

Fuels Europe Vision 2050

A pathway for the evolution of Liquid Fuels and the Refining Industry

Who is Fuels Europe?

FuelsEurope represents 41 Member Companies ≈ 100% of EU Refining



Policy Landscape

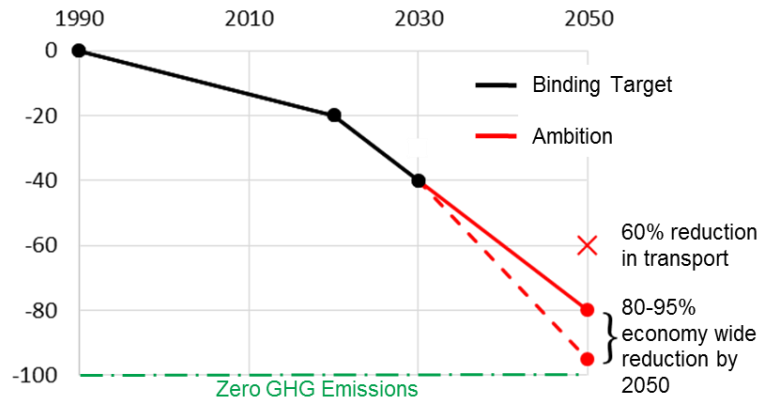
- **Multiple policy drivers**

- Ambitious EU GHG reduction goals
- More immediate air quality concerns
- Industrial strategy for alternative technologies

- **New Industry dynamics**

- Increasing diversification
- OEMs discredited

*** EU Emissions Reduction**
(% GHG reduction vs. 1990)



Global Integrated: Current activities in the low-carbon segment

	BP	Chevron	Eni	Equinor	ExxonMobil	Repsol	Shell	Total S.A.
Reduce direct operational emissions	Green	Green	Green	Green	Green	Green	Green	Green
Promote natural gas and LNG	Green	Green	Green	Green	Green	Green	Green	Green
Solar	Green	Yellow	Green	Green	Green	Green	Green	Green
Wind	Green	Yellow	Green	Green	Green	Green	Green	Green
Biofuels	Green	Green	Green	Green	Yellow	Yellow	Green	Green
Geothermal	Green	Yellow	Green	Yellow	Green	Green	Green	Green
Hydropower	Green	Green	Green	Green	Green	Green	Green	Green
Power transmission/distribution	Green	Green	Green	Green	Green	Green	Green	Green
EV/battery/charging infrastructure	Green	Green	Green	Yellow	Green	Green	Green	Green
Carbon capture, utilization, and storage	Yellow	Green	Green	Green	Green	Green	Green	Green

■ Current development focus and/or stated part of current strategy
■ Existing area of research and/or discussed as potential investment area

