

Routes and potential to produce

renewable methanol in Spain



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Why methanol?



- Methanol (MeOH) is employed by chemical industry (70%) and road transport (30%)
- The largest current producer is China
- 110 Mt/year in 2023 \rightarrow 500 Mt/year in 2050 (increase as maritime fuel)
- Current routes:
 - Coal, trough gasification to produce syngas
 - Natural gas, trough steam methane reforming
- Renewable routes:
 - (bio-MeOH) Solid biomass: gasification, as with coal
 - (bio-MeOH) Biomethane, as with natural gas
 - (e-MeOH) renewable hydrogen + biogenic CO₂





Routes proposed



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Costs and resources



- Scale of the facility: 200,000 t MeOH/year
- Biogenic CO₂ (biogas ugrading): 125 €/† CO₂
- Availability of CO_2 from biogas upgrading: 96 to 146 t CO_2 /GWh-HHV of biomethane

Substrates	Α	B	C	D
Landfill gas [%]	7	53		100
OFMSW [%]	6	47	100	
WWTP & Agri-Food Industry [%]	7			
Agriculture waste [%]	18			
Intermediate Crops [%]	43			
Manure [%]	19			
Potential [TWh/year]	135.19	16.73	7.92	8.81
Feedstock cost [€/MWh-HHV]	69.33	35.95	48.77	24.43

Substrates for biomethane







- Route 1 is the most efficient, but it needs CO_2 supply
- Route 2 and 3 are the less efficient, but produce biogenic CO_2 or green H_2
- Route 4 has an intermediate efficiency and does not require $\rm CO_2 \ or \ H_2$ management

	Feedstocks		Products			
Route	Biomethane	CO ₂	MeOH	H ₂	CO ₂	
	[MWh-HHV]	[t]	[t]	[t]	[t]	
1	8.03	0.34	1			
2	10.11		1		0.25	
3	10.17		1	0.04		
4	9.25		1			

Unitary balance







Current fossil MeOH: 250 \$/t

- e-MeOH: 800 to 1,600 \$/t
- bio-MeOH from biomass gasification: 450 to 750 \$/t
- Current bio-MeOH from
 biomethane: 790 to 800 \$/t









- Current MeOH consumption in Spain: 600 kt/year
- Maersk project at Huelva: 380 kt/year
- Potential capacity in Spain at 431 €/t: 800 kt/year (route 4)
- 21% Lower cost and 25% higher capacity (route 1) requires CO_2 supply

Substrates	А	В	С	D
Biomethane potential [TWh/year]	135.19	16.73	7.92	8.81
LCOM [€/t]				
Route 1	702	434	537	341
Route 4	846	537	656	(431)
Number of plants of 200 kt/year				
Route 1	84	10	4	5
Route 4	73	9	4	4







- Current production of MeOH by natural gas emits 0.5 kg CO₂/kg MeOH
- Renewable e-MeOH requires 1.38 kg CO₂/kg MeOH and its cost is very high (800 to 1600 \$/t)
- Routes 1 and 4 proposed:
 - Reduce (R1: 340 g CO₂/kg MeOH) or eliminate (R4: 0 CO_2) the required CO₂
 - Exhibit lower costs than using e-MeOH: 340 to 850 €/t
 - The potential capacity in Spain ranges from 800 kt/year to 16.8 Mt/year, being the current Spanish demand of 600 kt/year, with expectation to be increased with 380 kt/year of e-MeOH (at least 1 GW of electrolyser)
- Bio-MeOH is economically feasible against e-MeOH and its potential is linked to the biomethane development, being required 5.55 TWh-HHV to met the current Spanish demand





Questions?



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