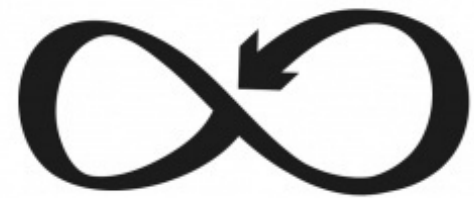




BIOREFINE CLUSTER EUROPE



European Sustainable Nutrient Initiative - ESNI 2020

Challenges associated to the LCA of P-recovery from wastewater and sludges
in the context of Phos4You project

Sylvie Gros Lambert

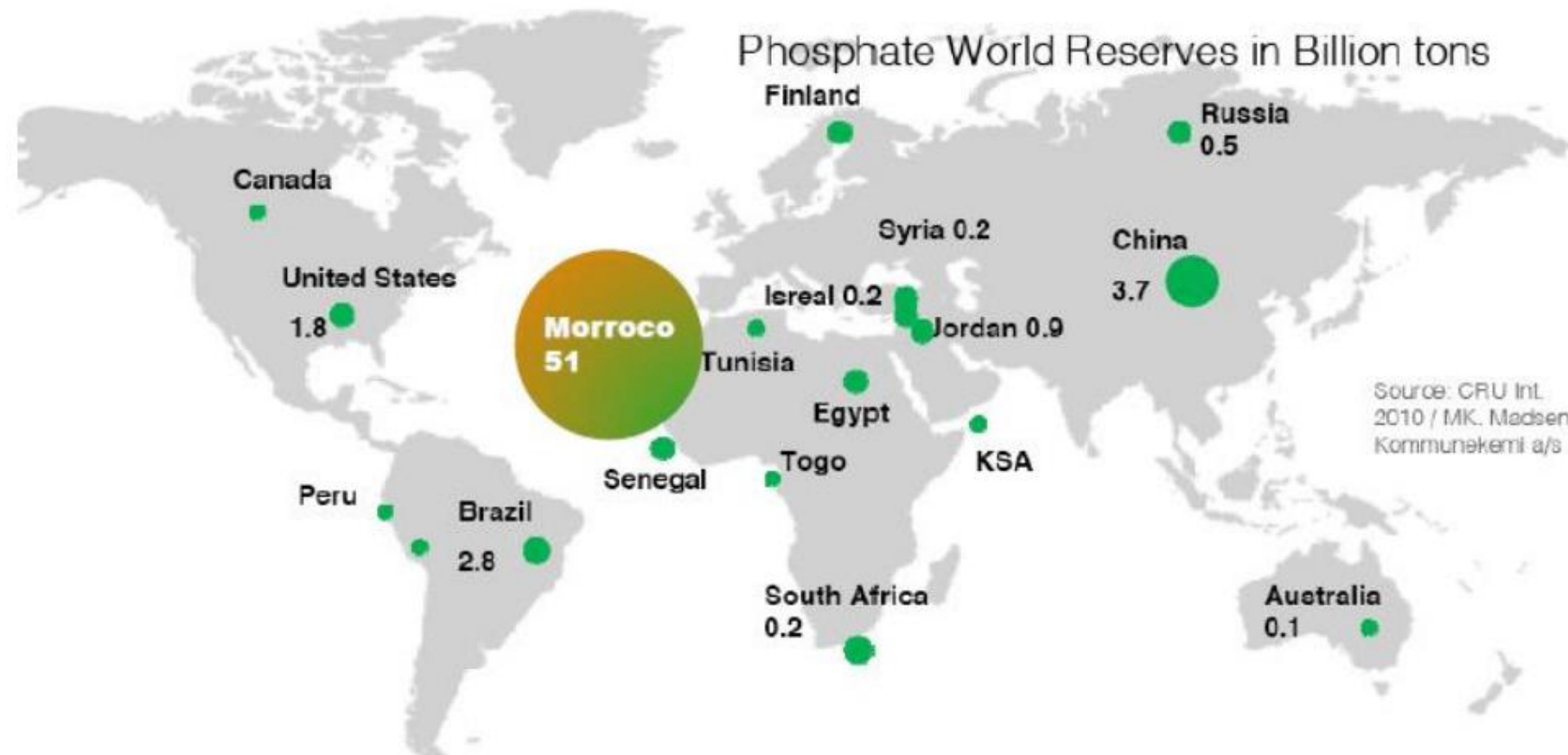
26th November, 2020

The P context in Europe – P dependance

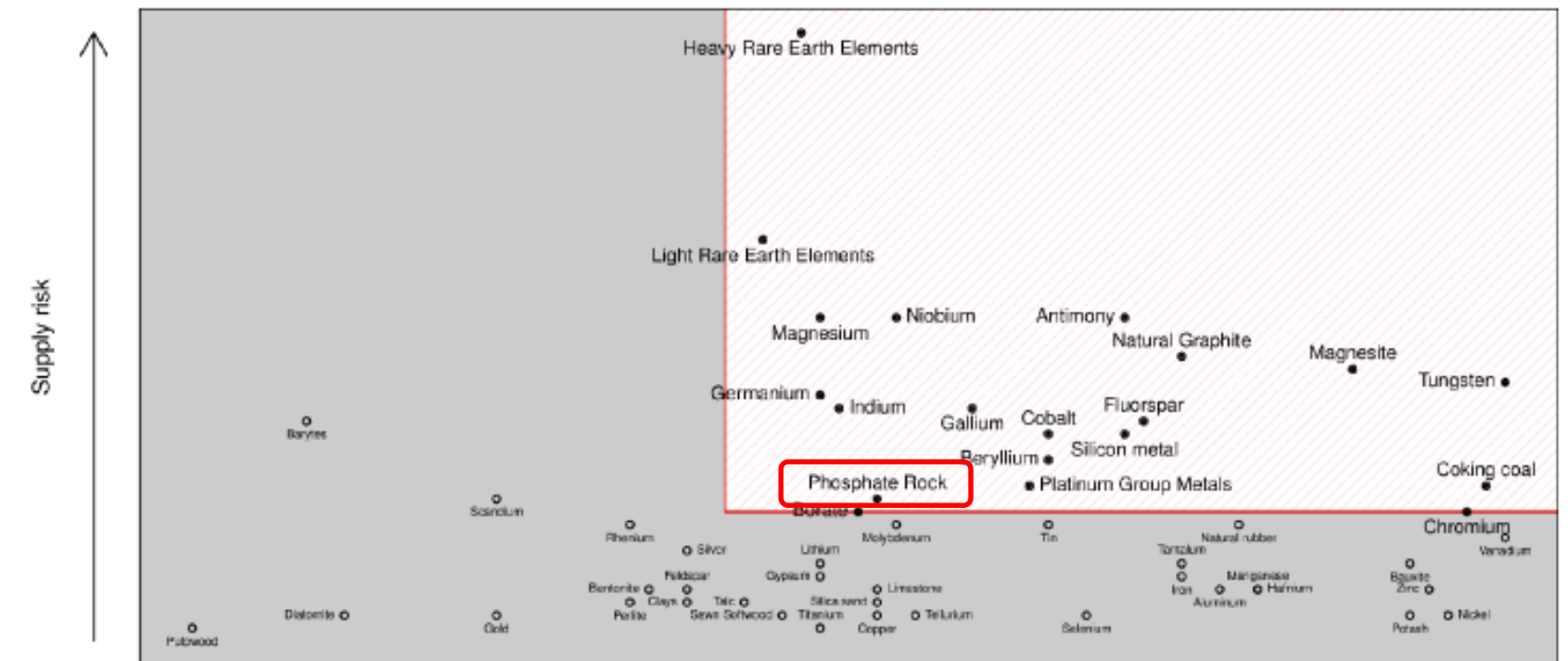


- P based fertilizers are essential for crop production
