Organiza: Universidad de Murcia · Campus Mare Nostrum

V ENCUENTRO
Ingeniería de la Energía

Patrocinadores:

ACTAS DEL CONGRESO

V ENCUENTRO DE INGENIERÍA DE LA ENERGÍA DEL CAMPUS MARE NOSTRUM

Editores:

Mariano Alarcón García (Editor)

Manuel Seco Nicolás (Co-editor)

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Quinta edición del Encuentro orientado a servir de espacio de reunión para tratar las distintas facetas de las aplicaciones de la Energía en los ámbitos académico y profesional, así como de instituciones y empresas en el que compartir trabajos, se muestren avances creando un espacio virtual de debate y reflexión en el que plantear soluciones a los importantes retos que la Sociedad tiene en el ámbito de la Energía, englobado en el ODS-7, *Energía asequible y no contaminante*, desde una vocación tecnológica pero a la vez con sensibilidad social.

Universidad de Murcia

Campus Mare Nostrum

Del 23 al 26 de noviembre de 2020

PONENCIA INVITADA

e-Fuels: Combustibles líquidos con cero emisiones netas para la movilidad

Alba Soler Estrella

Concawe – Environmental Science for European Refining

PRESENTACIÓN

Trabaja en Concawe como Asociada en Investigación Avanzada de Vías de Bajas emisiones de Carbono, con base en Bruselas, liderando varios estudios claves en la exploración del papel de los piensos bajos en carbono, tecnologías y fueles sostenibles y su contribución hacia la transición del Reto Verde.

Posee sólidos conocimientos y experiencia en refinerías, combustibles sostenibles y materias primas y tecnologías bajas en carbono. Comprometida con el marco regulador de la UE.

Anteriormente, trabajó en Repsol durante 10 años para la industria del refino. Primero como ingeniera de procesos y después como ingeniera técnica senior de desarrollo y planificación de negocios, con sede en Madrid.

Formación: Licenciatura en Ingeniería Química y Máster en Refino, Petroquímica y Gas. Certificado en Programa de Líderes Emergentes. Programa de negociación - London School of Economics and Political Science (LSE).

Presentación accesible en

https://tv.um.es/video?id=143782&serie=25241&cod=a1

e-Fuels: Combustibles líquidos con cero emisiones netas para la movilidad

Concawe, 25th Nov 2020

Alba Soler, Science Associate, Concawe

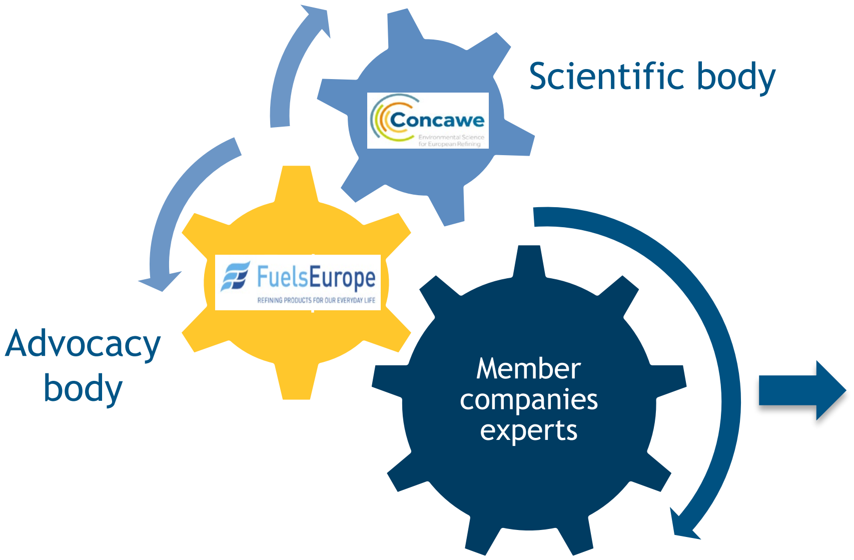
Agenda

01 Concawe - Who we are

Who we are

Scientific body of the European Petroleum Refiners Association

The Association represents 40 Member Companies ≈ 100% of EU Refining



02 E-fuels: Setting the scene

Reference box for additional comments

Concawe

Setting the scene

A Clean Planet for all: EU long-term strategic vision

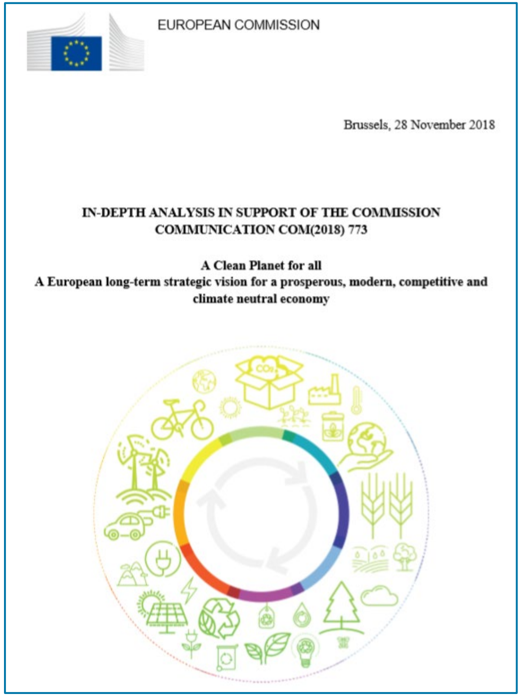
The **EU Commission** has **recently published** (28th Nov 2018) its long-term strategic vision for a prosperous, modern, competitive and climate neutral economy in Europe.

