P-bac® - a biochemical approach for phosphorous recovery from ashes

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Materials, Recycling and Resource Strategies

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Where we come from - The Fritzmeier Group

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1926 - 1959 Company founded as a saddlery.
OEM of tractor seats.
First canopies for tractors.

60s establishment of the main plant in Großhelfendorf. Safety devices for tractors. Production of the first cabs.

70ies focus on tool design and construction
Manufacture of the first skis made in solid plastics.

Manufacture of boats and surfboards.

1975 Manufacture of safety cabs for tractors.

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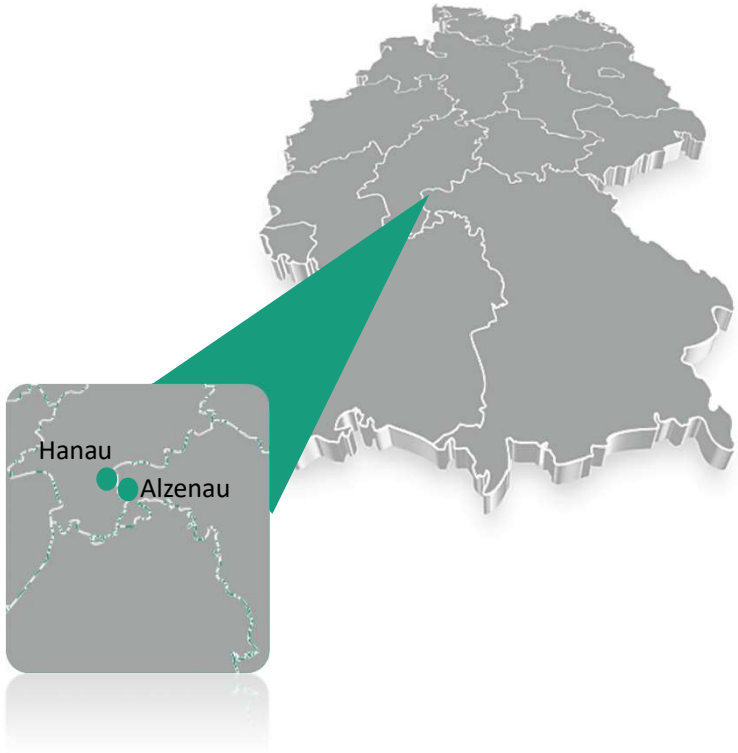
- Founded 2011
- Start-up phase 2012-2017
- Parent Institute:

  Fraunhofer ISC - Institute for Silicate Research in Würzburg

- Locations:

  Hanau (Hesse)

  Alzenau (Bavaria)



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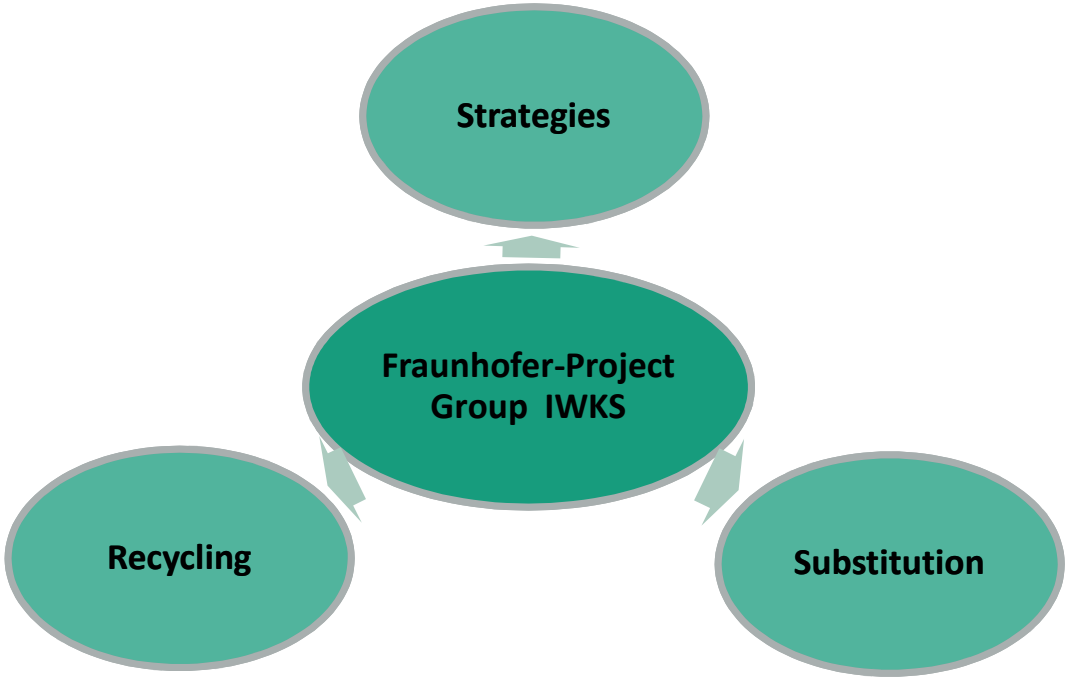
RESEARCH APPROACH OF THE FRAUNHOFER-PROJECT GROUP IWKS



