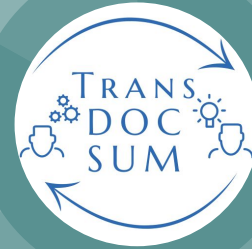




Save the world by saving phosphorus

based on the Kraków-Płaszów WWTP



Group 5: The P Rescuers

- ★ Advait Palakodeti
- ★ Alicia Hernández Mora
- ★ Bernard Morino Ganou Koungang
- ★ Magdalena Zaborowska
- ★ Marcelina Sottysik
- ★ Maria Milousi

Index



Introduction

- Know our hero
- Identified problems

Materials and energy challenge

- AshDec technology
- Closing the loop
- Other methods for increasing efficiency in the wastewater sector

Business challenge

- Business canvas
- Innovative solutions to be applied in the WWTP in Krakow
- Possible cooperators of the WWTP

Social challenge

Results



Introduction: need of a WWTP facility for the Kraków-Płaszów region

Raw wastewater flow:

- 165 000 m³/d (average)
- 328 000 m³/d (maximum)

Effluent receiver:

Drwina river (Vistula tributary)



Know our hero

Jacek Majchrowski: Mayor of Krakow

- Worried about Krakow citizens
- Engaged in environmental issues
- Worried about the economy in these difficult times
- Innovative and open minded to new solutions and ideas

