Towards a circular bioeconomy: Urban biorefineries will transform municipal solid waste into bioproducts

How can microalgae be integrated into waste biorefineries?

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Introduction & objectives

In Europe, each habitant produces an average of 250 kg of Organic Fraction of Municipal Solid Waste (OFMSW) per year. OFMSW contains carbohydrates, proteins and lipids with high potential to be converted into bioproducts. The facilities that will transform waste into bioproducts, contributing to a more circular economy, are called Urban Biorefineries.

Urbiofin Project aims at demonstrating the techno-economic viability of transforming 30 t/d of OFMSW into chemical building blocks (bioethanol, VFA, biogas), biopolymers (PHA and biocomposites) and biobased fertilisers. One of the modules of the project will implement different biological technologies for the upgrading and valorisation of the biogas produced during the anaerobic digestion of OFMSW such as: anoxic desulphurisation of biogas, biocconversion of CH₄ into PHA and photosynthetic biogas upgrading using microalgae.

The photosynthetic biogas upgrading using microalgae combines the conversion of a OFMSW by-product into a consumer product (biogas into biomethane), the treatment of a waste effluent from anaerobic digestion (digestate) and the production of microalgal biomass for further valorisation as biofertiliser.

Process description

Biogas

Biomethane

Vehicle fuel

Absorption column

High rate algal pond

Microalgal-based fertiliser

Zero effluent!!!

Microalgae from digestion of OFMSW

High rate algal pond

Biomethane quality:

CH₄ ≥ 95 %, CO₂ ≤ 2.5 %, O₂ ≤ 1 % and traces of H₂S

Digestate nutrient removal:

> 70 % C and P and > 90 % N

Microalgal productivity:

22.5 g/m² · d

Natural gas grid injection

Lab-scale (TRL 4)

Year-round outdoors experiment: summer/winter variations

Biogas-to-biomethane optimized: day/night variations

Key parameters: pH ↑ alkalinity ↑

Scale-up (TRL 7)

Scale-up from 1.2 m² to 300 m²

Biogas treatment capacity: 12 m³/d

Microalgae valorised as fertiliser 3-4 kg/d

Publications


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