Recognising that **climate change** represents an **urgent threat to societies and the planet**, the **2015** Paris Agreement sets the goal of keeping global warming well below 2°C above pre-industrial levels, and pursuing efforts to limit it to 1.5°C (global warming already reached 1°C).

The EU Commission strategy:

- ✓ confirms Europe's commitment to lead in global climate action
- ✓ provides an assessment, in accordance with the Paris Agreement, to reduce EU **greenhouse gas emissions**, starting at -80% going up to -100% by 2050 compared to 1990.

Link: https://ec.europa.eu/clima/sites/clima/files/docs/pages/com_2018_733_analysis_in_support_en_0.pdf


EUROPEAN COMMISSION

Brussels, 28 November 2018

IN-DEPTH ANALYSIS IN SUPPORT OF THE COMMISSION COMMUNICATION COM(2018) 773

A Clean Planet for all
A European long-term strategic vision for a prosperous, modern, competitive and climate neutral economy

Setting the scene

Eight scenarios to achieve GHG emissions reductions between 80% and 100% by 2050 (compared to 1990)

Long Term Strategy Options

	Electrification (ELEC)	Hydrogen (H2)	Power-to-X (P2X)	Energy Efficiency (EE)	Circular Economy (CIRC)	Combination (COMBO)	1.5°C Technical (1.5TECH)	1.5°C Sustainable Lifestyles (1.5LIFE)
Main Drivers	Electrification in all sectors	Hydrogen in industry, transport and buildings	E-fuels in industry, transport and buildings	Pursuing deep energy efficiency in all sectors	Increased resource and material efficiency	Cost-efficient combination of options from 2°C scenarios	Based on COMBO with more BECCS, CCS	Based on COMBO and CIRC with lifestyle changes
GHG target in 2050	-80% GHG (excluding sinks) ["well below 2°C" ambition]					-90% GHG (incl. sinks)	-100% GHG (incl. sinks) ["1.5°C" ambition]	
Major Common Assumptions	• Higher energy efficiency post 2030 • Deployment of sustainable, advanced biofuels • Moderate circular economy measures • Digitilisation • Market coordination for infrastructure deployment • BECCS present only post-2050 in 2°C scenarios • Significant learning by doing for low carbon technologies • Significant improvements in the efficiency of the transport system.							
Power sector	Power is nearly decarbonised by 2050. Strong penetration of RES facilitated by system optimization (demand-side response, storage, interconnections, role of prosumers). Nuclear still plays a role in the power sector and CCS deployment faces limitations.							
Industry	Electrification of processes	Use of H2 in targeted applications	Use of e-gas in targeted applications	Reducing energy demand via Energy Efficiency	Higher recycling rates, material substitution, circular measures	Combination of most Cost-efficient options from "well below 2°C" scenarios with targeted application (excluding CIRC)	COMBO but stronger	CIRC+COMBO but stronger
Buildings	Increased deployment of heat pumps	Deployment of H2 for heating	Deployment of e-gas for heating	Increased renovation rates and depth	Sustainable buildings			CIRC+COMBO but stronger
Transport sector	Faster electrification for all transport modes	H2 deployment for HDVs and some for LDVs	E-fuels deployment for all modes	Increased modal shift	Mobility as a service			• CIRC+COMBO but stronger • Alternatives to air travel
Other Drivers		H2 in gas distribution grid	E-gas in gas distribution grid				Limited enhancement natural sink	• Dietary changes • Enhancement natural sink

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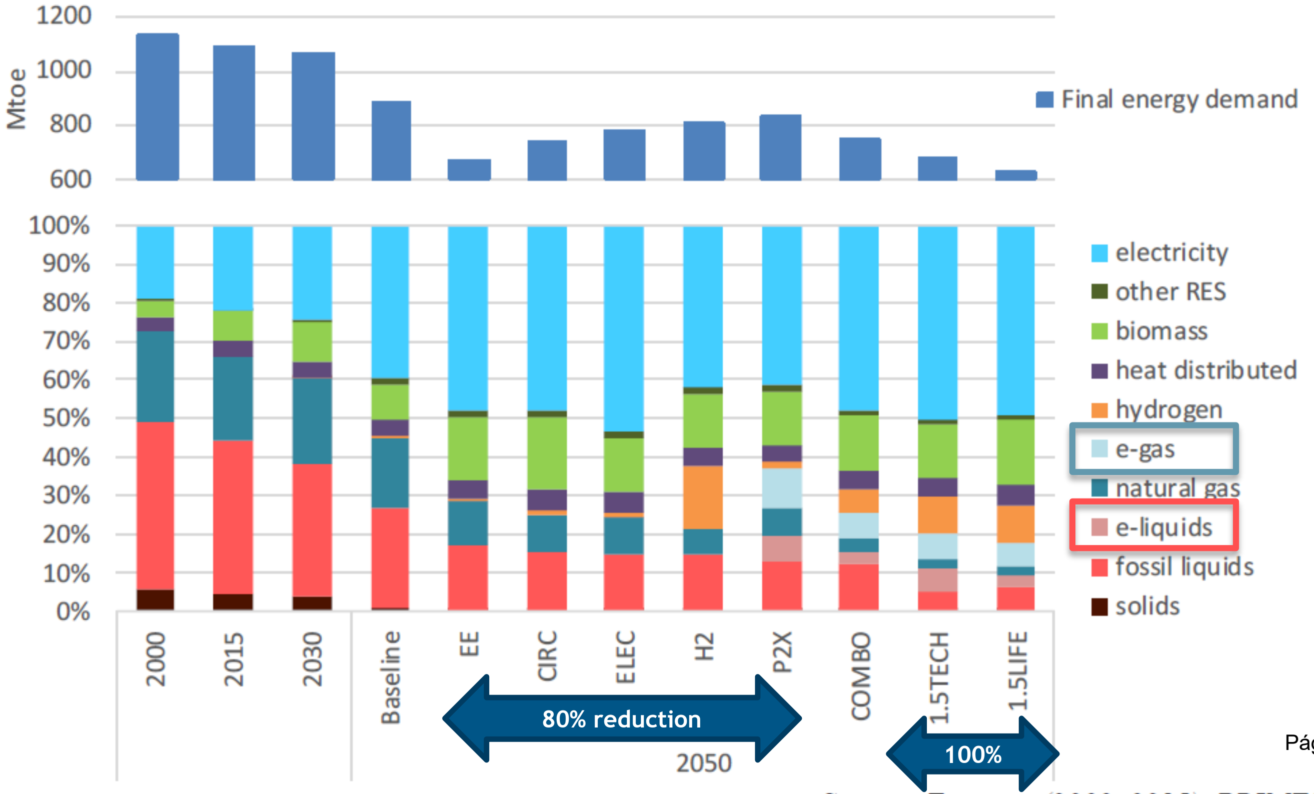
Setting the scene