- Phosphate rock reserve <<<
- 1 operating mine in Finland

- > 90% of P rock is imported
- EU = 2nd largest importer
- ~5.5 million t P-rocks imported (EU-28 - 2017)



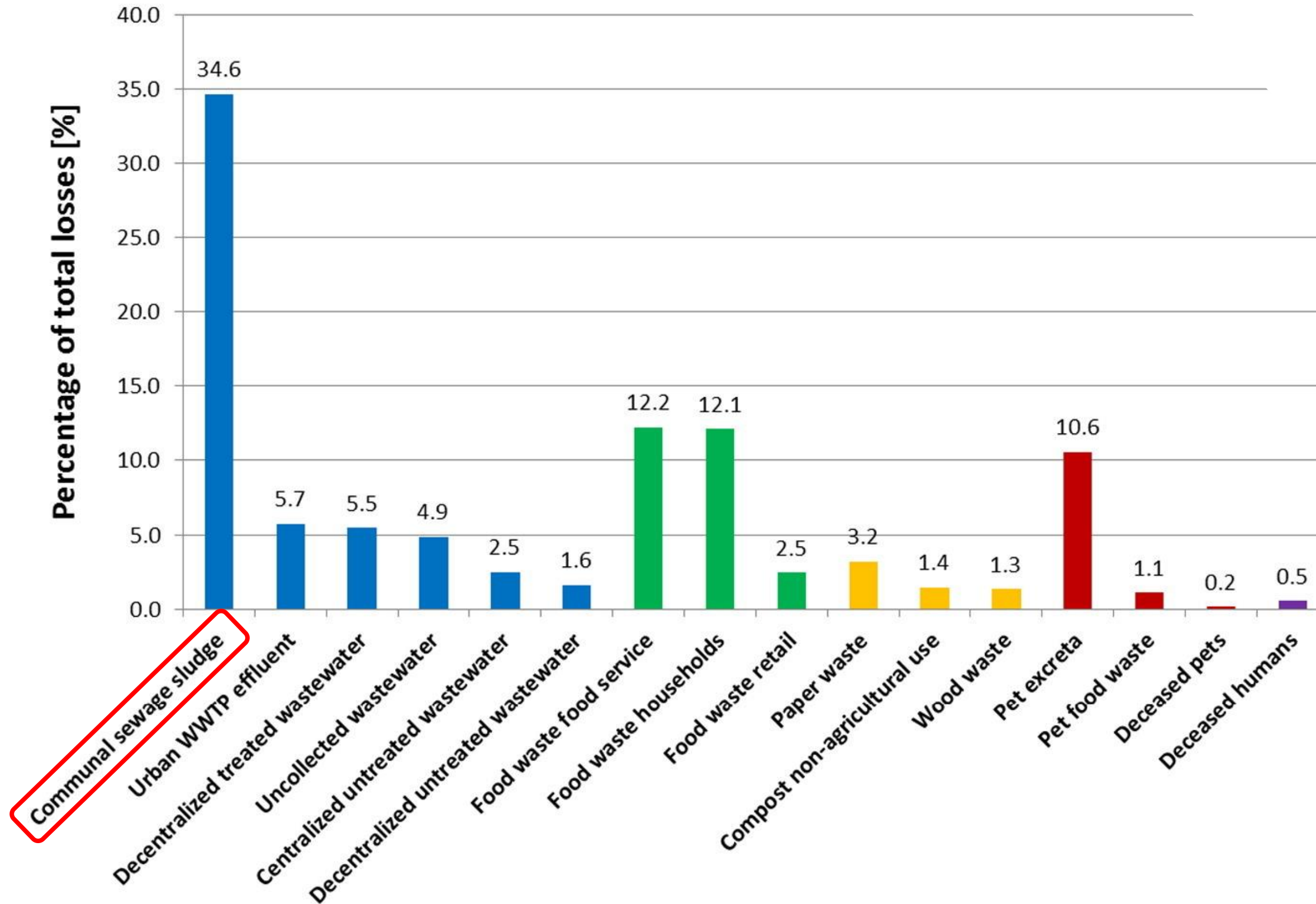
- ⇒ P-rock put on critical raw-material list of the EU



Nesme, Thomas & Doré, Thierry & Leenhardt, Delphine & Pellerin, Sylvain. (2016). Agriculture et ressources naturelles : de quoi parlons-nous ?.

