

# Refining: the potential of value chain emissions reductions



ERCST, “Role of Supply Chain Emissions in decarbonization and compliance”

Damien Valdenaire, Concawe

16<sup>th</sup> March 2021

# Concawe - Environmental Science for European Refining

## Concawe Membership

Concawe represents 40 Member Companies  
≈ 100% of EU Refining

Open to companies owning refining capacity in the EU



## Concawe mission

To conduct research to provide impartial scientific information, in order to:

- scientific understanding
- Assist the development of technically feasible and cost effective policies and legislation
- Allow informed decision making and cost effective legislative compliance by Association members.

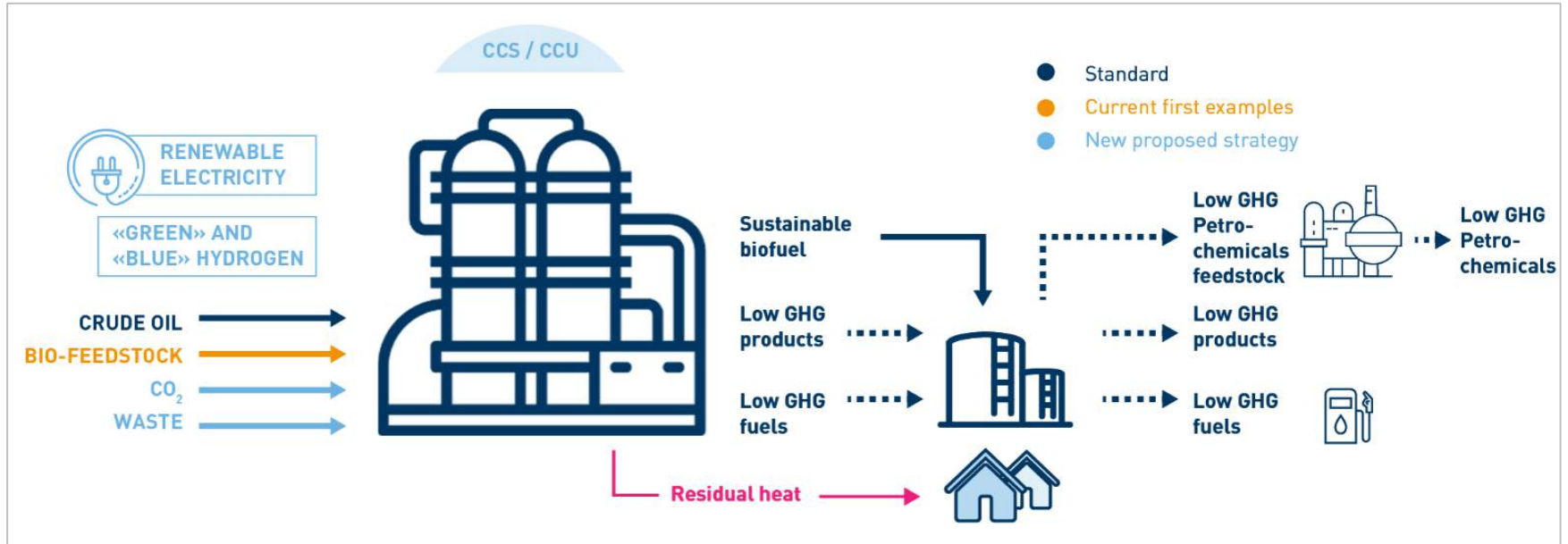


A vintage light blue gas pump stands in a weathered, industrial setting. The pump has a circular gauge with a red diagonal line through it, indicating it is out of service. At the bottom of the pump, the text "Rauchen verboten" (No smoking) is visible. The background is a textured, yellowish wall with some electrical boxes and pipes. The floor is concrete and shows signs of wear.

