



# Techno-Economic Assessment of making Bioplastics from Sewage

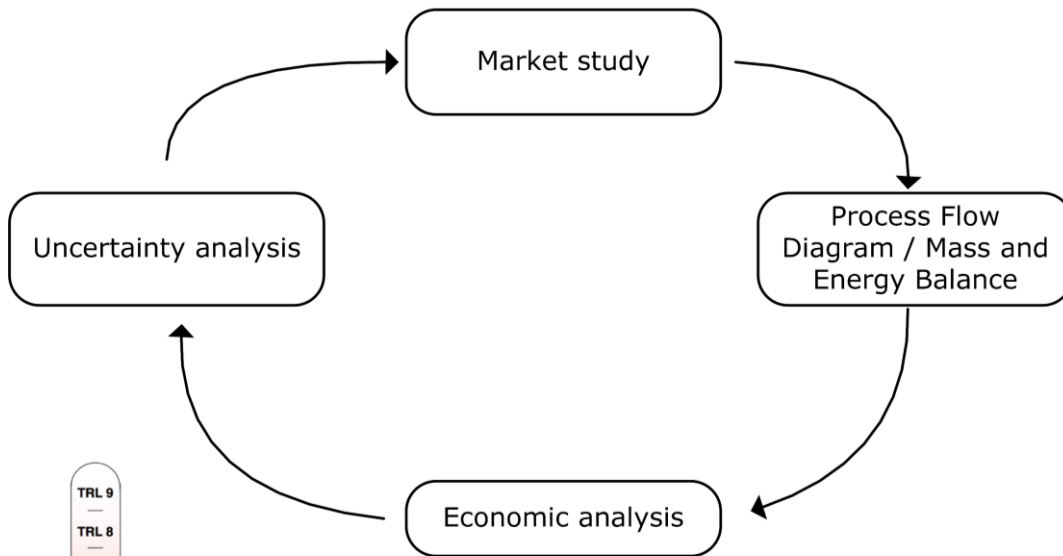
29 October 2020

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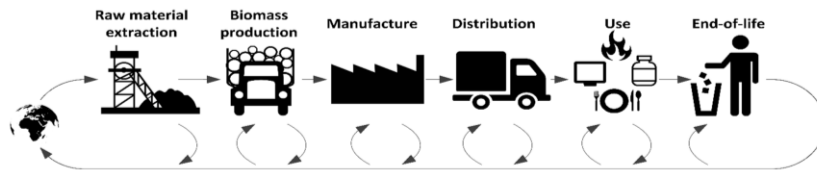
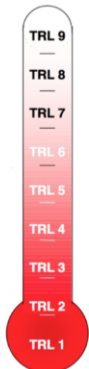