Share of energy carriers in final energy consumption



Source: Eurostat (2000, 2015), PRIMES.

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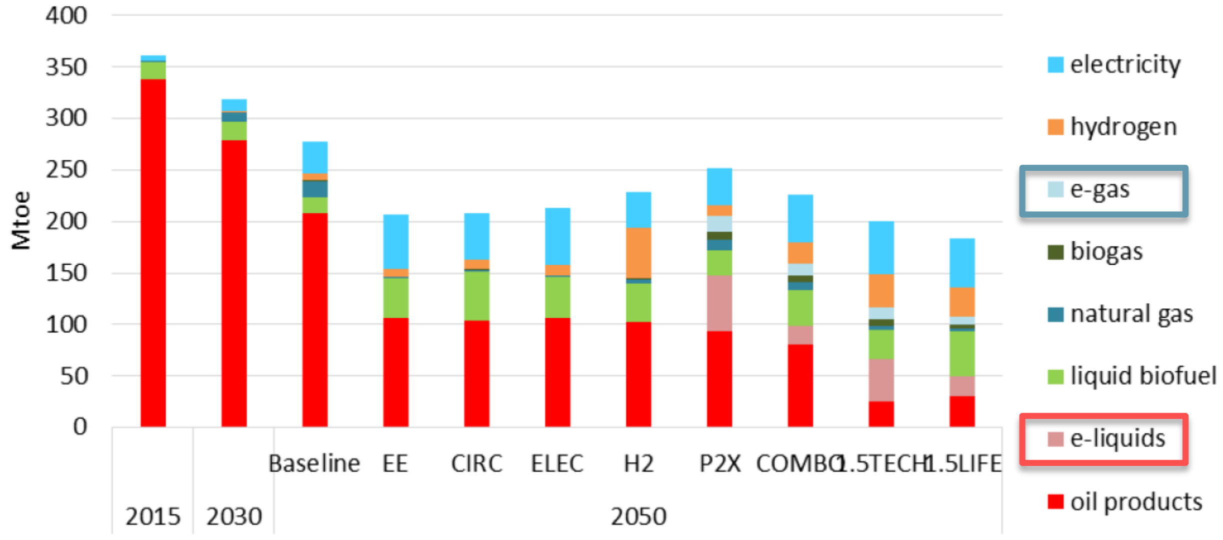
Setting the scene

Fuels Consumed in the transport sector

E-fuels could represent up **to 28%** of the energy demand in transport **in 2050** **(71 Mtoe/y).**



Source: PRIMES.

"[…] For those transport modes where the deployment of zero emission vehicles is unfeasible due to the energy density requirements or technology costs, advanced biofuels and e-fuels can be deployed for use in conventional vehicle engines"

Low Carbon Pathways

Concawe's programme contributing to the EU decarbonisation goals

Identifying opportunities & challenges for different low-carbon technologies **(such as E-fuels)** & feedstocks to achieve a significant reduction of the CO_2 emissions associated with the manufacturing & use of refined products in EU by 2030/2050.

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https://www.concawe.eu/low-carbon-pathways/

Report: Role of e-fuels in the European transport system – Literature review

https://www.concawe.eu/publication/concawe-report-14-19-role-of-e-fuels-in-the-european-transport-system-literature-review/

