



FLEXIBLE DIMETHYL ETHER PRODUCTION FROM BIOMASS GASIFICATION WITH SORPTION ENHANCED PROCESSES

Final webinar

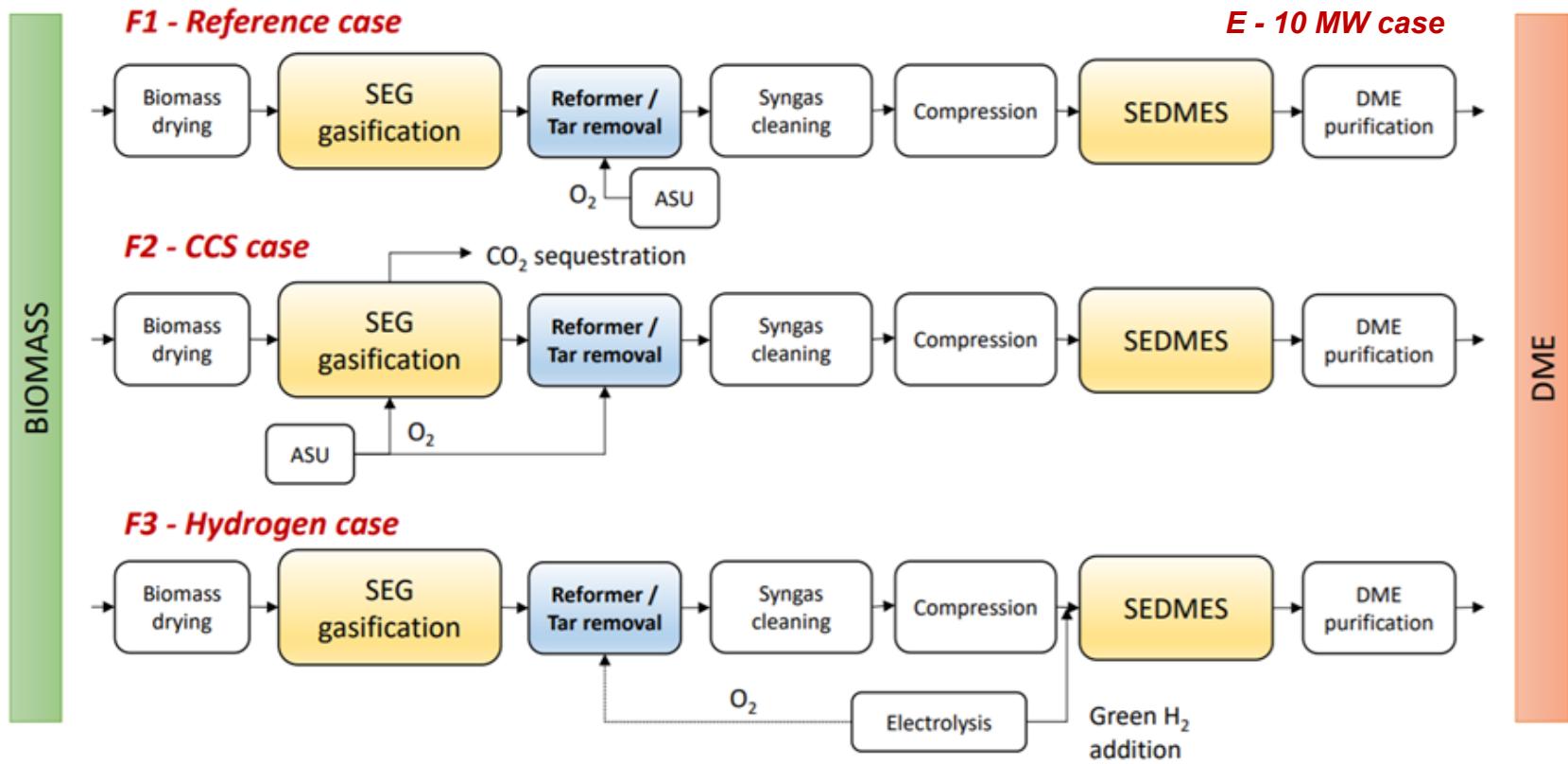
Large scale DME synthesis plant from wooden
biomass: feasibility and economic analysis