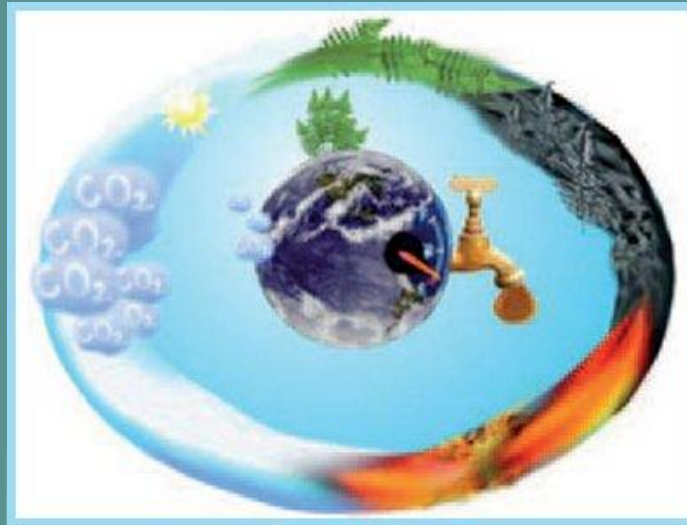


Identified problems



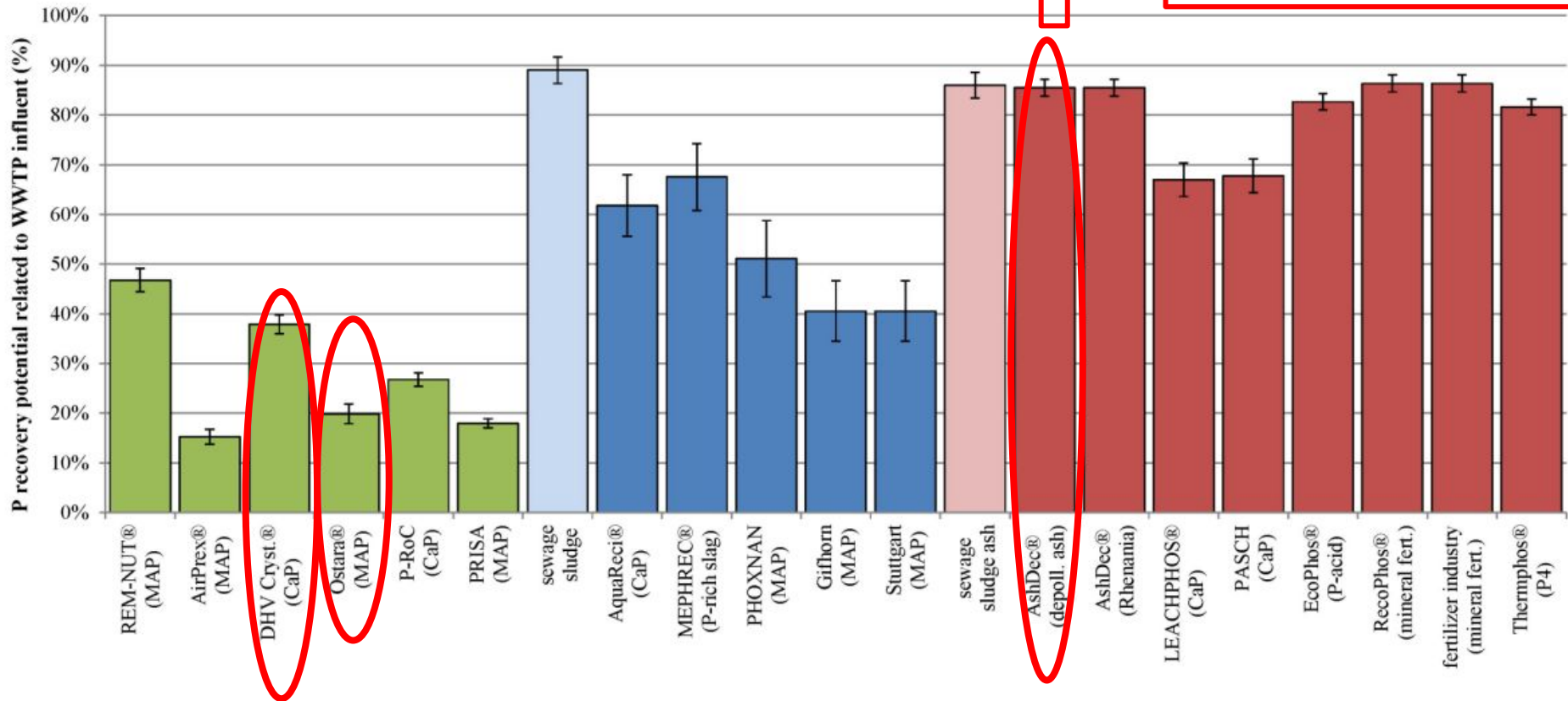
- Scarcity of phosphorus rock
- High concentration of phosphorus in lakes, rivers and aquifers
- Population worries about pollution & possible health consequences
- Lack of local phosphorus fertilizers sources
- Production of high volume sewage sludge

Materials and energy challenge



Comparison between different technologies

P recovery technologies	Strengths	Weaknesses	Opportunities	Threats
Sewage sludge ashes (SSA)	<ol style="list-style-type: none"> 1. P recovery rates ~90% 2. P-rich bio fertiliser formed 3. Comparatively less less chemicals reqd 4. Clean & risk-free product 	<ol style="list-style-type: none"> 1. Expensive process 2. High temperatures required 3. Requires construction of extra facilities 	<ol style="list-style-type: none"> 1. Widely implementable 2. Valorisation of P-rich fertiliser 	<ol style="list-style-type: none"> 1. Costs depend upon unit energy price 2. European legislation for fertilisers
Precipitation from sewage sludge liquors	<ol style="list-style-type: none"> 1. High-quality P minerals applicable directly to the field 2. Established process 	<ol style="list-style-type: none"> 1. P recovery in 10-40% 2. Chemical intensives 3. If high OM: crystallization inhibited 	<ol style="list-style-type: none"> 1. Small amount of residual waste compared with standard fertilizers 2. Struvite has excellent fertilizer qualities under specific conditions 	<ol style="list-style-type: none"> 1. Delivering heavy metals to soil / food 2. The cost of the process may exceed the profits from selling struvite (eg. in the form of fertilizer)

