



# E-fuels: future markets and challenges

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*Alba Soler - Science Executive Refining Transition*

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# 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

## Report

Report no. 9/19

### Refinery 2050: Conceptual Assessment.

Exploring opportunities and challenges for the EU refining industry to transition towards a low-CO<sub>2</sub> intensive economy



[Refinery 2050](#)

## Report

Report no. 14/19

### Role of e-fuels in the European transport system - Literature review



[E-fuels literature review](#)



As part of Concawe's Low Carbon Pathways project, this review presents a literature review on e-fuels, with a view to build a better understanding of their production technologies and implications in terms of efficiency, greenhouse gas reduction, technology readiness level, environmental impact, investment, costs and potential demand. It is a summary of the information literature review work to date to be published by the end of 2020.

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#### Introduction

In December 2019, France led the climate finance ministers' Conference on Climate Change convened in Paris for the 13<sup>th</sup> Conference of Parties (COP21). The conference was an important step towards addressing the near possibility climate change through an agreement to keep the global temperature increase well below 2°C above pre-industrial levels, and also efforts to limit it to 1.5°C above pre-industrial levels. To achieve these goals, the European Union (EU) is exploring different mid-century scenarios leading to a net carbon footprint of zero by 2050.

In line with the EU's low emissions strategy, Concawe's cross-sectoral Low Carbon Pathways (LCP) programme is exploring opportunities and challenges presented by different low carbon technologies to achieve significant reduction in carbon dioxide (CO<sub>2</sub>) emissions associated with both the manufacture and use of refined products in Europe over the medium (2030) and longer term (2050).

In the scenario considered by the Commission (REF-CO2e), 1.1 TWh and 1.5 TWh of e-fuels are potential at 2030 and 2050 respectively through the possible use of both the potential of the LCP programme, as well as the global temperature increase to well below 2°C, and various efforts to limit it to 1.5°C.

#### E-fuels concept

E-fuels are synthetic fuels, resulting from the combination of 'green' or 'grey' hydrogen produced by electrolysis of water with renewable electricity and CO<sub>2</sub> captured either from compressed natural gas (the green route) or industrial sites (from the gas or liquid or natural gas (LNG)). Synthetic gas produced in the literature as methanol, power-to-gas (PtG), power-to-liquids (PtL), power-to-gas (PtG) and synthetic fuels. E-fuels may also be produced from other sources.

[E-fuels Concawe Review](#)



Report no. 7/22

### E-Fuel: A techno-economic assessment of European domestic production and imports towards 2050

New publication!

# 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



# Agenda

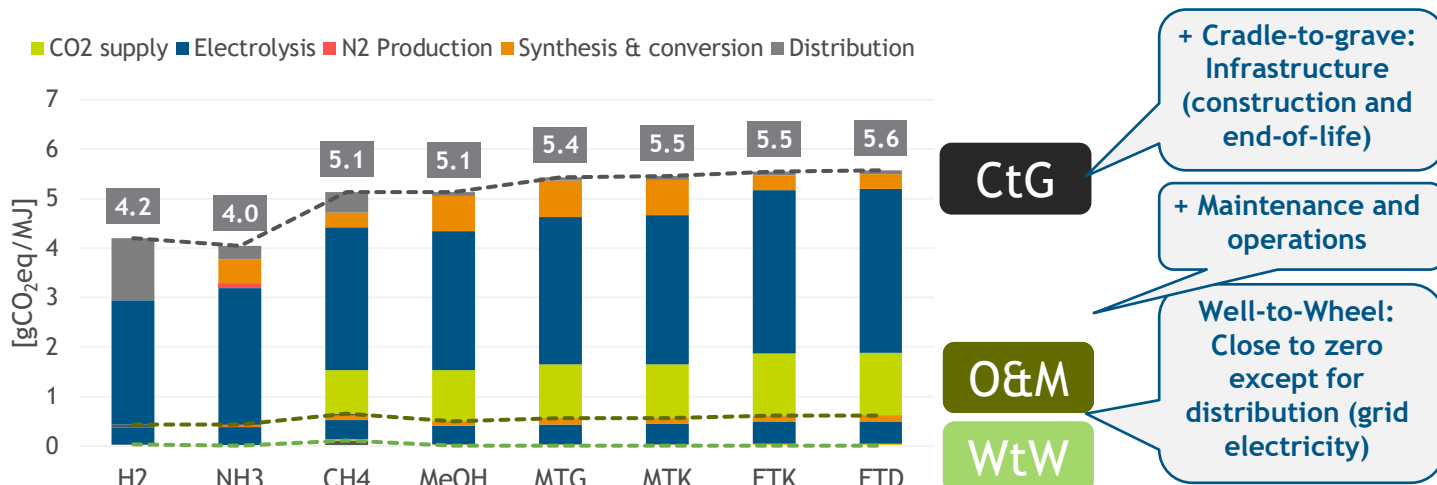
- 1 Background
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# Technical assessment