<https://phosphorusplatform.eu/scope-in-print/news/359-phosphate-rock-in-eu-critical-raw-materials-list>

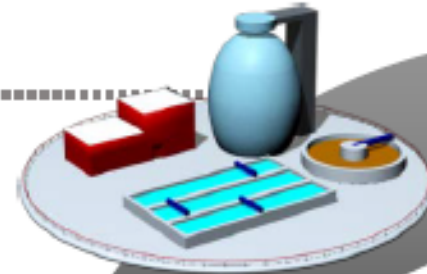
The P context in Europe - P losses



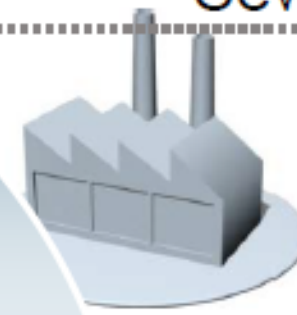
The P context in Europe – Closing the cycle



WWTPs remove P to avoid P discharge in rivers



Sewage sludge containing P is removed



Avoid P-loss!

Consumer take up P in their food, release it in human excrements => P gets into waste water



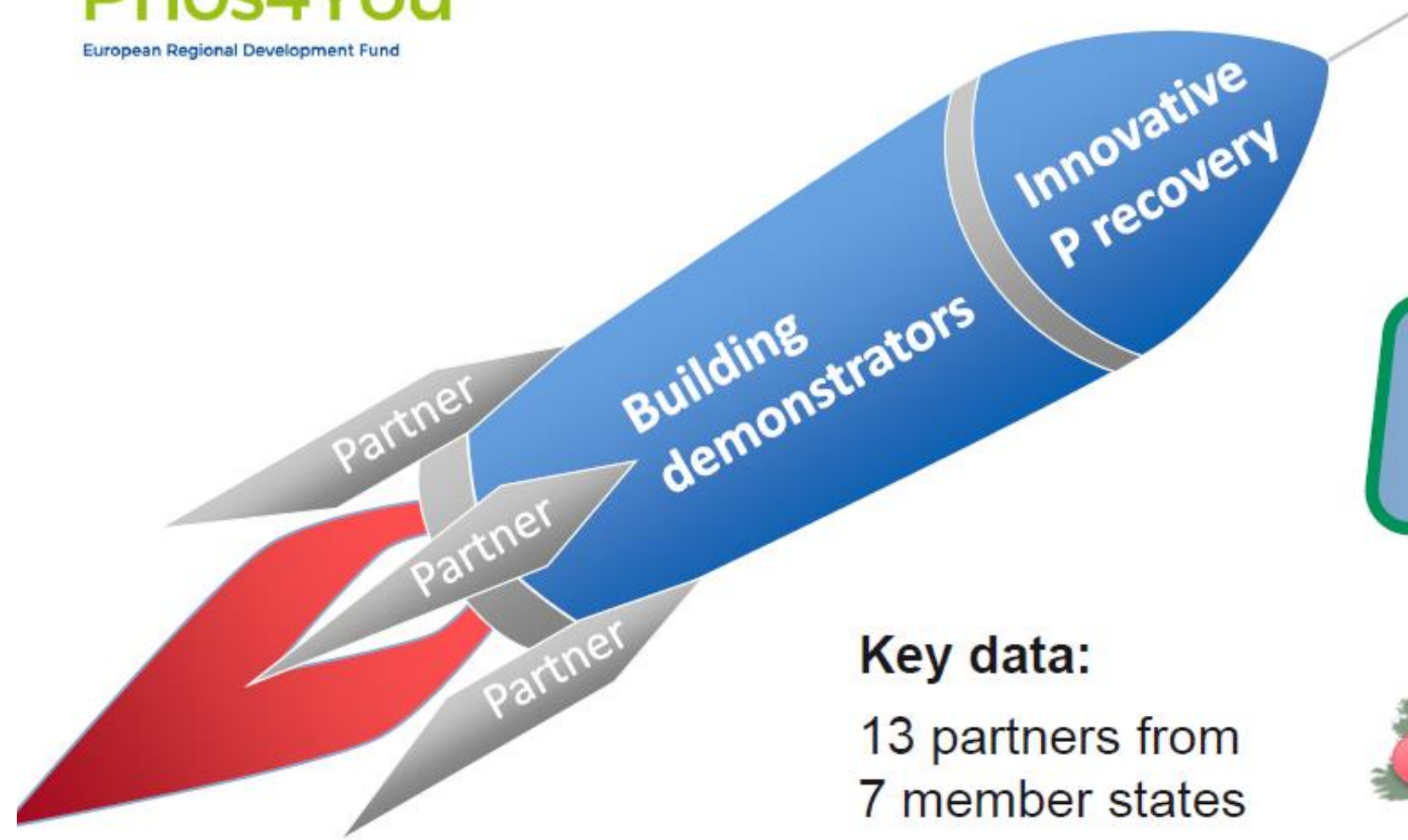
Agriculture & food production need P



Reduce P-rock import into EU!

Close P cycle

The Phos4You project



Aim:
P-Recycling
from waste
water

APPROVED!

Key data:

