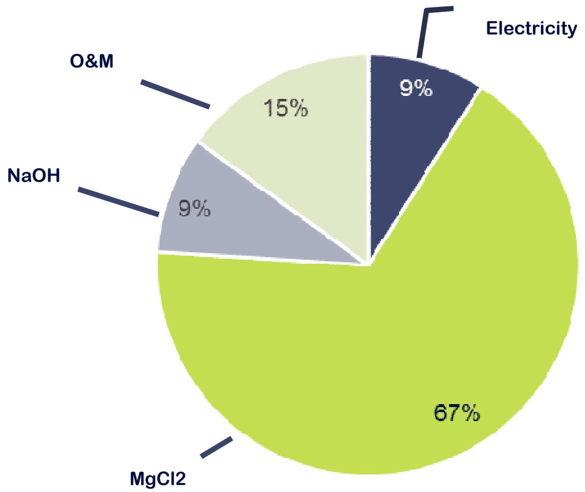


example of Herning plant

Savings and income distribution



Costs distribution



Reduce plant OPEX

suez

economy

reduced plant OPEX

Phosphogreen

can help reducing chemical consumption

for phosphorus removal

by 15 to 50 % on a WWTP

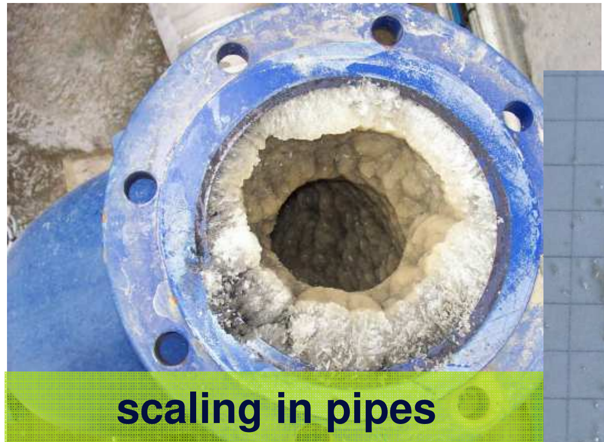
(for example $FeCl_3$ or $AlSO_4$)

reduced maintenance costs

Uncontrolled struvite precipitation can lead to an increase in maintenance costs due to:

- scaling in pipes increasing maintenance intervention
- deposits in digester, increasing cleaning frequency and stand by time for anaerobic digestion
- scaling in pumps leading to breakage

more pictures



operation & smart

reduced maintenance costs

scaling in pipes

environmental footprint

carbon mass balance for Phosphogreen on 100,000 PE WWTP

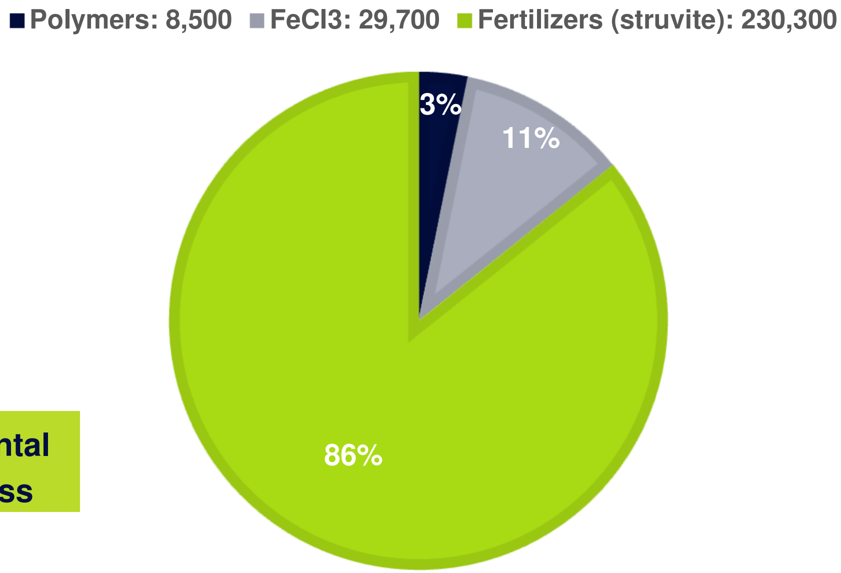
Phosphogreen can **lower by 10% the environmental footprint** of a 100 000 PE WWTP.

Struvite is an **alternative to phosphate rock** extracted from mines that has a high carbon footprint.

Results
Analysis of dewatered sludge

CARBON avoided

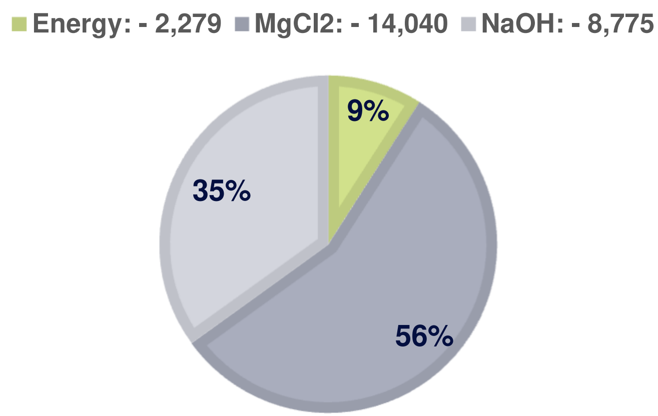
CO_2 emission avoided (in kg eqC/an)



an environmental friendly process

CARBON emissions

CO_2 emission produced (in kg eqC/an)



5 Phosphogreen references

Example

Åby (Aarhus, Denmark)

plant's characteristics

- Municipal wastewater
- 84,000 PE
- No primary treatment
- P-recov. unit start-up date: 2013

- **inlet of the plant**

  450 kg/d N_{tot}
  105 kg/d P_{tot}

- **outlet**

  300 kg/d struvite (incl. 37 kg P/d)

~ 35% of the phosphorus entering the plant is recovered

highlights

Phosphogreen

economy

5 to **10**
Years ROI

350 €/t
revenue from struvite

reduced plant OPEX

operation & smart

reduced maintenance cost
with controlled struvite precipitation

environment

- 10%
plant environmental footprint

production of a recycled fertilizer

5
references

energy

very low energy consumption

technology

fluidized bed reactor

80%
phosphorus recovery yield

1 to **3** mm
struvite pellets