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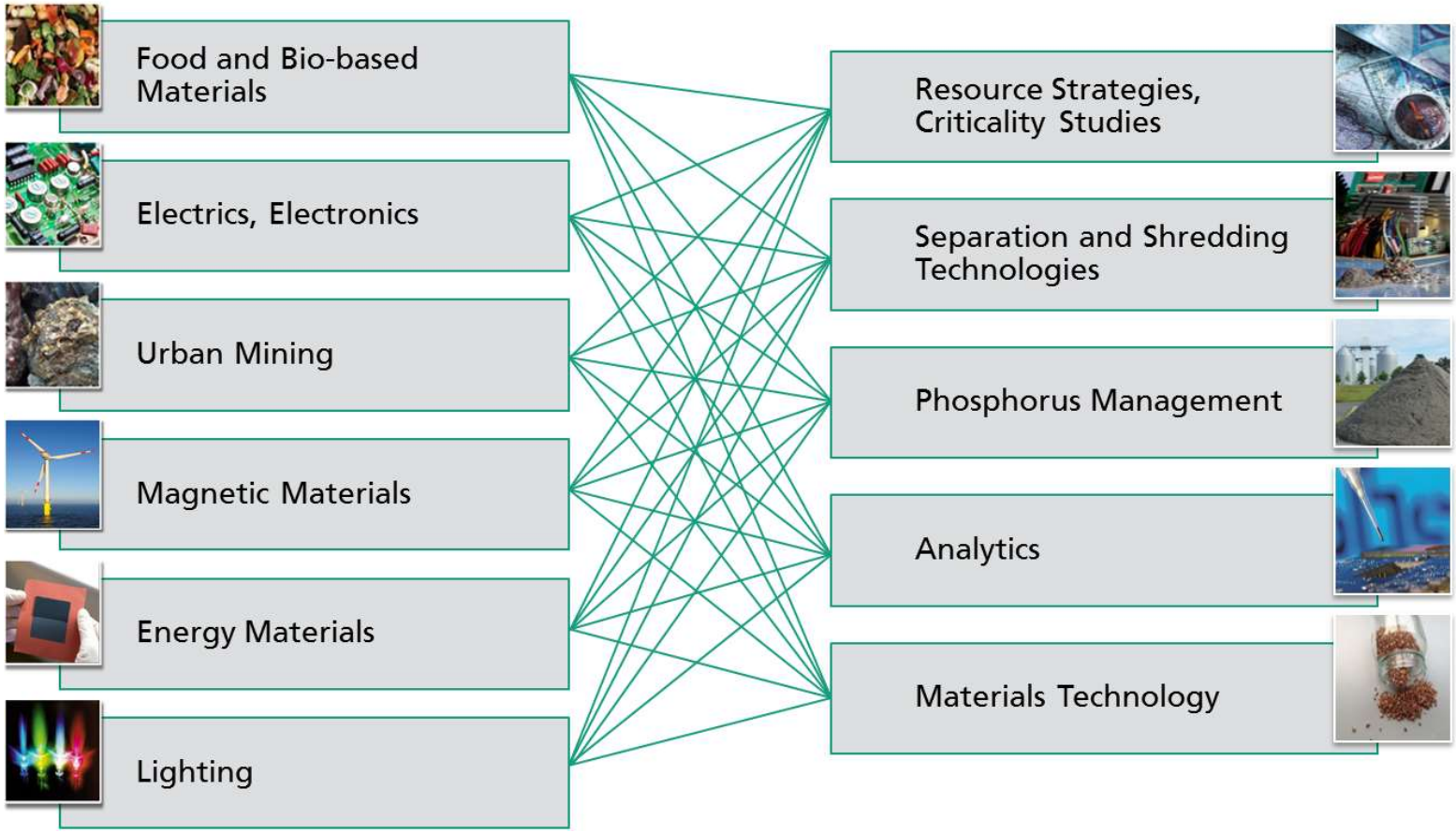
Business Units and Expert Groups



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Division Biogenic Systems
Nutrient recycling

Waste water | sludges | Ashes | Fertilizer

Resources of interest

- Phosphorus
- Nitrogen
- Potassium.