13 partners from
7 member states

10,9 Mio. €

2016 - 2020

60% ERDF



The Phos4You project



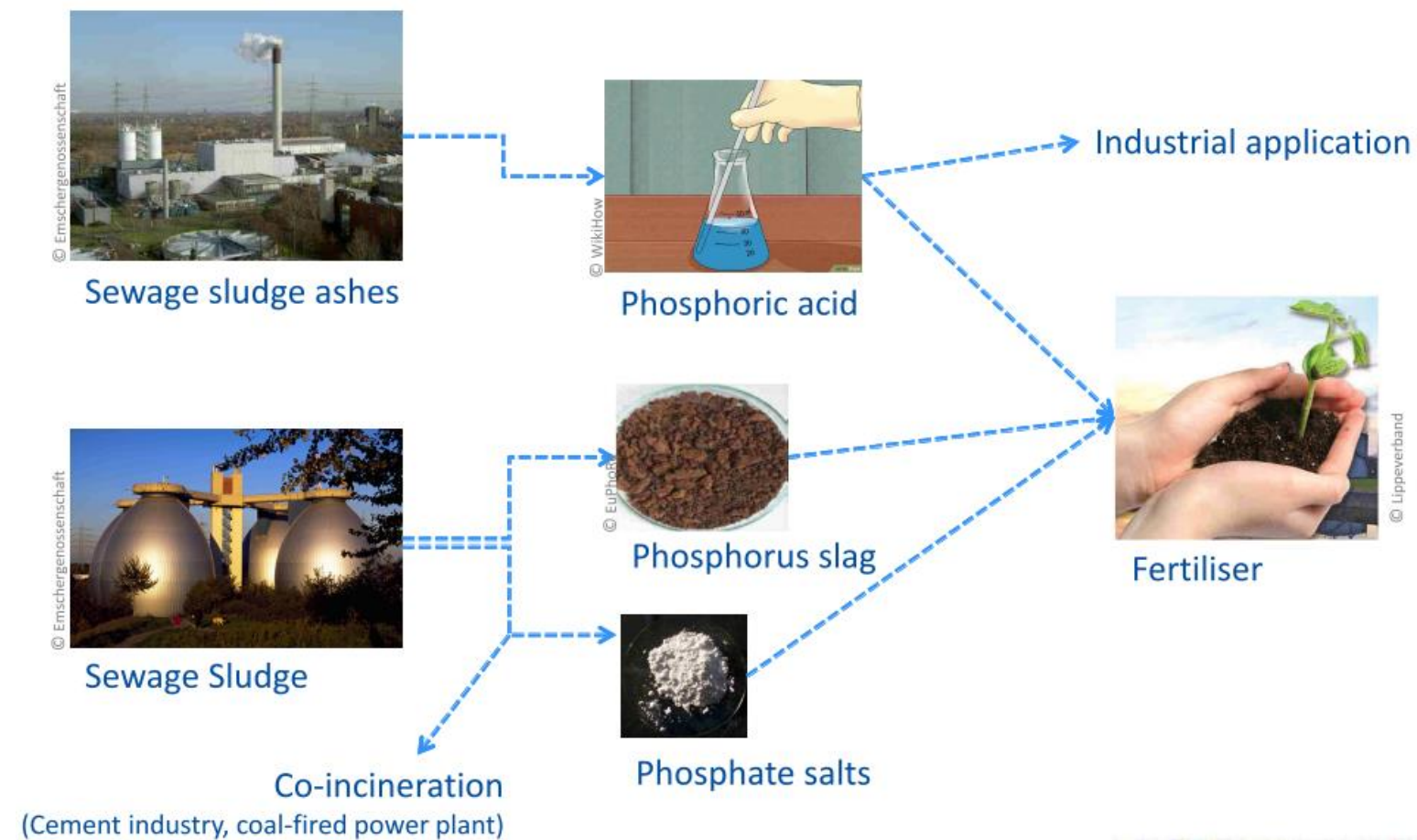
Partnership



The Phos4You project - Demonstrators



- Different inlet material, different P recovery technologies, different outlet products



Novel P recovery technology		Fertilizing product	
	Thermal process		P slag
	Sludge leaching		DCP/P acid
	Ash leaching		Ca/K/Mg phosphate
	Nature based process		Microalgae
	P adsorption		Granules
	P salt precipitation		MAP/DCP

- Different scales and mature
- Quality assessment: coordinated by UGhent
- LCA/LCC: by ULiège

The Phos4You project - Demonstrators



I1
Sludge/Thermal

EuPhoRe®

Piloted by: Emschergenossenschaft and EuPhoRe GmbH
P-source: Sewage Sludge (dewatered or pre-dried)
P-product: Phosphate fertiliser (12-20 % P_2O_5)



I2
Ash/Leaching

REMONDIS TetraPhos®

Piloted by: Lippeverband with REMONDIS Aqua
P-source: Sewage sludge ashes with low P-load
P-product: Phosphoric acid (H_3PO_4)



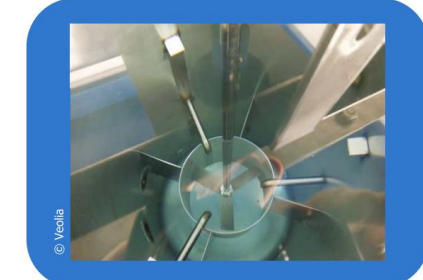
I6
Sludge liquor/
MAP prec.

Biological phosphorus dissolution before P precipitation from sludge liquor

Piloted by: IRSTEA and Véolia
P-source: Sludge liquor
P-product: Struvite ($MgNH_4PO_4 \cdot 6H_2O$) or "Phosphate salts" based products

Phosphorus precipitation at small-scale sewage plants : Struvia™

Piloted by: Véolia with Cork Institute of Technology and Glasgow Caledonian University
P-source: Waste water at small-scale wwtp
P-product: "Phosphate salt" product



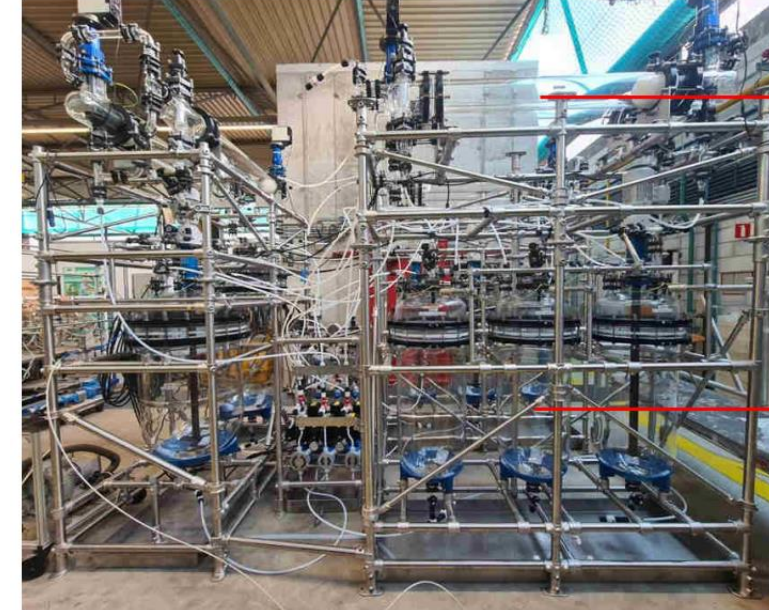
The Phos4You project - Demonstrators



13
Sludge/ Leaching

Acid leaching of phosphorus from partially/fully dried sewage sludge: PULSE process

