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Environmental performance and potential of biomethanation in PtX field

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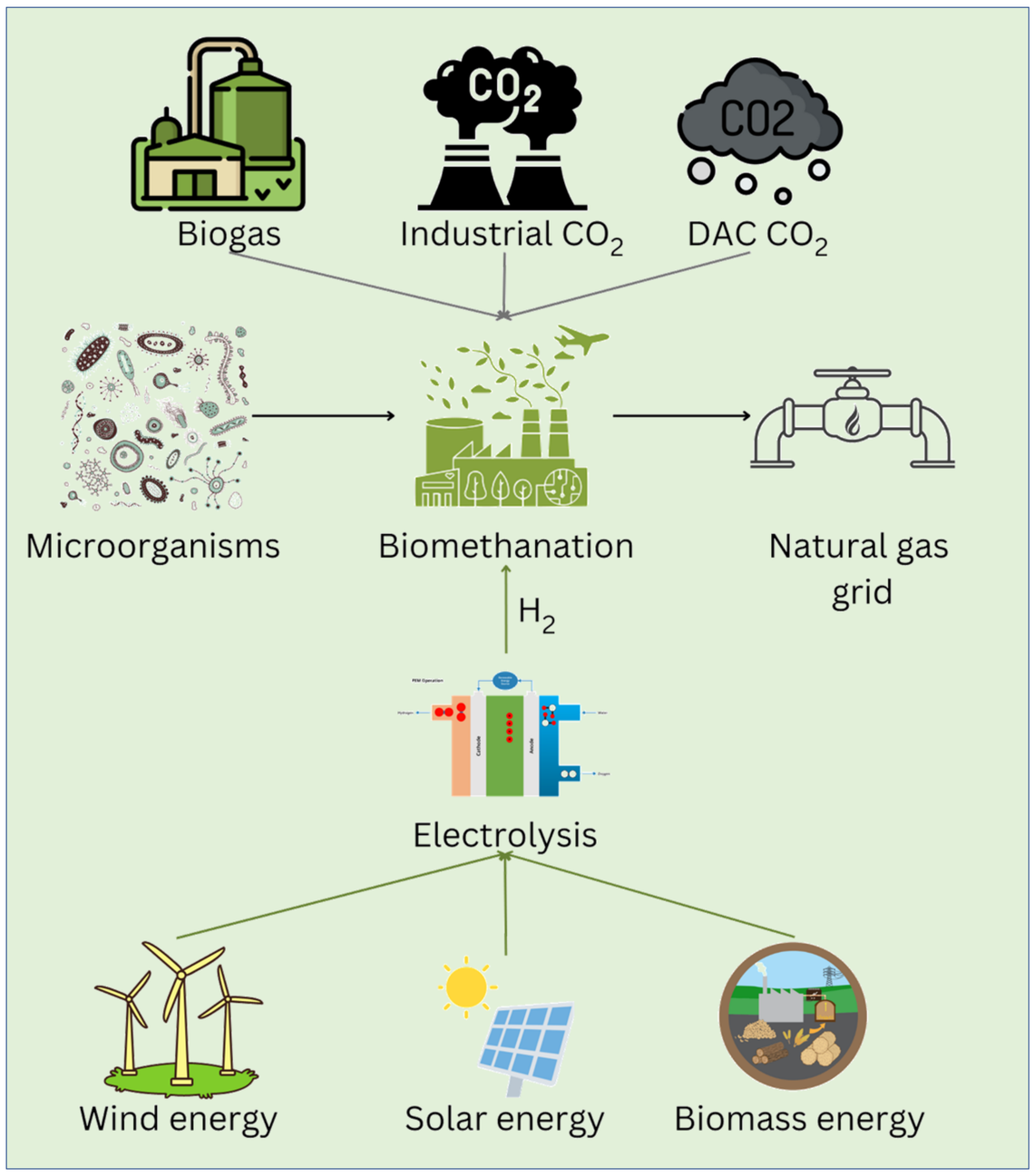
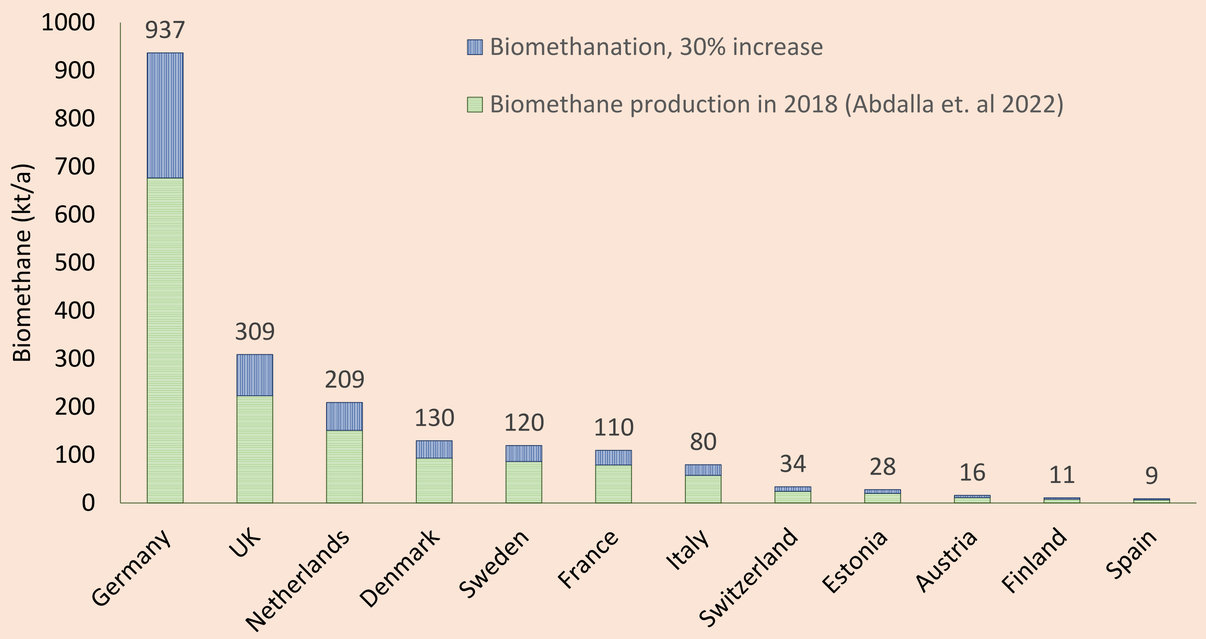


