Refining: the potential of value chain emissions reductions

ERCST, "Role of Supply Chain Emissions in decarbonization and compliance"

Damien Valdenaire, Concawe

16th 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

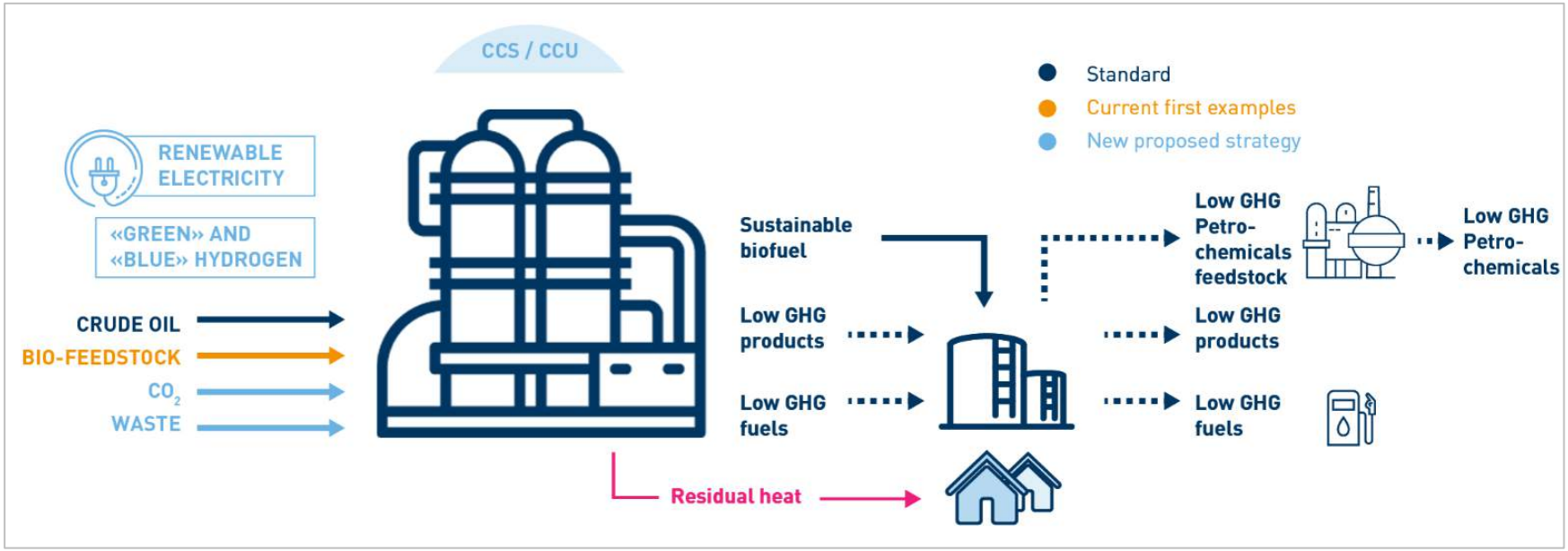
To conduct research to provide **impartial scientific information**, in order to:

- 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 vision for Manufacturing: Refinery 2050

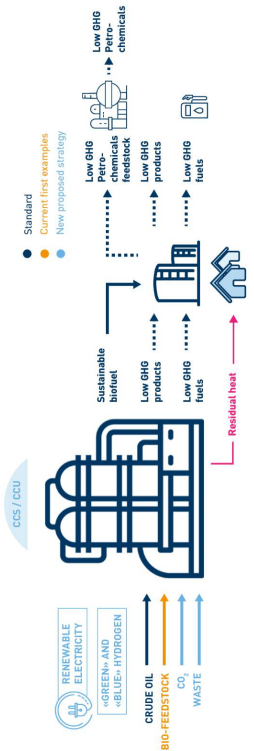
Vision 2050: The refinery as an ENERGY HUB…

… 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?

