E-fuels: future markets and challenges

European Hydrogen Week 2022 - Brussels
26th Oct 2022

Alba Soler – Science Executive Refining Transition

E-fuel concept

Agenda

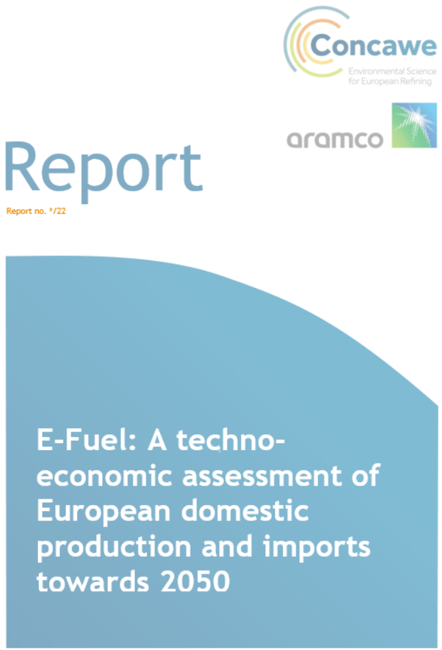
1. Background
2. E-fuels: Technical assessment
3. E-fuels: Economic assessment
4. A look into EU e-fuel demand

Previous Concawe reports on e-fuels

[Refinery 2050]

[E-fuels literature review]

[E-fuels Concawe Review]



New publication!

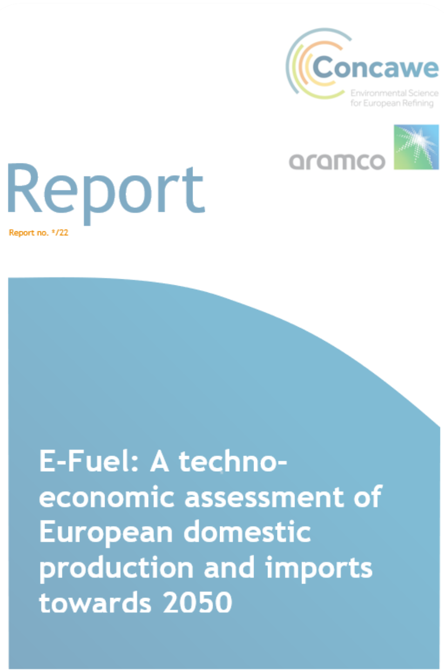
Concawe

New Concawe report on e-fuels

Joint collaboration Concawe & Aramco, and LBST & E4tech as consultants

- **Timeframe:** 2020 / 2030 / 2050
- **Pathways:** e-hydrogen, e-methane, e-methanol, e-OMEx, e-methanol-to-gasoline, e-methanol-to-kerosene, e-ammonia, e-Fischer-Tropsch kerosene & diesel
- **Regions:**
    - Domestic production in North Europe (**Norway**), Central EU (**Germany**) and South EU (**Spain**)
    - Production in Middle East (**Saudi Arabia**) and import into EU
    - Sensitivities to production in **Morocco, Chile & Australia**, and import to EU

9 base cases for 4 geographies + sensitivities =>
>100 pathways assessed



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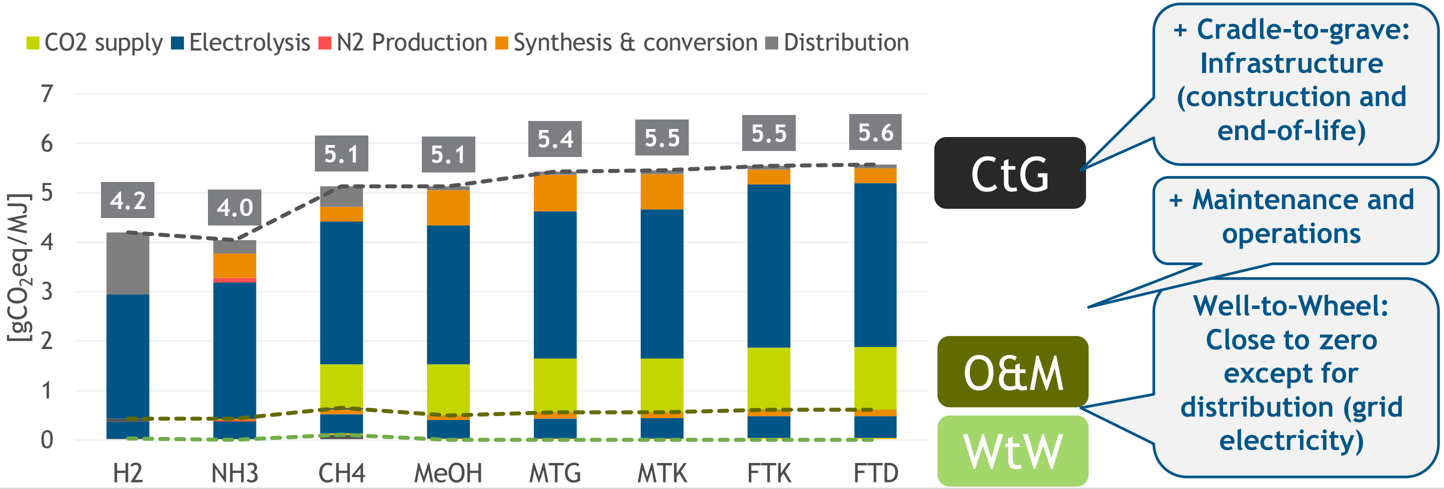
Technical assessment

