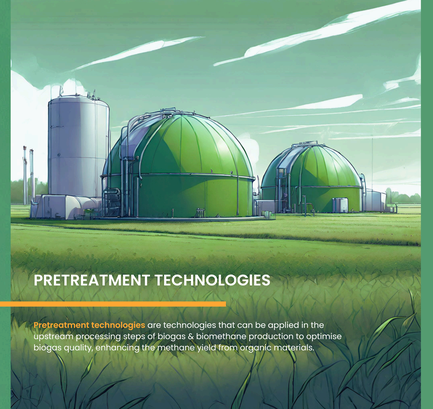


BIP Europe
Biomethane Industrial Partnership

PROMOTING INNOVATIVE TECHNOLOGIES FOR BIOMETHANE PRODUCTION

DRIVING THE EU BIOMETHANE TARGET BY 2030 REQUIRES KEY TECHNOLOGICAL ADVANCEMENTS FOR ENHANCED PRODUCTION EFFICIENCY

Explore the current state of the art of biomethane production technologies in Task Force 5 report



PRETREATMENT TECHNOLOGIES

Pretreatment technologies are technologies that can be applied in the upstream processing steps of biogas & biomethane production to optimise biogas quality, enhancing the methane yield from organic materials.

ENZYMATIC HYDROLYSIS

Enzymatic hydrolysis is used as a pre-treatment step in biomethane production, in order to **increase the methane output of anaerobic digestion**.

INPUT → *Enzymatic hydrolysis* → OUTPUT

Biomass (complex carbohydrates)
Cellulose, hemicellulose and lignocellulose

Enzymes (proteins) are used to break down complex carbohydrates

Monomeric sugars
Long carbohydrates are broken down into simpler sugars

PROS

Ecological no inorganic chemicals needed

GHG emission saving depending on sources

Operates at mild conditions contributing to process efficiency

TRL

Enzymatic hydrolisis has a TRL of 6-9

9 Actual system proven in operational environment
8 System complete and qualified
7 System prototype demonstration in operational environment
6 Technology demonstrated in relevant environment

RECOMMENDATIONS

Reduce high CAPEX and OPEX
Enzymes' high cost can impact OPEX. Enzymatic hydrolysis is also a slow process, necessitating large installations, thus resulting in high CAPEX.

CAPEX (€/kWth): 530 - 4100
OPEX (€/kWth): 11.2 - 530

Research on new enzymes with lower cost and higher resistance
New enzymes can cut OPEX and last longer, boosting process efficiency.

Make the process more efficient
The efficiency of enzymatic hydrolysis could be improved with pre-treatments like milling, grinding, or steam explosion.



ACID HYDROLYSIS

Acid hydrolysis is used as a pre-treatment step in biomethane production, in order to **increase the methane output of anaerobic digestion**.

INPUT → *Acid hydrolysis* → OUTPUT

Biomass (complex carbohydrates)
Cellulose, hemicellulose and lignocellulose

Acid and water are used to break down complex carbohydrates

Monomeric sugars
Long carbohydrates are broken down into simpler sugars

PROS

Faster process compared to enzymatic hydrolysis

GHG emission saving depending on sources

TRL

Acid hydrolisis has a TRL of 6-9

9 Actual system proven in operational environment
8 System complete and qualified
7 System prototype demonstration in operational environment
6 Technology demonstrated in relevant environment

RECOMMENDATIONS

Using equipment with high resistance to corrosion
The use of acids such as sulfuric acid can damage the equipment.

Developing chemicals recovery and reuse
Acid hydrolysis chemicals can be toxic. Developing methods to recover and recycle them can reduce environmental impact.

Using microorganisms less sensitive to inhibitors
The acid hydrolysis process can release inhibitory compounds reducing anaerobic digestion efficiency.

LIGNOCELLULOSE STEAM EXPLOSION

Lignocellulose steam explosion is a pre-treatment method aimed at breaking down lignocellulosic biomass to **unlock new feedstock types for anaerobic digestion**.

INPUT → *Lignocellulose steam explosion* → *Enzymatic hydrolysis* → OUTPUT

Lignocellulosic biomass
Cellulose, hemicellulose, and lignin

Industrial steam
Lignocellulosic biomass is subjected to high-pressure steam followed by rapid decompression

Hydrolysed lignocellulosic biomass
The sudden decompression disrupts the biomass structure, making it more accessible for enzymatic hydrolysis

Monomeric sugars
Long carbohydrates are broken down into simpler sugars

PROS

Low CAPEX and economical → CAPEX (€/kWth): 110 - 1806; OPEX (€/kWth): excluding feedstock cost: 19 - 246

Low energy use if digestate or another on-site energy source can generate steam

GHG emission savings
BioFuel Fab project
A main benefit stems from 20 kton hardwood per year, with savings of **26,585 t/y** CO2 equivalent, **14,520 t/y** fossil natural gas replacing **12,065 t/y** digestate captured by

Little to no environmental impact particularly if digestate is used as soil enhancer, acting as a carbon sink

TRL

Lignocellulose steam explosion has a TRL of 6 or 9

9 Actual system proven in operational environment — TRL for ethanol, pulp & paper, energy (silica pellets)
6 Technology demonstrated in relevant environment — TRL for biogas

RECOMMENDATIONS

Evaluate the effectiveness of steam explosion across different feedstocks
Steam explosion efficiency varies with feedstock. In the EU, major sources are straw, softwood residues, hardwood residues, and dry manure. Understanding steam explosion efficacy with each feedstock is crucial for technology optimisation.

Continuously improving the effectiveness of the technology and mobilisation of feedstock
Achieving this improvement is essential because to produce 35 bcm of biomethane at a production rate of 300 m3 CH4/ton of volatile solids, roughly 120 Mton of feedstock would be needed, such as hardwood. A study could prioritise feedstocks based on their abundance, from the largest supply to the smallest.