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Introduction

Economical evaluation of 4 FLEDGED process variations (F1, F2, F3 and E)



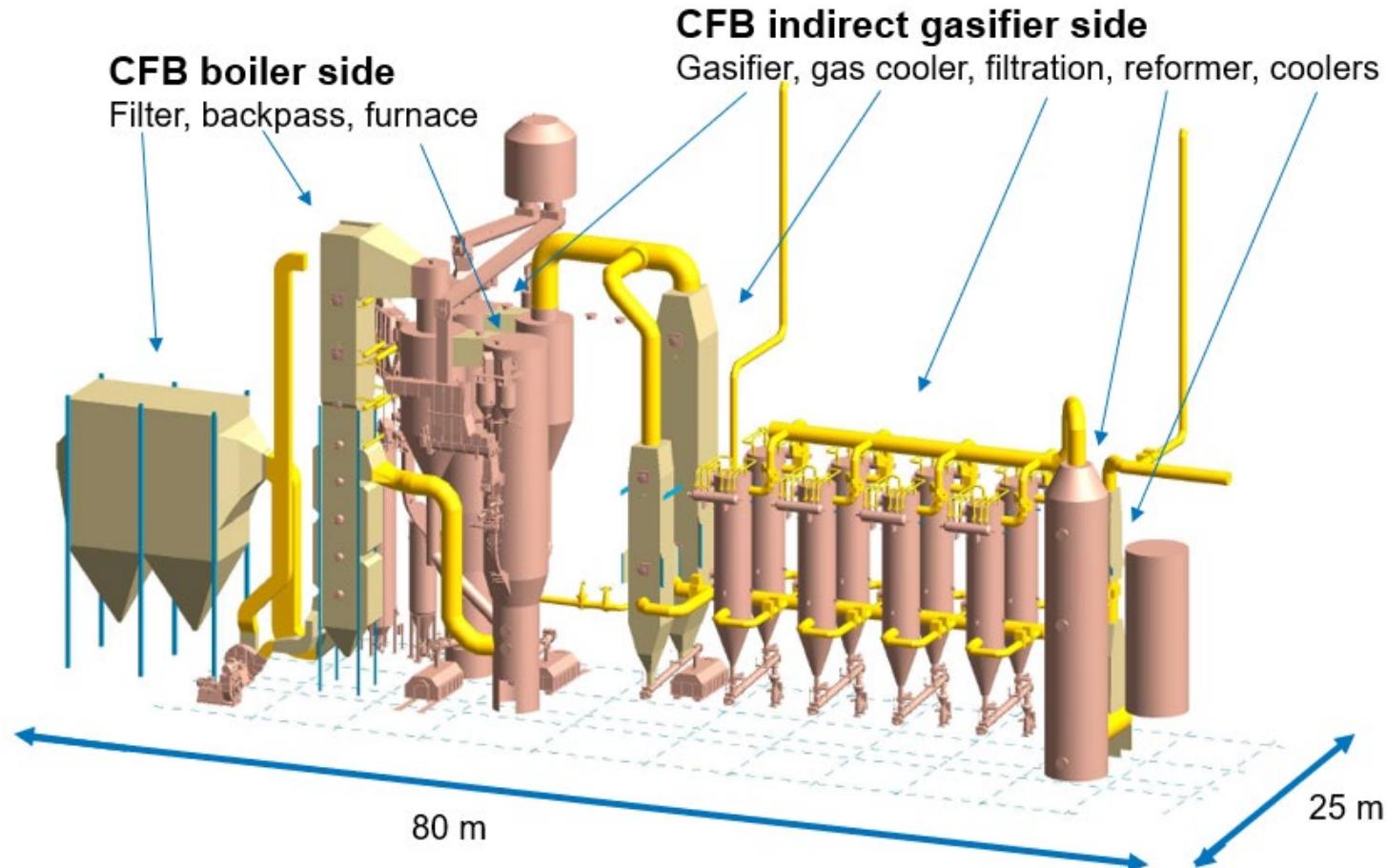
Introduction

- CAPEX
- DME production costs
- DME as a renewable transportation fuel



CAPEX estimation

SEG section design (100 MW)