# A vision for Manufacturing: Refinery 2050

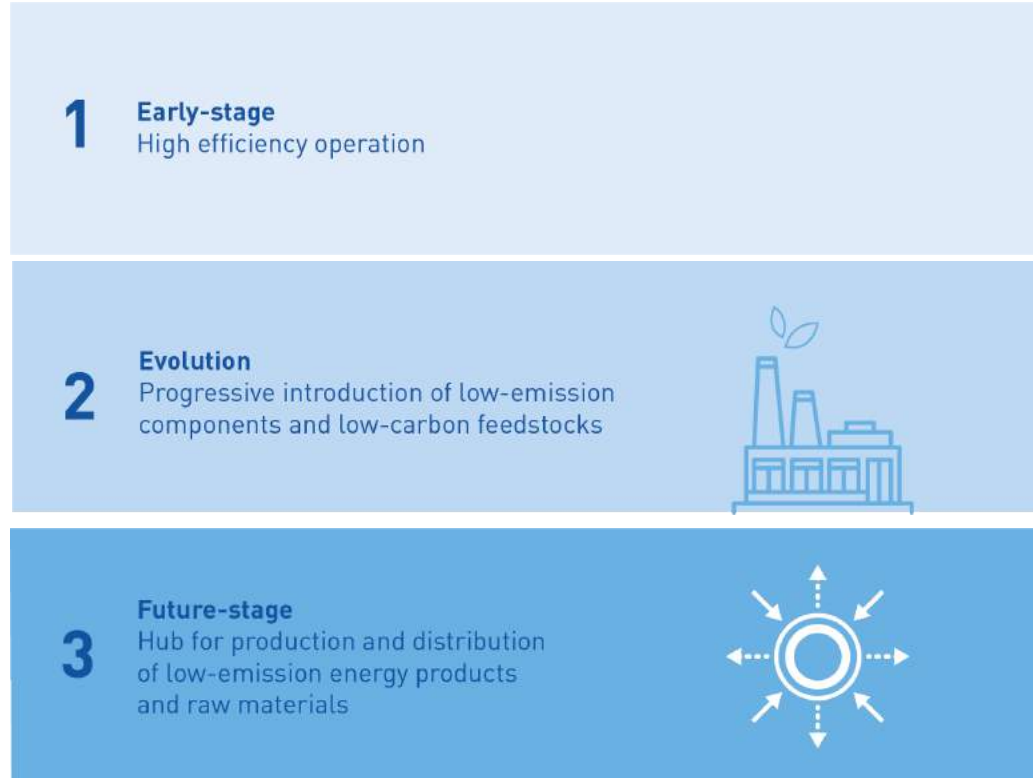
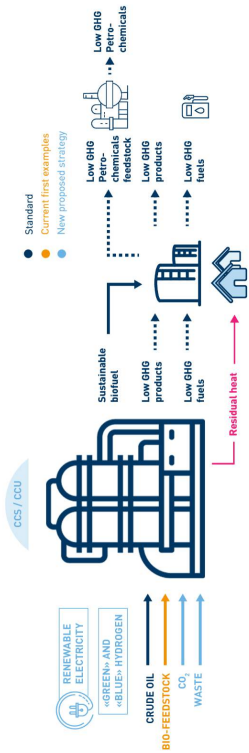
# Vision 2050: The refinery as an ENERGY HUB...

## ... within an INDUSTRIAL CLUSTER,



Reducing emissions within the site + the final use of our products

# Can the EU refining industry effectively contribute to a low CO2 economy?



## Report

**CO<sub>2</sub> reduction technologies. Opportunities within the EU refining system (2030/2050).**

(Qualitative & Quantitative assessment for the production of conventional fossil fuels (Scope 1 & 2))