Material characterization

Analysis according to relevant ordinances

(DüMV, AbfKlärV, DepV)

Development of marketable Recycling-Fertilizer

- Pelleting and coating (controlled release fertilizers)
- Feasibility studies, LCA
- Approval of fertilizers
- REACH

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Selective Adsorption materials

Removal and recycling of contaminants and nutrients from waste waters

Superparamagnetic particles

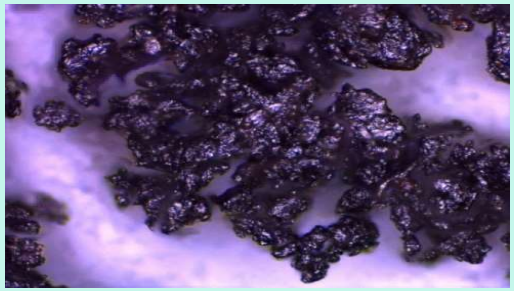
- Functionalised surfaces by LDH
- Magnetic separation
- Recycable by regeneration
- Selective Adsorption

Calcium silicate hydrates

- Simple and natural raw materials (lime, sand, water)
- Economic in production
- Selective Adsorption possible

Biobased secondary raw materials

- Great variety, large quantities available
- cheap
- Functionalization possible



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Biogenic Ressources

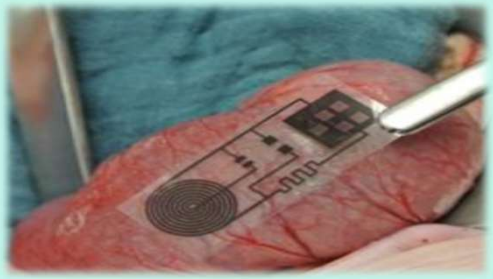
Processing and application of by-products/wastes from the food industry

Biobased coatings

- Development of biodegradable barriers in plastic sheets
- Substitution of petrochemicals in fertilizers

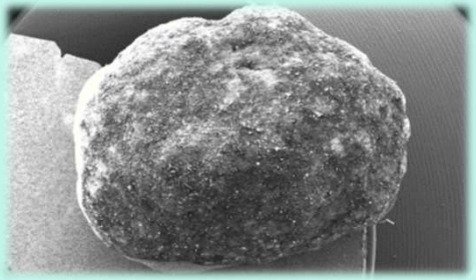
Medical materials

- Biodegradable electronics for active implantates
- Evaluation on degradation according DIN-ISO codes