CAPEX estimation

SEDMES section design (1 MW)



CAPEX estimation

SEDMES section design (1 MW)

SEDMES reactors

Distillation columns

TEG absorber

Regeneration gas blower

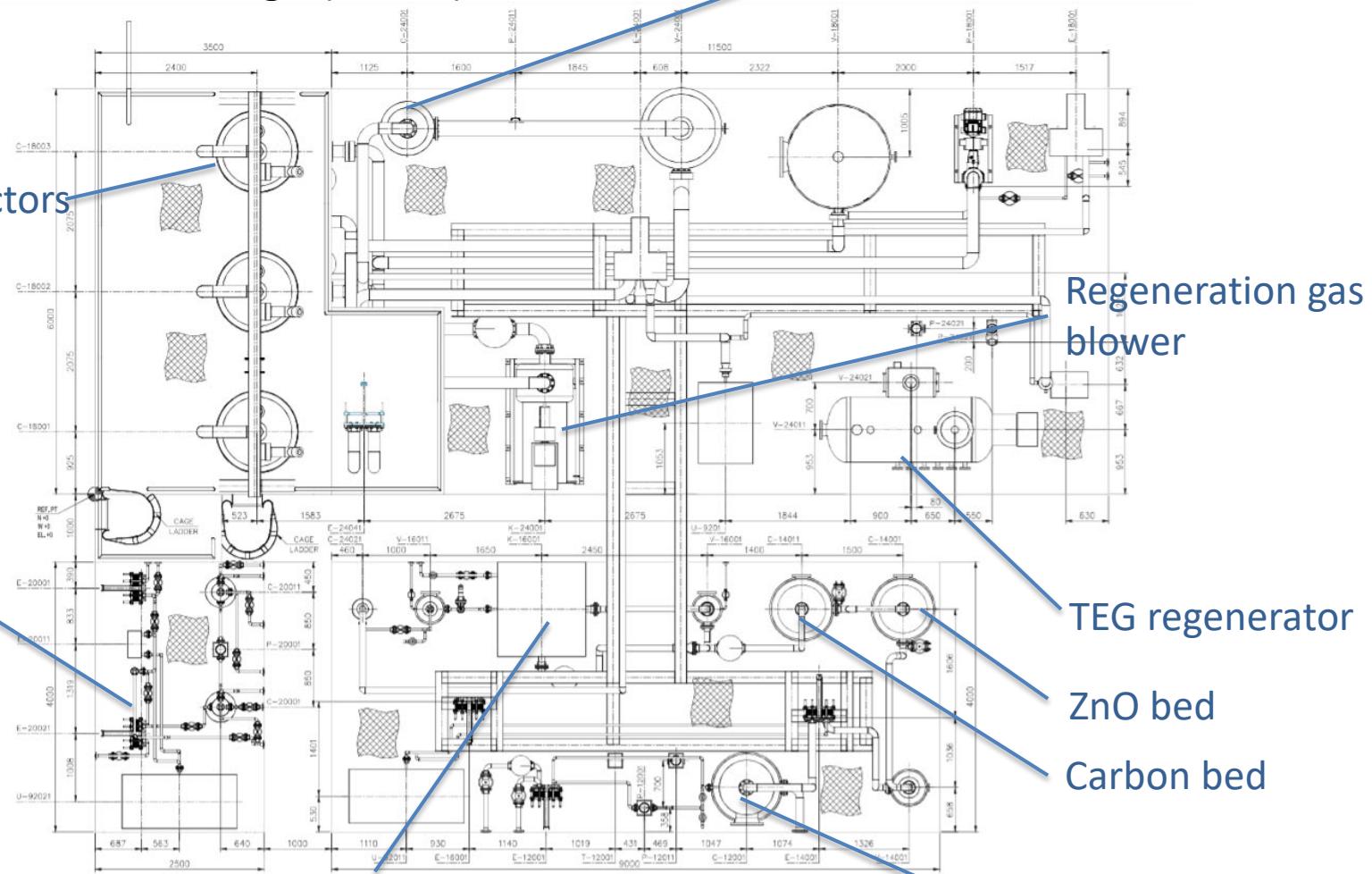
TEG regenerator

ZnO bed

Carbon bed

Quench

Syngas compressor



CAPEX estimation

*Percentage of
Delivered-Equipment
Cost Method*

	Percent of delivered-equipment cost for		
	Solid Processing plant	Solid-fluid processing plant	Fluid processing plant
Direct costs			
Purchased equipment delivered	100	100	100
Purchased-equipment installation	45	39	47
Instrumentation and controls (installed)	18	26	36
Piping (installed)	16	31	68
Electrical systems (installed)	10	10	11
Buildings (including services)	25	29	18
Yard improvements	158	12	10
Service facilities (installed)	40	55	70
Total direct plant cost	269	302	360
Indirect costs			
Engineering and supervision	33	32	33
Construction expenses	39	34	41
Legal expenses	4	4	4
Contractors fee	17	19	22
Contingency	35	37	44
Total indirect plant cost	128	126	144
Fixed-capital investment	397	428	504
Working capital	70	75	89
Total capital investment	467	503	593

$$CAPEX = \sum (E + f_1E + f_2E + f_3E + \cdots + f_nE) = E \sum (1 + f_1 + f_2 + f_3 + \cdots + f_n)$$