Low Carbon Pathways

## Report

**Refinery 2050: Conceptual Assessment.**

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

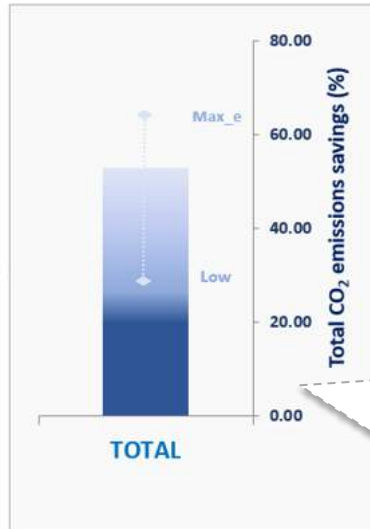
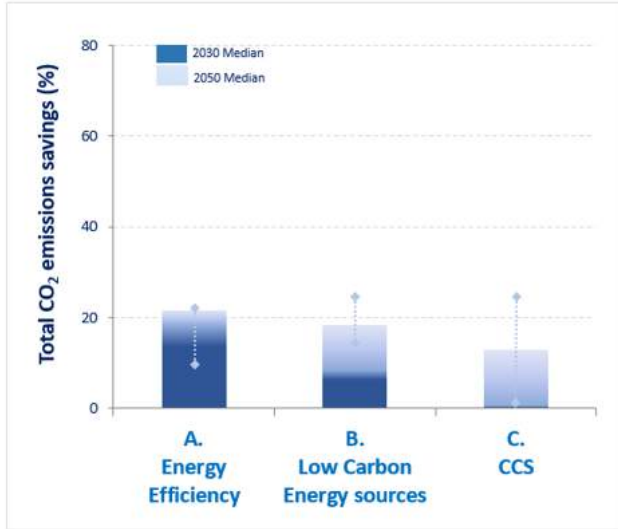
Low Carbon Pathways

# 1 Early-stage High efficiency operation

CO<sub>2</sub> reduction technologies.  
Opportunities within the EU refining system (2030/2050).

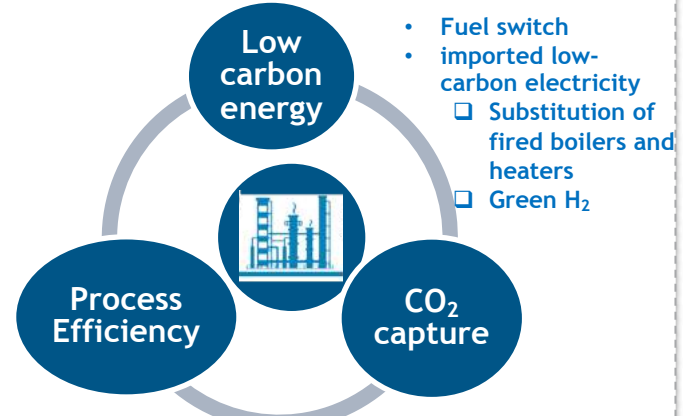
(Qualitative & Quantitative assessment for the production of conventional fuels: Refs (Scope 1 & 2))

Low  
Carbon  
Pathways



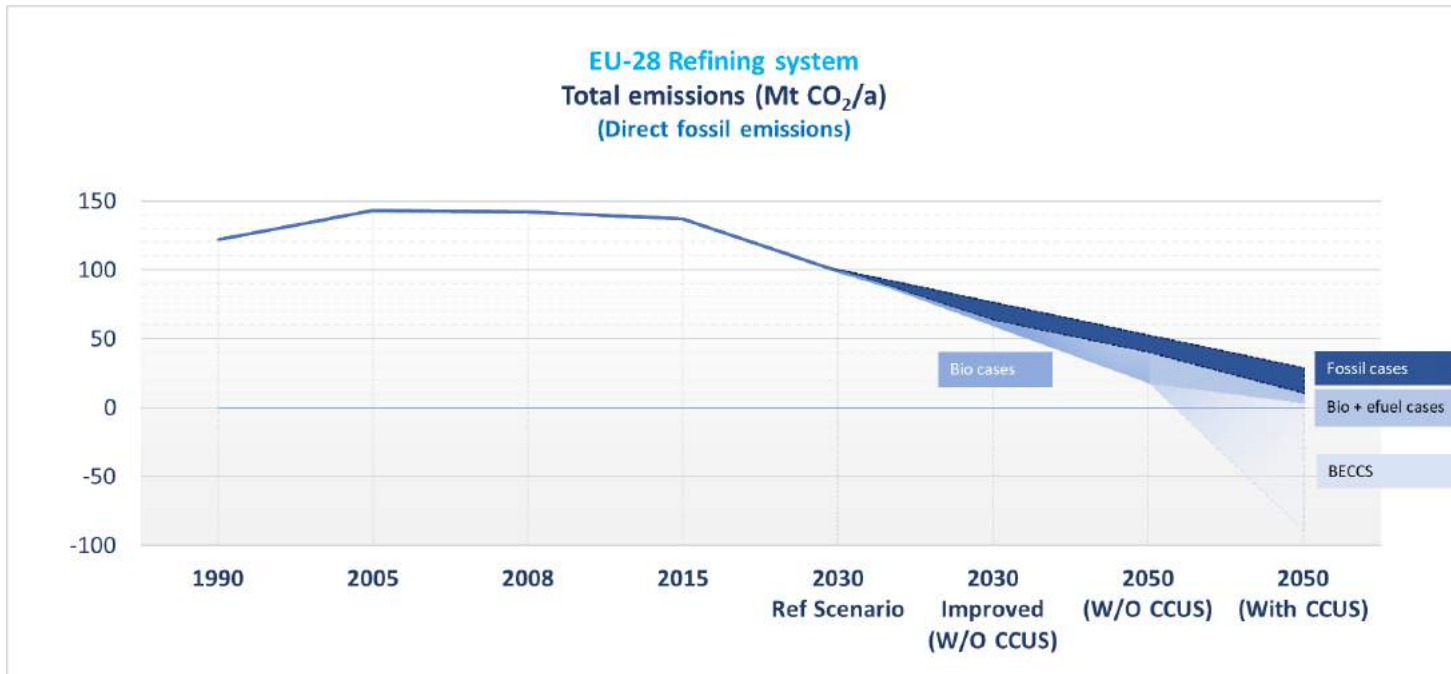
Note: Electrification may account for up to ~23% of the CO<sub>2</sub> reduction in the 2050 High electrification sensitivity case. This incurs significant additional capex outside the refinery not included in the scope of this assessment.