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



| Fossil reference* →   | H2    | NH3   | CH4  | MeOH  | MTG  | MTK  | FTK  | FTD  |
|-----------------------|-------|-------|------|-------|------|------|------|------|
| Value                 | 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<sub>2</sub>eq/MJ) is used

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

Excluding e-OMEx with 10.6 g CO<sub>2</sub>eq/MJ due to the higher processing due to the complexity of the molecule



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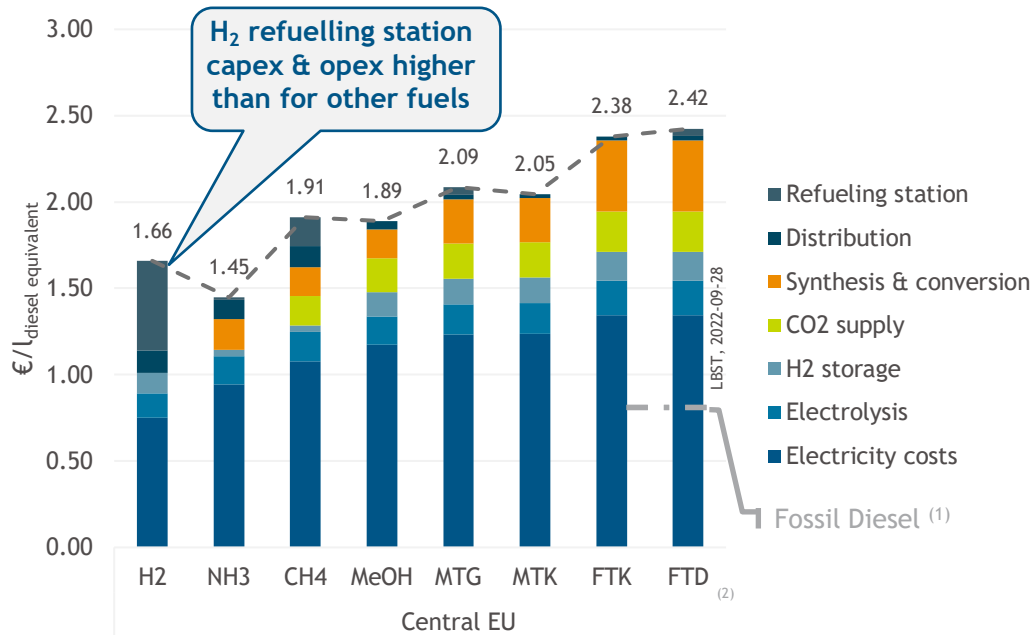




