Strategical options for recycling phosphorus from wastewater in the Emscher-Lippe region

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Content

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  • IT STARTS WITH QUESTIONS

• Basics
  • TECHNOLOGY / VALUE CHAIN OF PRODUCTS / GENERAL OPTIONS

• Three options
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• Summary & conclusion
  • SHORT S-W-O-T TO CURRENT SITUATION / FURTHER ACTION
Objectives pursued in the Phos4You project

- Develop scenarios for regional P recovery and recycling from sewage sludge ashes in CH
- Showcase the P-recycling pathway implemented with NL-sewage sludge ashes
- Prepare a business plan to recover P from sewage sludge ashes in Emscher-Lippe region
Strategical options

IT STARTS WITH QUESTIONS
Many questions from the beginning

Sewage sludge ashes (SSA)
- No. 1
- No. 2
- No. x

Sewage sludge (SS)
- No. 1
- No. x

- ash
- both
- sludge
- only own
- also external
Many questions from the beginning

What?

Which?

Sewage sludge ashes (SSA)
- No. 1
- No. 2
- No. x

Sewage sludge (SS)
- No. 1
- No. x

Processes
- No. 1
- No. 2
- No. 3
- No. 4
- No. x

TetraPhos
PARFORCE
PULSe
Phos4Life
EuPhoRe
Phos...
...Phos
Many questions from the beginning

What?  Which?  Where?

Sewage sludge ashes (SSA)
- No. 1
- No. 2
- No. x

Sewage sludge (SS)
- No. 1
- No. x

Processes
- No. 1
- No. 2
- No. 3
- No. 4
- No. x

Locations
- No. 1
- No. 2
- No. 3
- No. x

- Bottrop
- Lünen
- Other operation site
- Extern

Chart n° 7
Many questions from the beginning

What?

Sewage sludge ashes (SSA)
- No. 1
- No. 2
- No. x

Sewage sludge (SS)
- No. 1
- No. x

Processes
- No. 1
- No. 2
- No. 3
- No. 4
- No. x

Locations
- No. 1
- No. 2
- No. 3
- No. x

How?

Core business
- No. 1

Outsourcing
- No. 2

Set-up
- No. 1

Where?

Subsidiary
- No. 1

Privat partner
- No. 2
- No. x
Many questions from the beginning

Which tasks and responsibilities along the recovery and recycling chain should EGLV perform?

What is our business model?
LET´S TAKE A LOOK TO THE BASICS

Sewage sludge strategy & Phos4You Project
Basis for planning

• Sewage sludge strategy
  – modernization and investment
  – Capacity increase

  Bottrop
  • 2021 solar thermal dryer

  Lünen
  • 2023 thermal dryer

• EGLV
  – 55 WWTPs
  – 2 Incinerators

85,000 Mg SS
227,000 Mg SS
65,000 Mg DM
97,400 Mg DM
380,000 Mg SS
44,000 Mg SSA
30,000 Mg SSA
>70,000 Mg SSA

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Phos4You - Technology Demonstration

Wet-chemical process

Thermo-chemical process

By-products

Klärschlammmasche

EuPhoRe® Anlage
Distribution & marketing (1)

- Phosphoric acid
  main stakeholders that might be implicated in the recycling pathways of phosphoric acid produced

Legende
- Stakeholder
- Material / Product
- Delivery
- Alternatively

Source: Blöhse et al., 2020

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Chart n° 13
Distribution & marketing (2)

- EuPhoRe® ashes
  main stakeholders that might be implicated in the recycling pathways of SSA

Source: Ploteau et al., 2020, modified
Business models - Overview

General Options

1st Conclusion
- Production of fertiliser are not our scope (incl. distribution/marketing)
- Just production of „raw-materials“

Preferred Options:
- Core business incl. P-Recovery
  - Performance of the legal obligation for P-recovery
- Just core business (outsourcing)
- Subsidiary for P-Recovery

2nd Conclusion
- Integration of private companies tends to be questioned critically, since water management is generally carried out under public law
- Privat Public Partnership (PPP) is a complex construct, which is not easy to implement for a waterboard as EGLV
Some answers to create concrete scenarios

**What?**
Because of sewage sludge incineration at EGLV, a SSA related P-recovery is focused on

**Which ?**
Wet-chemical processes to produce P-Acid and usable by-products, but modified incineration processes to produce SSA with fertilising value are also looked at

**Where?**
Own operating sites are preferred, but suitable external sites are also considered

**How?**
By our own, possibly as subsidiary, but suitable provider for outsourcing are also considered
Strategical options

THREE OPTIONS
1st Option

WE MAKE IT OURSELVES
1st Option – Implement in core business Various locations possible

• More than two options for location
1st Option – Implement in core business
Different technologies

• Possible implementation for EuPhoRe®-Technology

• **Current modernisation** with **high investments** do condition the conversion to an alternative combustion technology only in the long-term
2nd Option

OUTSOURCING
2nd Option - Outsourcing

- Delivery of SSA as waste-based raw material to existing production sites in Europe

~73,000 Mg SSA

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2nd Option – Outsourcing
Use of inland harbour

- Infrastructure waterway NRW
- Ship transport
- International stakeholder
  - YARA - Norway
  - PRAYON - Belgium
  - Elixir Group – Serbia
  - ICL – Netherlands
  - Fertiberia – Spain