CAPEX estimation

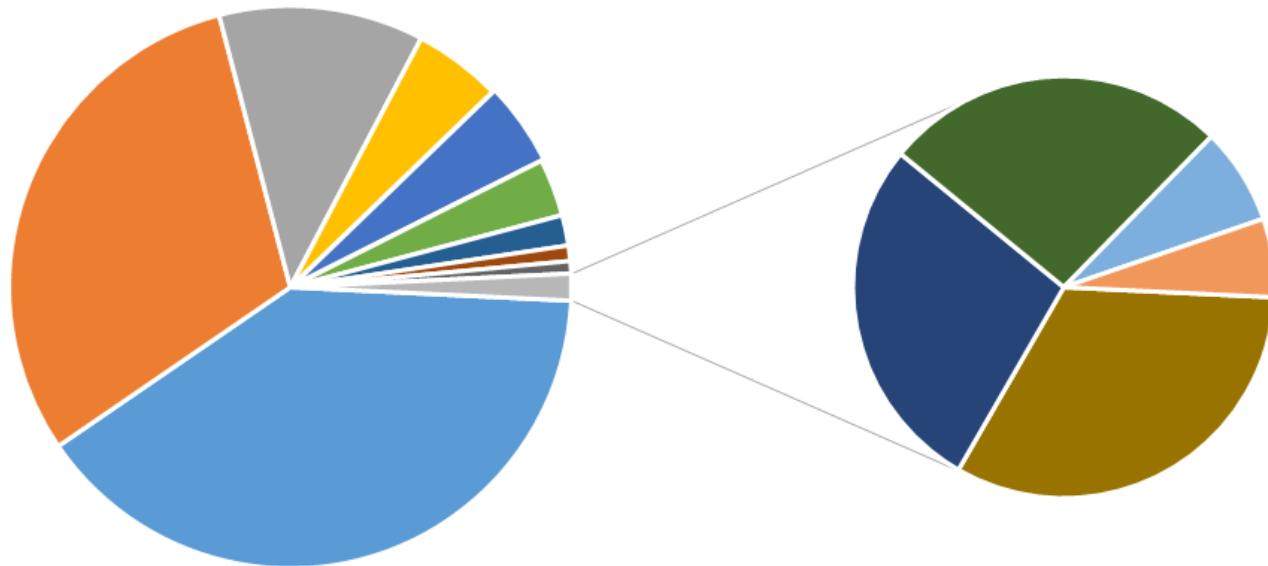
Results Fixed Capital Investment

Case	FCI -20%	FCI	FCI +30%
E	41	51	67
F1	200	250	324
F2	219	274	356
F3	280	350	455



CAPEX estimation

Results