Biobased composite materials

- Natural fibre reinforced materials
- Hemicelluloses as adhesion promotor



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P-bac ® Process

Solid material:
i.e. sewage sludge ash

Rich in heavy metals
& phosphates

Removal of Heavy Metals

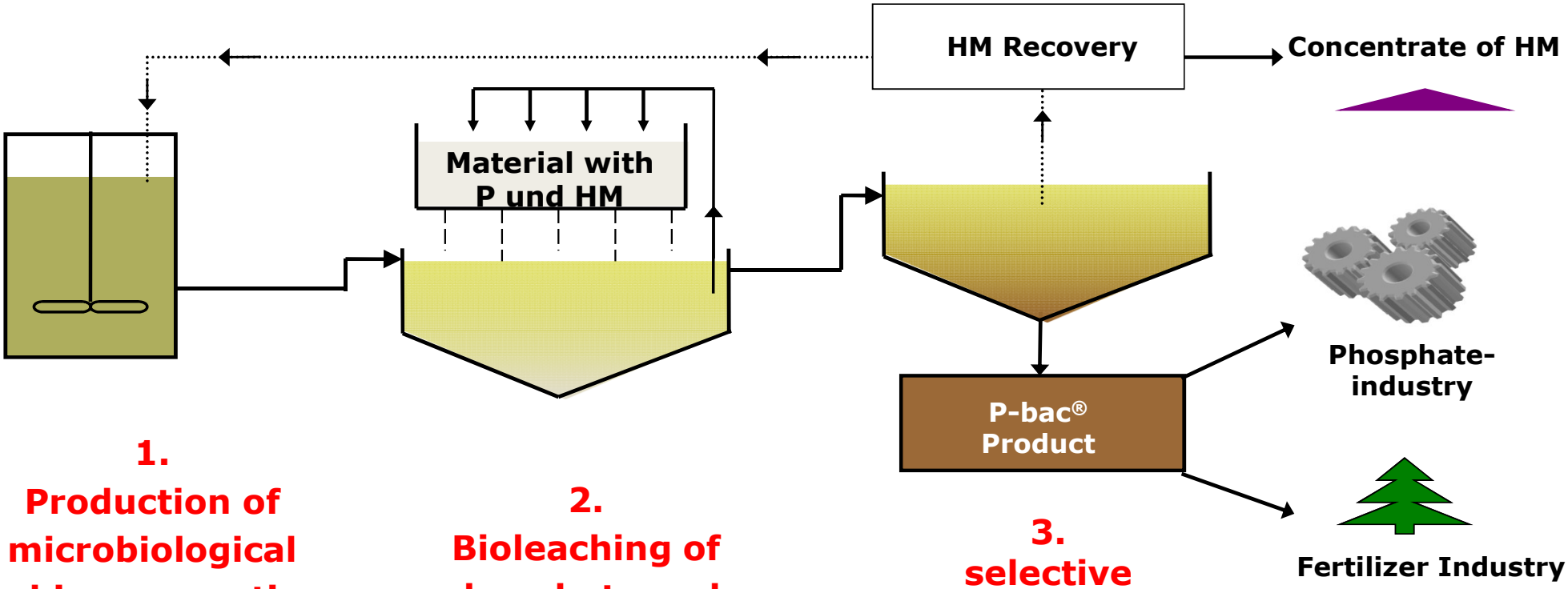
Phosphate-Recovery

P-bac® Process

Solid ash
HM & P reduced

HM concentrate:
further separation possible

P-bac® process scheme



1.
Production of microbiological leaching consortium; CO_2 fixation

2.
Bioleaching of phosphate and heavy metal

3.
selective P-Recovery

Bioleaching in nature

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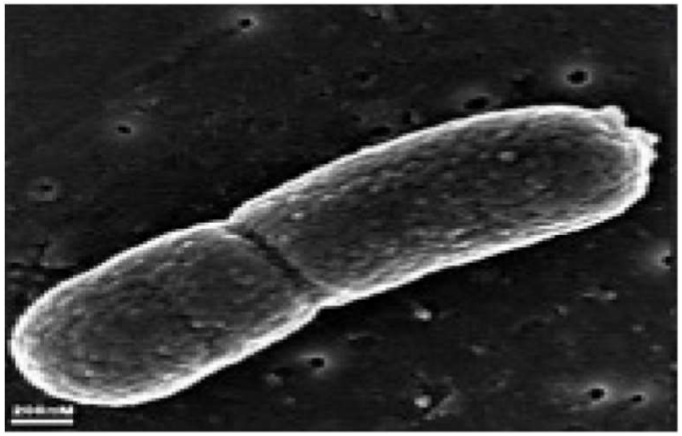
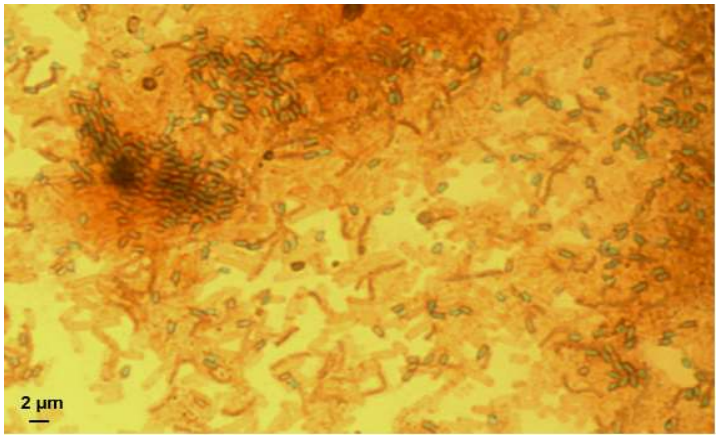
Leaching of ores using microorganisms
in industrial application:
uranium, copper, zinc, gold

Rio Tinto, Spain www.wikipedia.org

Microorganisms

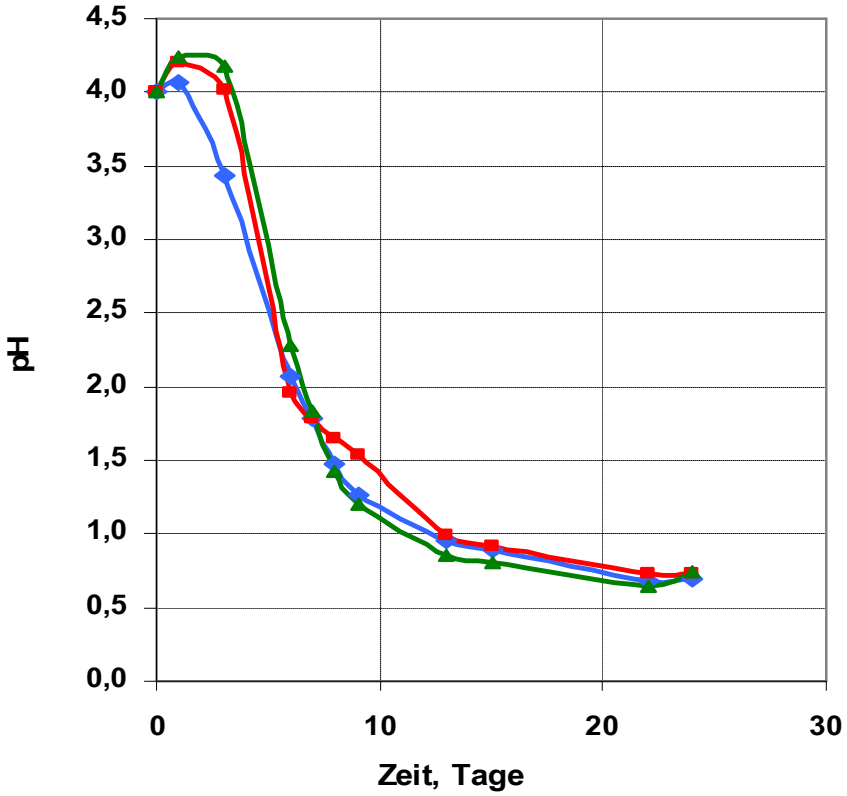
- leaching of phosphate and heavy metals in one step under acid conditions pH < 1
- CO_2 is used as carbon source
- Sulphur is used as energy source
- accumulation of polyphosphate: energy storage in living organisms
- microbiological induced P-precipitation





