

An aerial photograph of a dry, cracked riverbed. The central area is a large, light gray, cracked expanse of dried mud. Winding through this and the surrounding darker, more textured areas are channels of thick, orange-brown sludge. The sludge flows in a meandering pattern, creating a complex network of paths. The overall scene suggests a water management or wastewater treatment context.

# CIRCULAR SYSTEM SLUDGE





# Sludge, Braunschweig – Circular System Characteristics

## System characteristics:

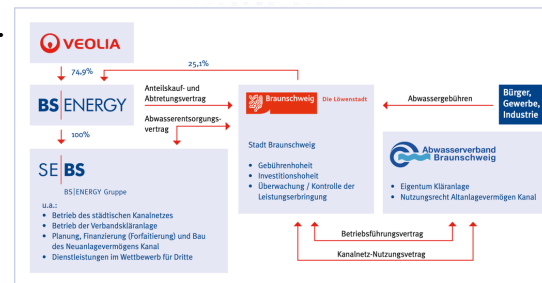
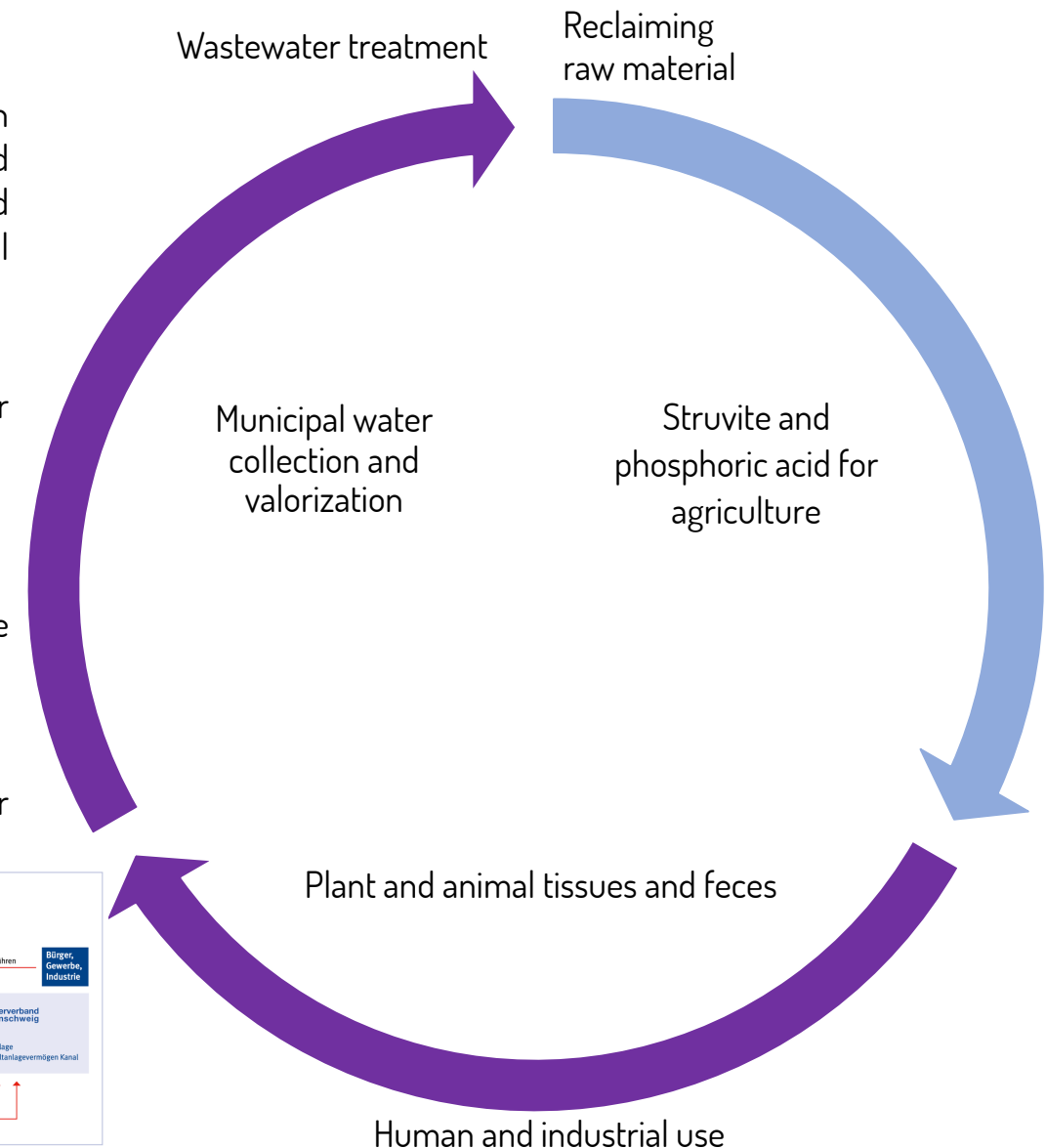
The city water management companies recycle phosphorus fully (closed loop), solutions have been found on a regional level within the district of Braunschweig. The phosphorus gets fully recycled and used as fertilizer for the production of maize (for energy use). So far it is prohibited to produce food using recycled phosphorus. The case proves feasibility. A technological, hygienical and environmental assessment has been passed.