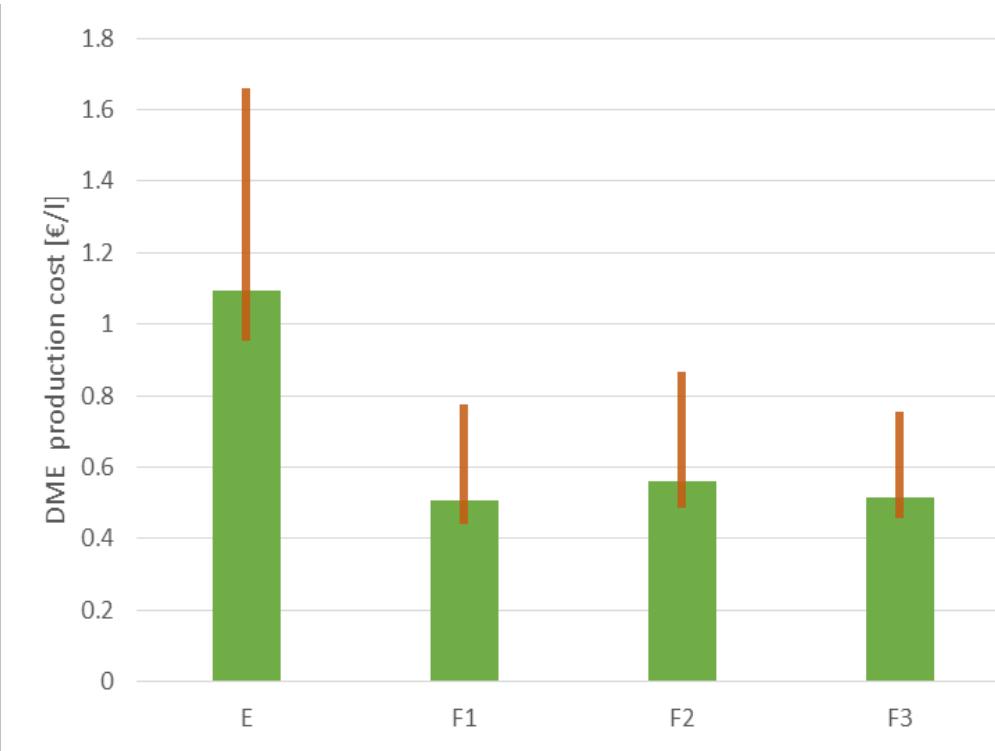


- SEDMES
- Distillation
- Waste water treatment
- Activated carbom
- Gasifier
- Power cycle
- Glycol drying
- ZnO bed
- Syngas compressor
- CHP
- Scrubber
- ASU
- Liquid redox
- Cooling plant