## CO<sub>2</sub> reduction technologies



# Refinery 2050

## EU-wide scale



- Potential CO<sub>2</sub> savings** range from **50 to 90% vs 1990** and 85% vs 2030 improved scenario  
 (-70% Optimized oil-based cases)  
 Pathways enabling **negative emissions** through Biomass + CCS!
- Total **electricity** consumption from **150 to 550 TWh/y** in 2050  
 Multiplied by **5-18 times** vs 2030 improved scenario
- Total **Hydrogen** consumption (from 7 to 15 Mtoe/y) multiplied by **2-5 times** vs 2030 improved scenario
- Estimated **CAPEX** could range between **1 - 10 G€** for the limited penetration cases, and between **6 - 15 G€** for the extreme cases.

# Concawe alternative scenario towards climate neutrality for Refining and transport





# What are Low-Carbon Liquid Fuels?

- Sustainable **liquid** fuels from **non-petroleum** origin, produced from new feedstock such as biomass, renewables, waste and captured CO<sub>2</sub>.



- With **no** or very limited **net CO<sub>2</sub> emissions** during their **production** and **use** compared to fossil-based fuels.
- These feedstock's **comply** with the existing **EU sustainability standards**.
- Low-Carbon Liquid Fuels are **complementary** to **electrification** and **hydrogen**. We will need all technologies to deliver climate neutrality.

# Not just one single solution

Collaboration is key: JEC Well-To-Wheels (WTW) v5



**WTT**  
fuel  
gCO<sub>2</sub> /  
MJ

**TTW**  
Powertrain  
efficiency  
MJ / km



**FLEET**



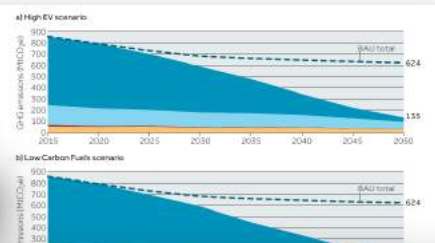
**Penetration  
of alternative  
powertrains**

> 250 Resource to fuel  
pathways

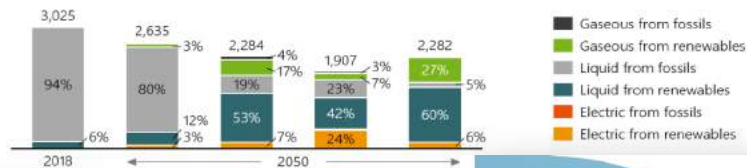
>60 powertrains  
combinations

> 1500 possible combinations!

