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Biohydrogen from biogas

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1. Hydrogen in Europe
2. Biohydrogen production technologies
3. Carbon footprint and economics
4. Policy recommendations

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1. Hydrogen in Europe

Different types of hydrogen

- **Hydrogen can be biological or non-biological**
- **Several production pathways, categorised in colours**
- **Difference in feedstock and energy sources**

Type of hydrogen	Feedstock	Energy source	Process	Products
Grey	Natural Gas	Natural Gas	SMR	H_2 + CO_2 (released)
Blue	Natural Gas	Natural Gas	SMR	H_2 + CO_2 (% captured and stored)
Turquoise	Natural Gas	Natural Gas	Pyrolysis	H_2 + C (solid)
Red	Water	Nuclear Power	Catalytic splitting	H_2 + O_2
Purple/Pink	Water	Nuclear Power	Electrolysis	H_2 + O_2

Biohydrogen definition

Biohydrogen refers to hydrogen obtained from biogenic sources (for example, biogases and biomass) using a variety of technologies.

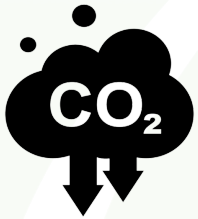
Type of hydrogen		Feedstock	Energy source	Process	Products
Green	RFNBO (non-biological origin)	Water	Renewable electricity	Water splitting processes (thermolysis, photolysis, electrolysis)	$H_2 + O_2$
	Bio-hydrogen (biological origin)	Biogenic sources (biomass, Biogas, Biomethane	Biomass derived energy[22]	Biological, thermochemical and bioelectrochemical (See Chapter 2)	H_2 + biogenic CO_2 + co-product (digestate, C, biochar, others)

Why biohydrogen from biogas?

Biohydrogen increases the versatility and flexibility of anaerobic digestion plants, by diversifying the energy products

Demand driven

Geographical location



Negative emissions opportunity

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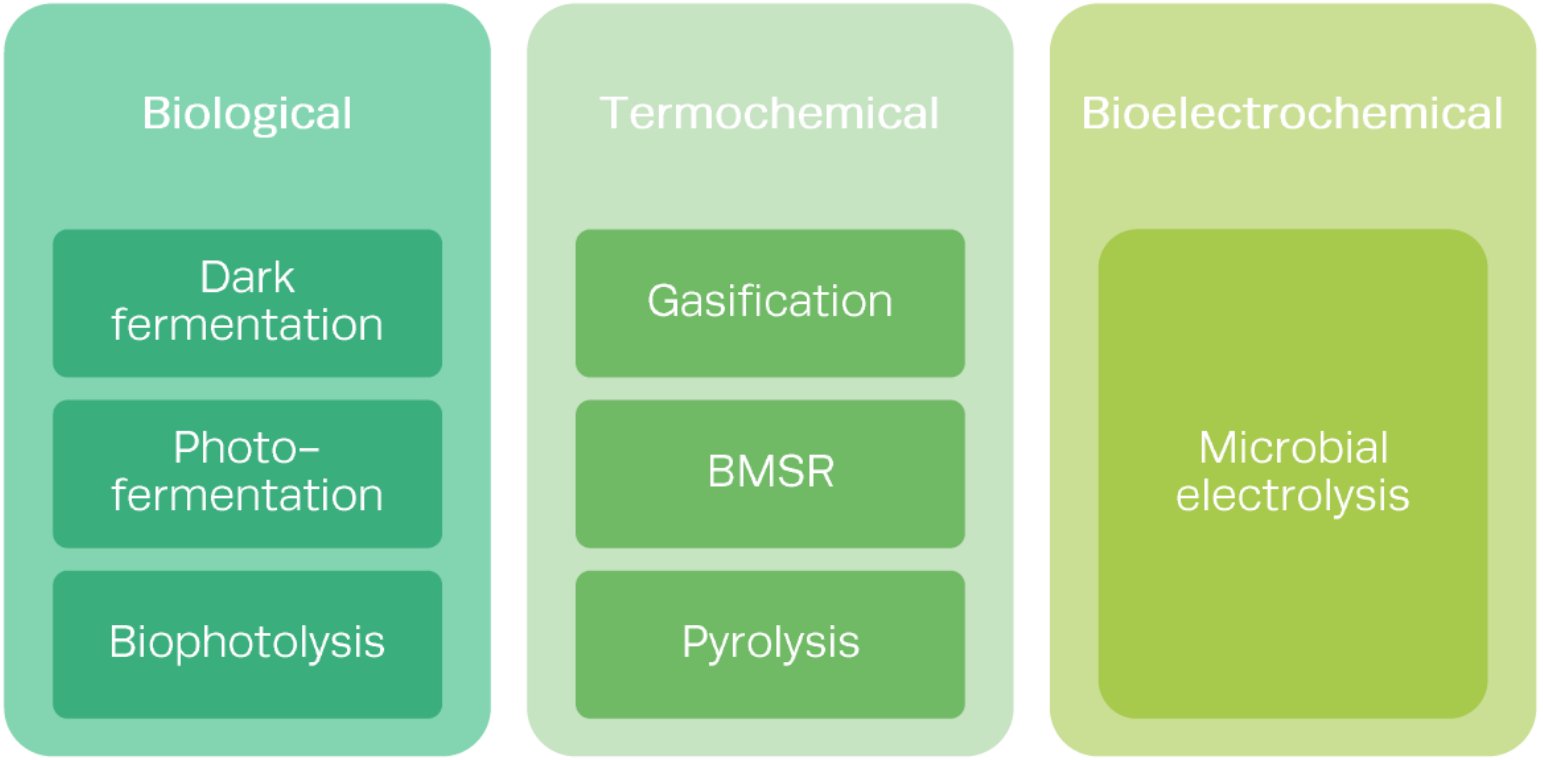
2. Biohydrogen production technologies