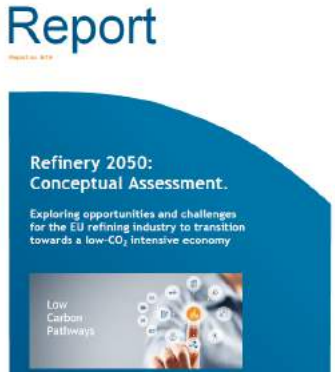


1 Early-stage
High efficiency operation

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

3 Future-stage
Hub for production and distribution of low-emission energy products and raw materials

Concawe

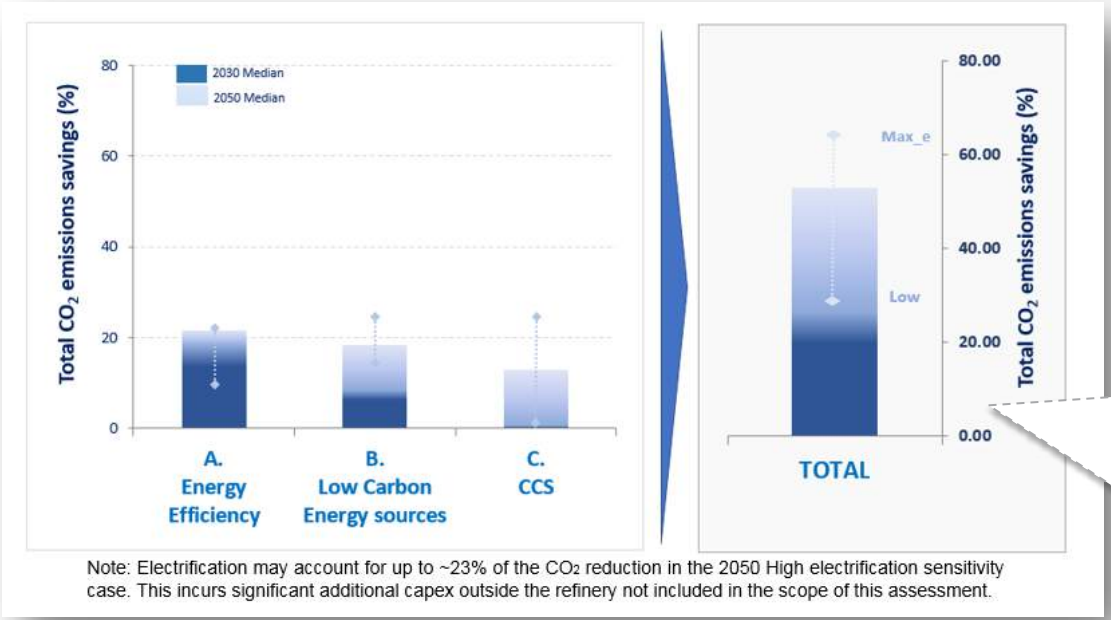


https://www.concawe.eu/wp-content/uploads/Rpt_19-9.pdf

https://www.concawe.eu/wp-content/uploads/Rpt_19-8.pdf

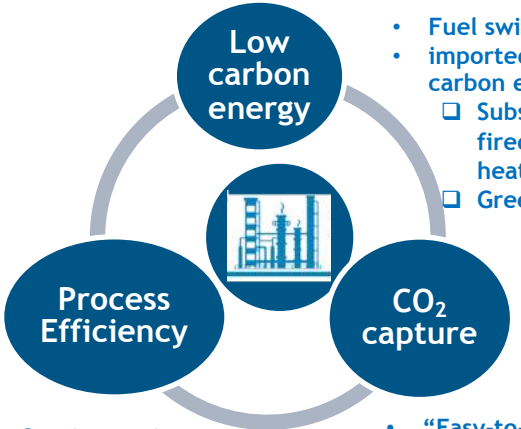
Concawe

1 Early-stage
High efficiency operation



Note: Electrification may account for up to ~23% of the CO_2 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_2 reduction technologies



- Fuel switch
- imported low-carbon electricity
  - ❑ Substitution of fired boilers and heaters
  - ❑ Green H_2

