The production of biopolymer from wastewater treatment

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Resource recovery from wasted sewage sludge

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Concept

Sewage sludge is generally produced by wastewater treatment plants (WWTPs) and represents a waste byproduct. The management and disposal of sewage sludge highly contribute to WWTPs' operational costs. In a circular economy context, sewage sludge may become a resource for the production of various renewable products, such as polyhydroxyalkanoates (PHAs) [1]. PHAs are renewable and biodegradable polyesters with attractive properties. By using surplus sludge as a raw material input for an inexpensive PHA production process, we cannot only reduce the cost of production but also address the environmental concerns associated with traditional petroleum-based plastics. These plastics, which are often difficult to dispose of and can cause environmental contamination and harm to the ecosystem and human health, can be effectively replaced by PHAs [2].

Scientific approach

The use of sewage sludge for PHA production, both as feedstock and as inoculum for biomass enrichment by feast and famine cycles, has been already demonstrated in the literature. However, there is still a lack of overall cost-effectiveness in the process, consistency in the property of the obtained polymer and environmental impact of the process. Strategies that address needs in both productivity, polymer quality and carbon footprint are essential towards establishing regional economies with surplus sewage sludge as an abundantly available raw material for biopolymer value chains [3].

Fundamental insights leading to innovative process methods are anticipated to come from:

- The optimization of sludge acidogenic fermentation step in order to obtain a stream with high volatile fatty acids (VFA) concentration and low nutrient concentration.
- The optimization of mixed-microbial-culture enrichment and PHA accumulation in order to achieve high PHA cell contents.
- Innovative downstream processing methods to recover the polymer and maintain its properties.
- Optimize the process while reducing greenhouse gas (GHG) emissions.

Research objectives

The objective of the PhD project is to establish optimal engineering design and operational principles for mixed culture PHA production while considering the process's environmental impact. The experimental approach will be based on batch tests and pilot plants treating real wastewater.

The pilot plant is located at the University of Palermo campus and is fed with wastewater from the university dormitory and canteen (Figure 1). Different plant layouts will be comprehensively compared, taking into account the system performance in contaminants removal, PHA production, and the process's carbon footprint.

The activities are part of the Horizon2020 project - Wider-Uptake [1].

[1] Mannina et al. (2021), Water 13(7), 946
[2] Mannina et al. (2020), Bioresource Technology 297 122478
[3] Estevez-Alonso et al. (2021), Bioresource Technology 327 124790

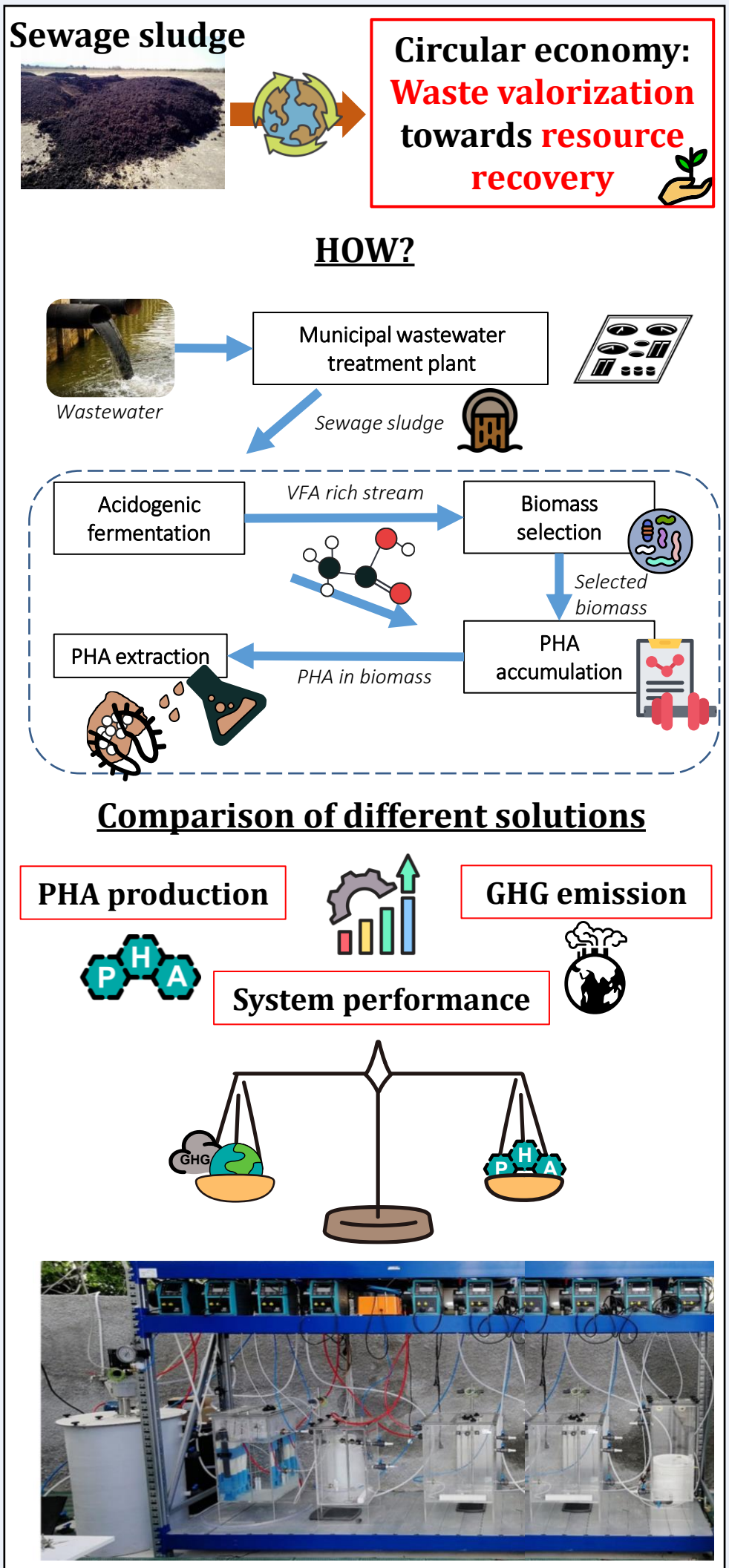

Figure 1 – PHA pilot plant located at UNIPA