# Techno-Economic Assessment

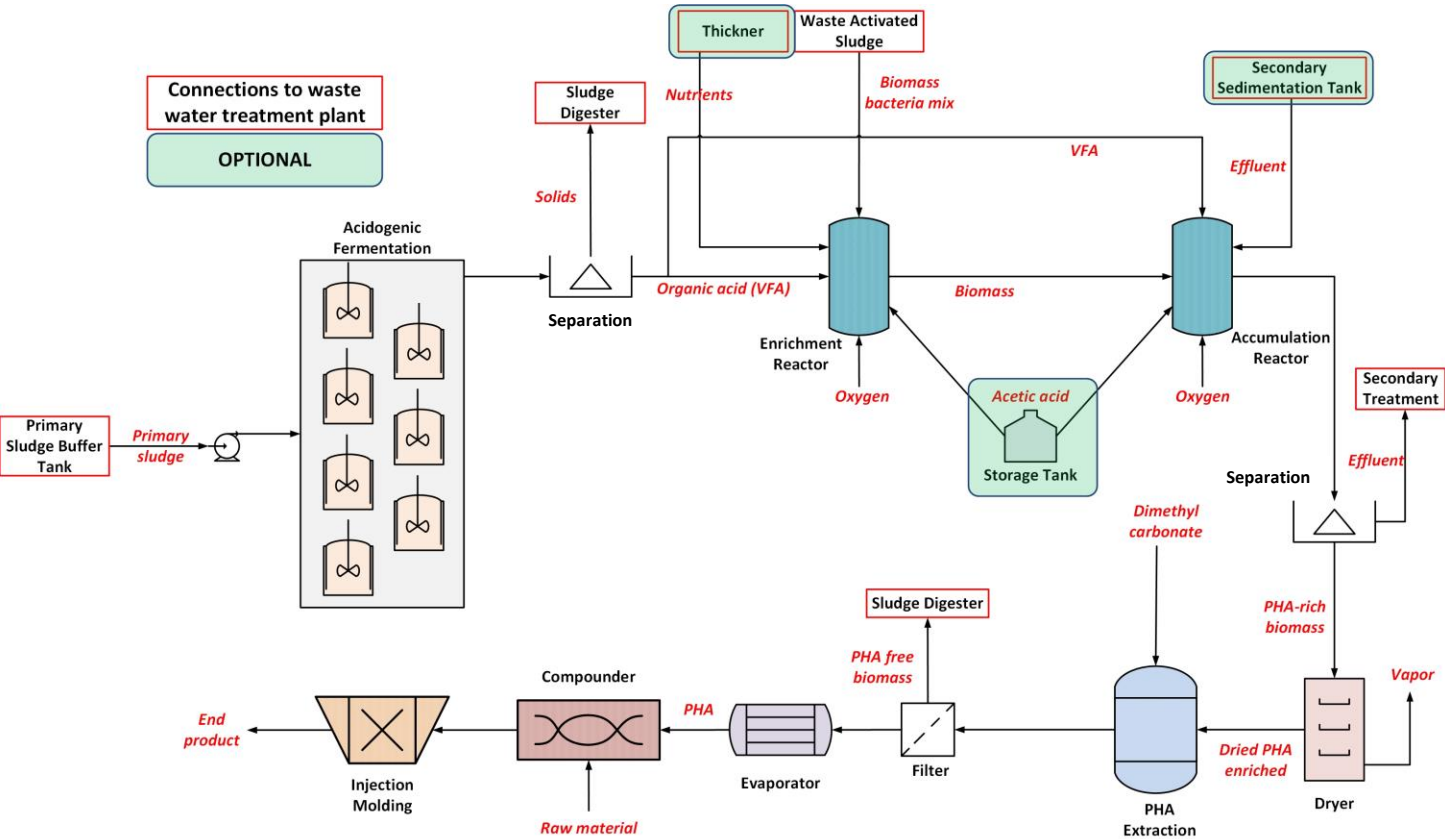


## Benefits

- Reduction of time-to-market and costs
- Optimal spending of available resources
- Setting R&D targets
- Lowering the risk of failed market introduction
- Well-informed decision making



# PHA PLANT - Process Flow Diagram



**Polyhydroxyalkanoates (PHA)**

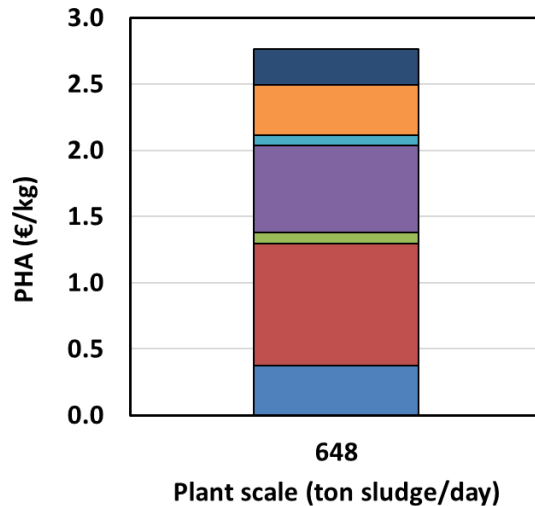
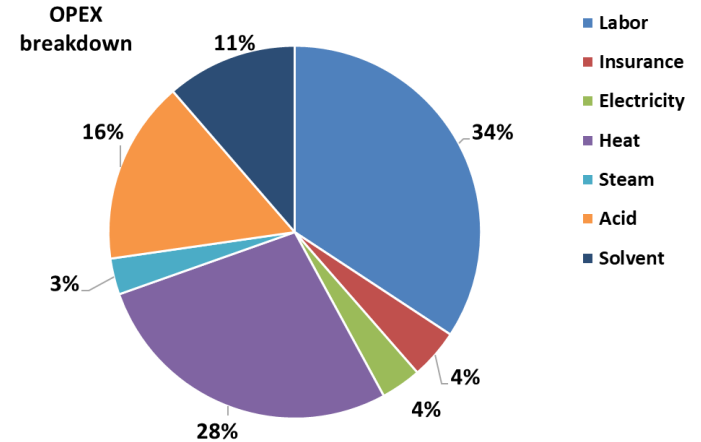
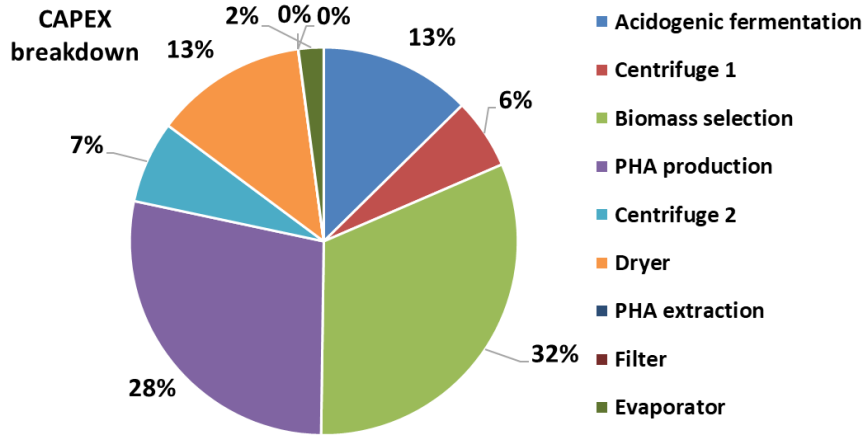
Source: de Souza Reis et al. 2020