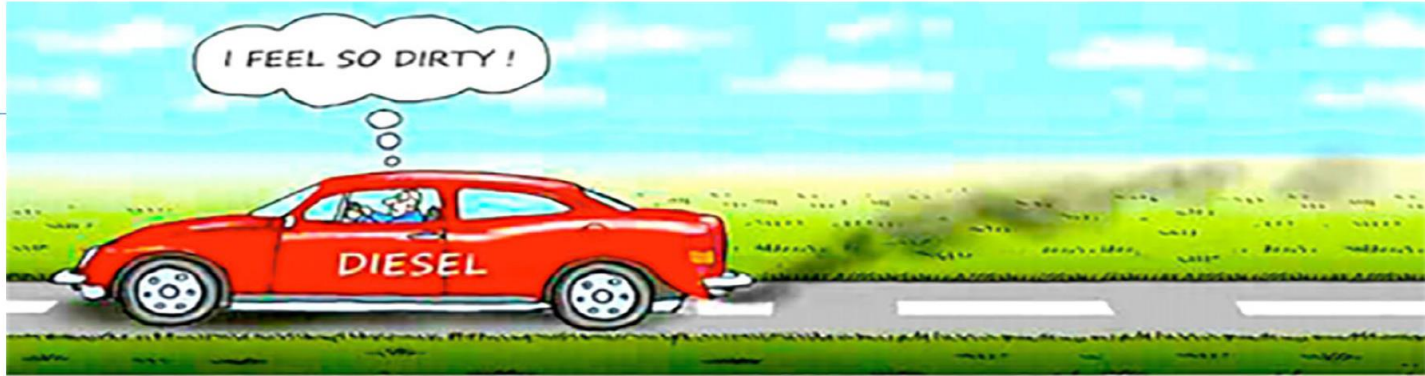
Source: IHS Markit © 2018 IHS Markit

Need for Long Term Vision

- National Energy and Climate Plans to 2030
- EU Mid Century Strategy
- Expectation that energy intensive industries transform



- Need to offer compelling vision of refining industry low carbon transition
- Rally support from industrial sectors linked to ours to shape consistent proposition
- Influence EU industrial & technology strategy, and enabling policy framework
- Ensure technology neutral policies

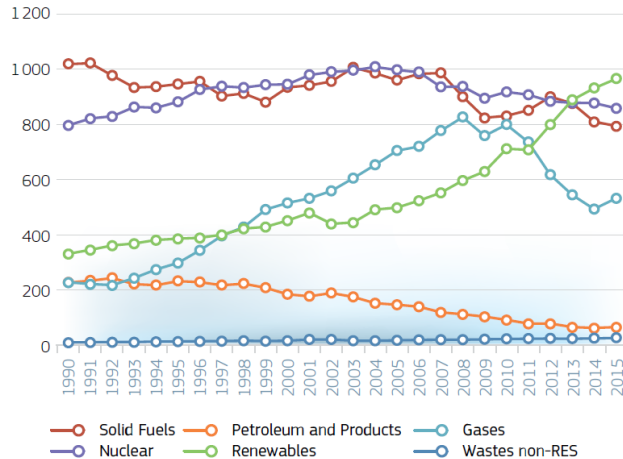


Source of Electricity

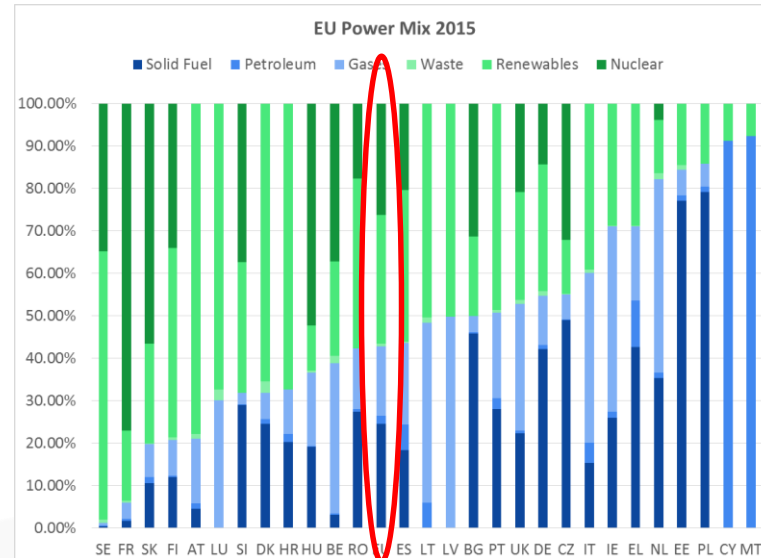
- There is still a lot of coal in the EU power mix (791 TWh out of 3234 TWh total in 2015)
- Renewable electricity has so far mostly replaced gas, but trend appears to be changing
- EU mix 2015 carbon footprint ~ 347 g CO₂/kWh – is roughly equivalent to about 50-60 g CO₂/km for an average
- The actual source of incremental power should be considered as more EVs connect to the grid