Concawe

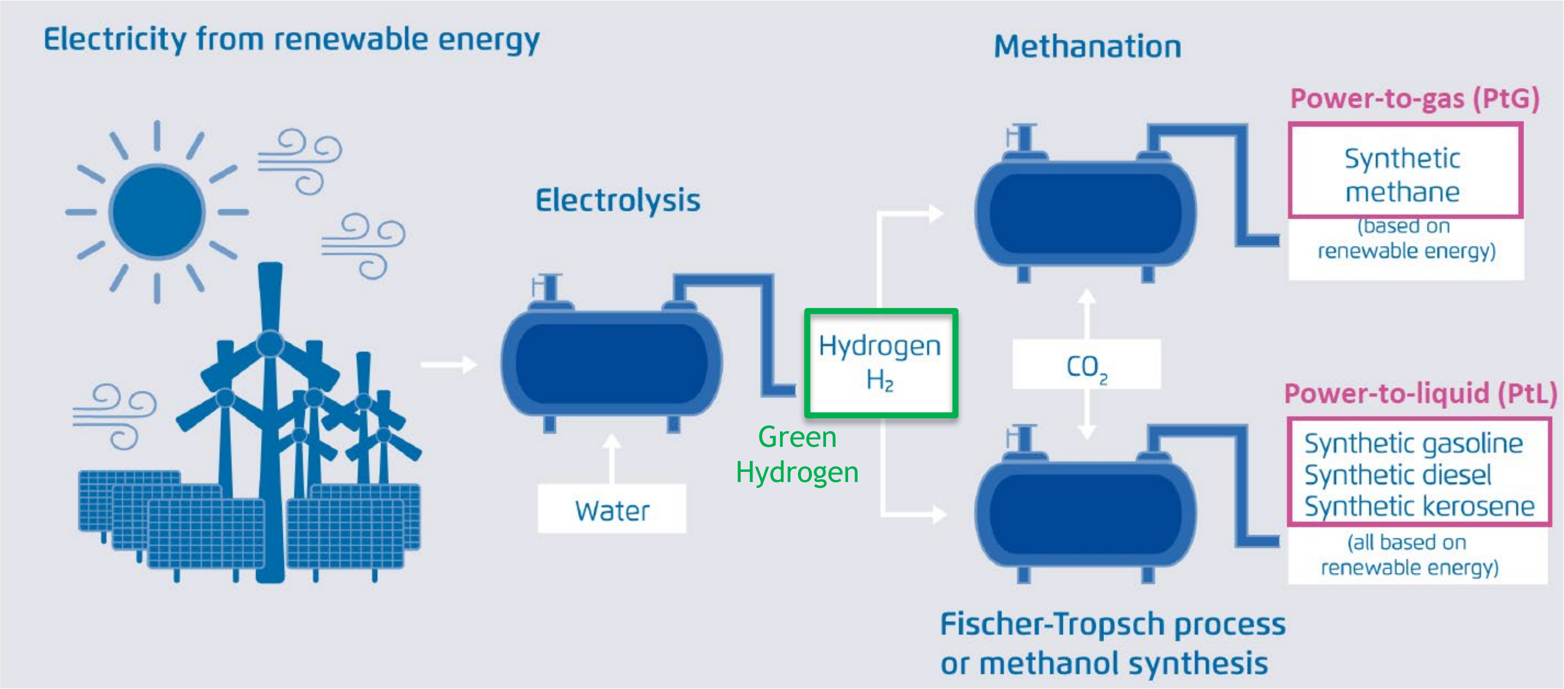
03

E-fuels technology

Reference box for additional comments

Technology

E-fuels or Power-to-X



Agora Verkehrswende (2018), adapted

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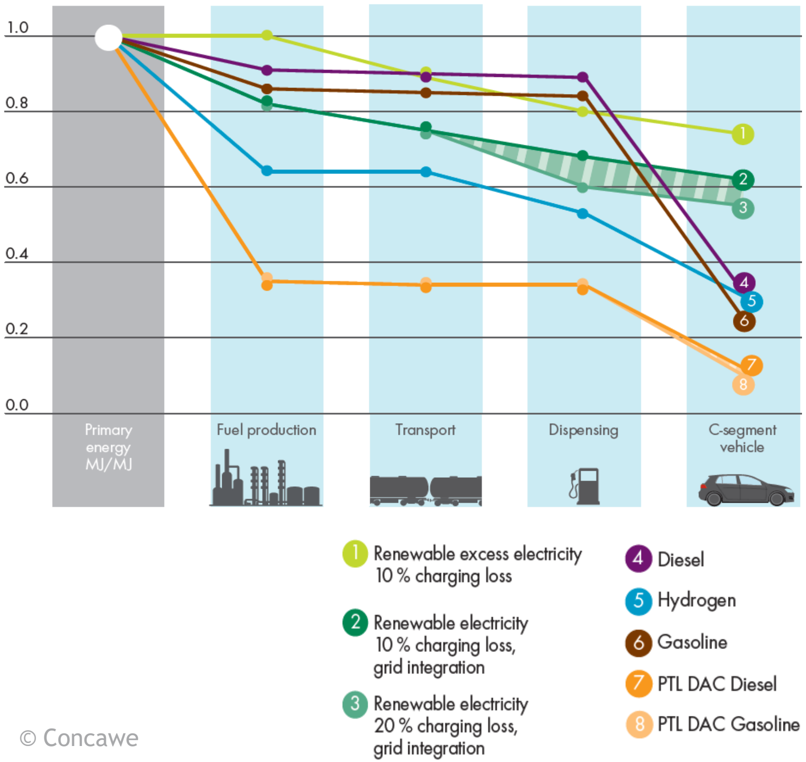
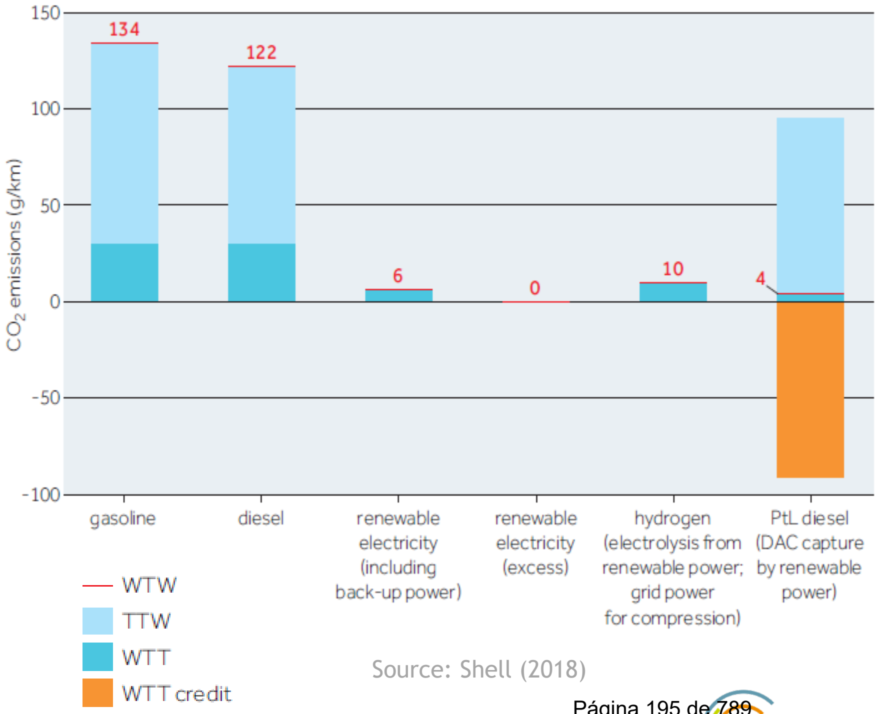
Technology