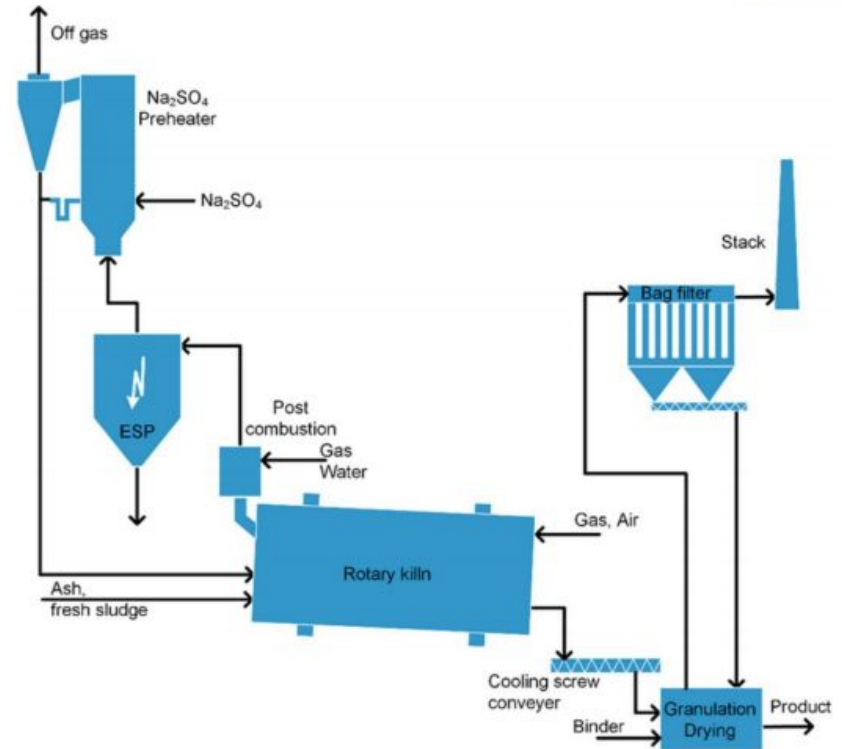


P recovery potential much higher than the other technologies considered

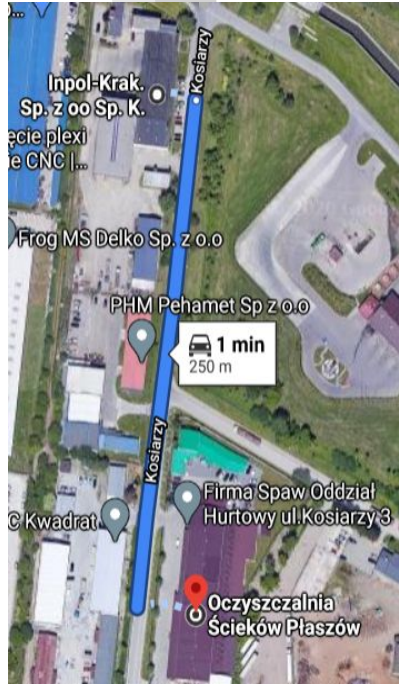
Selected solution: AshDec technology

AshDec sewage sludge ash facility

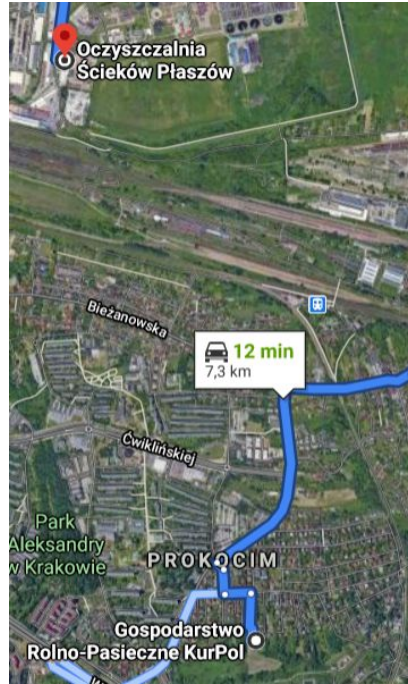
- ~90% Phosphorus recovery
- Bio-rich fertiliser
- No heavy metals