➔ defined mixed cultures of microorganisms

Production of leaching-fluid



Bioleaching of solids
Example: main elements

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	Solid material before treatment (g/kg)	Solid material after treatment (g/kg)	Leaching
P (Phosphorus)	44,5	4,6	90%
Al (Aluminium)	43,1	7,5	82%
Ca (Calcium)	313	216	31%
Fe (Ferrum)	81,1	27,9	66%
K (Kalium)	4,6	1,8	61%
Na (Sodium)	11,6	3,2	72%

Phosphate release ~ 90%

P-bac® Process
Heavy metal release

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	Solid material before treatment (mg/kg)	Solid material after treatment (mg/kg)	Leaching
As (Arsenic)	15	14	- 8%
Cr (Chrome)	80	27	- 67%
Cu (Copper)	540	27	- 95%
Mo (Molybdenum)	26	12	- 55%
Ni (Nickel)	71	11	- 85%
Pb (Lead)	67	19	- 72%
Sn (Tin)	37	3	- 93%
Tl (Thallium)	< 0,5	< 0,5	
V (Vanadium)	35	4	- 89%
Zn (Zinc)	1100	41	- 96%

Very efficient release of heavy metals ➔ reduction in the solid material

Phosphate Recovery
Microbial Polyphosphate Production

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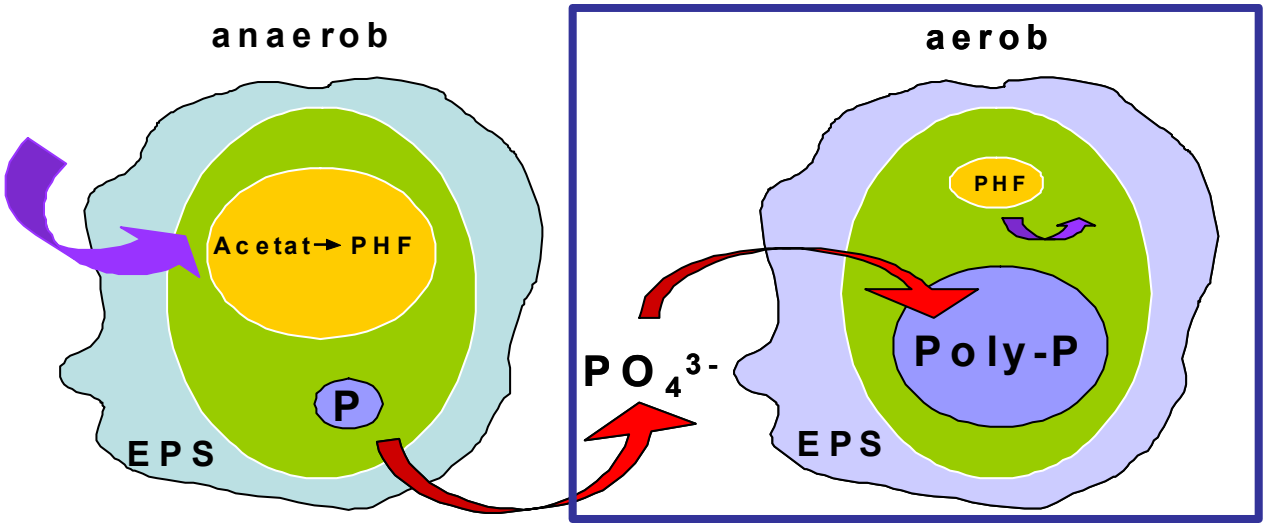
Microbial polyphosphate - accumulation

Formation of polyphosphates by *Acidithiobacillus* and other acid-tolerant phosphate accumulating micro-organisms