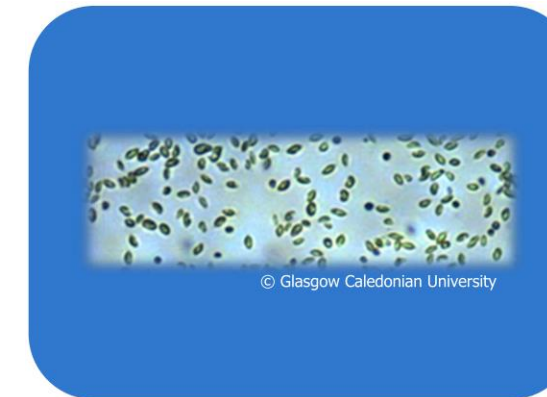
Piloted by: Université de Liège (ULiège)
P-source: Partially/fully dried sewage sludge
P-product: CA/K/Mg phosphate salts



14
Small wwtp
/NBS

Microalgae to recover phosphorus from small-scale waste water treatment plants

Piloted by: Glasgow Caledonian University
P-source: Waste water at small-scale wwtp
P-product: Microalgae biomass containing phosphates



© Glasgow Caledonian University

15
Small wwtp
/innovations

Phosphorus adsorption for small scale use: FiltraPHOS™

Piloted by: Environmental Research Institute (ERI), part of Univ. of the Highlands and Islands, and Veolia
P-source: Waste water (low volume), i.e., septic tanks, small WWTPs
P-product: Sorbent material enriched in phosphate (ideally for direct land application)



© Veolia



- **The impact (or not) of the P-recovery process on the WWTP is of importance.**
 - **Case 1: no effect as sludge is ‘collected and treated’**
 - **Pulse, Euphore**
 - **Possible to evaluate the LCA related to P_2O_5 recovery with sludge considered as free**
 - **Case 2: effects on the WWTP operation**
 - **Struvia with bioacidification**
 - **Impact on sludge digestion, dewatering ...**
 - **Possible to evaluate the LCA of treating 1 m³ of wastewater, with and without the P-recovery process**

The Phos4You project – The context of LCA



- Comparison of P-products between each others is not relevant

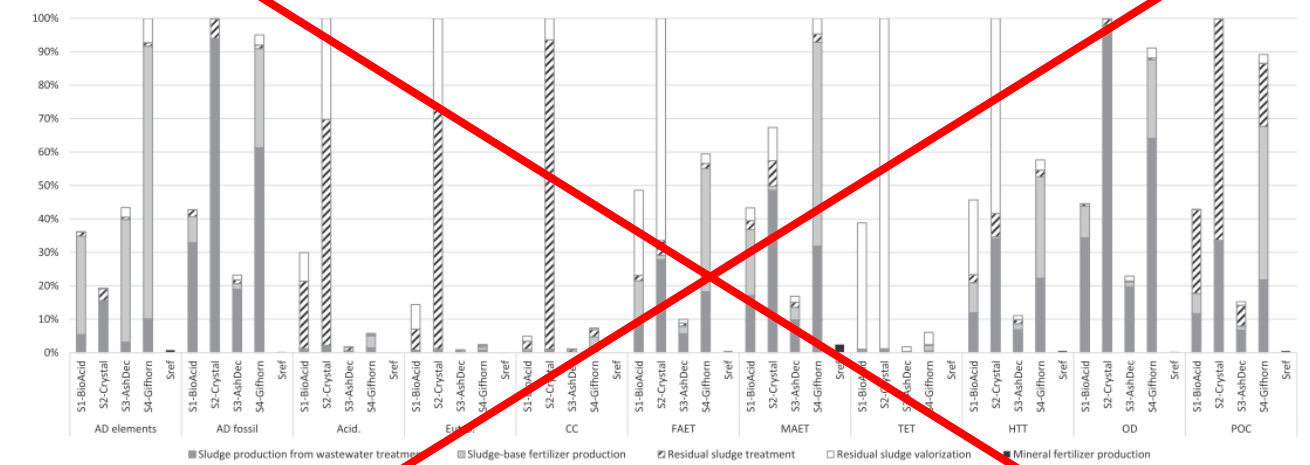


Fig. 4. Contribution analysis of processes to relative gross impacts of each scenario for each CML-IA impact category (AD elements: mineral resource depletion, AD fossil: fossil energy resource depletion, Acid.: acidification, Eutro.: eutrophication, CC: Climate change, FAET: freshwater aquatic ecotoxicity, MAET: Marine aquatic ecotoxicity, TET: terrestrial ecotoxicity, HT: Human toxicity, OD: Ozone depletion, POC: photochemical oxidation).

- LCA is seen as an eco-design tool to improve each process



- Comparison with fossil P could be investigated after quality assessments
 - BAU treatment of water/sludge (and disposal) + production of ("traditional") P fertilizer
 - P fertilizers with recovery process