Results: GHG emissions – North Europe (2050) 100% offshore wind, 100% DAC

Cradle-to-Grave (CtG) emissions are similar for all the pathways: The ones less energy-intensive to produce are more energy-intensive to transport



	H2	NH3	CH4	MeOH	MTG	MTK	FTK	FTD
Fossil reference* →	113.0	121.4	67.6	100.6	90.4	83.0	83.0	92.1
Reduction vs fossil →	-96%	-97%	-92%	-95%	-94% **	-93% **	-93% **	-94% **

*Source: JEC WtT Study v5, GaBi Database

**Additional reduction if RED II fossil fuel comparator (94 gCO_2eq/MJ) is used

E-fuels achieve up to 92-97% GHG reduction vs fossil alternatives

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Excluding e-OMEx with 10.6 g CO_2eq/MJ due to the higher processing due to the complexity of the molecule

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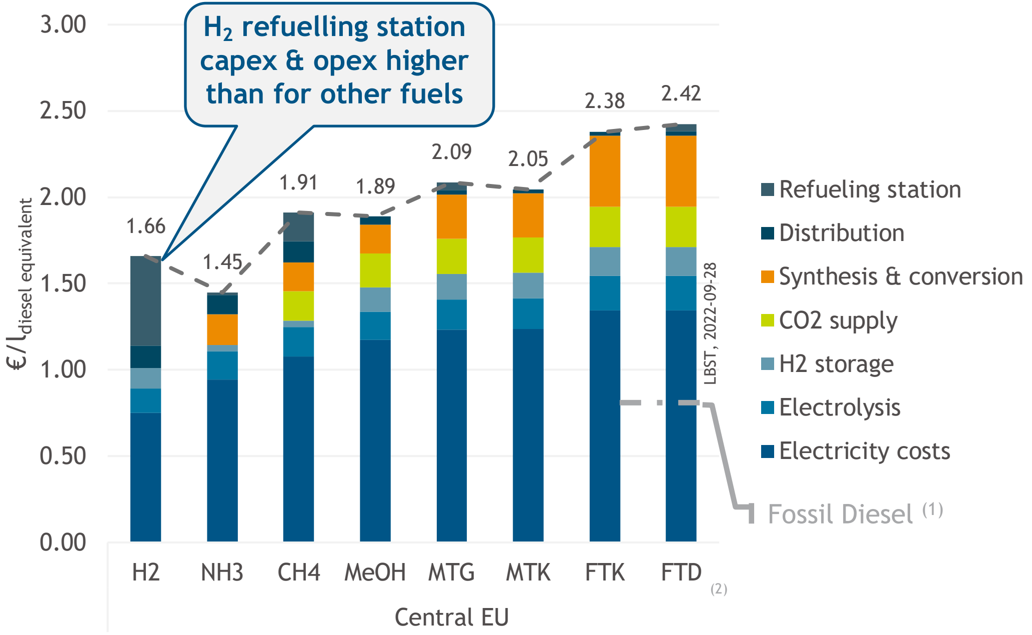
Economic assessment

Results: Costs of fuel supply - Example (EU Central, 2050, 100% DAC)

E-fuels that are less energy-intensive to produce generally lead to lower costs of fuel supply