# From individual fuels towards a EU strategy



Final energy carrier demand in PJ



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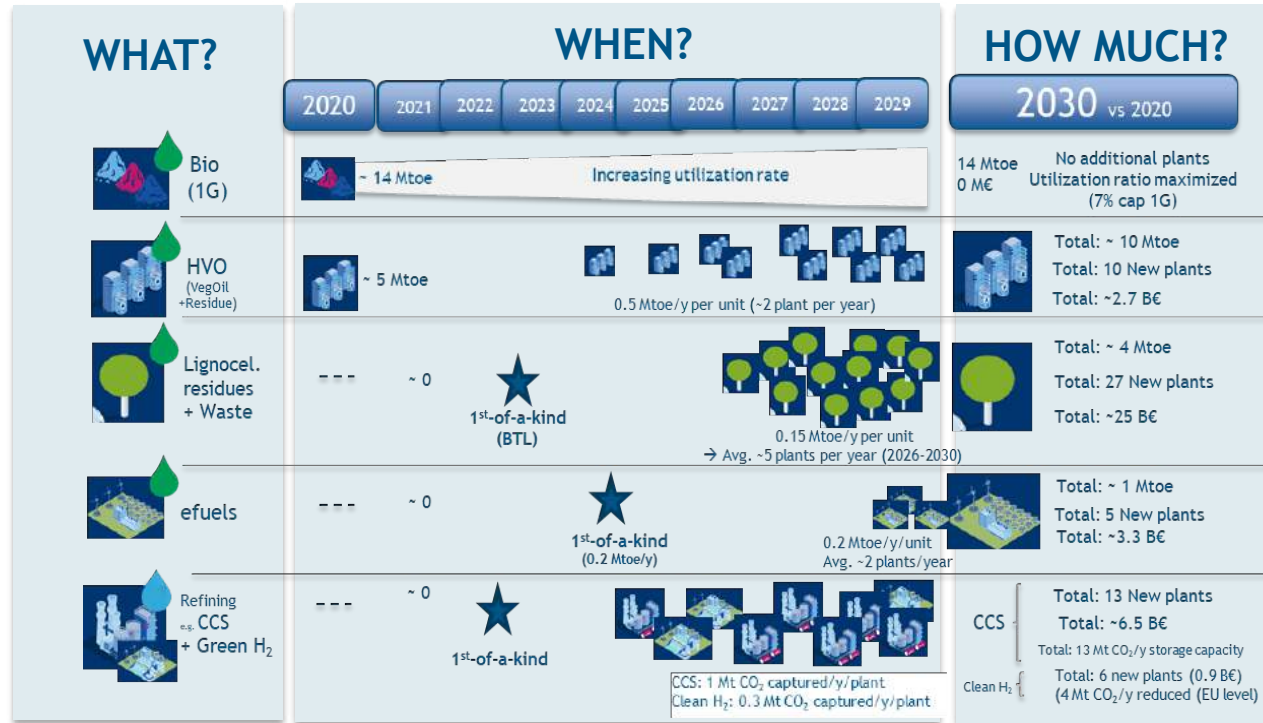