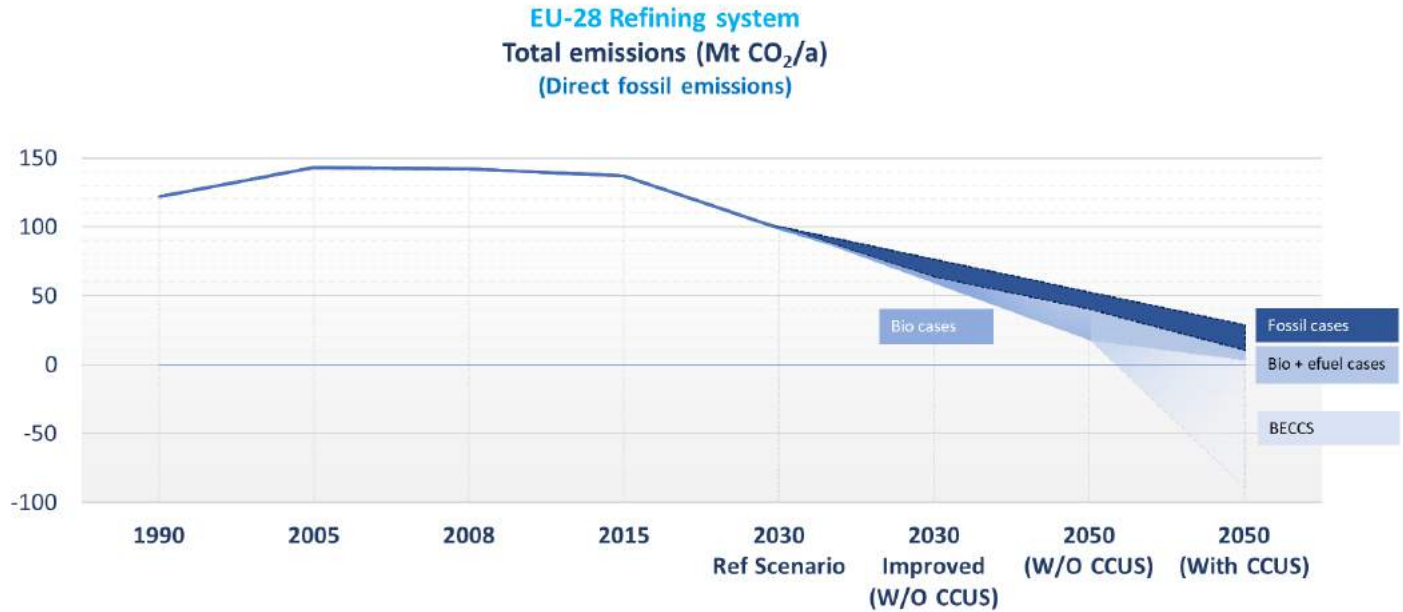
- Continuous improvement
- Energy Management
- Major capital projects

- "Easy-to-capture" (H_2 production)
- Other plants

Concawe

Refinery 2050

EU-wide scale



- Potential CO_2 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 CO2.

- With **no** or very limited **net CO2 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
gCO2 / 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