Fuel-powertrain efficiency and GHG abatement potential





Source: Shell (2018)

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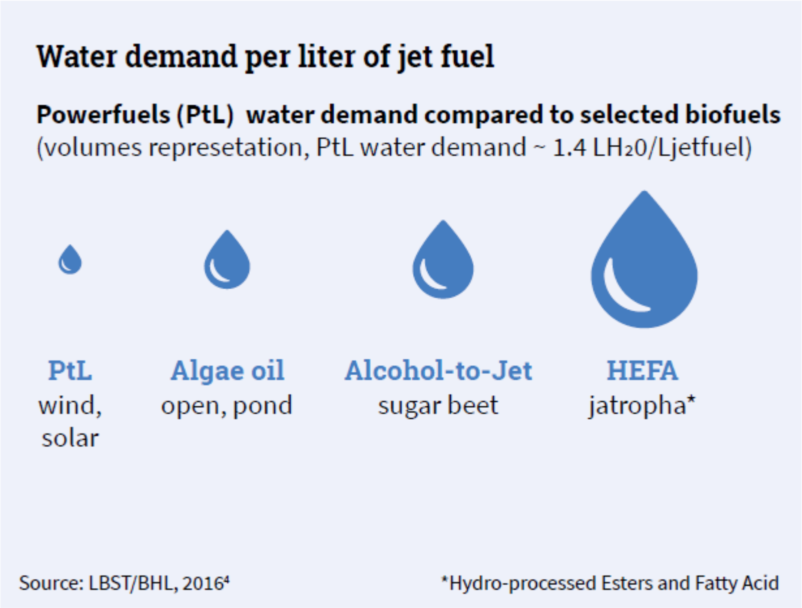
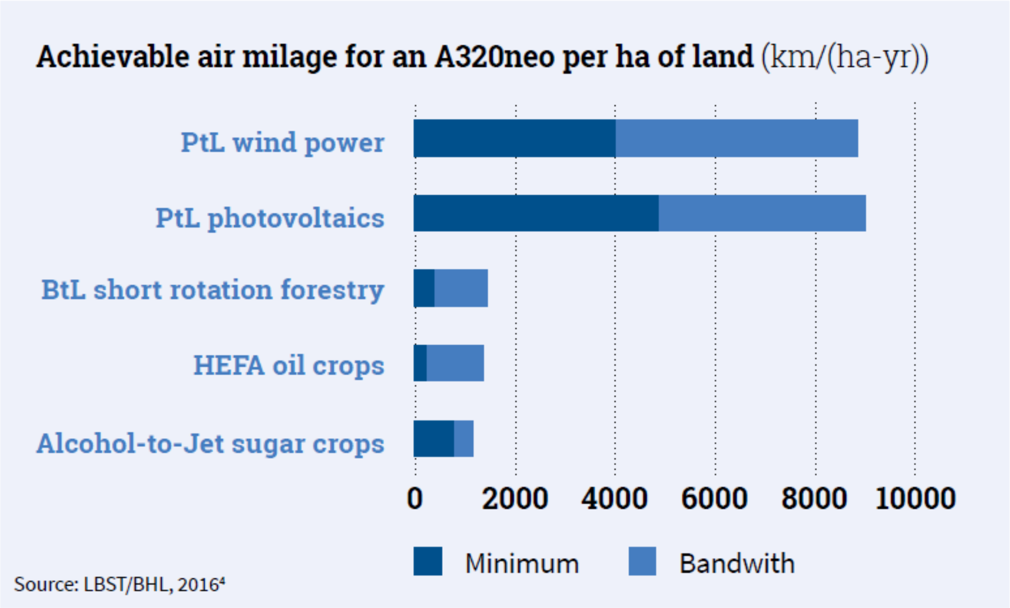
Technology

Other impacts





Source: Global Alliance Powerfuels / dena (2019)

https://www.powerfuels.org/fileadmin/gap/Publikationen/Factsheets/190612_dena_FS_Aviation_eng_web.pdf

04 Current TRL and potential future developments

Reference box for additional comments

Current technology readiness level

Currently, technology at a demo scale (TRL 6-9)