## The Clean Fuels for All Strategy



# The Clean Fuels for All Strategy

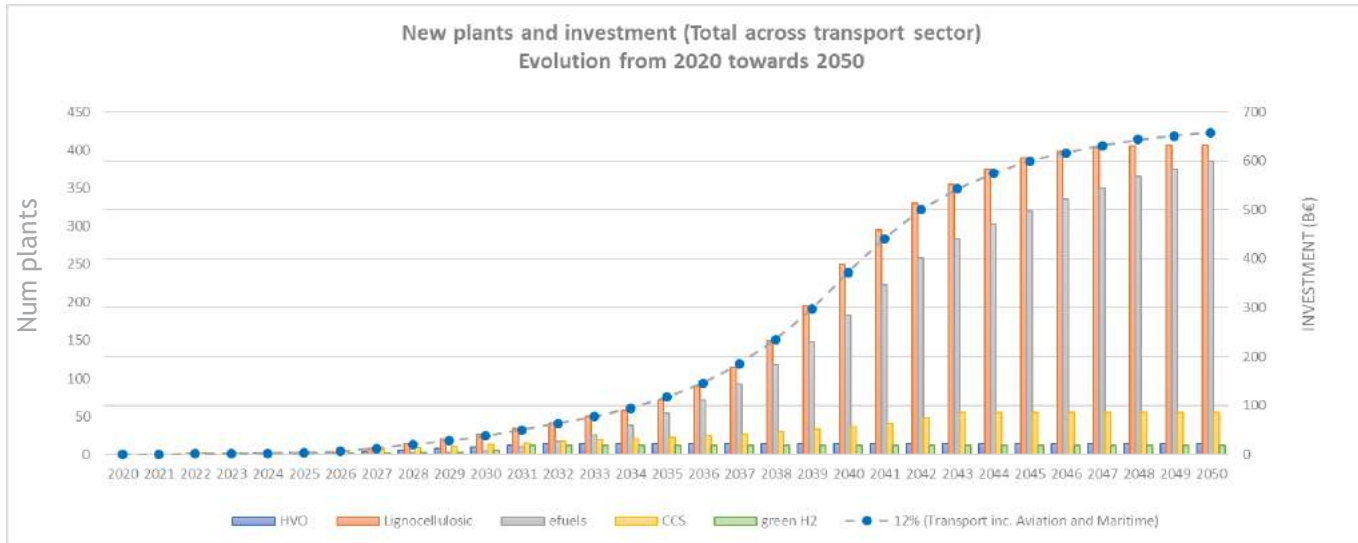
Demo and Scale-up is needed!



Accelerating  
the pace  
towards  
1<sup>st</sup>-of-a-kind  
in parallel to  
supply chain  
+ market creation!

# The Clean Fuels for All Strategy

## A challenging techno-economic trajectory in numbers



Cumulative (Transport)	2020-2030	2020-2035	2030-2040	2020-2050
Total volume LCF (Mtoe)*	~30	~40	~90	~150
Total investment, B€*	~30-40	~75-110	~240-350	~420-630
Total new plants (bio+efuels)	~40	~130	~420	~760

~ 150  
Mtoe/y

t/y Low Carbon Liquid fuels

~400-650  
B€

Investment needed

~ 100  
Mt CO<sub>2</sub>/y

GHG savings in transport by  
2035 <-> 50 M BEVs

# Takeaways

A scenic landscape at sunrise or sunset. A gravel path leads from the bottom left towards the center, where it meets a larger gravel path that curves to the right. The path is flanked by green grass and small plants. In the background, a dense line of trees is silhouetted against a bright, golden sky. The sun is low on the horizon, creating a strong lens flare and illuminating the scene with a warm, orange glow. The overall atmosphere is peaceful and serene.

# Refiners as long term fuel suppliers

- **Refineries contributing** to the Europe's objective of (net) climate neutrality in 2050 by **delivering low-carbon fuels**.
- The **scenario explored by Concawe** (Refining contribution to EU2050 Climate Ambition) shows **feasibility** to reach **climate neutrality in transport by 2050 with low carbon liquid fuels**.
  - *High investment with R&D efforts on technology scale up and rapid deployment, mobilization of resources across the whole value chain and high engineering/construction resources.*



# Back up's





Check-out on our web site <https://www.concawe.eu>



Low Carbon Pathways  
*A bridging programme in Concawe*

Concawe

The graphic features a central orange circle with a factory icon, surrounded by several smaller white circles containing various icons related to energy, environment, and industry. A hand is shown pointing at the central circle.



Fuels Quality & Emissions


For many years, European air quality objectives have focused on reducing vehicle exhaust emissions through integrated improvements in engine performance, after-treatment technology, and fuel quality.

The image shows a gas station at night with several pumps and a car parked. The station is illuminated by bright lights under a dark sky.



Refinery Technology

The image shows a large industrial refinery complex at night, with numerous tall distillation columns and storage tanks illuminated by lights against a dark sky.



Air Quality

The image shows a tall, cylindrical industrial tower or chimney structure against a clear blue sky.