**End product**

Source: ASD Reports

# Economic Assessment Results – PHA Production

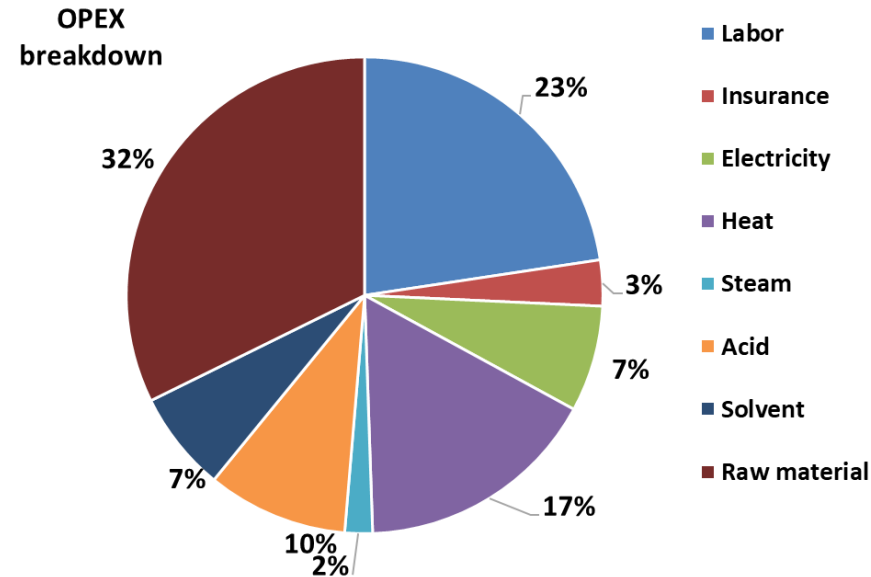
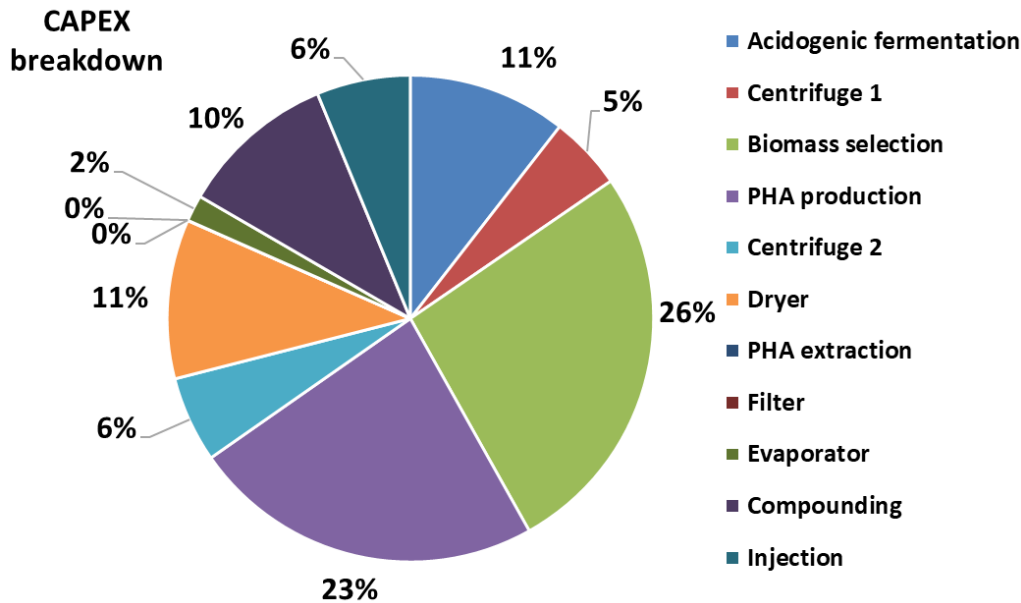


