



**Polyhydroxyalkanoates (PHA)** are a family of **biodegradable polymers** with comparable characteristics to polypropylene and polyethylene that can be produced biologically from numerous carbon substrates. Unfortunately, PHA commercialization is hindered by their high production costs (4-20 €/kg).

**Biogas** (mainly CH<sub>4</sub> and CO<sub>2</sub>), produced in the anaerobic digestion of organic waste, constitutes a globally available and low-cost substrate to produce PHAs. However, it remains unknown if biogas transformation into PHA can compete with the current utilization of biogas for heat and power generation (CHP) in waste treatment plants.

### **Techno-economic analysis: Why are PHAs so expensive?**



- Investment cost of PHA are higher than CHP
- High energy requirements increase PHA production costs
- PHA higher added value enhances sales income

#### **Geographical analysis: Where can PHA be competitive with CHP?**

Other

44%

Water

**CHP+PHA** 

3%

**Raw material** 

53%

**1. PHA production promotes anaerobic digestion** in countries where CHP is not economically viable

2. In countries with low energy prices, CHP depends on fiscal incentives for energy production

3. Using CHP for energy production minimizes PHA production costs in countries with high energy prices







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## **Sensitivity analysis: How can production costs be reduced?**

PHA production in Sydney (€/kg PHA) 0.9\_ 100 s Concentration (g X/L) PHA accumulation (g PHA/g X) 0.6 0.4 0.8 0.2 Biomas 0.2 0.6 0.4 1.0 0.4 + 30 **Elimination Capacity Elimination Capacity** 60 428 60 428  $(g CH_4/m^3 \cdot h)$ (g CH₄/m<sup>3</sup>·h)

## **Conclusions:**

- **CH**<sub>4</sub> elimination capacity in bioreactors and PHA accumulation in bacterial cells are the most relevant process parameters for decreasing PHA production costs
- Increasing the biomass concentration in the bioreactor did not show a significant effect on PHA production costs
- PHA production costs can be reduced by >90% to a minimum PHA cost of 0.1 €/kg
- The end of fiscal incentives and the decreasing solar and wind energy prices open new ways for biogas valorization in waste treatment plants
- PHA production in waste treatment facilities constitutes a competitive alternative to current utilization of biogas for electricity and heat production
- If CH<sub>4</sub>-elimination and PHA accumulation is improved, PHA will be soon produced from biogas at prices competitive with oil-based plastics



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