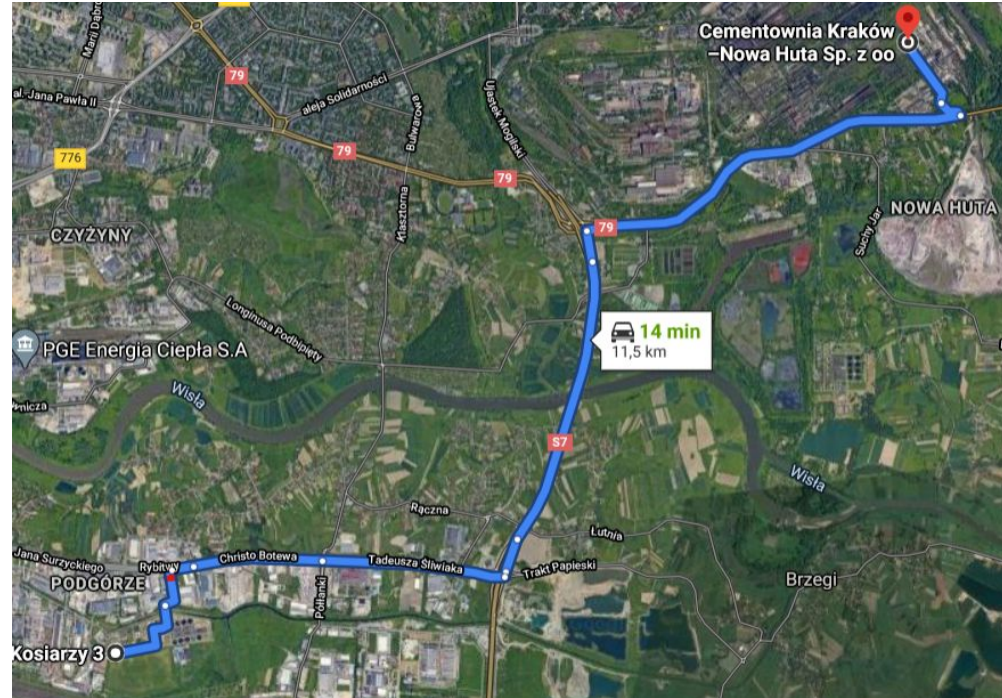
Closing the loop in WWTPs



The post-processed water could be delivered to a company producing steel products



The fertilizer can be delivered to an agri-beekeeping farm ca. 7 km away

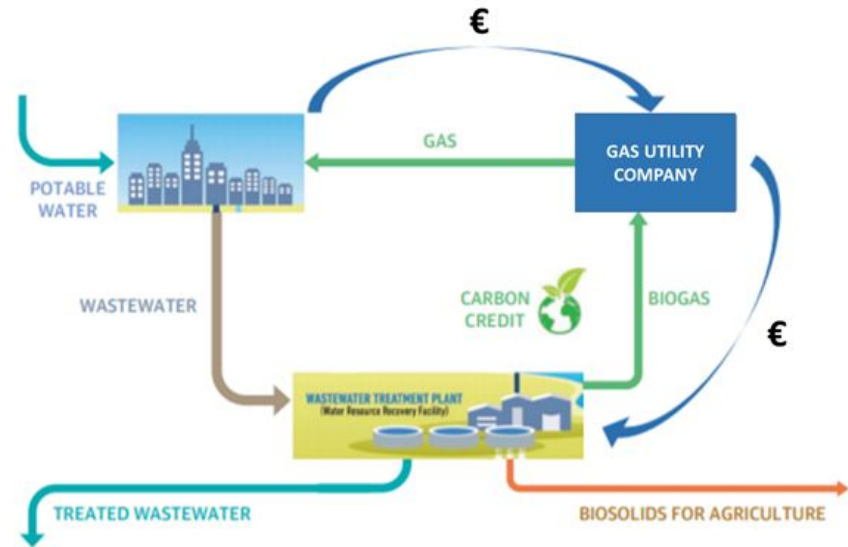


Ash from sludge incineration can be used as an additive to cement (cement plant ca. 11 km from WWTP) and asphalt.