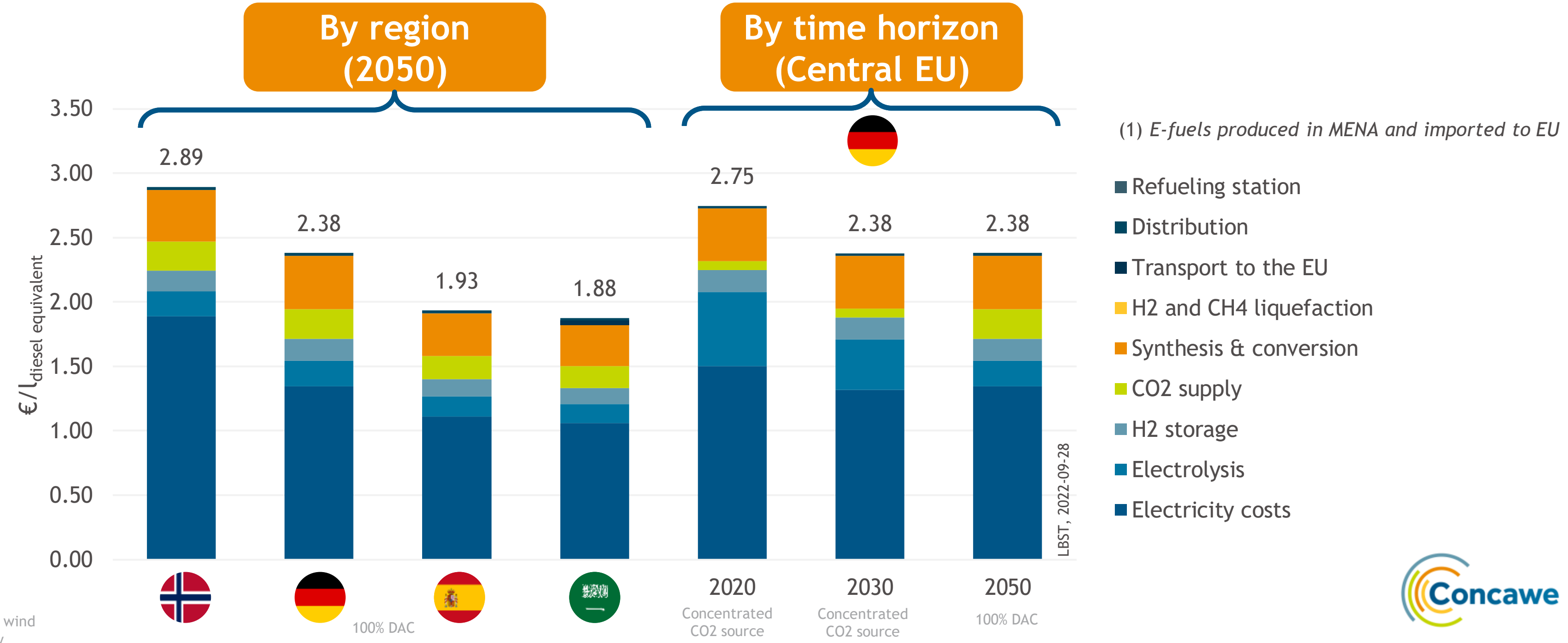


Note
(1) Diesel price: 0.3 €/l (2020) - 0.8 €/l (2050), with crude-oil prices (40 €/bbl (2020)-110 €/bbl (2050) taken from the EU Commission Impact Assessment
(2) e-OME_x production cost: 2.67 €/l

Economic assessment

Results: Impact of geography & time (example: e-kerosene)

E-fuels produced in MENA and South EU show the lowest fuel costs, followed by Central and North EU