- Current study - **2.74 €/kg**
- PHARIO (2017) - 3.4 €/kg
- Mudliar (2008) - 10 €/kg
- Biomer\* - 7-10 €/kg

*\*PHA from starch, sugar etc.*

# Economic Assessment Results – End product

**Blending ratio: PHA (70%) + RM (30%)**

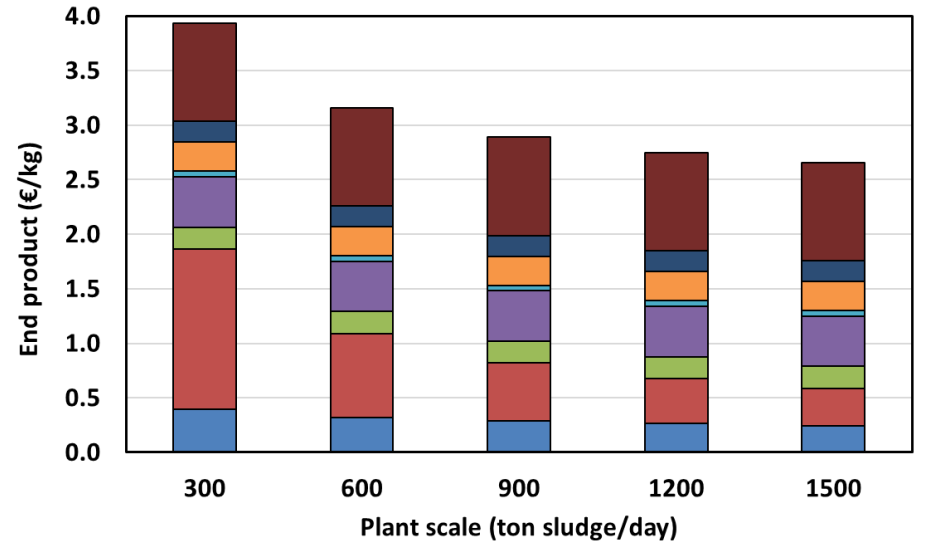
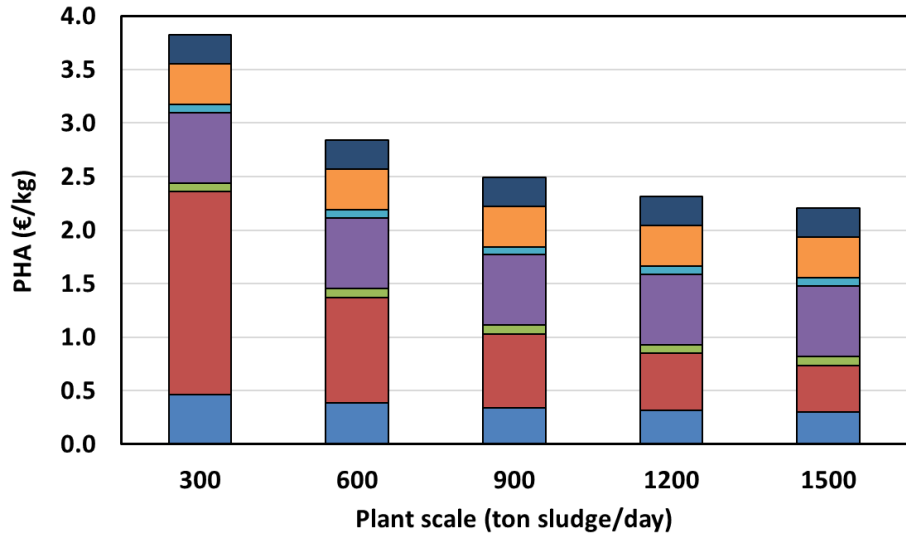