Stress response auf low pH und high concentration of metals



Phosphate Recovery
Combination of both processes

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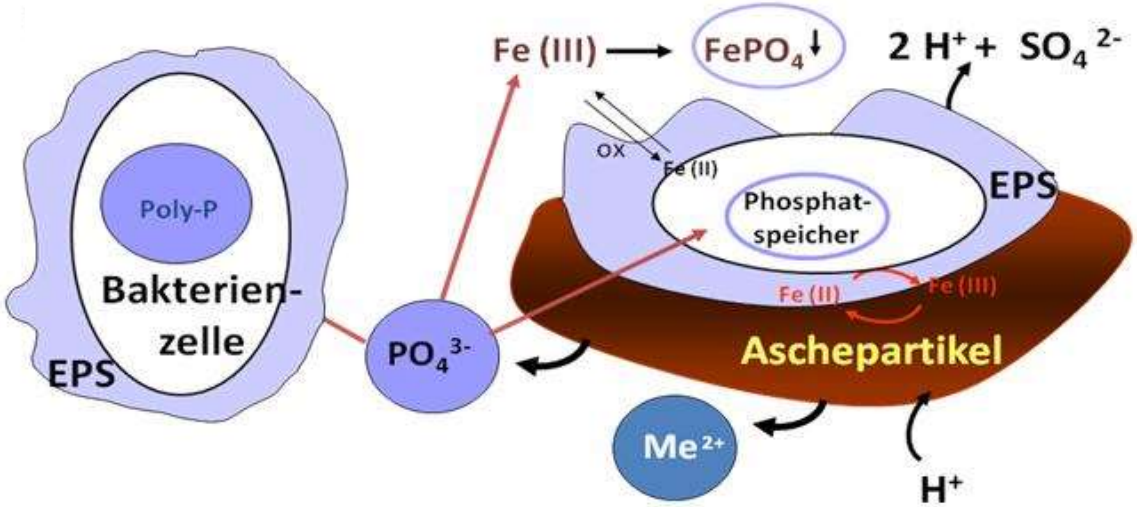
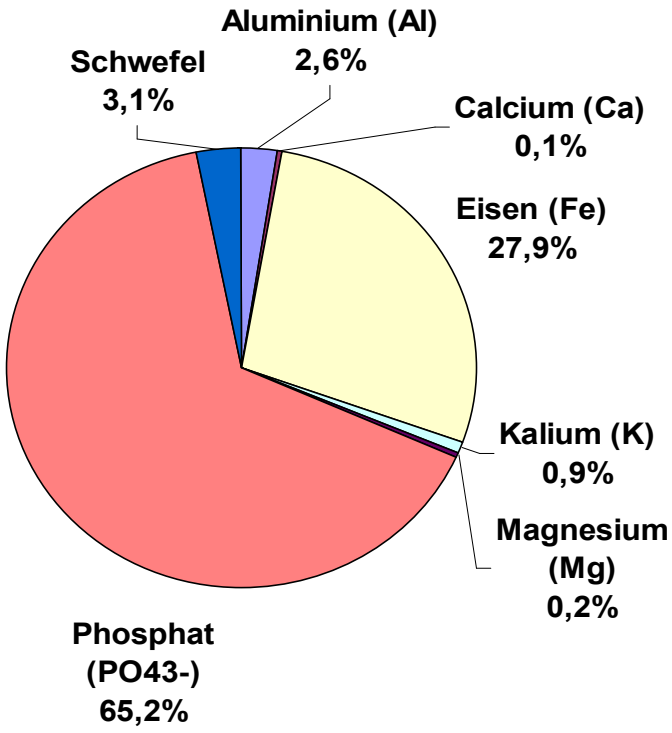
a. microbial polyphosphate production

b. microbial induced iron(III)phosphate precipitation



Phosphate Recovery
Combination of both processes



Scale up - proof of principle

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Step 1:

- production of leaching fluid
- leaching of metals and phosphate
- separation of leached ash
- accumulation of phosphate

➔ semi technical scale (8m^3)

Scale up - proof of principle

Step 2:

- Concentration and separation of phosphate

➔ Chamber filter press

Scale up - proof of principle

Recycled phosphate product P-bac®

Phosphor-Recycling – vom Rezyklat zum intelligenten langzeitverfügbaren Düngemittel (PRiL)

Duration: 01.08.2016 – 31.12.2018

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ICL Fertilizers

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Münchner Stadtentwässerung

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Bundesministerium für Ernährung und Landwirtschaft