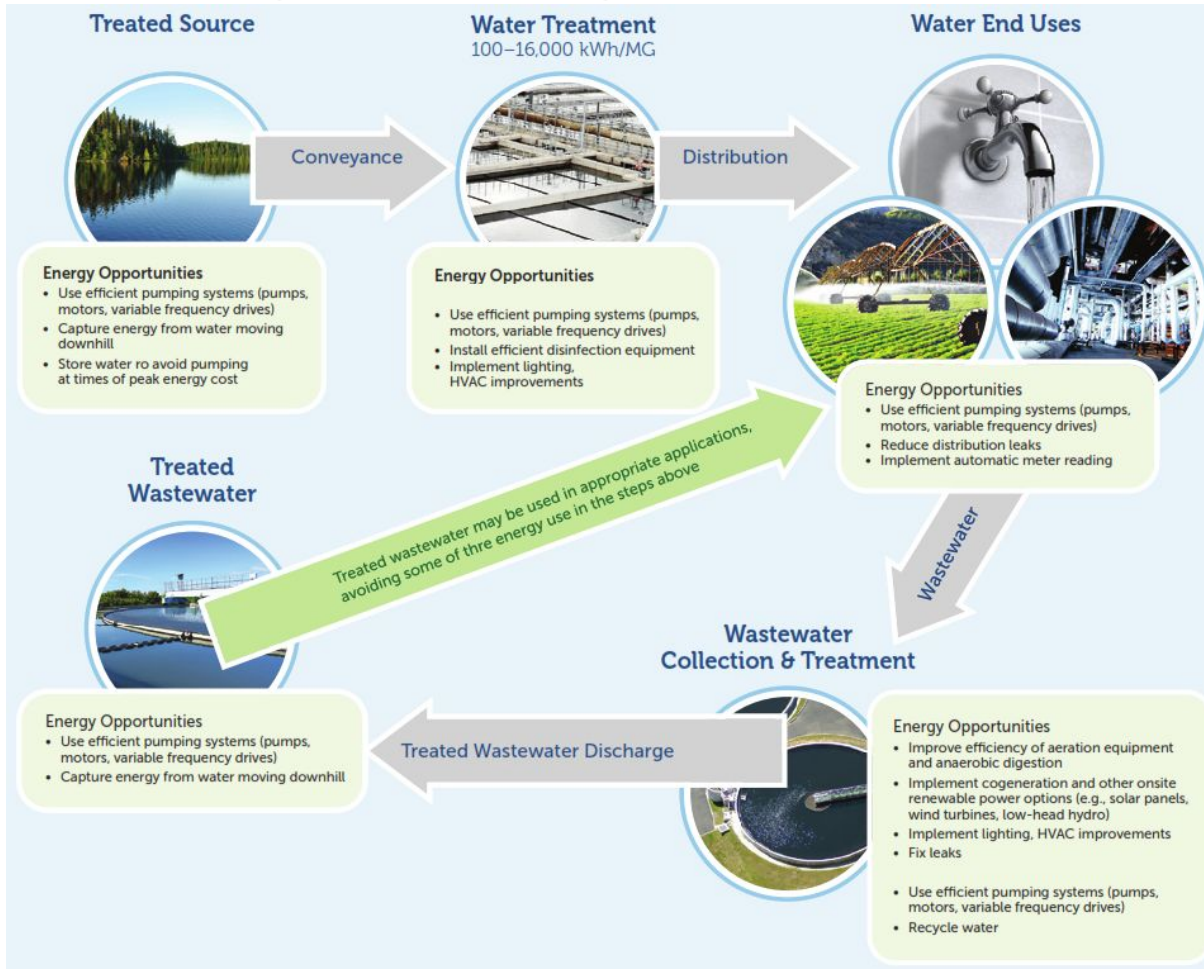
Energy & economic efficiency in the WWTP

The biogas produced during the fermentation of sewage sludge will be used for WWTP own needs.

