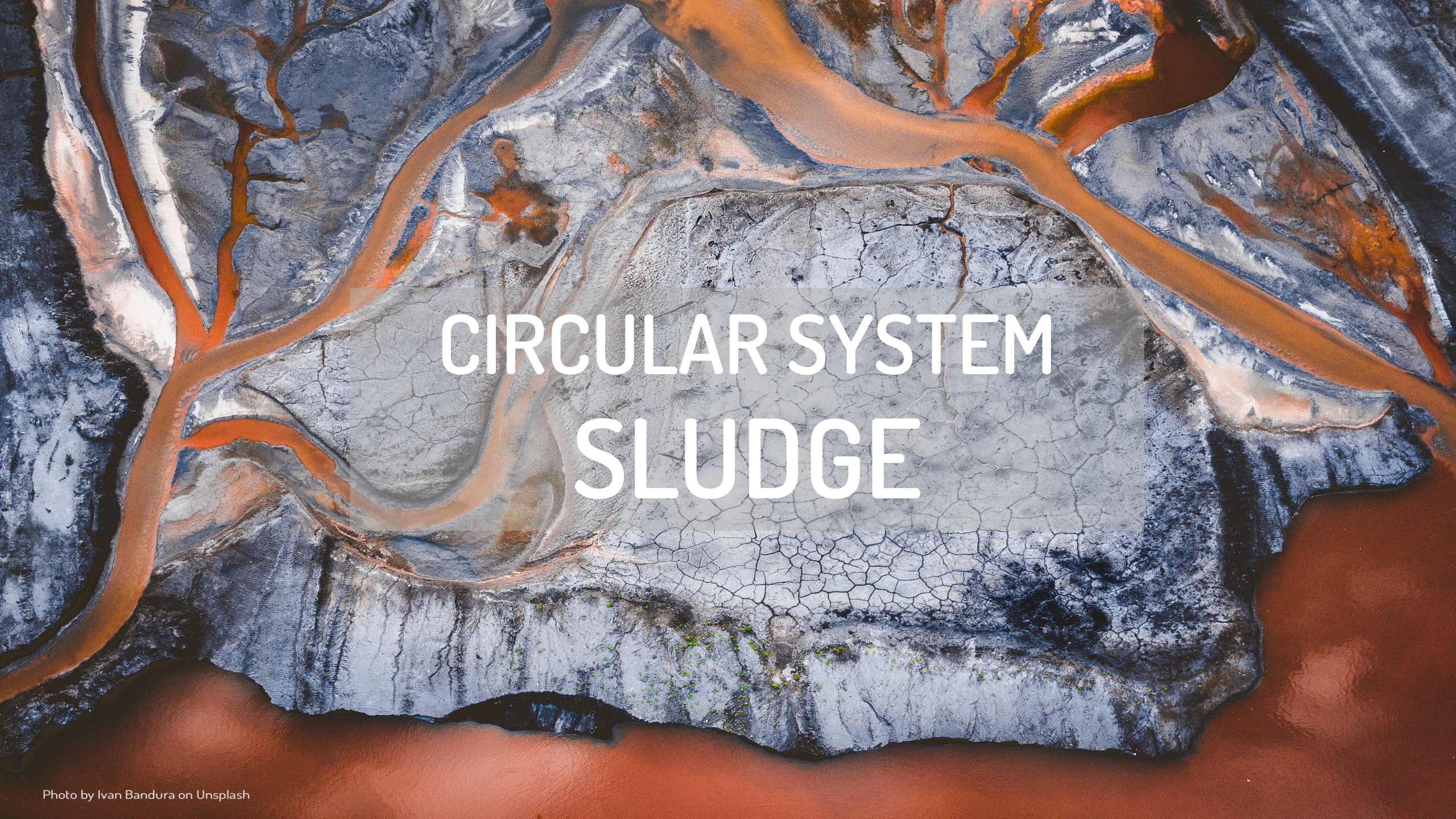


Photo by Ivan Bandura on Unsplash

Sludge, Braunschweig – Circular System Characteristics

System characteristics:

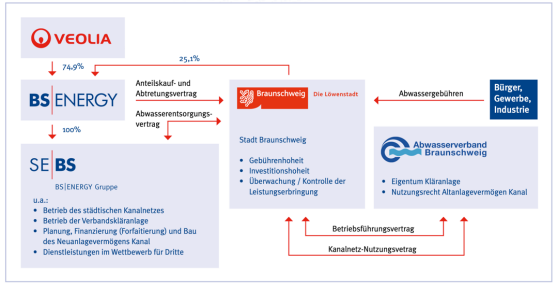
The city water management companies recycle phosphorus fully (closed loop), solutions have been found on a regional level within the district of Braunschweig. The phosphorus gets fully recycled and used as fertilizer for the production of maize (for energy use). So far it is prohibited to produce food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