Source: Sunfire (2018)

CO_2 capture:
2,460 kg CO_2/day
(0,9 kt CO_2/a)

Global Leader in CO_2 capture from air (TRL 6-7)
Climeworks, Switzerland / Germany

Global Leader in e-Methanol (TRL 8-9)
Carbon Recycling International, Iceland

E-methanol production:
5 Million litres/a
(4 kt/a)

150 kW electricity -
40 Nm3/h hydrogen
(0,02 kt/a H_2)

Global Leader in green hydrogen generation (TRL 7-8)
Hydrogenics, Belgium / McPhy, France / ITM, UK

Global Leader in e-Crude via Fischer-Tropsch (TRL 6-7)
Sunfire and Ineratec, Germany

E-fuels production:
0.057 Million litres/a
(0,045 kt/a)

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Announcements for future plants

Integration with other industrial players

- ✓ **Nordic Blue Crude/Norsk e-Fuel** [(1)] have announced a project in Heroya (Norway) to scale-up the e-fuels technology to 10 Million litres/a (8 kt/a), starting to operate in 2021, with CO_2 from Yara.
- ✓ Future plans: to scale-it up to 200 Million litres/a by 2025 (160 kt/a), and to install 10 x 100 Million litres/a plants all across Norway by 2030, and 60 x 100 Million litres by 2050 (1/8 of current jet-fuel consumption)

Nordic Blue Crude

"E-Fuel 1" plant at Herøya

Nordic Blue Crude "E-Fuel 1" Plant at Herøya, Norway, planned comm. 2020 — For illustration purposes, not correct techn. Configuration, not scaled correctly

(1) Independent projects in the same location

Demand and production costs

Customers

MARQUARD & BAHLS · SkyNRG · den hartog b.v. Mobil authorized distributor · Audi · H2R · uniper

~350m liter of indicated annual demand from these customers alone

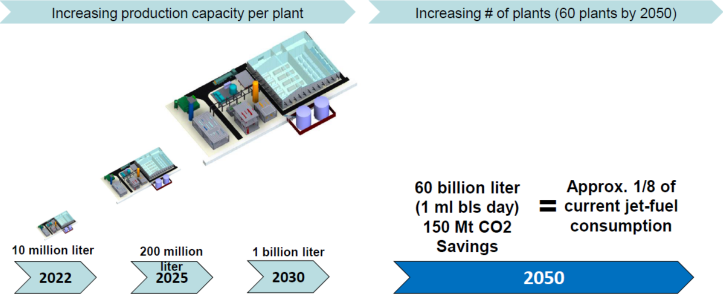
Fuel Products

Wax products

- **~4 EUR/liter** market price for small volumes of E-products in the market today
- **2.0-2.5 EUR/liter plus upside** sharing already offered by one of our partners
- **~3.5 EUR/liter achievable** until the industry scales up
- LOIs in place with partners

Source: Nordic Blue Crude (2020)

Commercial strategy



- Unique advantages through location secures affordable access to feedstock
- Potential sites for expansion identified for ambition to scale to 1 billion liter in 2030
- CO2 current point source emitters of until 2030 – thereafter also direct air capture (DAC) expected

Source: Nordic Blue Crude (2020)

Announcements for future plants

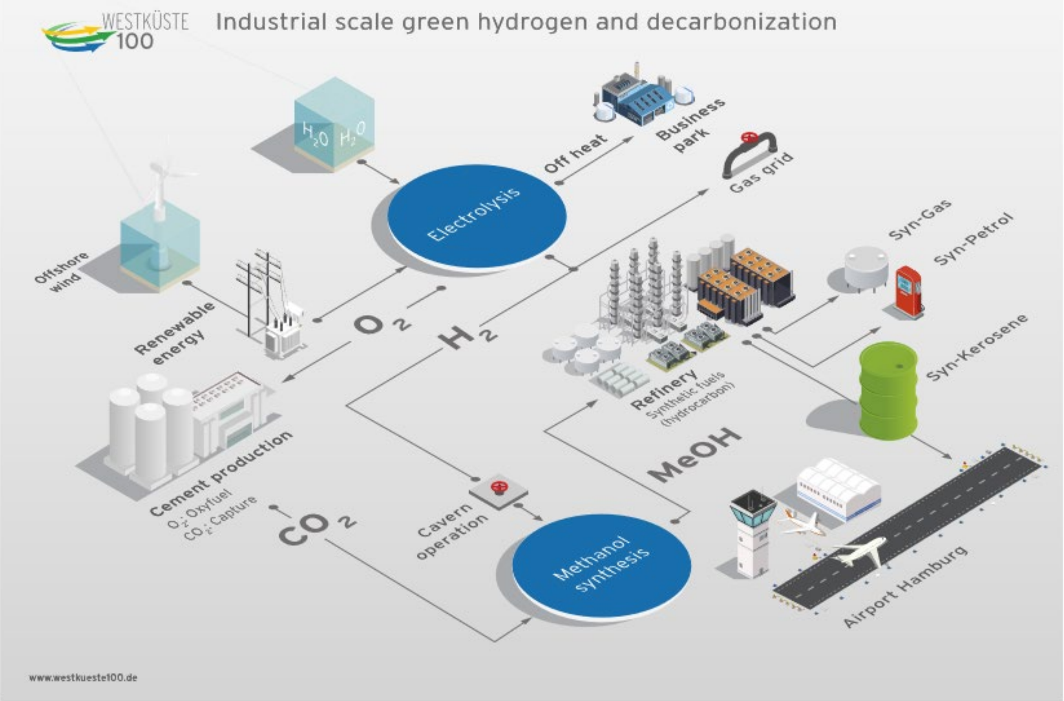
WESTKÜSTE 100

ReWest100 project

Integration in refineries

ReWest100 project

- ✓ **Lufthansa** has announced a project to source 5% of the kerosene it uses at Hamburg airport (Germany) with e-kerosene within 5 years (by 2025) (17.5 kt/a e-kerosene)
- ✓ The supplies will come from the nearby **Heide refinery** (Klesch Group) which already provides 350 kt/a of conventional fossil jet fuel



https://www.westkueste100.de/, Transport & Environment 2019

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Announcements for future plants