# Economic assessment

## 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

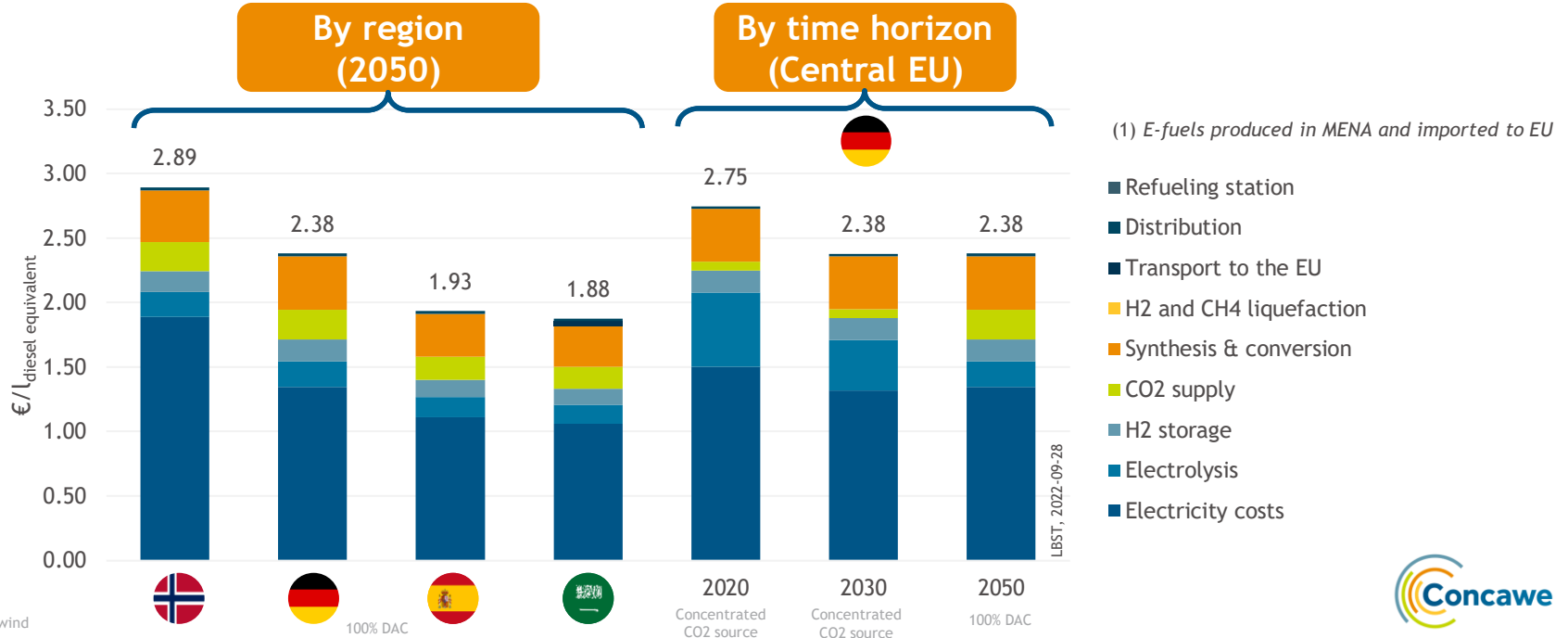
(1) Diesel price: 0.3 €/l (2020) - 0.8 €/l (2050), with crude-oil prices (40 €/bbl (2020)-110 €/bbl (2050) taken from the EU Commission Impact Assessment

