Supplementary Information (SI) for Sustainable Energy & Fuels.

SUPPORTING INFORMATION

Shaping the future of methanol production through carbon dioxide utilisation strategies

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Supplementary Note 1 – Process Inventory for direct e-MeOH (CO_2ER)

Inventory for the CO_2 electrolysis process is given (Table S1). Cathode elements are adapted for MeOH production from a previous work.[1], assuming CuO_2 as catalyst at a load of 1.8 mg/cm^2. A proton exchange membrane (Nafion 117) is used. Platinum foil is considered as anodic electrocatalyst. Electrolyzer stack is based on the alkaline design from Zhao et al.[2] Balance of plant uses the inventory from Bareiß et al.[3] Capture of CO_2 is assumed to be performance with amine-based absorption using inventory from Giordano et al.[4] Material and energy needs (water, heat, electricity, minor chemicals) are calculated in the black-box model described in work of the research group. [5–7]

Table S1. Simplified inventory to produce MeOH by the CO_2ER route.

Flow	Scenario		Unit
	SoA	HP	
Inputs			
Anode	4.24· 10-4	2.23E-05	m^2
Membrane	6.06 · 10-4	2.79E-05	m^2
Cathode	4.24 · 10-2	2.23E-05	m^2
Stack	2.12 · 10-4	1.12E-05	m^2
Balance of Plant (BoP)	2.12 · 10-4	1.12E-05	m^2
CO_2 captured	1.63	1.38	kg
Deionized water	3.80	1.80	kg
Electricity	40.6	8.5	kWh
Heat	160.6	20.73	MJ
Outputs			
MeOH	1	1	kg
H_2	0.19	0.03	kg
O_2	3.00	0.58	kg
CO_2 to air	0.26	0.18	kg

Supplementary Note 2 – Process Inventory for H2-e-MeOH

Inventory for the H_2-e-MeOH process is reported in Table S2. Cathode, anode and stack is based on a previous work from Rumayor et al.,[8] BoP and CO_2 capture uses the same as for the CO_2ER route. CO2 hydrogenation inventory uses data from Ravikumar et al., [9]

Table S2. Simplified inventory to produce MeOH by the H2-CO_2ER route.

Flow	Value	Unit
Inputs		
Anode	2.23E-05	m^2
Membrane	2.79E-05	m^2
Cathode	2.23E-05	m^2
Stack	1.12E-05	m^2
Balance of Plant (BoP)	1.12E-05	m^2
CO_2 captured	1.38	kg
Deionized water	2.1	kg
Electricity	10.86	kWh
Heat	4.6	MJ
Outputs		
MeOH	1	kg
CO_2 to air	0.18	kg

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