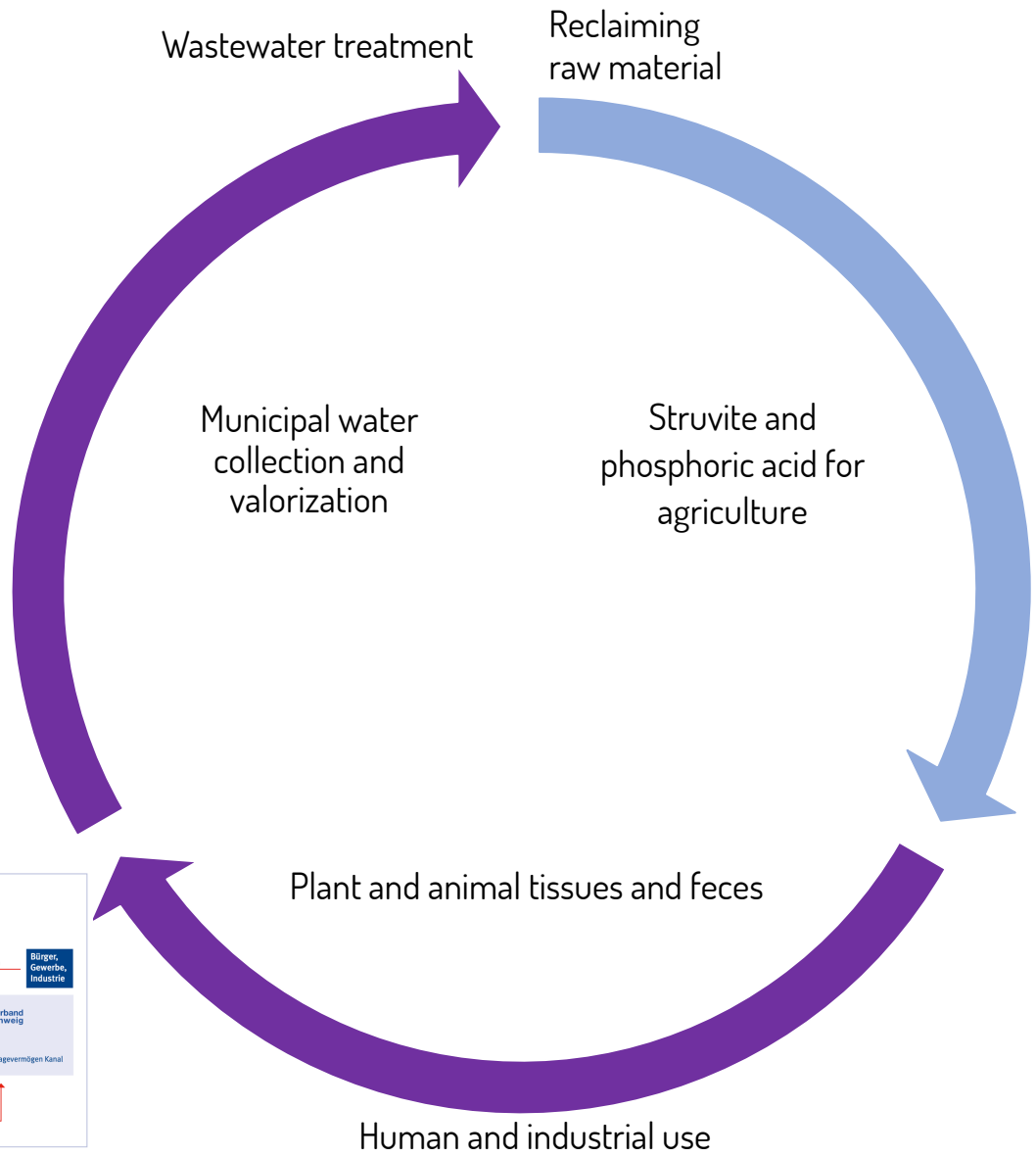
Availability/Role of recycling technology:

- 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.**





Source: SEBS 2020

SWOT Sewage Sludge / Slurry

Strength

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

Weakness

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

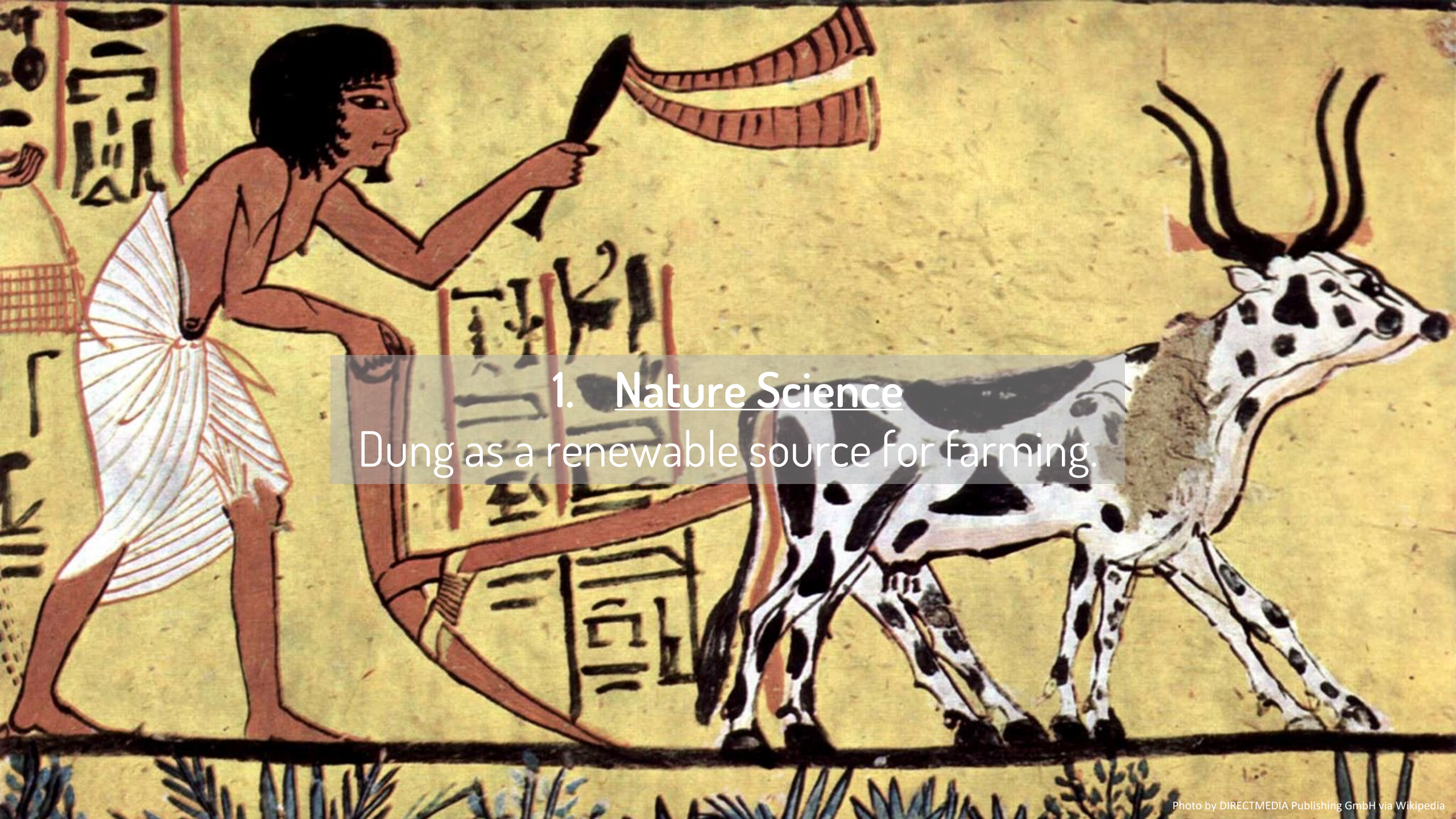
Opportunity

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

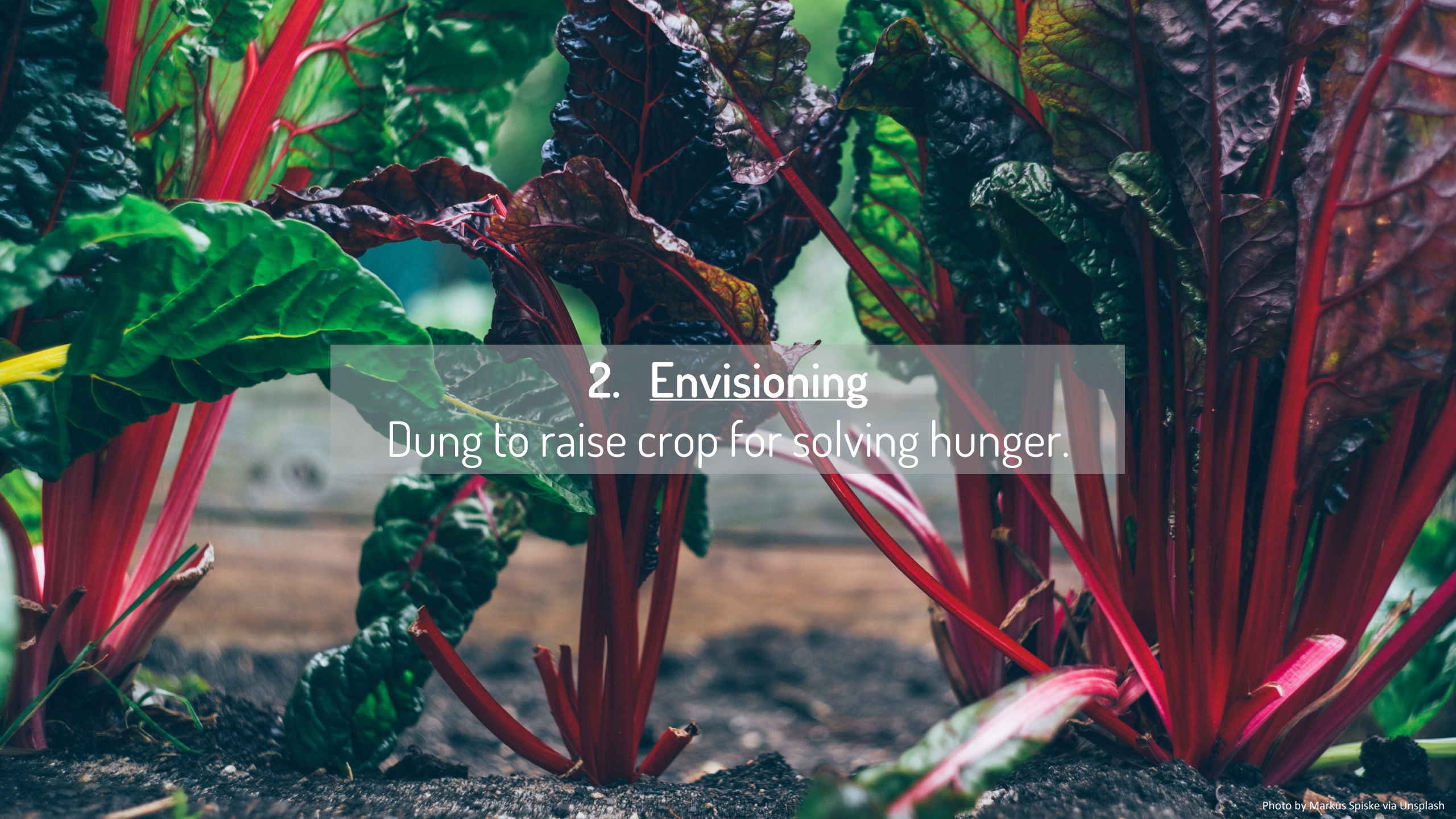
Source: Stenzel et. al 2019, Krämer 2019, Döing 2015, Mavhungu et. al 2020, SE/BS 2020, BMU/UBA 2017



1. Nature Science

Dung as a renewable source for farming.

Photo by DIRECTMEDIA Publishing GmbH via Wikipedia



2. Envisioning

Dung to raise crop for solving hunger.

Photo by Markus Spiske via Unsplash

3. Investment

Farming equipment is growing to make agriculture more efficient.

Photo by H. Esch via kreis-ahrweiler.de

4. Rocket Science

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

Photo by Tom Fisk via Pexels

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.