**Plastic processing – Injection molding**

**CAPEX – 20% ↑**

**OPEX – 67% ↑**

# PHA and End Product Price – Plant Scale



■ Investment 
 ■ Fixed OPEX 
 ■ Electricity 
 ■ Heat 
 ■ Steam 
 ■ Acid 
 ■ Solvent

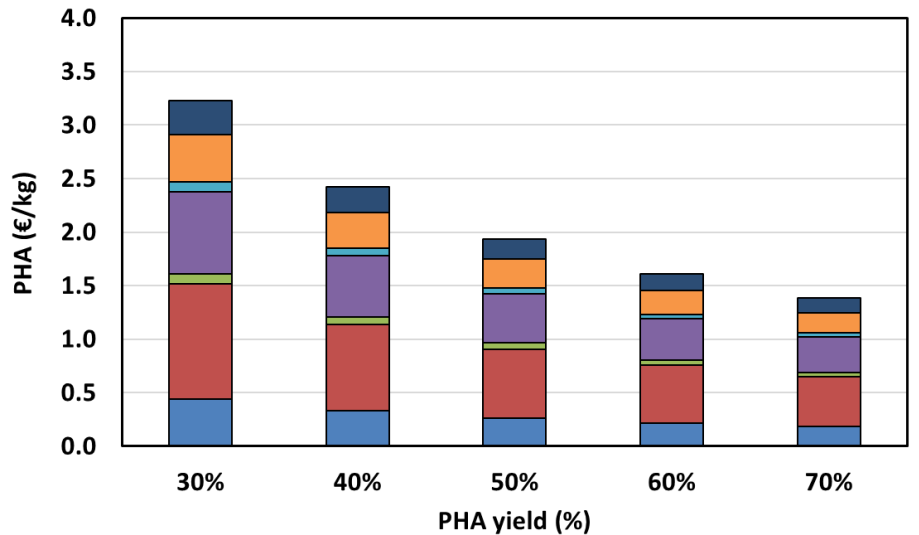
■ Investment 
 ■ Fixed OPEX 
 ■ Electricity 
 ■ Heat 
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 ■ Solvent 
 ■ Raw material

## Base case assumptions

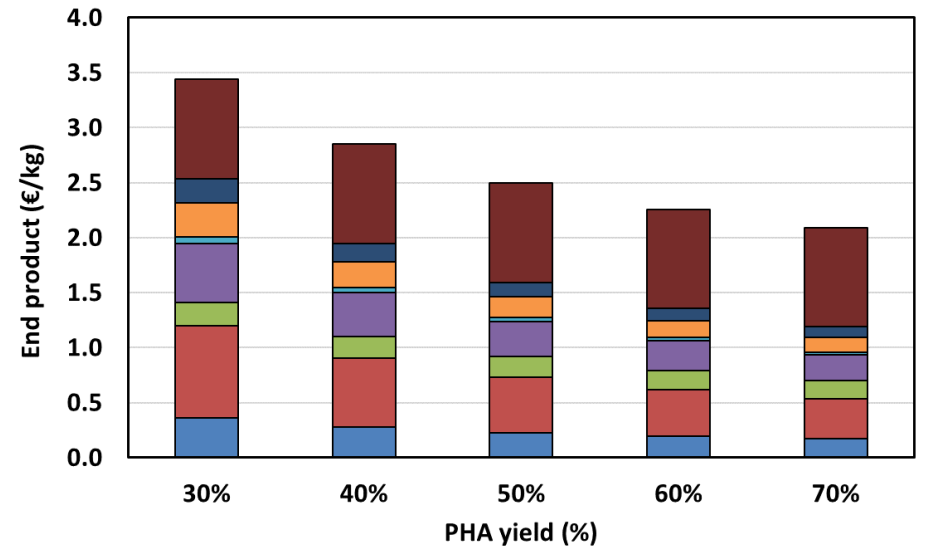
- Plant scale - ~650 ton-sludge/day
- PHA yield - 35%
- Cell disruption - 100%
- NG price - 34 €/MWh
- Acid price - 0.5 €/kg
- Raw material price - 3 €/kg