## Availability/Role of recycling technology:

- High expectation in durability of the entire water system, technical enabling by private partner **Veolia for investment in additional phosphor recycling technology.**
- District of Braunschweig: 280.000 inhabitants and companies.
- 1,378 km water pipes of which including, 98 pumping stations, 60 water pools.
- 270-hectare land for outbring of phosphorus and agricultural production of energy plants.
- 617 km waster water pipes, 677 km rainwater pipes, 82 km mixed water pipes, 65 km pressure producing pipes.

## Maturity of market:

- The market is highly regulated. The use of phosphorus for agricultural use has been started after political decision making on the local level.
- **The business case was designed for the city of Braunschweig.**





# SWOT Sewage Sludge / Slurry

1. Closed loop
2. Biological cycle, C2C
3. Well organized water management in Germany (water industry and municipal water associations)

## Strength

1. Small-scale structure, 7000 municipal sewage companies and 266.600 farmers in Germany
2. Phosphorus dependency: Resources are concentrated in four countries only, that mine 230 thousand tons/year

## Weakness

## Opportunity

1. Expanding world market
2. Landfill ban for sludge and slurry since 2020
3. Legal requirements for recycling/reporting from 2029 on
4. Obligatory innovation need for 7000 municipal sewage companies in Germany
5. Additional biochar technology available
6. Reinvestment requirement and initiated changes in environmental regulation
7. Market restructuring

## Threat

1. Adaptation lack in agricultural sector
2. Missing openness for new technical solutions by regulatory regime
3. Missing technology assessments authorities for some available technological solutions





# 1. Nature Science

Dung as a renewable source for farming.





## 2. Envisioning Dung to raise crop for solving hunger.





### 3. Investment

Farming equipment is growing to make agriculture more efficient.





#### 4. Rocket Science

The invention of fertilizer and industrial agriculture solves efficiency, demands more phosphor and leads to phosphor exploitation.



An aerial photograph of a vast phosphate mining operation. The landscape is dominated by large, terraced pits and massive piles of reddish-brown phosphate ore. A complex network of conveyor belts and transport tracks crisscrosses the site, moving material across the landscape. In the background, a line of green trees marks the horizon under a clear sky. The foreground shows more detailed views of the mining infrastructure, including conveyor systems and large piles of processed material.

## 5. Historic Event

After the global food crisis during the 1970s, fertilizer became an answer of how to more efficiently raise grain crops. Though phosphor is non-renewable and peaking, agriculture became dependent.



## 6. Cognition for System Relevance

Phosphor has become indispensable for industrial agriculture.





An aerial photograph of a wastewater treatment plant. The facility features several large, circular aeration tanks with dark water and mechanical scrapers. There are also rectangular sedimentation tanks and various pipes and walkways. The plant is surrounded by green grass and some trees. In the background, a large body of water is visible.

## 7. Technical Innovation

Market players have developed digitized sewage sludge recycling technology to get phosphor back out of the water for solving scarcity.





**BS ENERGY**

Anteilskauf- und  
Abtretungsvertrag

Abwasserentsorgungs-  
vertrag



Die Löwenstadt

Abwassergebühren

**Bürger,  
Gewerbe,  
Industrie**

100%

## 8. Business Innovation

The system has become manageable through a network of players.

Stadt Braunschweig

- Sachzielenhoheit
- Investitionshoheit
- Überwachung, Kontrolle der Leistungserbringung



- Eigentum Kläranlage
- Nutzungsrecht Altanlagevermögen Kanal

**SE BS**

BS|ENERGY Gruppe

u.a.:

- Betrieb des städtischen Kanalnetzes
- Betrieb der Verbandskläranlage
- Planung, Finanzierung (Forfaitierung) und Bau des Neuanlagevermögens Kanal
- Dienstleistungen im Wettbewerb für Dritte

Betriebsführungsvertrag

Kanalnetz-Nutzungsvertrag



30,973

P

## 9. Life Cycle

System has evolved. Technical cycle is working.  
Phosphor gets fully recycled.

15 (Phosphor)





A high-angle, wide shot of a massive crowd of people, mostly young adults, gathered on a city street. Many are wearing white t-shirts, some with blue or red accents. They are holding up various signs and banners, including one with the word 'LOVE' and another with 'HUMAN RIGHTS'. The crowd is dense and fills the entire frame. In the background, there are buildings, streetlights, and a few cars, including a white van and a red car. The overall atmosphere is one of a large-scale public gathering or protest.

## 10. Forecast

Due to population growth, phosphor demand is forecasted to remain and even rise.



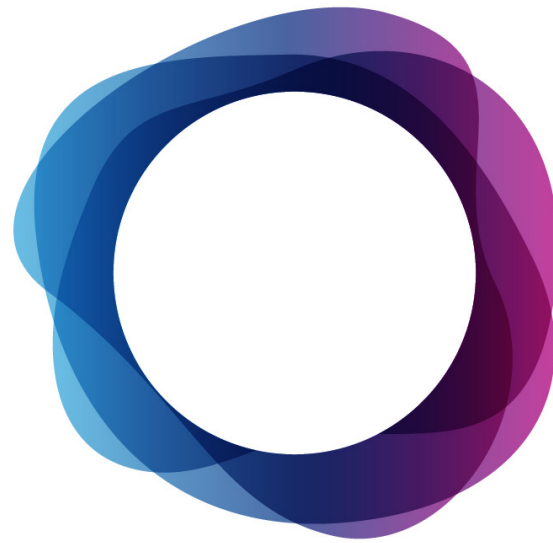


Phosphorus cycle – product system evolvement



Thank you  
for your  
attention

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