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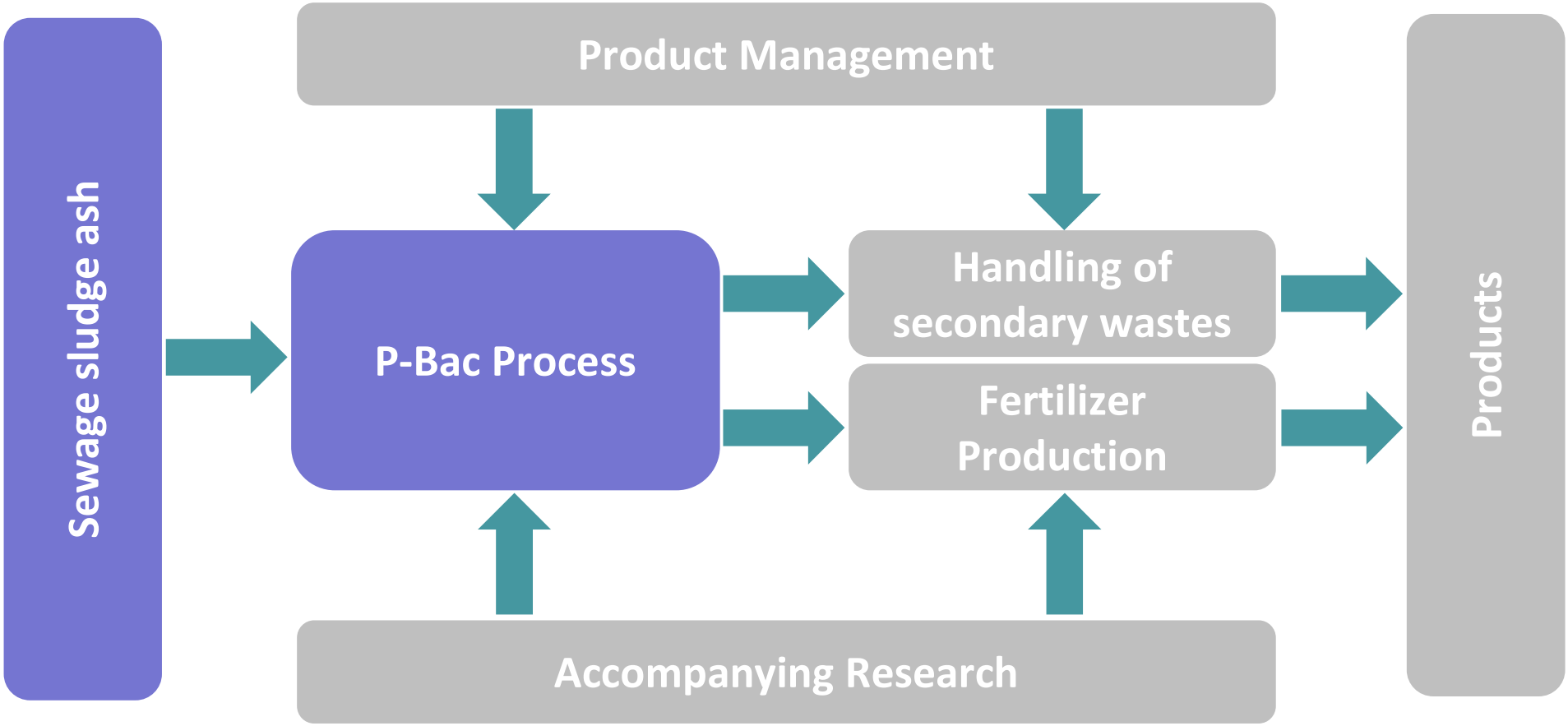
THE PRIL-PROJECT



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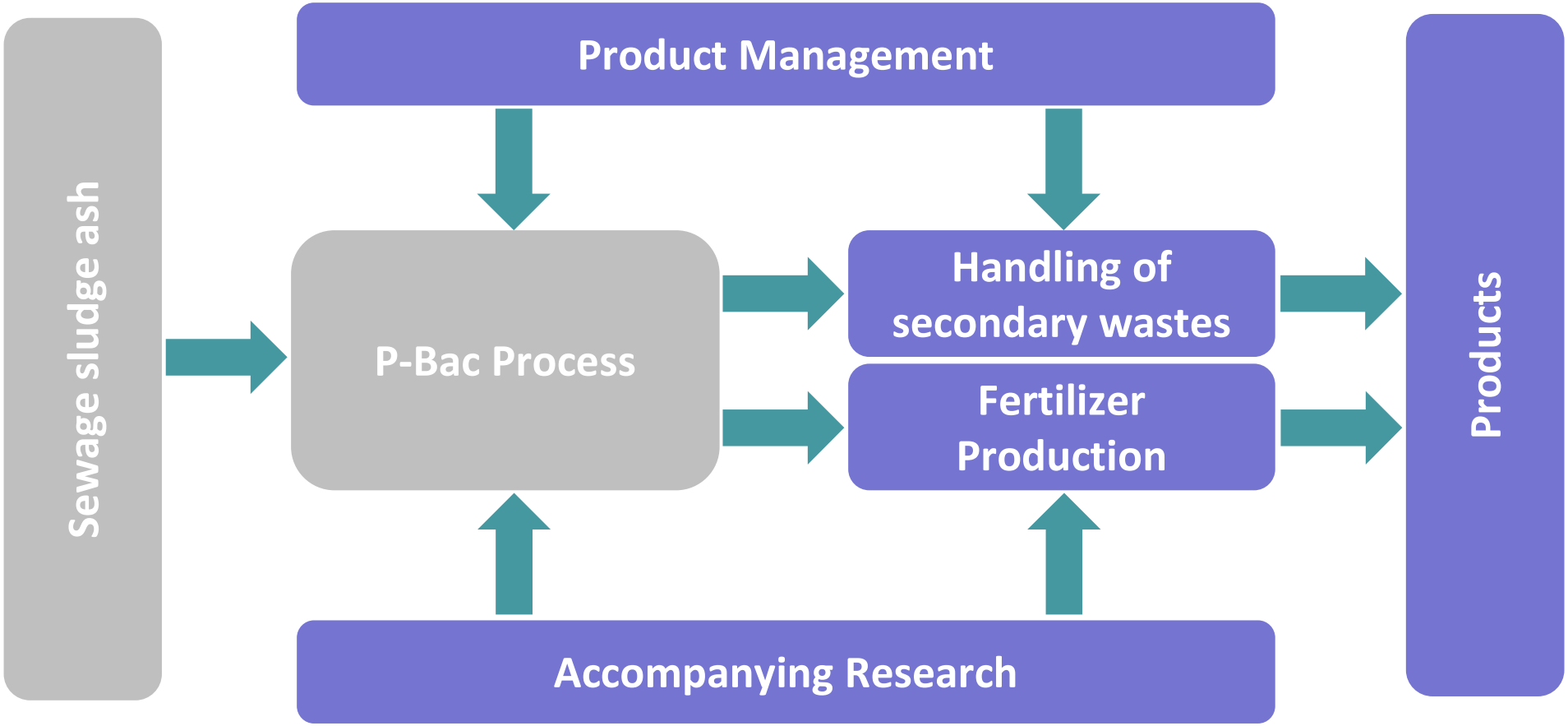