2.6.2 Gross Electricity Generation

BY FUEL – EU-28 – 1990-2015 (TWh)



Reproduced from: European Commission – DG Energy, Statistical Pocketbook 2017



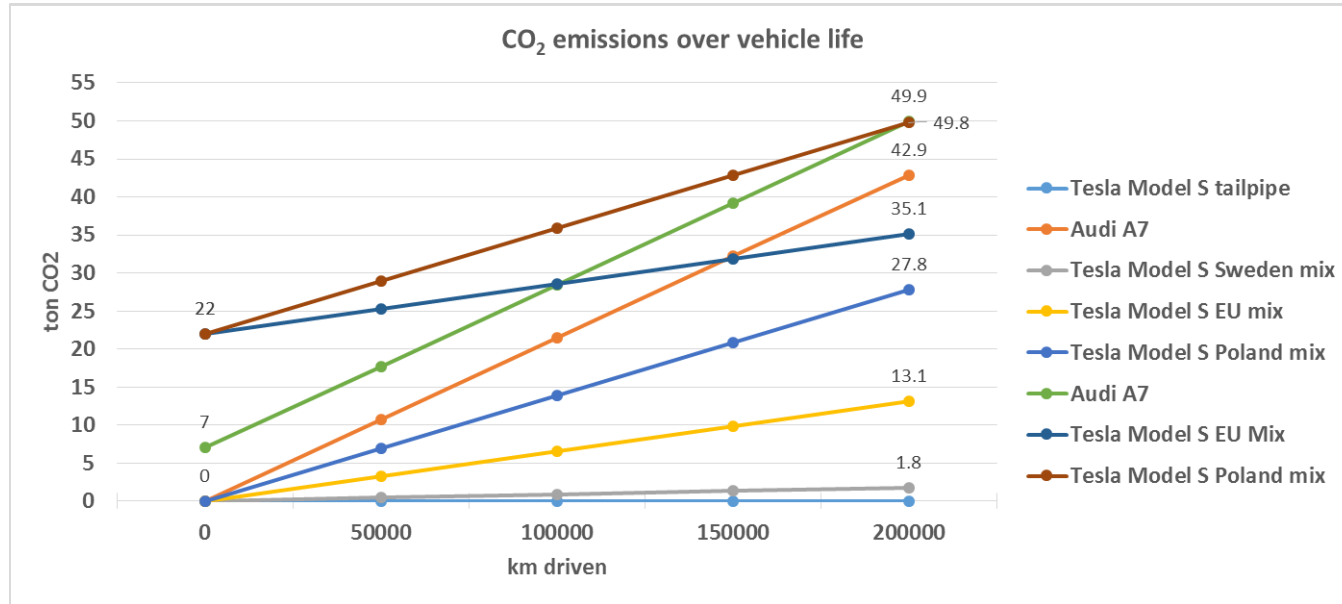
Data source: European Commission – DG Energy, Statistical Pocketbook 2017

GHG Life Cycle Analysis

Production of electric vehicles is typically more energy-intensive than conventional vehicle manufacture. It needs approximately 70 % more primary energy to make BEVs than conventional vehicles, mainly for the electric engine systems and batteries. These higher energy requirements can lead to higher emissions of GHGs and associated air pollutants, depending on the source of energy used.

EEA, Electric vehicles in Europe, EEA Report No 20/2016

Tailpipe vs Life Cycle GHG impact



Audi A7 3.0 TDI
1800 kg
4.7 l/100 km (NEDC)



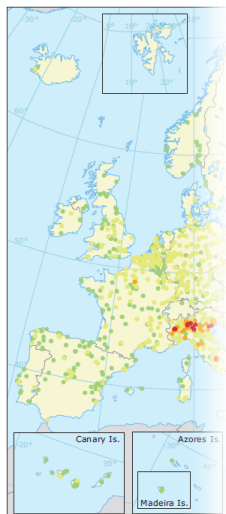
Tesla Model S
2100 kg
100 kWh battery
181 Wh/km