DME production costs

Annual operating hours: 7889

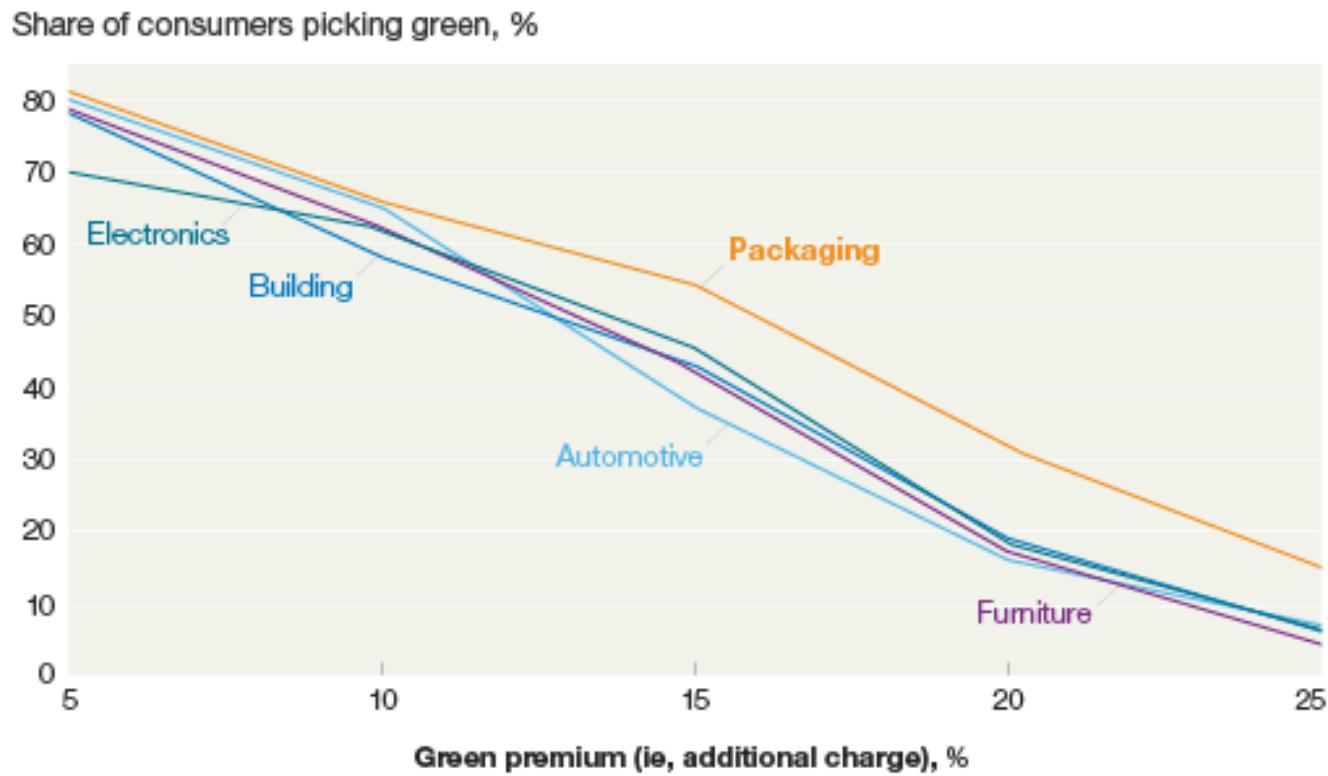


Operating life of plant: 20 years



FLEDGED DME as a renewable transportation fuel

For a 10 % market share of DME, the price per distance travelled should not be 25% higher than for diesel