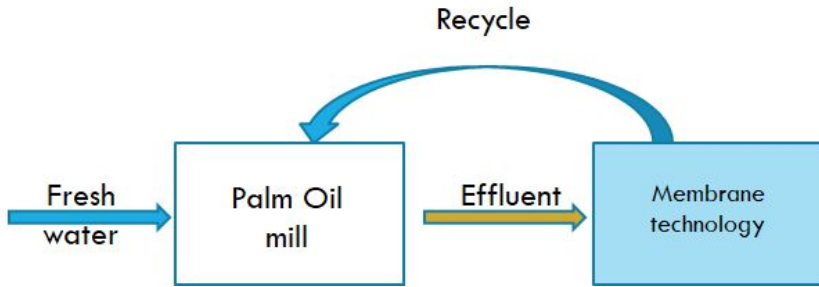
- Biogas can be converted to heat or used for electricity production through co-generation systems (biogas engines / microturbines).
- An economic revenue stream is created by using the energy produced on-site or by selling it to the local grid.



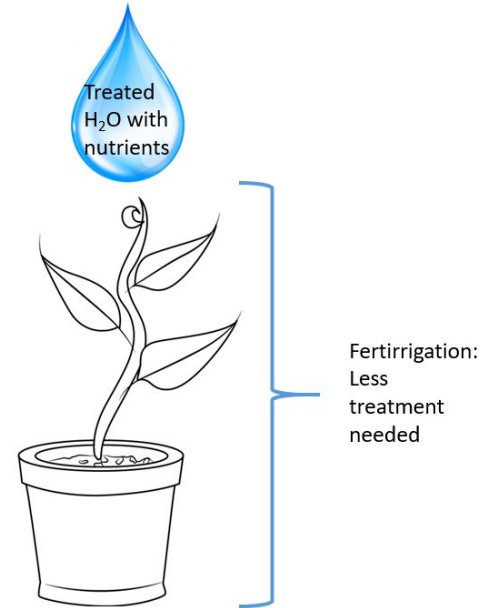
Increasing the energy efficiency of WWTP



Increasing economic efficiency of WWTP



Less fresh water =
More savings





Other methods for increasing energy and economic efficiency in the wastewater sector