## Blending ratio: PHA (70%) + RM (30%)

# PHA and End Product Price – PHA Yield



Investment Fixed OPEX Electricity Heat Steam Acid Solvent



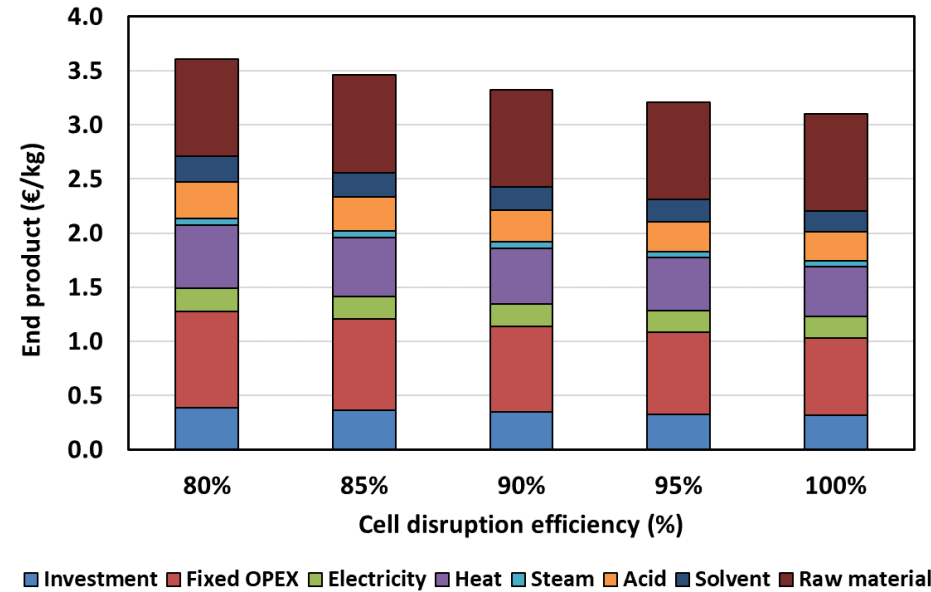
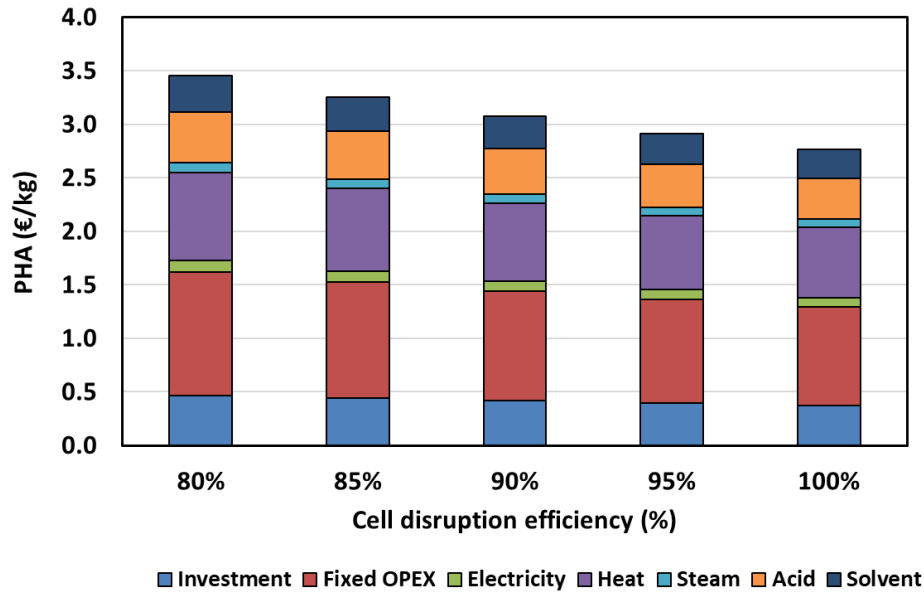
Investment Fixed OPEX Electricity Heat Steam Acid Solvent Raw material