Note: 100% off-shore wind considered in Norway

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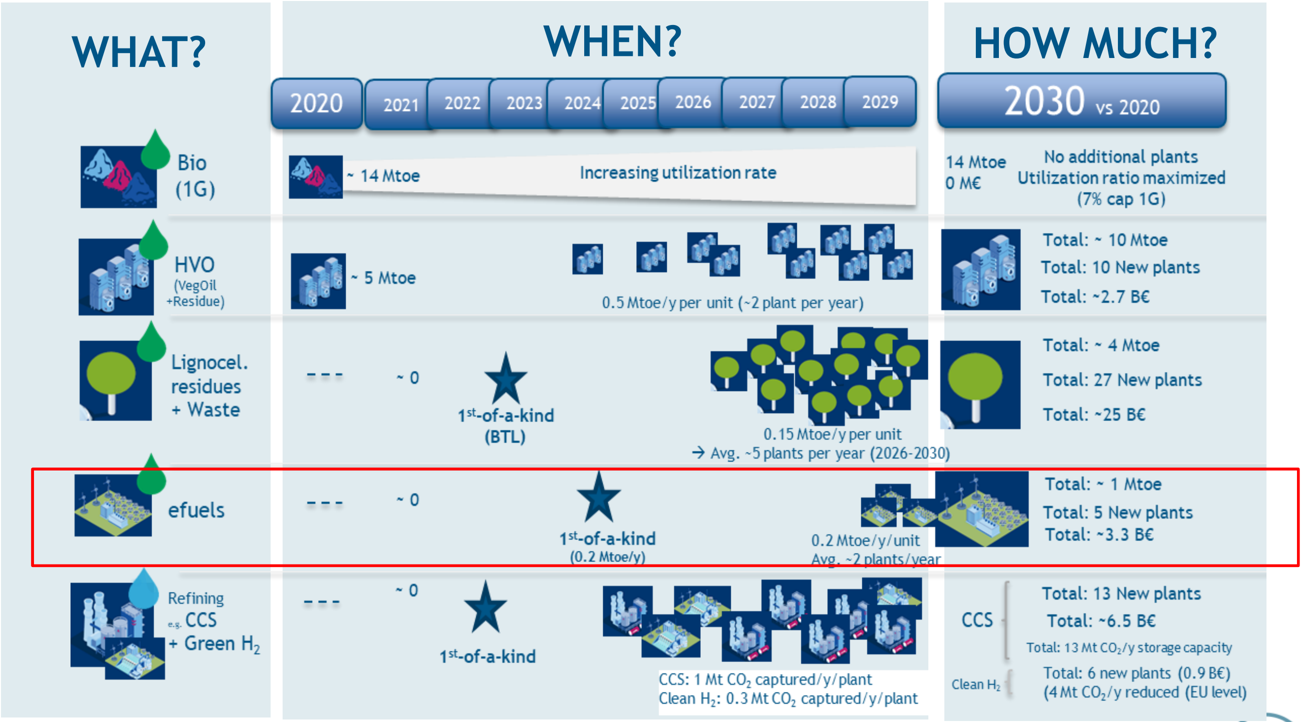
Concawe's 2050 LCF demand scenarios

Accelerating the pace towards 1st-of-a-kind in parallel to supply chain + market creation



Concawe's 2050 LCF demand scenarios

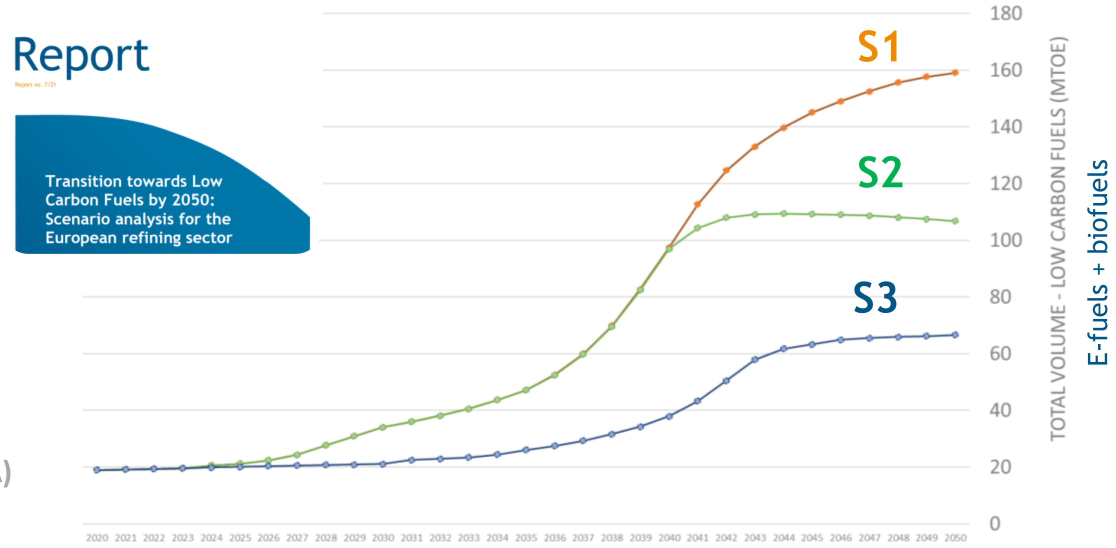
Three 1.5°C scenarios exploring different penetration of LCF into Transport

In a context of high electrification of road transport (consumption of liquids divided by 3 vs. today)

S1. All transport (updated ACF4A)
New sales mix for Road based on the EU Commission *A Clean Planet for all* (ACP4A) 2050 baseline

S2. Heavy Duty, Aviation & Maritime
Assuming no ICE in PC's in the sales mix beyond 2035

S3. Aviation & Maritime
Demand based on RefuelEU Aviation (consistent with 1.5TECH) + H2Mar70 (ACP4A)



This analysis is to be considered as a theoretical assessment and it is not intended to become a roadmap for the industry. Other trajectories could be defined or appear depending on the framework conditions and successful development and scale-up of the different technologies presented and their related value chains.

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Thank you for your attention

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