Concawe  
Environmental Science  
for European Refining

Review

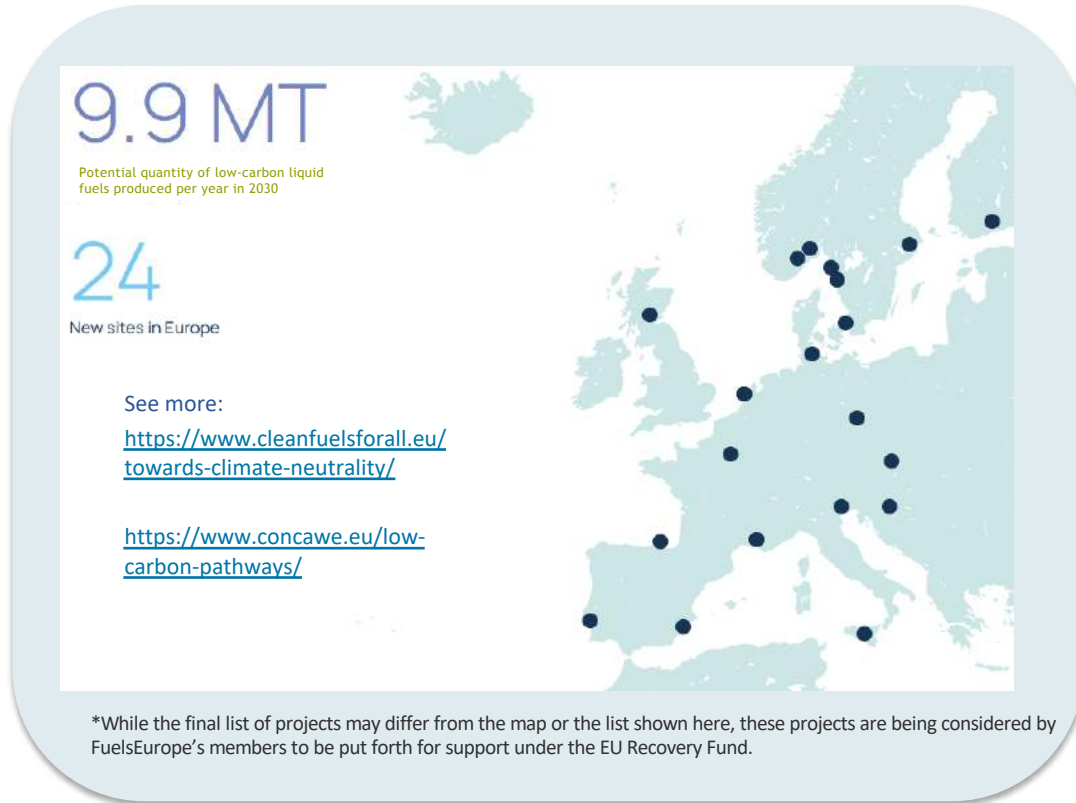
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June 2020

The cover features the Concawe logo at the top right, the title 'Review' in large blue letters, and the volume and issue information below it. The bottom half of the cover shows a photograph of green trees reflected in a body of water, with a blue curved graphic element above the image.

# EU refining industry contribution to Green Deal

The journey has already started...