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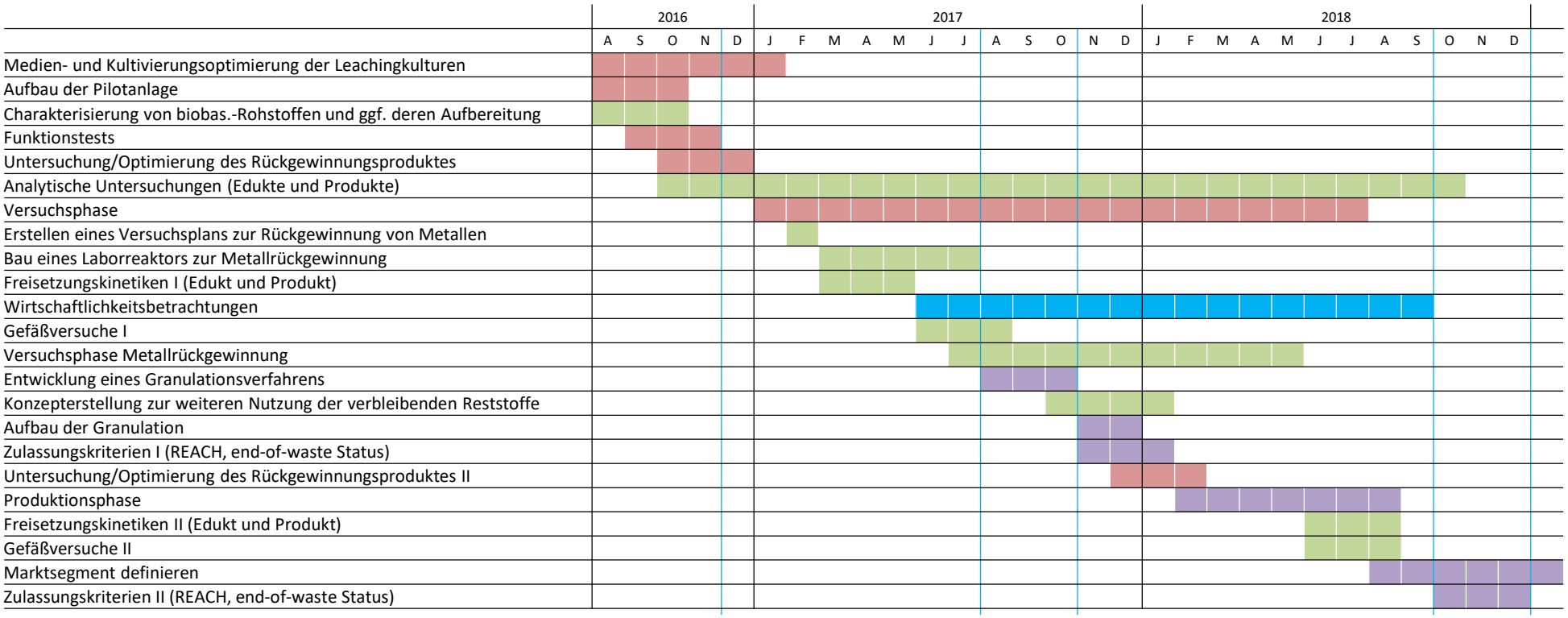

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