Biohydrogen production technologies



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microwave biogas cracking

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3. Carbon footprint and economics

Biohydrogen carbon footprint

Biohydrogen can be carbon negative

Table 3. Carbon footprint comparison of the different types of hydrogen in 2021

Hydrogen type	Carbon footprint (kg CO_2/kg H_2)
Grey hydrogen	10 to 20
Blue hydrogen	1.5 to 5
Green hydrogen (RFNBO)	0.5 to 1.5
Biohydrogen (with or without CCS)	-26.5 to 10.8

Source: Adapted from Lou et al. (2023)

Depending on the feedstocks and technologies used

Table 4. General comparison of the various biohydrogen production technologies

Biohydrogen production technologies	Carbon footprint (kg CO_2/kg H_2)
Gasification without CCS	0.31 to 8.63
Gasification with CCS	-22.15 to -11.66
Pyrolysis	-13.8 to -3.8
BMSR (with or without CCS)	-26.5 to 8.6
Biophotolysis	Data not available

Source: Adapted from Lou et al. (2023)

Production cost of biohydrogen compared to other types of hydrogen

Biohydrogen has a lower cost ranges compared to RFNBO

Table 5. Production cost of biohydrogen compared to other types of hydrogen in 2021

Hydrogen type	Cost range (€/kg H_2)	Cost range (€/kWh H_2)
Grey hydrogen	0.46 – 1.8	0.01 – 0.05
Blue hydrogen	1.3 – 2.2	0.04 – 0.07
Green hydrogen (RFNBO)	2.51 – 11.94	0.08 – 0.36
Biohydrogen (with or without CCS)	1.15 – 9.65	0.03 – 0.29

Source: Adapted from Lou et al. (2023)

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4. Regulatory barriers and recommendations

Regulatory barriers & recommendations

1. **Lack of market access.**
Failure to recognise biohydrogen as a hydrogen of renewable origin and lack of access to gas networks.

2. **Lack of price signals through taxation.**
No recognition of H_2 in Energy Taxation Directive (2003), therefore no common minimum level of taxation for it

3. **Insufficient and discriminatory consumption targets.**
Sectoral consumption targets under RED II and RED III discriminate against biohydrogen

Recommendations

To recognize biohydrogen as hydrogen of renewable origin in EU legislation

To revise of the minimum taxation levels in the Energy Taxation Directive, the Gas Directive and the Gas Regulation accordingly

To expand targets for RFNBO in RED III, to include all types of renewable hydrogen.

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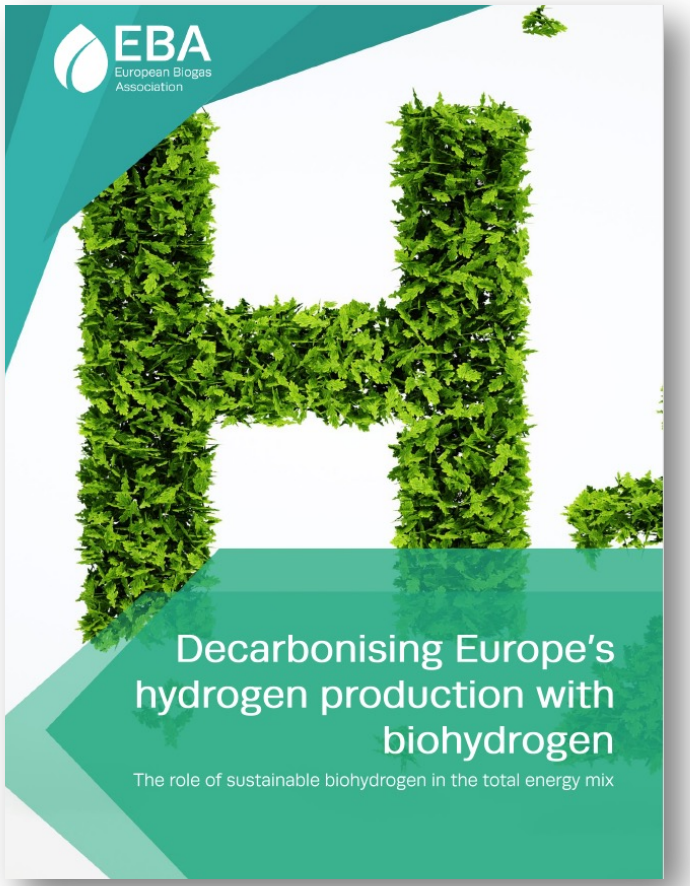
Full paper available



For any questions, please contact us at info@europeanbiogas.eu

Thank you for your attention!

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