## Base case assumptions

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# PHA and End Product Price – Cell Disruption Efficiency



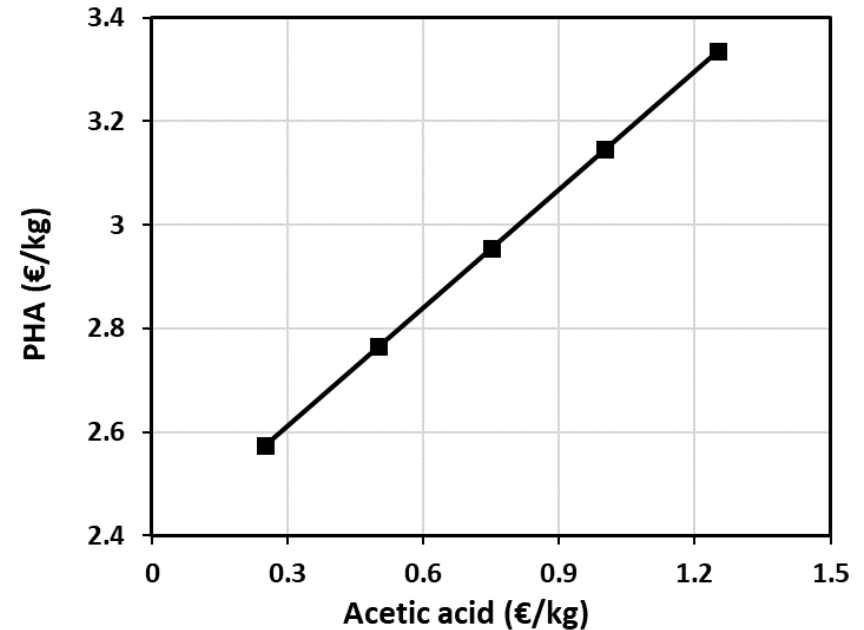
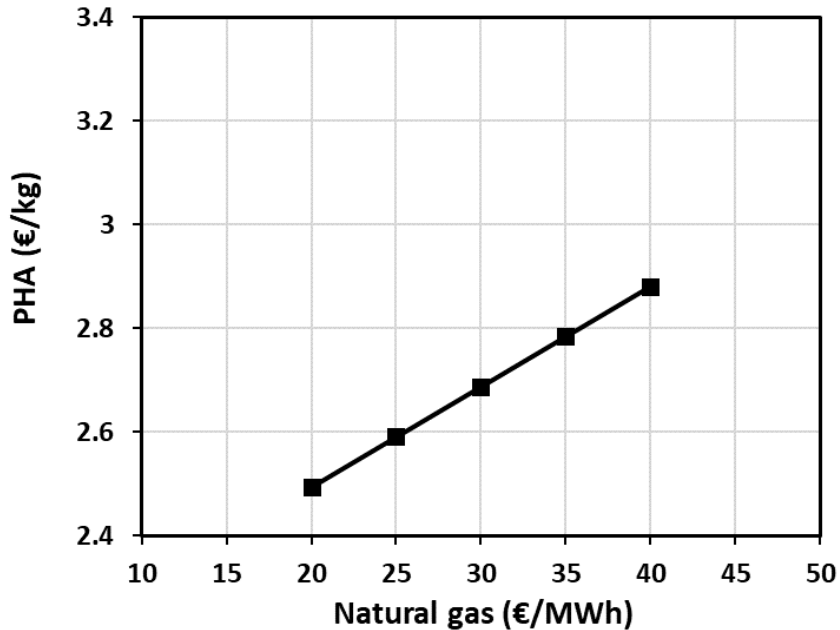
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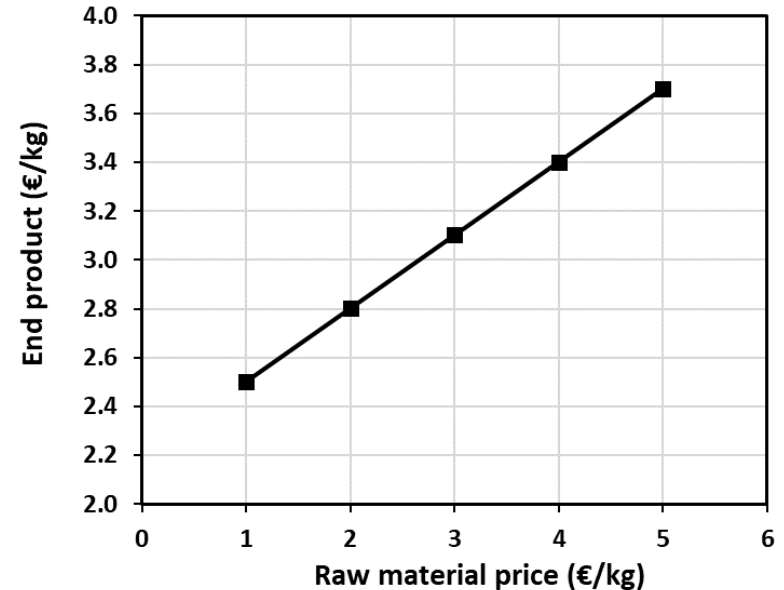
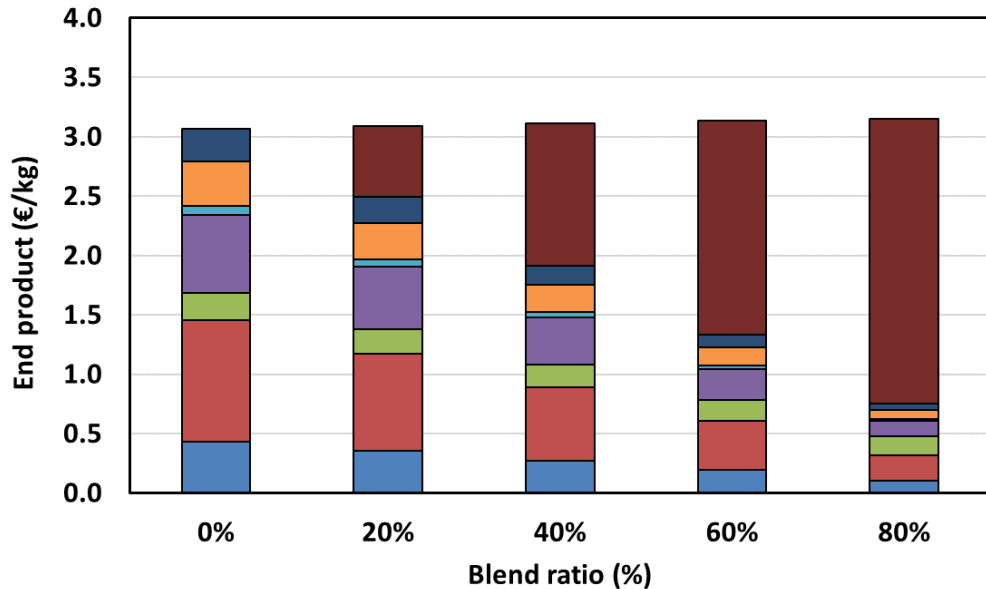
# PHA Price – Fuel and Acid