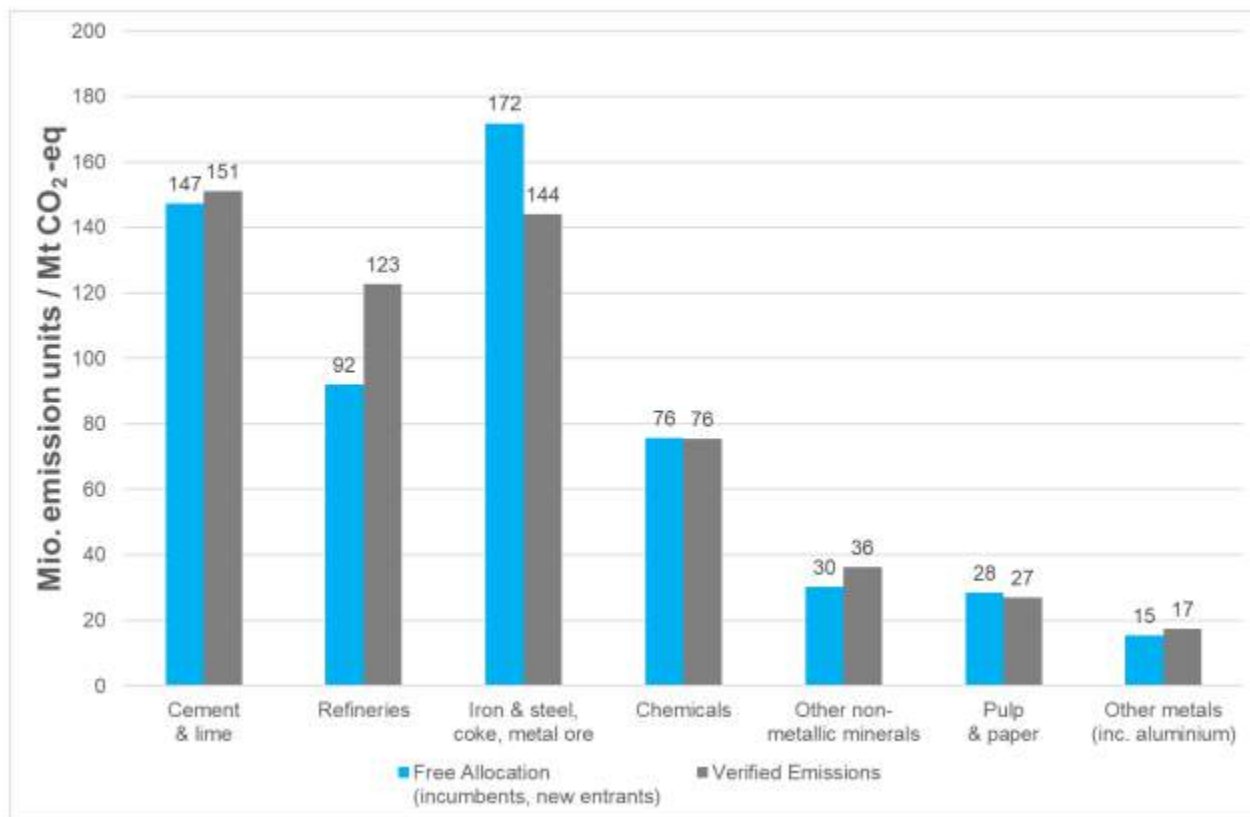
**20**  
**projects**  
for low-carbon  
liquids have  
already been  
started or are  
planned until  
2030



Some examples\*:

- **8 Advanced biofuel projects**, with capacities between 100.000 and 750.000 tonnes of output.
- **6 CCUS projects**, up to 6 mt. of capacity for CO2 sequestration.
- **10 Green Hydrogen Projects**, some of which lower the GHG intensity of manufacturing processes, others combine the green H2 with captured carbon to produce synthetic fuels with a capacity of up to 3.4 million tonnes of output per year.
- **3 Waste-to-fuel projects**, with a capacity of up to 100.000 tonnes per year in output (derived from urban waste).

**Figure 1.4 Balance of free allocations and emissions, industrial sectors, 2019**



# Extract and processing data from EUTL

Mainstream refineries in operation	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
free allowances (million T CO <sub>2</sub> eq)	129,8	130,8	134,7	134,6	138,2	101,3	98,3	94,2	91,8	90,2	88,5	85,3
verified emissions (million T CO <sub>2</sub> eq)	132,6	124,5	122,2	122,7	119,7	128,2	125,0	127,9	127,4	126,4	124,6	122,7
% coverage	97,9%	105,0 %	110,2 %	109,7 %	115,4 %	79,0%	78,6%	73,7%	72,0%	71,4%	71,1%	69,5%

## 2

### Evolution

Progressive introduction of low-emission components and low-carbon feedstocks

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## R&D

### Some of the key R&D(&I) challenges

#### Lipid

- Alternative feedstocks development (e.g. waste, algae).  
Biology still in early R&D

#### BTL

#### Biomass To Liquid

- Technology not commercially available yet
- How to ensure continuous operation when processing different feedstocks is still an issue
- Conversion efficiency / Increasing resource availability as key factors
- Establishment of large lignocellulosic / residue supply chain in line with new plants start-up needed!

#### Pyrolysis

- Technology needs to scale up
- Processing of pyrolysis in refineries requires further R&D

#### E-fuels

- Technology needs to scale up
- Efficiency improvement required to reduce electricity requirement and improve CO<sub>2</sub> capture ratio → cost reduction