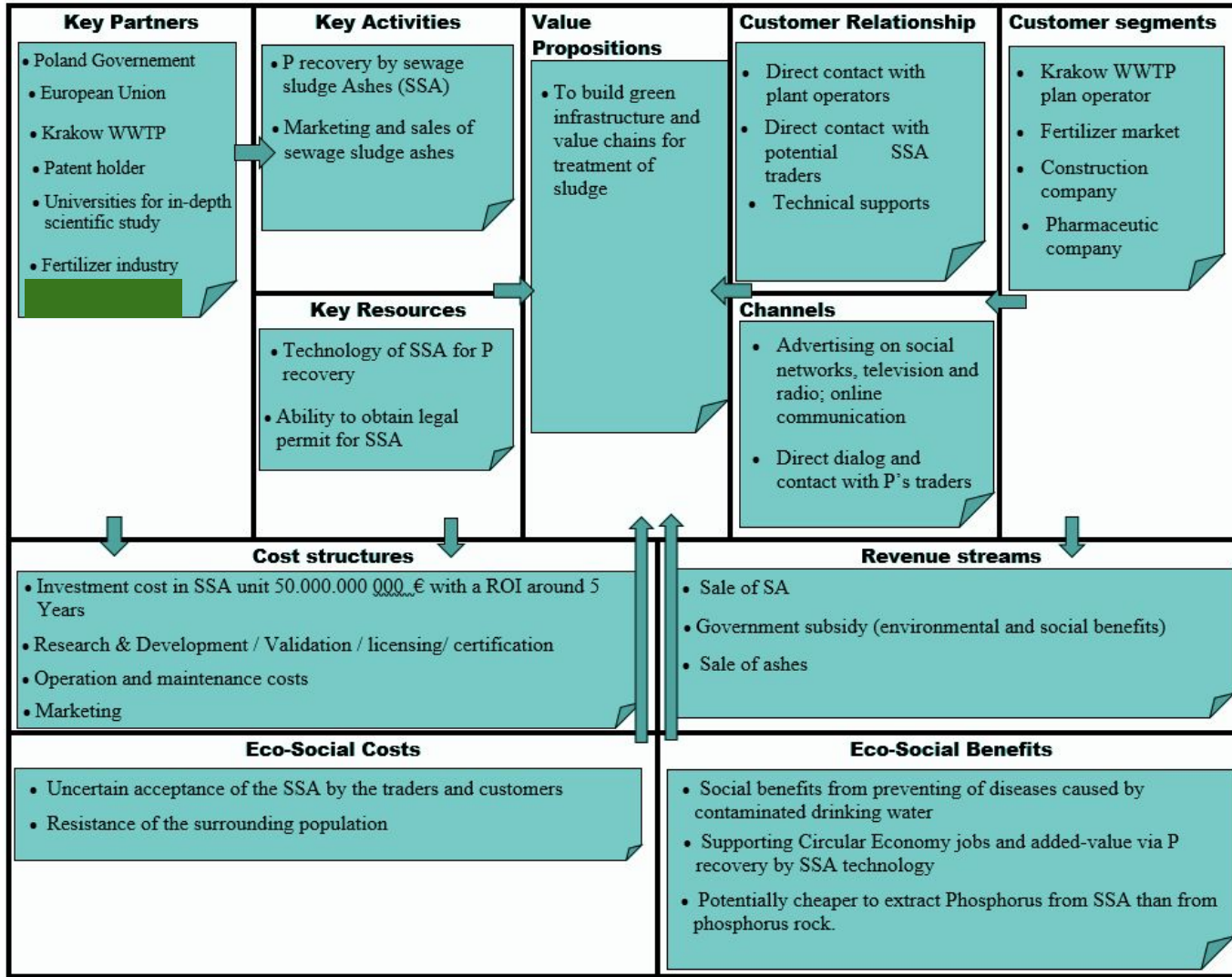
- The cellulose that gets caught in the primary treatment can be upcycled into paper
- Creation of construction materials with WWTP by-products
- Optimization software installed into the facility system to control and save energy
- Industry 4.0: Machinery driven by interaction with real-time data (digital twins)
- Water 4.0 offers enormous potential for optimising the management of water infrastructure systems for even more efficient use of resources (e.g. energy, water, staff) with simultaneous improvement in the security of supply and disposal (e.g. minimizing water pollution)



Business challenge



Business canvas

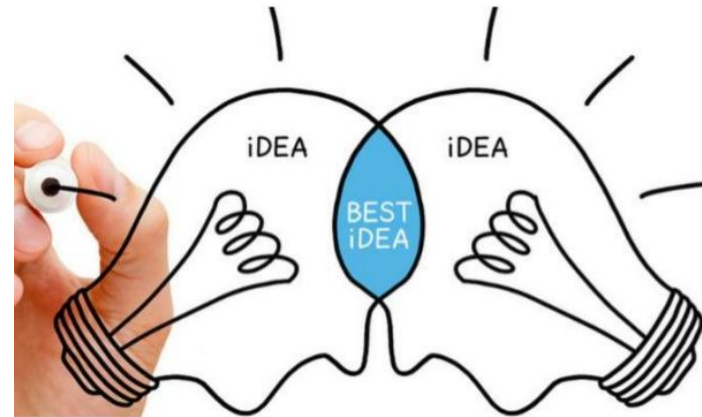


Innovative solution for the business model which could be applied in WWTP in Krakow