Photo by Alexandra Pugachevsky via theconversation.com

6. Cognition for System Relevance

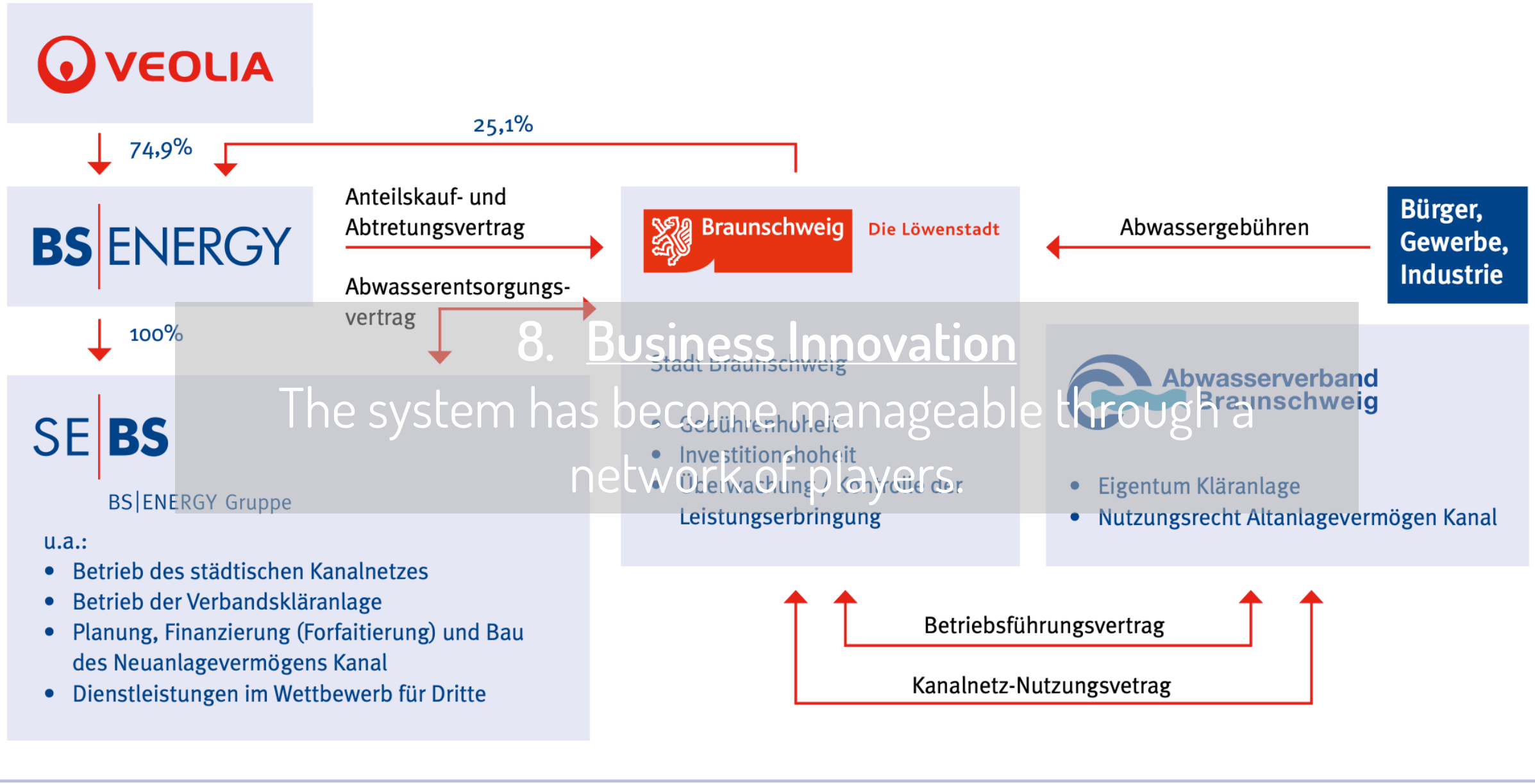
Phosphor has become indispensable for industrial agriculture.

Photo by Mark Stebnicki via Pexels

7. Technical Innovation

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

Photo by Klärwerk Steinhof via stadtentwaesserung-braunschweig.de



8. Business Innovation

The system has become manageable through a network of players.

9. Life Cycle

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

Photo by iStock via ethz.ch

10. Forecast

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

Photo by Joseph Chan via Unsplash

Phosphorus cycle – product system evolvement

Thank you for your attention

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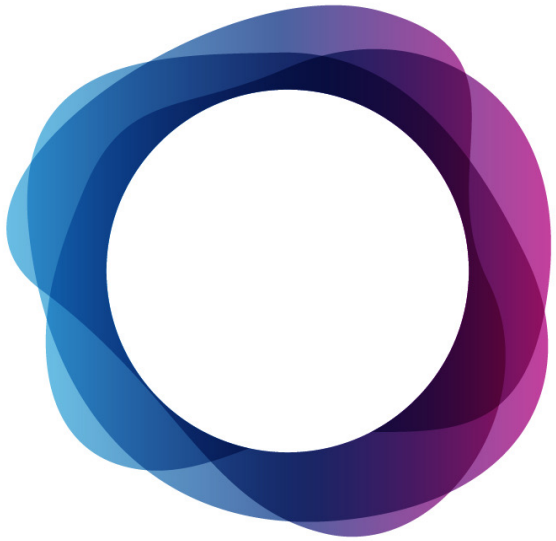

Thinking Circular