Transport and storage?
Conditions at the plant of the external provider?
SSA-requirements of external provider?
2nd Option – Outsourcing
Conditions and requirements

FAQ – Keywords

- Transport options
  - Truck
  - Train
  - Ship

- Storage/handling warehouse
  - Required investment
  - Available areas

- Notification (hazardous waste)
  - Effort (time/human resources)
  - Fee
  - surety/liability risks

- State of the art
  - Purchase capacity (tonnes SSA)
  - Ecological aspects - Disposal of wastewater and ash residues
  - All required permits (acceptance of hazardous waste)
  - Quality of SSA (low P/Impurities)
  - Infrastructure for transport/storage

- Gate fee
  - Stable prices
  - Contract terms

- Certificates
  - Of P recovery: acceptability for e.g. German authority
3rd Option

WE DO IT IN COOPERATION
3rd Option – Cooperation
Concept AMPHORE

- Project started 2020
  - 5 years
  - 5 waterboards
  - 5 incinerators
  - approx. 120,000 Mg SSA/a

regional SSA-based approach / large-scale technology implementation
3rd Option – Cooperation
Various locations possible
3rd Option – Cooperation
Material flow management

- Challenge of a centralized approach

<table>
<thead>
<tr>
<th>Goods in transit</th>
<th>Factor per Mg SSA(^{a})</th>
<th>Capacity of P-recovery plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSA(^*)</td>
<td>1.0</td>
<td>30,000</td>
</tr>
<tr>
<td>Chemical-demand</td>
<td>0.5 – 1.5</td>
<td>15,000-45,000</td>
</tr>
<tr>
<td>(\text{H}_3\text{PO}_4) (75 %)</td>
<td>0.2</td>
<td>6,000</td>
</tr>
<tr>
<td>Ca-Byproduct</td>
<td>0.3 – 0.4</td>
<td>9,000-12,000</td>
</tr>
<tr>
<td>Fe/Al-Byproduct</td>
<td>1.0 – 2.0</td>
<td>30,000-60,000</td>
</tr>
<tr>
<td>Residues</td>
<td>1.0 – 1.2</td>
<td>30,000-36,000</td>
</tr>
<tr>
<td><strong>Total (min-max)</strong></td>
<td><strong>2.5 – 3.8</strong></td>
<td><strong>120,000-189,000</strong></td>
</tr>
</tbody>
</table>

\(^{a}\)Source: Ploteau et al., 2020

*minus the SSA arising at the location of the P-recovery plant

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Chart n°29
3rd Option – Cooperation
Logistic aspects (1)

- Phos4You-logistics study
  - Approach
    - Implementation of alternative transport via ship and/or train
    - Calculation of transport costs and emission
      - Supply, labor, and energy costs
    - Estimation of costs for infra- and superstructure
    - Consideration of different locations
      - Two operation sites of (EG – Bottrop/Innovatherm – Lünen)
      - Three external (2 different chemical parks, 1 industrial area - chemical wholesaler)
3rd Option – Cooperation
Logistic aspects (2)

• Phos4You-logistics study
  – Results
  • Relatively short distance for train and barge
  • **Transport costs** are 1.8 to 2.8 (2.0 to 3.1 economically) times higher for truck transport than for optimal transport.
  • **Emission costs** are 2.6 to 3.9 times higher for truck transport than for optimal transport.
    – **Transports by rail and inland waterway are cheaper and possible**, despite the short distances, with sufficient storage capacity on site.
    – Cost are between 6 and 18 €/Mg SSA **depending on availability of chemical suppliers and customer**/user of by-products
    – Investements for infra- and superstructure are estimated between 20 and 30 Mio. €
3rd Option – Cooperation
Location aspects

• Phos4You-logistics study
  – Criteria catalogue for assessment of location
    • Land availability
    • Right of approval
    • Modality
    • Investment needs
    • Logistics costs
    • Other location factors
      – Suppliers/customers - on site/or not
      – Disposal or utilisation opportunities - on site/or not
      – Energy surplus (electricity/heat) - on site/or not

  – various advantages and disadvantages - all sites can be considered further
Strategical options

SUMMARY
Summary

• 1<sup>st</sup> Option – In-house
  – Directly implementable, but P recovery is not expected to be cost-covering and technology readiness is still "low"

• 2<sup>nd</sup> Option - Outsourcing
  – High provider engagement is required and there are a lot of open questions which are investigate

• 3<sup>rd</sup> Option - Cooperation
  – Joint cooperation provides many possible synergies, but also challenges. Investigation started with new project AMPHORE
Conclusion

P-RECOVERY IN 2029
Conclusion
P-recovery 2029

Strengths

- EGLV & subsidiaries are broadly positioned with their activities
- Technical solutions are identified
- Good networking with stakeholders at national and international level

Opportunities

- Potential for process optimization exists
- High willingness from the stakeholders to engage into collaboration
Conclusion
P-recovery 2029

Weakness

• **Suboptimal** technology readiness and market availability as well as diversity

Risks

• **Time horizon** until 2029
• The presumably high costs have a strong influence on the development of the fees of our citizens/members

Further action

• Continue to track and promote technology development
• Evaluate detailed aspects of implementation (location/logistics/customers/suppliers)
• The strategic options must be regularly reviewed and adjusted in the case of new developments
Many thanks to all the partners, stakeholders, suppliers & consultants