The Phos4You project - LCA of EUPHORE process

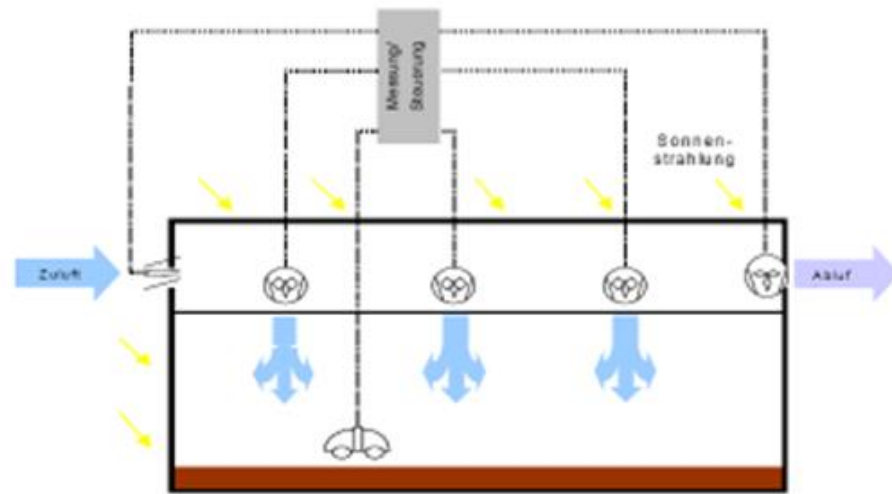
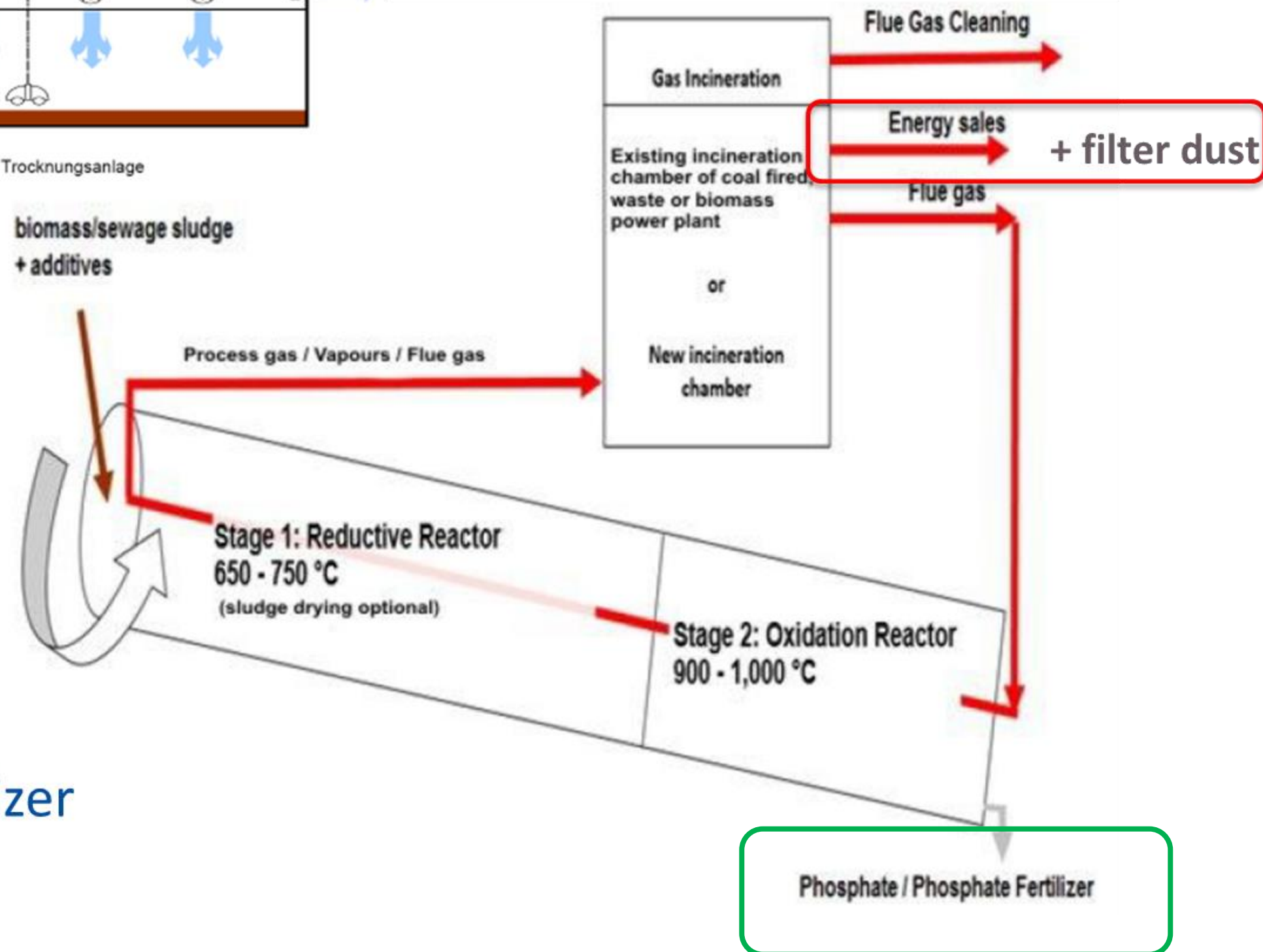