## Base case assumptions

- Plant scale - ~650 ton-sludge/day
- PHA yield - 35%
- Cell disruption - 100%
- NG price - 34 €/MWh
- Acid price - 0.5 €/kg
- Raw material price - 3 €/kg

# End Product – Blend Ratio/Raw Material price



■ Investment 
 ■ Fixed OPEX 
 ■ Electricity 
 ■ Heat 
 ■ Steam 
 ■ Acid 
 ■ Solvent 
 ■ Raw material

## Base case assumptions

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# Conclusions

- Current study demonstrate that PHA can be produced in the range **2-3 €/kg**
- **Plant scale and PHA yield** are the key important parameters that reduce the PHA price significantly
- Natural gas and acetic acid prices have **significant** effect
- **Blend ratio** is also a key parameter when **cheaper** raw materials are used
- Raw material price is the most **significant** parameter

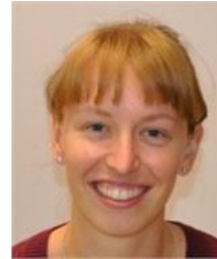
# Future Research

- Sequential batch reactor cost reduction
- Alternate drying process with low energy consumption
- Increasing the PHA yield during accumulation stage
- Keeping the disruption efficiency high using other cheaper solvents
- Develop instrumentation control strategies for plant operation
- Increasing the product quality by using cheap raw materials

# Partners



## TEA(M)



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