Biomethanation
- Specific microbes convert CO_2 and H_2 to CH_2
- In-situ = H_2 fed to biogas reactor
- Ex-situ = CO_2 and H_2 to external reactor

Biomethane production in the EU



Parameter	Biomethanation	Chemical Methanation
Reaction temperature	25-65°C	300-500°C
Reaction pressure	Atmospheric to 10 bar	1-30 bar
Catalyst	Microbial consortia or pure cultures	Metal catalysts (e.g., Ni, Ru)
Methane purity	Up to 99%	Up to 97%
By-products	None or minimal	Water and trace amounts of CO
Energy consumption	Low	High
Environmental impact	Low carbon footprint	High carbon footprint

Hydrogen use and emission factor

	H_2 use kg H_2/kg CH_4	PtX (RE+nuclear) kg CO_2,eq./kg CH_4	PtX (fossil) kg CO_2,eq./kg CH_4	Reference (NG) kg CO_2,eq./kg CH_4
Methanation (Sabatier)				
Reiter and Lindorfer 2015	0.50	0.3-1.5	13.8	3.2
Chauvy et al. 2022	0.46	0.98-0.98		4.1
Tschiggerl et al. 2018		0.18-1.45	11-13	
Vega Puga et al. 2022	0.50	0.06-0.06	13-20	3.2
Zhang et al. 2017	0.50	2.5-2.6		3.2
Para et al. 2017				
Uusitalo et al. 2017	0.53	2.1		3.3
Nabil et al. 2021			2.65	
Sternberg and Bardow 2016	0.51	1.4-2.3	4-11	5.1
Hoppe et al. 2017	0.52	0.74-1.6		3.0
Average	0.50	1.3	11	3.6
Biomethanation				
Vo et al. 2018	0.20	2.3-2.5	6-6.2	
Elyasi et al. 2021	0.19	0.45		
Goffart De Roeck et al. 2022	0.19	0.37		
Average	0.19	1.4	6.0	3.6

Climate impact reduction potential

	Hydrogen need kg H_2/kg CH_4	Reference	Impact reduction potential kg CO_2,eq./kg H_2	Mean value kg CO_2,eq./kg H_2	LCA studies
Methanation (Sabatier)					
Renewable energy + nuclear	0.46-0.502	Natural gas	1.3-6.8	4.3	8
Gridmix or fossil	0.46-0.502	Natural gas	No reduction potential-1.53	No reduction potential	5
Biomethanation					
Renewable energy + nuclear	0.186-0.199	Natural gas	5.7-17	11.5	3
Gridmix or fossil	0.186-0.199	Natural gas	No reduction potential	No reduction potential	1

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