Collaborative learning:

- Establishment of cooperation network with the surrounding facilities to cover their needs
- Creation of WWTP forum. Open invitation to other WWTP to exchange knowledge.
- Scholarship for PhD studies

Collaborative Learning Environment





Possible cooperators of the WWTP

Flow	Source (in WWTP)	Cooperating Stakeholder	Application
<u>Water</u>	Treated effluent	Textile industry	Water for textile processing
<u>Energy</u>	Heat from sewage sludge ashes process (~900 °C)	Utilities Dept of Krakow Municipality	Energy recovery in WWTP/Energy generation for the city of Krakow
<u>Waste</u>	Grit from preliminary treatment	Paper & pulp mill	Recovering cellulose to produce paper
	Sewage sludge ash	Neighbouring farmer	Application of P-rich fertiliser

Social challenge



Social Challenge: Social Corporate Responsibility

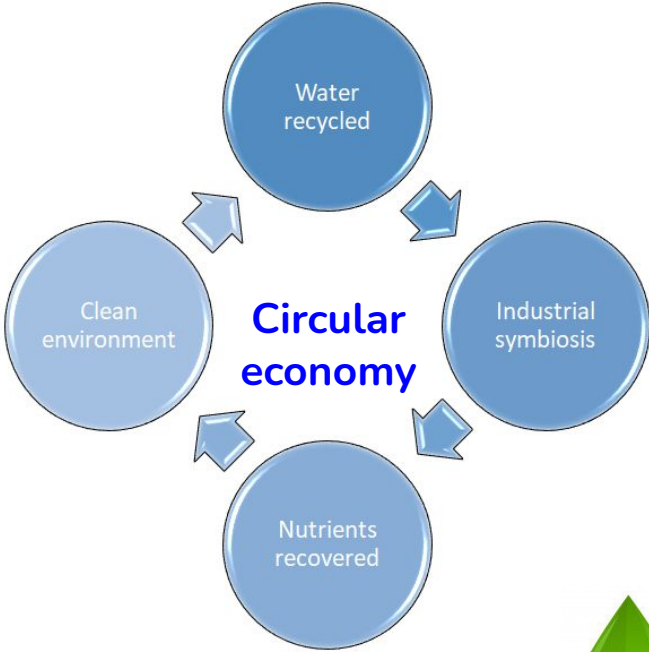
- **Workplace**: Continuous formation of employees, giving incentives and rewards for efficiency
- **Marketplace**: direct contact with plant operators, potential SSA traders and local universities
- **Community**:
 - Guided visits for school and educational institutions.
 - Auditory by an external evaluator.
 - WWTP present in social media.
 - Award for innovative projects related to the WWTP know-how.



Results



Results



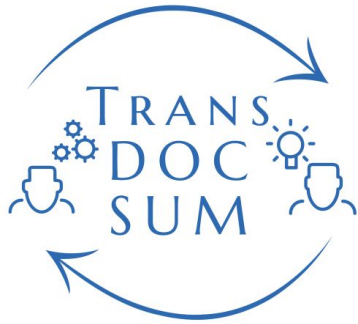
AshDec facility

P recovery: 86 Mg/yr
Biogas: 9×10^6 m³/yr
Power: 24732 KWh/yr



Consulting the best: P-Rescuers

- Multidisciplinary team of 6 people with specific training related to phosphorus recovery in WWTP:
 - Reliable technology, applied with success in other areas
 - Support from the local university and experts



PRescuers

"Save the world by saving phosphorus"

Contact: PRescuers@winterschool.com