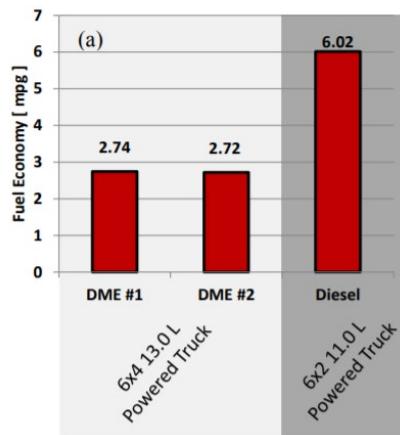


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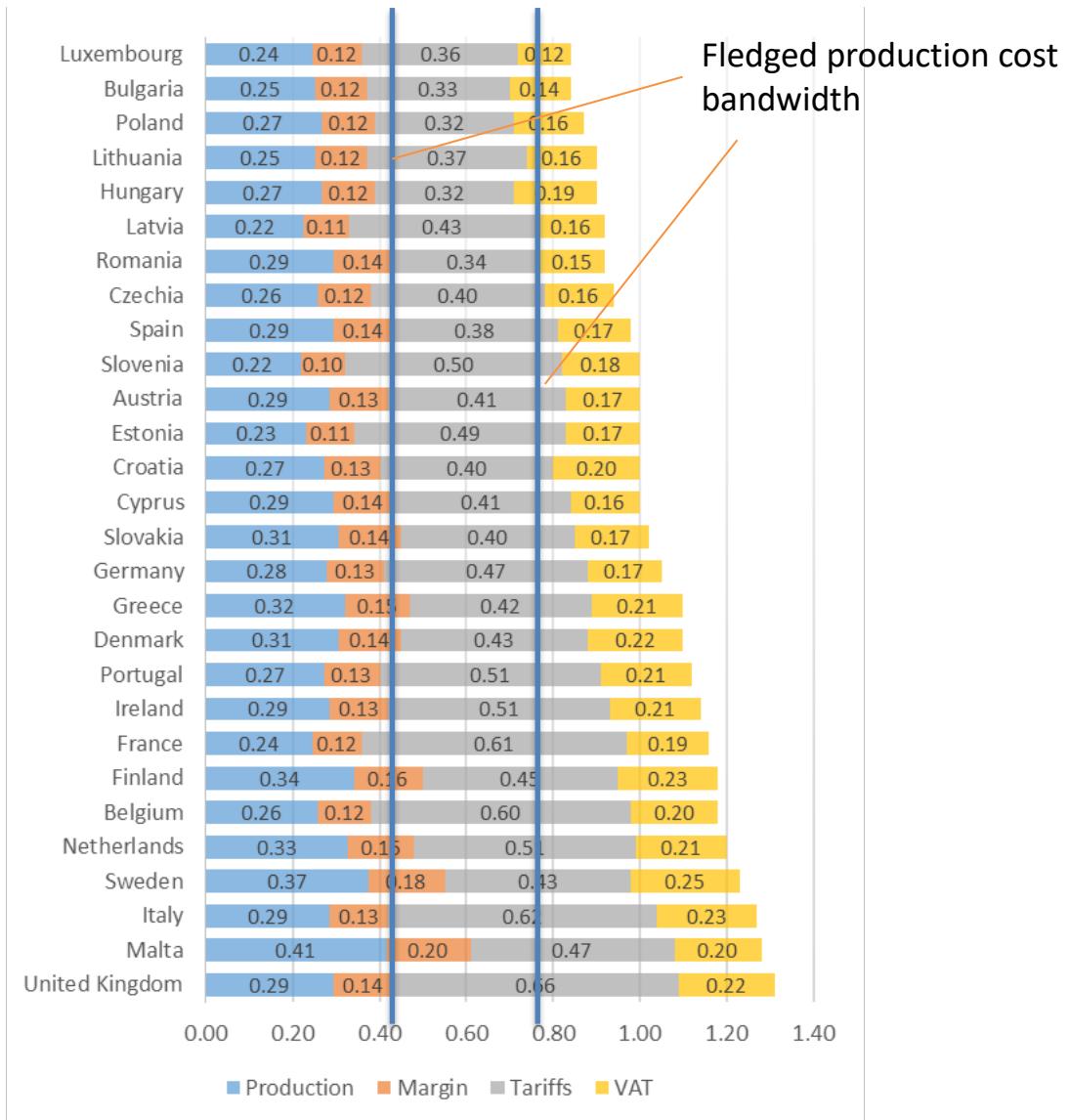


FLEDGED DME as a renewable transportation fuel

Breakdown of diesel prices at the pump [€/l]



Fuel economy of DME and Diesel fuel (Szybist et al, 2014)