The Clean Fuels for All Strategy

Concawe

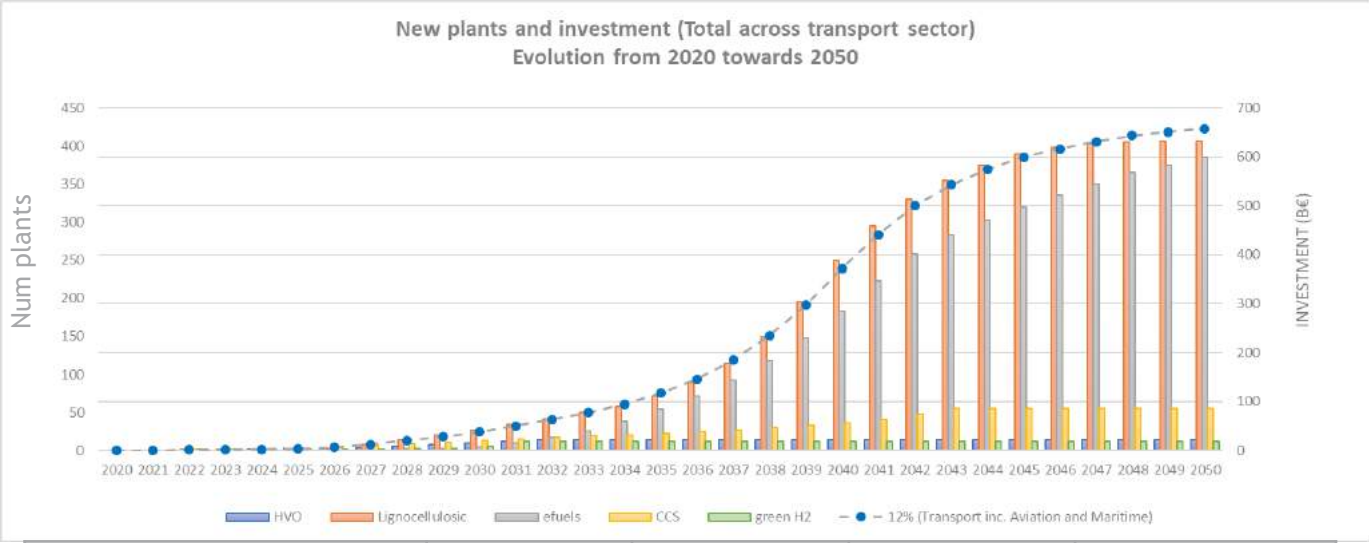
The Clean Fuels for All Strategy

Demo and Scale-up is needed!

Accelerating
the pace
towards
1st-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 CO2/y

