

From emissions to feed: Quantifying the GHG emission avoidance potential of microbial protein production with hybrid living materials

Ilva Danenberg¹,
Rohan Karande²,
Elina Dace^{1,*}

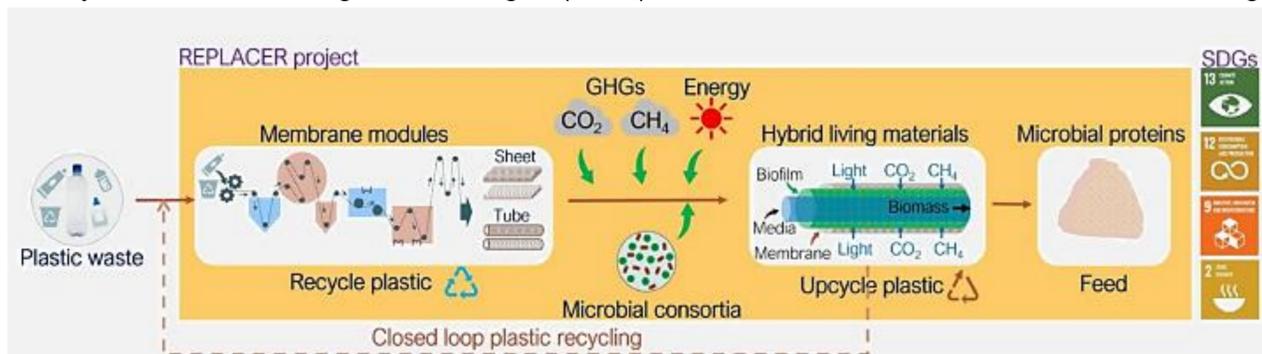


¹ Institute of Microbiology and Biotechnology, University of Latvia, Riga, Latvia
² Research and Transfer Center for Bioactive Matter b-ACTmatter, Institute of Biochemistry, Leipzig University, Leipzig, Germany

E-mail: ilva.danenberg@lu.lv; *elina.dace@lu.lv

CONCEPT

Scalable, carbon-negative waste-to-resource systems that transform emissions into sustainable feed have high potential in supporting the necessary 17% reduction of greenhouse gas (GHG) emissions to meet the EU GHG emission targets by 2030.



The REPLACER project demonstrates a proof-of-concept Carbon Capture and Utilization (CCU) platform using Hybrid Living Materials (HLMs). This system, inspired by nature, fosters the cultivation of biofilm-based methanotrophic and phototrophic microbial consortia on porous membranes (recycled PET or viscose), directly sequestering CH₄ and CO₂ to produce high-value microbial protein suitable for animal feed.

Aim: To assess and quantify GHG emission mitigation potential of HLM-based microbial protein production.

METHODOLOGY

- **Framework:** EU Innovation Fund (InnovFund v5.1) GHG Emission Avoidance methodology for energy intensive industries
- **System boundary:** 'Cradle-to-Gate' with End-of-Life (EoL) phase

The climate impact will be quantified over a 10-year operational cycle using two standardized metrics:

(1) Absolute GHG Avoidance Equation: Quantifies the total physical volume of carbon equivalents prevented from entering the atmosphere.

$$\Delta GHG_{abs} = \sum_{y=1}^{10} (Ref_y - Proj_y + CCcredit_y)$$

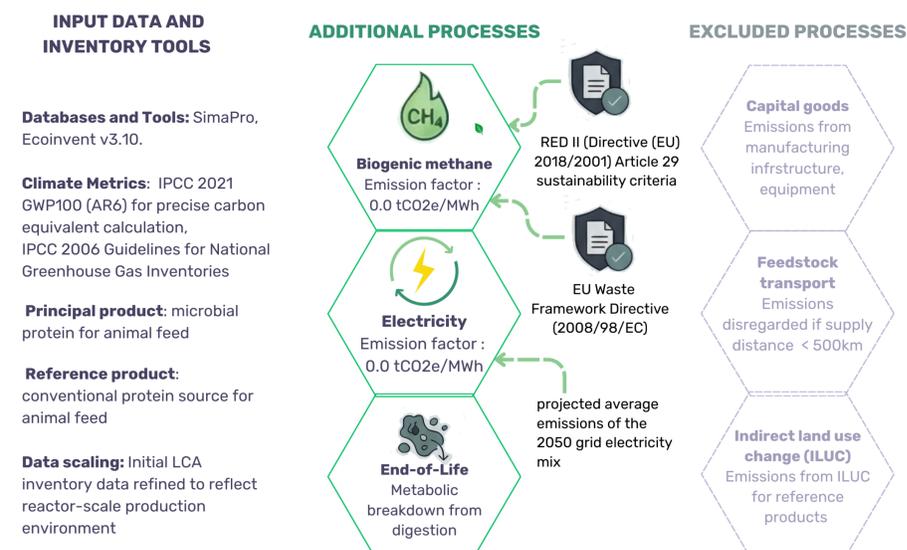
ΔGHG_{abs} – Net absolute GHG emissions avoided due to operation of the project during the first 10 years of operation, in tCO₂e.

Ref_y – GHG emissions that would occur in the absence of the project in year y , in tCO₂e.

$Proj_y$ – GHG emissions in the project scenario in year y ,

$CCcredit_y$ – Credit for utilization of captured CO₂ in year y , in tCO₂e

Y – year of the operation of the project



(2) Relative GHG Avoidance Equation: Demonstrates the percentage improvement and technological efficiency of the project against the reference baseline.

$$\Delta GHG_{rel} = \frac{\Delta GHG_{abs}}{\sum_{y=1}^{10} (Ref_y)}$$

ANTICIPATED OUTCOMES AND IMPACT

- Quantitative absolute and relative GHG emission avoidance assessment based on a 1 kg/day microbial biomass production prototype (TLR 3-5).
- Comparison with reference feeds – soymeal and fishmeal.
- Assessment for two different membrane materials – rPET and viscose.
- On a broader societal impact level, the REPLACER platform has demonstrated environmental sustainability and GHG avoidance potential.