Bild 2.2.1: Thermo System Trocknungsanlage



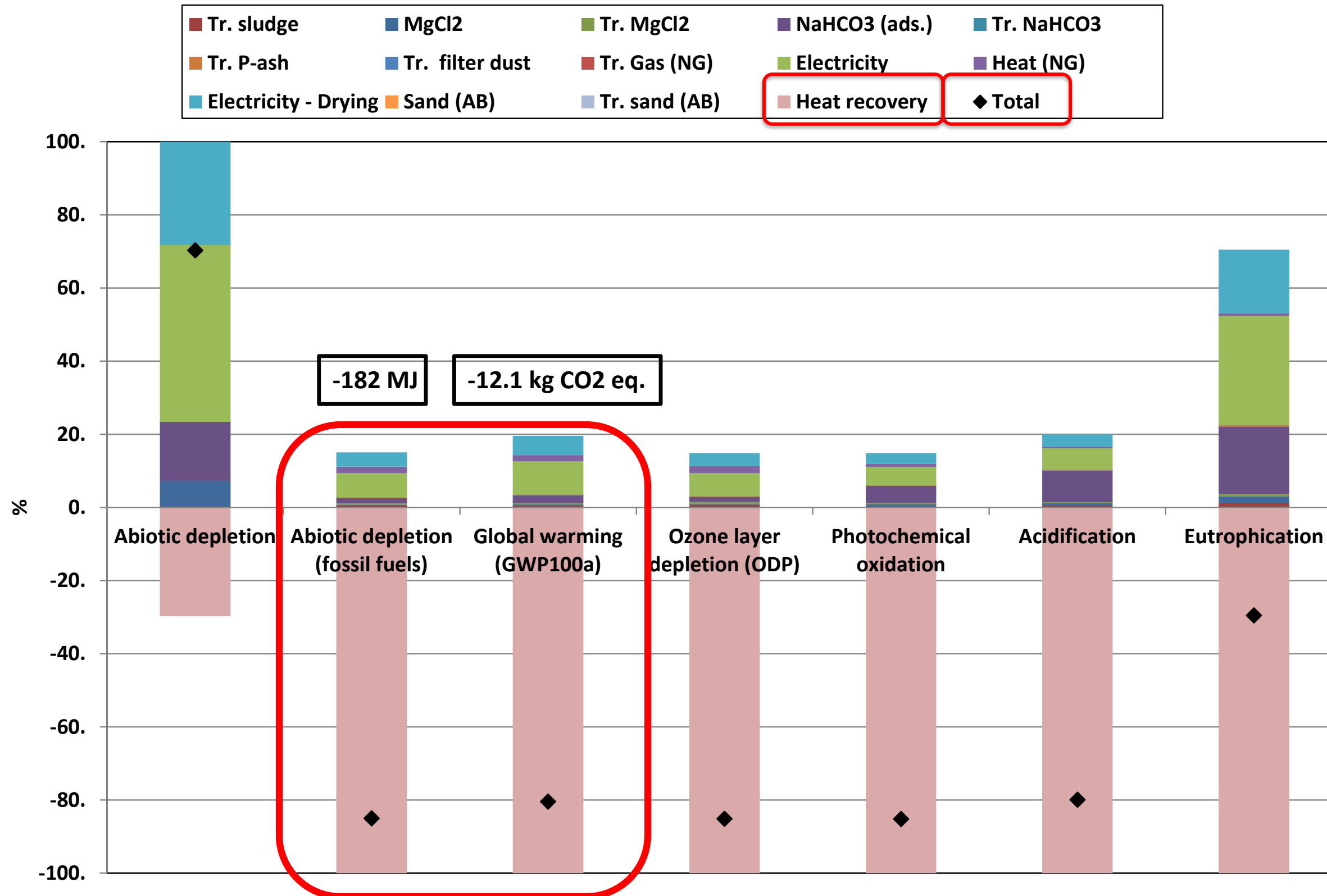
"Missing"

- AB fertilizer

The Phos4You project - LCA of EUPHORE process

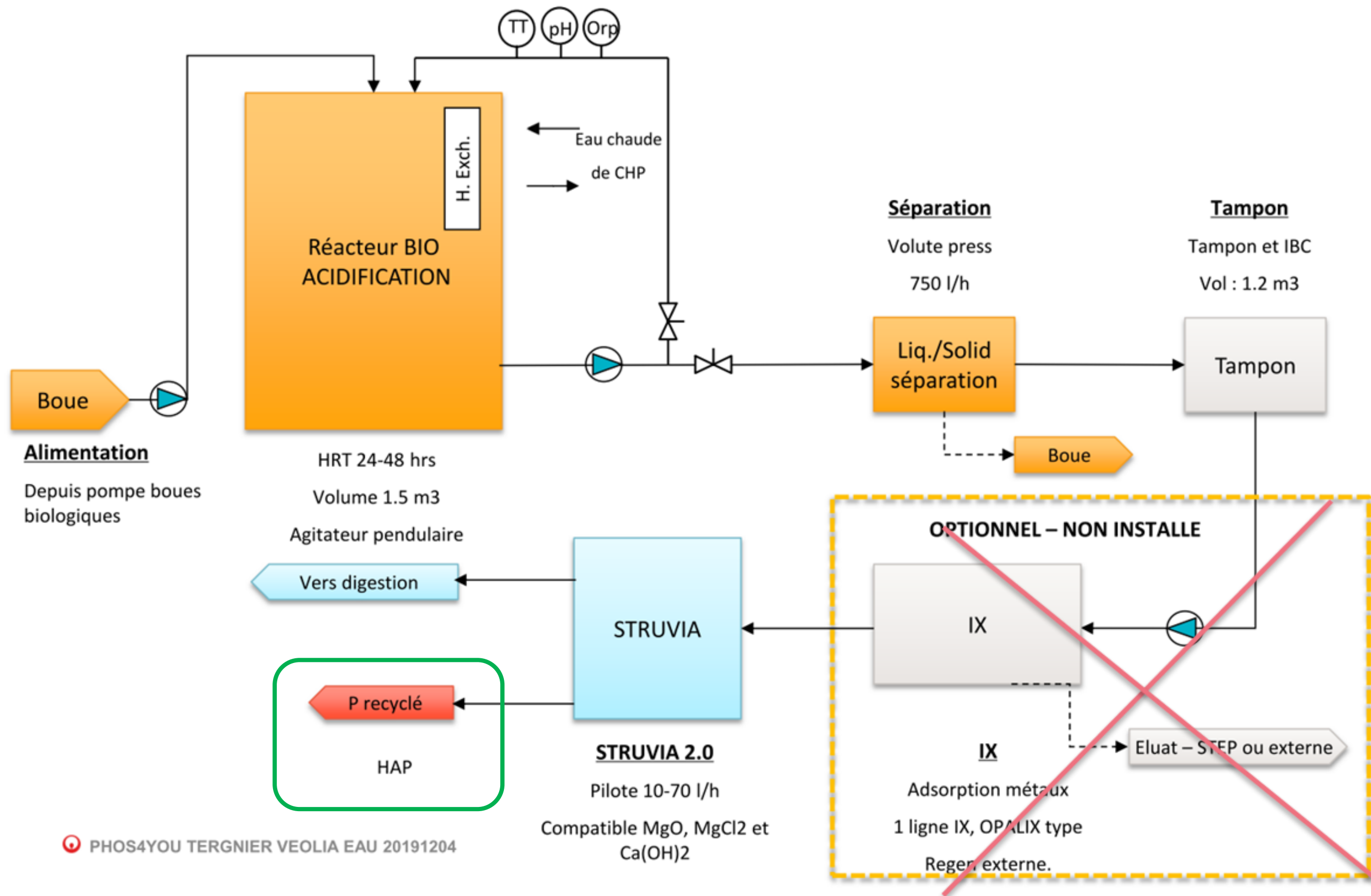


- Characterization (CML-IA) results: 1 kg P₂O₅



- Main categories:
Abiotic depletion Fossil fuels and Global warming potential
- Large benefits through heat recovery (avoid burden)