(2) e-OME<sub>x</sub> 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

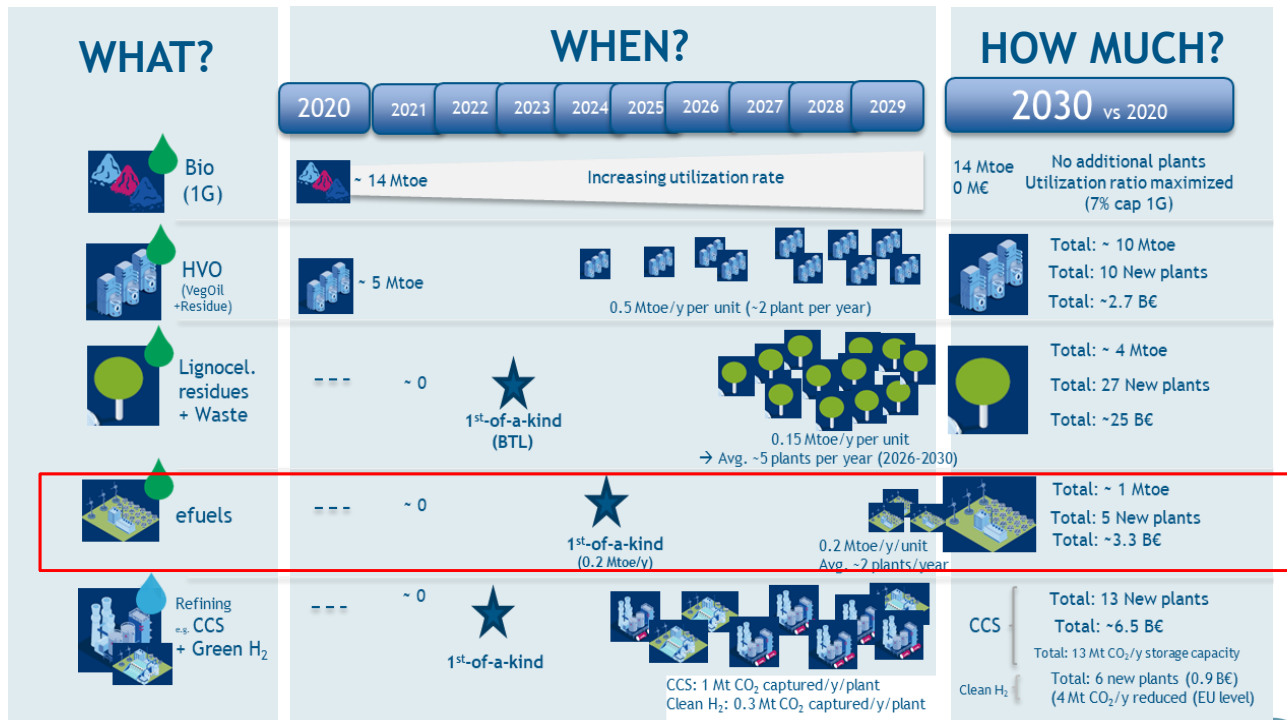
Accelerating the pace towards 1st-of-a-kind in parallel to supply chain + market creation



## Report

Report no. 7/21

Transition towards Low Carbon Fuels by 2050: Scenario analysis for the European refining sector



# 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)

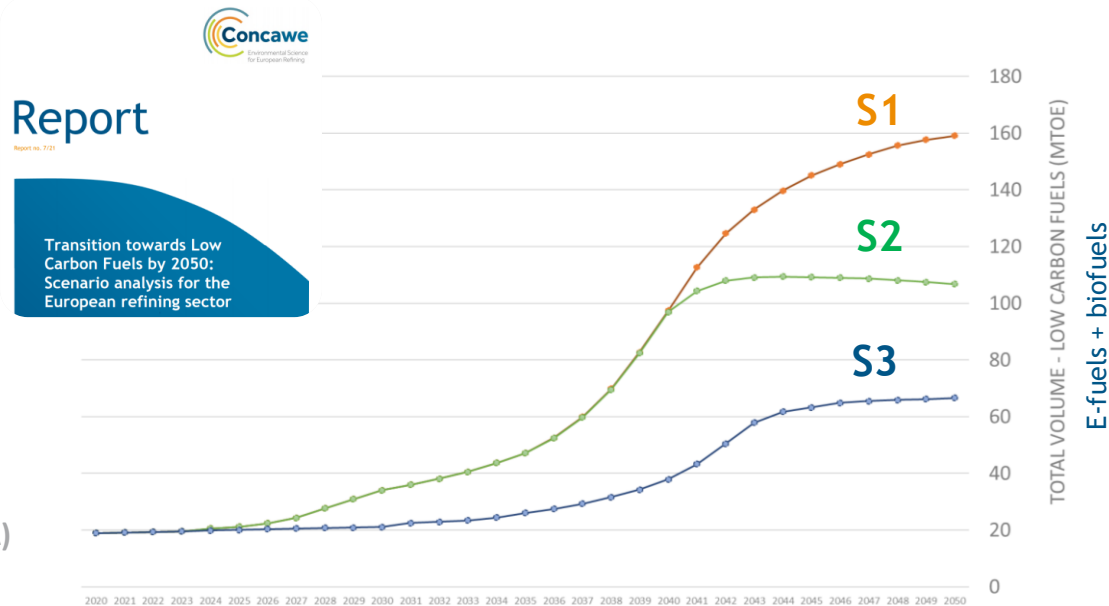
New sales mix for Road based on the EU Commission *A Clean Planet for all* (ACP4A) 2050 baseline

### 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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