Integration in refineries

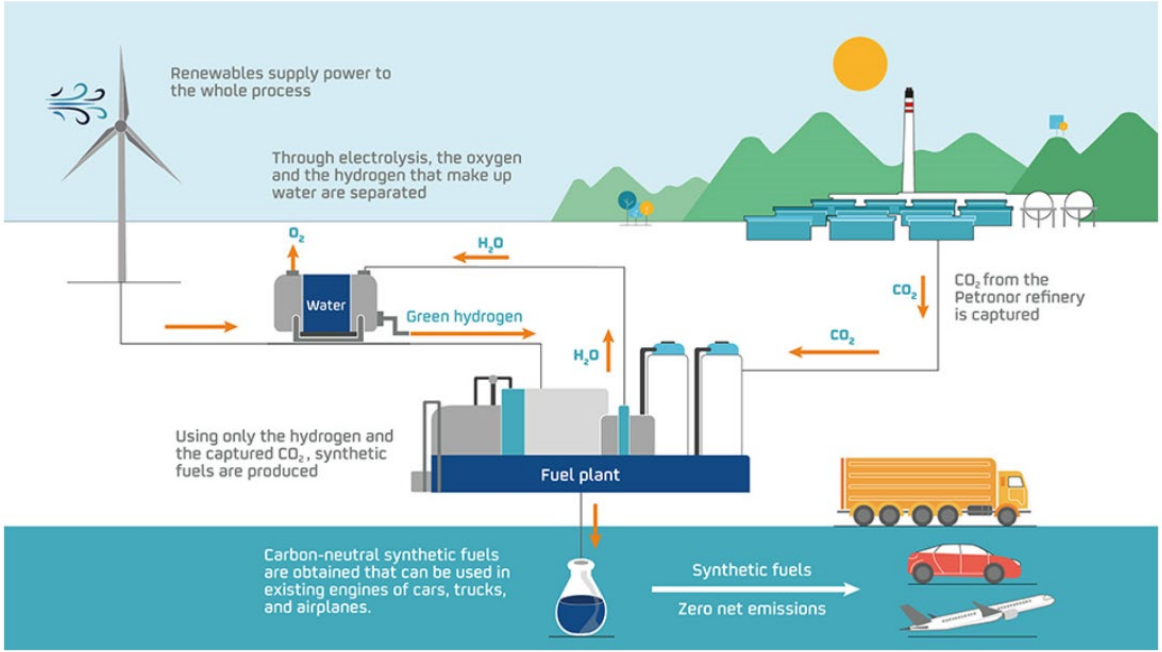
- ✓ **Sunfire and Total** announced they will team up on a pilot project to produce e-methanol at the **Leuna refinery in Germany.**
- ✓ Production is expected to start in 2021, generating 500 tonnes of e-methanol in the first three years (0.2 kt/a e-methanol).
- ✓ Sunfire will provide and operate a 1MW electrolyser that could later be integrated in the production of industrial-scale amounts of e-methanol and green hydrogen from CO_2 generated in the refinery processes.

https://www.reuters.com/article/total-sunfire-hydrogen/germanys-sunfire-partners-with-total-to-produce-hydrogen-fuels-at-refineries-idUSL5N26N4BY

Announcements for future plants

Integration in refineries

✓ **Repsol** has announced a project of e-Fuels in collaboration with Aramco in the Petronor refinery (Bilbao, Spain). Capacity: 3.6 Million litres/a <> 3 kt/a. Start-up: 2024. Investment: 60 M€



https://www.spglobal.com/platts/en/market-insights/latest-news/coal/061520-spains-repsol-to-develop-hydrogen-fed-synthetic-fuel-plant-at-bilbao

https://www.repsol.com/en/press-room/press-releases/2020/repsol-to-develop-two-major-emissions-reductions-projects-in-spain.cshtml

Announcements for future plants out of EU

Decentralized vs centralized concept

ProQR – Cooperational project in Brazil

- ✓ Amazon region in Brazil have enormous logistical challenges due to the long and complicated fuel transportation (done by boat or by plane), generating high costs and harm to the environment.
- ✓ It is a region in the world well placed to build decentralised e-fuels plants (1000 litres/day - 0.3 kt/a e-fuels) for these niche markets.
- ✓ Future plans: to scale it to not only to remote airports in the north of Brazil but also to the regional airports in the south of Brazil.

ProQR - Climate neutral alternative fuels

https://www.giz.de/en/worldwide/63299.html

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05 A look into OEM's strategies for e-fuels - examples

Reference box for additional comments

Cars manufacturers announcements

Examples of OEMs strategies for e-fuels

Audi

Press Releases

03/09/18 | Audi MediaCenter

Audi advances e-fuels technology: new “e-benzin” fuel being tested

Audi is convinced of the potential of the fuels e-gas, “e-benzin” (e-gasoline) and e-diesel and is continuing to pursue its e-fuels strategy. In the case of synthetic Audi “e-benzin” (e-gasoline), the Ingolstadt company has now...