The Phos4You project - LCA of STRUVIA process

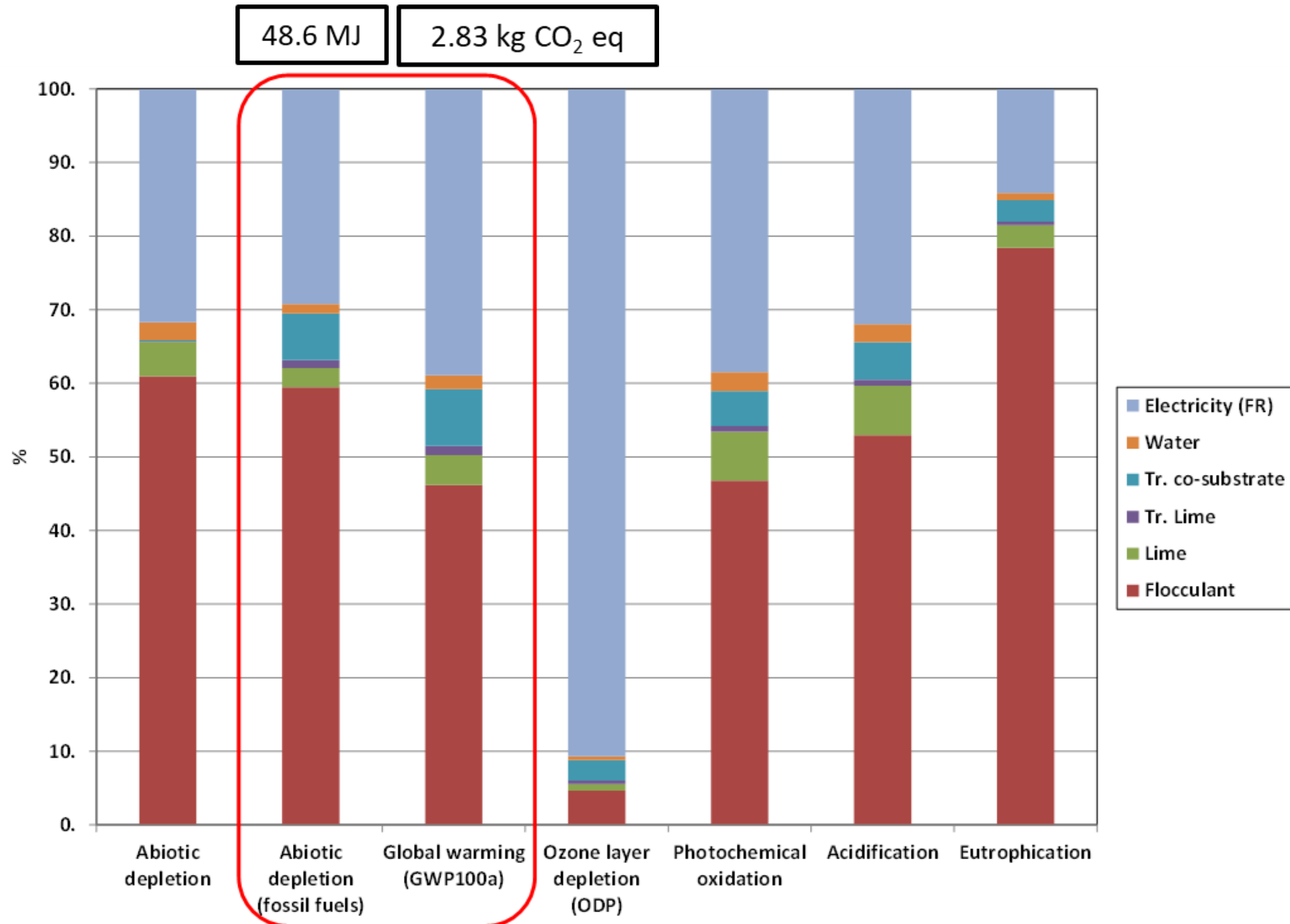


- Data from pilot plant in Tergnier (FR)
- Addition of co-substrate: residue of sugar from candied fruit or molasses production = waste ("free")

The Phos4You project – LCA of STRUVIA process



- **Characterization (CML-IA) results: 1 kg P₂O₅**



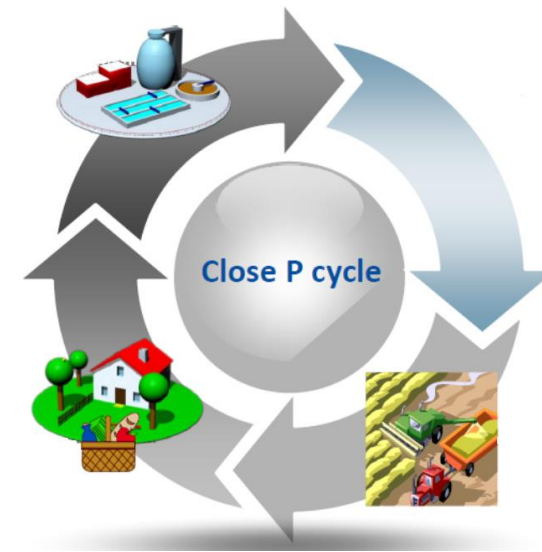
- **Main categories:**
Abiotic depletion Fossil fuels and Global warming potential
- **Importance of flocculant, energy**

Take home message



P recovery from WWTP needs to be improved to be concurrential with P-rock

BUT



In a circular economy

AND

in an "P independant Europe" perspective

it is worth to work on it!

... and that is what we do in the Phos4You project