GHG savings in transport by 2035 <> 50 M BEVs

Takeaways

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.*

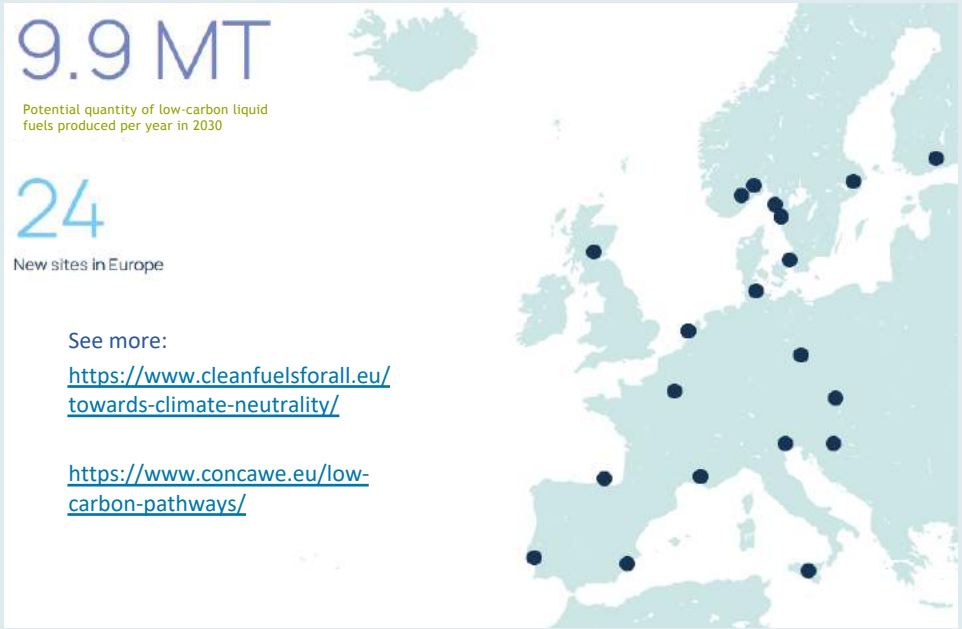
Back up's

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

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



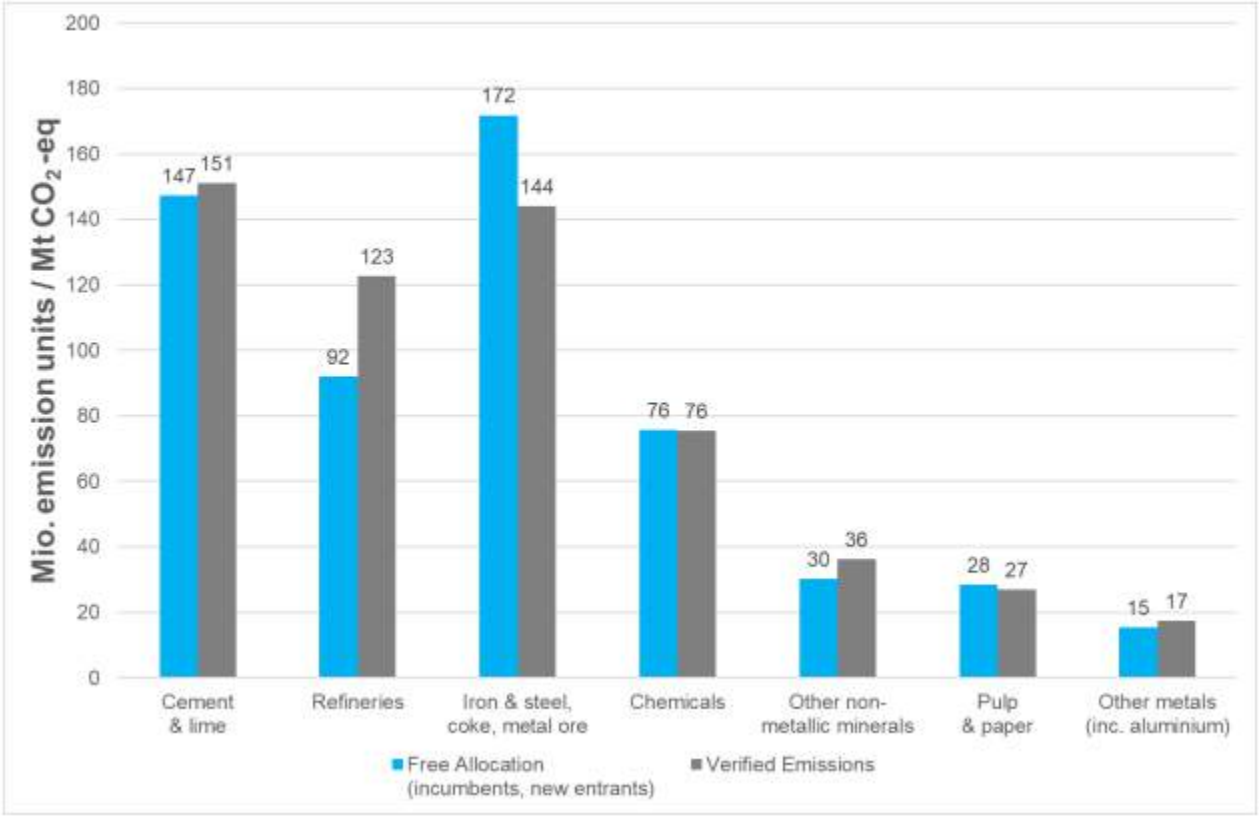
*While the final list of projects may differ from the map or the list shown here, these projects are being considered by FuelsEurope's members to be put forth for support under the EU Recovery Fund.

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).

Concawe

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

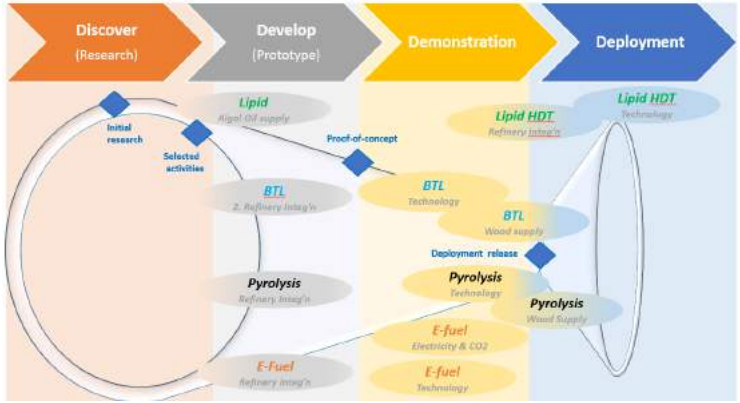


Extract and processing data from EUTL

Mainstream refineries in operation		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
free allowances (million T CO2eq)		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 CO2eq)		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

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_2 capture ratio → cost reduction

Concawe