FLEDGED DME as a renewable transportation fuel

Cost per distance travelled

				DME without tariffs and with subsidy	
Country	Diesel €/km	DME €/km	DME €/km no tariffs	DME €/km (Diesel +25%)	€/l subsidy
United Kingdom	0.51	1.60	0.98	0.64	0.24
Malta	0.50	1.42	1.04	0.63	0.31
Italy	0.50	1.59	0.99	0.62	0.28
Sweden	0.48	1.49	1.07	0.60	0.38
Netherlands	0.47	1.47	1.01	0.59	0.33
Belgium	0.46	1.52	0.97	0.58	0.30
Finland	0.46	1.47	1.04	0.58	0.38
France	0.45	1.51	0.95	0.57	0.29
Ireland	0.45	1.47	1.00	0.56	0.35
Portugal	0.44	1.48	0.99	0.55	0.36
Denmark	0.43	1.44	1.03	0.54	0.41
Greece	0.43	1.41	1.03	0.54	0.40
Germany	0.41	1.37	0.97	0.51	0.37
Slovakia	0.40	1.32	0.99	0.50	0.41
Cyprus	0.39	1.31	0.97	0.49	0.41
Croatia	0.39	1.39	1.01	0.49	0.44
Estonia	0.39	1.39	0.95	0.49	0.38
Austria	0.39	1.33	0.98	0.49	0.41
Slovenia	0.39	1.42	0.95	0.49	0.39
Spain	0.38	1.31	0.99	0.48	0.43
Czechia	0.37	1.30	0.97	0.46	0.43
Romania	0.36	1.24	0.98	0.45	0.46
Latvia	0.36	1.33	0.95	0.45	0.43
Hungary	0.35	1.32	1.02	0.44	0.51
Lithuania	0.35	1.29	0.97	0.44	0.46
Poland	0.34	1.25	0.99	0.42	0.49
Bulgaria	0.33	1.22	0.96	0.41	0.48
Luxembourg	0.33	1.20	0.93	0.41	0.45



FLEDGED DME as a renewable transportation fuel

Cost per liter

Country	DME price at pump €/l DME	Subsidy €/l DME	Tariffs missed €/l DME	Total effective subsidy €/l DME
United Kingdom	0.74	0.24	0.66	0.90
Malta	0.73	0.31	0.47	0.78
Italy	0.72	0.28	0.62	0.90
Sweden	0.70	0.38	0.43	0.81
Netherlands	0.68	0.33	0.51	0.84
Belgium	0.67	0.30	0.60	0.90
Finland	0.67	0.38	0.45	0.83
France	0.66	0.29	0.61	0.90
Ireland	0.65	0.35	0.51	0.86
Portugal	0.63	0.36	0.51	0.87
Denmark	0.62	0.41	0.43	0.84
Greece	0.62	0.40	0.42	0.82
Germany	0.59	0.37	0.47	0.84
Slovakia	0.58	0.41	0.40	0.81
Cyprus	0.57	0.41	0.41	0.82
Croatia	0.57	0.44	0.40	0.84
Estonia	0.57	0.38	0.49	0.87
Austria	0.57	0.41	0.41	0.82
Slovenia	0.57	0.39	0.50	0.89
Spain	0.56	0.43	0.38	0.81
Czechia	0.53	0.43	0.40	0.83
Romania	0.52	0.46	0.34	0.80
Latvia	0.52	0.43	0.43	0.86
Hungary	0.51	0.51	0.32	0.83
Lithuania	0.51	0.46	0.37	0.83
Poland	0.49	0.49	0.32	0.81
Bulgaria	0.48	0.48	0.33	0.81
Luxembourg	0.48	0.45	0.36	0.81



Conclusions

The estimated fixed capital investment of a 100 MW FLEDGED DME plant is between 250 and 350 M€. With case F1 being the cheapest and case F3 (with hydrogen addition) the most expensive. The estimation accuracy is -20% to +30%

To get renewable (FLEDGED) DME accepted by consumers subsidies are needed

The subsidies needed are well within the range of 'normal' renewable feedstock subsidies

Future research should focus on production rate improvements and resulting CAPEX reductions





*This project has received funding from the European Union's
Horizon 2020 research and innovation programme under grant
agreement N° 727600*