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11/08/17 | Technology

Audi steps up research into synthetic fuels

Audi is systematically building on its e-fuels strategy. Together with the partners Ineratec GmbH and Energiedienst Holding AG, the company has plans for a new pilot facility for the production of e-diesel in Laufenburg, in Canton...

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03/07/17 | Technology

Power from gas: The new Audi A4 Avant g-tron

Sporty and versatile: The A4 Avant g-tron* is yet another Audi vehicle offering sustainable mobility for the future. Dealers will begin taking orders for the midsize model starting in early summer 2017. It can be selected with ...

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https://www.audi-mediacenter.com/en/audi-e-fuels-243

Porsche

Company

- Porsche's Taycan electric car is in high demand at the moment.
- Nevertheless, the luxury German brand has also announced that wants to do research on e-fuels. This would also mean that internal combustion engines would have a future.

https://www-businessinsider-de.cdn.ampproject.org/c/s/www.businessinsider.de/wirtschaft/mobility/porsche-wagt-sich-an-kaum-erprobten-antrieb-wasserstoff-e-auto/?amp

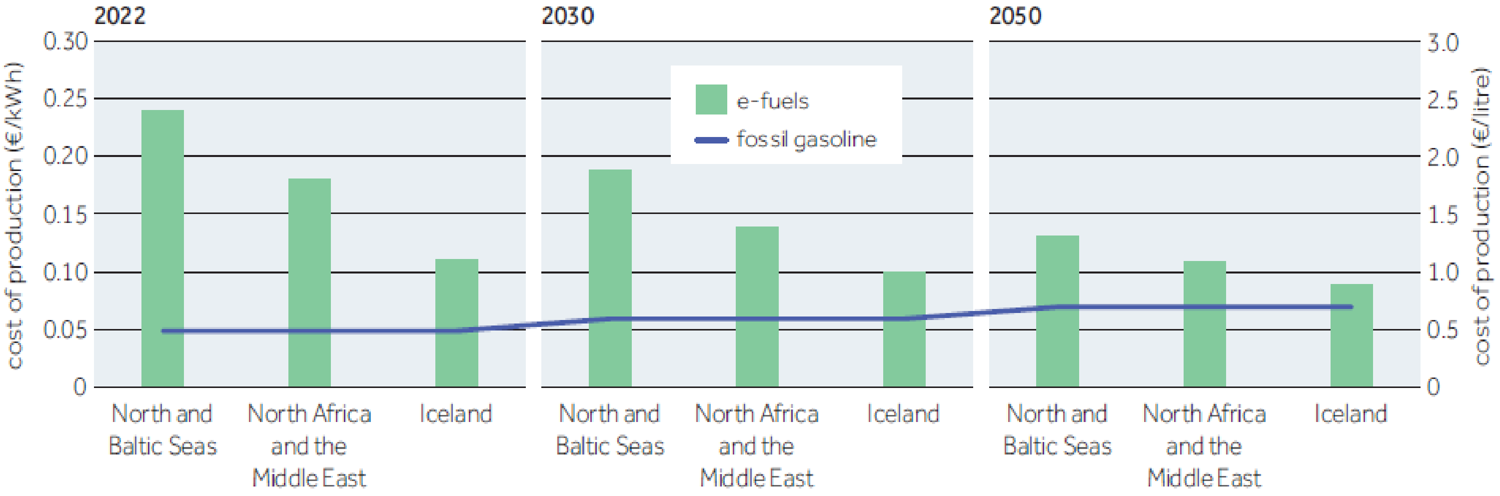
06 Production costs

Reference box for additional comments

Production costs

Literature review

- By 2020 and 2030, e-fuels potential costs are expected to be much higher than conventional fossil fuels
- By 2050, e-fuels and conventional fossil fuels potential costs tend to converge (still higher even in the best scenario)
- Importing e-fuels from low-electricity prices regions in the world could reduce costs up to 20-50%



- North and Baltic seas based on offshore wind power
- North Africa and Middle East on PV and PV/wind systems
- Iceland on Geothermal/hydropower

Source: Frontier Economics (2018)

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07 Opportunities and challenges

Reference box for additional comments

Opportunities

- Significant CO_2 reduction versus their equivalent fossil-based fuels
- E-fuels have a higher energy density compared to electricity, and can thus be used in aviation and shipping sectors where no electricity-based alternatives can be found.
- E-fuels are easy to store compared to electricity
- Existing infrastructure can remain in use for transporting and storing
- E-fuels could be deployed immediately across the whole transport fleet

Challenges

- The inherent thermodynamic conversion losses that occur when producing e-fuels
- The current low scale of the technology, still in a pilot/demo scale.
- The massive amount of capital-intense equipment
- High e-fuels costs production costs in comparison with conventional fossil fuels

Concawe
Environmental Science for European Refining

www.concawe.eu

Thank you for your attention

Alba Soler
alba.soler@concawe.eu

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ACTAS DEL CONGRESO V ENCUENTRO DE INGENIERÍA DE LA ENERGÍA DEL CAMPUS MARE NOSTRUM

PROCEEDINGS OF THE V MEETING OF ENERGY ENGINEERING OF CAMPUS MARE NOSTRUM

Editor

Mariano Alarcón García

Co-editor

Manuel Seco Nicolás

Murcia 2021