Source: Concawe Review, July 2018, based on data from Tesla and Audi brochures and NTNU data

Air Quality in Europe

- Despite slow improvements, air pollution continues to exceed limits and guidelines

Map 3.3 Concentrations of PM_{2.5} in Europe, 2016



Notes: Observed concentrations of PM_{2.5} in µg/m³ are shown. The map displays concentrations above the EU annual limit value (5 µg/m³) and WHO AQG for PM_{2.5} (10 µg/m³). Only stations with more than 75 % of valid data have been included in the map. The French overseas territories' stations are not shown in the map but can be found at <https://www.eea.europa.eu/data-and-maps/dashboards/air-quality-statistics>

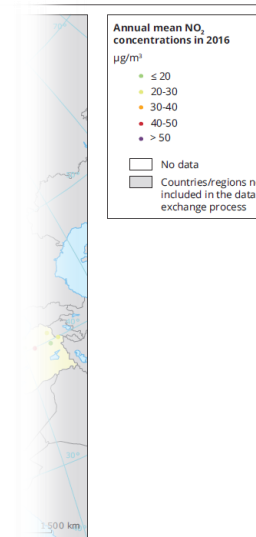
Source: EEA, 2018a.



Air pollution is an invisible killer and we need to step up our efforts to address the causes. In terms of air pollution, road transport emissions are often more harmful than those from other sources, as these happen at ground level and tend to occur in cities, close to people. That is why it is so important that Europe redoubles its efforts to reduce emissions caused by transport, energy and agriculture and invest in making them cleaner and more sustainable,



Map 5.1 Concentrations of NO₂ in Europe, 2016



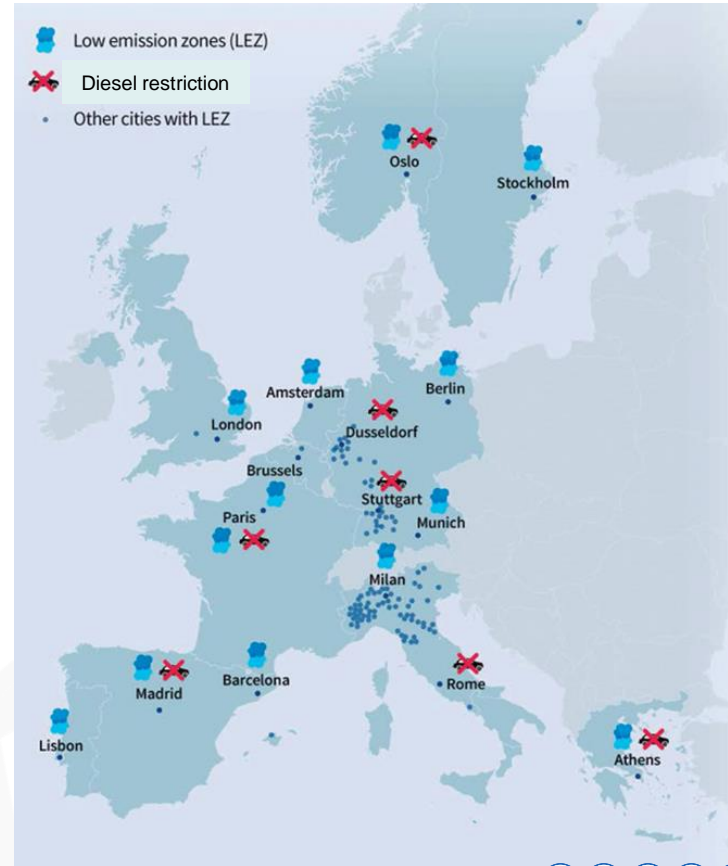
Notes: Annual mean NO₂ concentrations in µg/m³ are shown. The map displays concentrations above the EU annual limit value and WHO AQG for NO₂ (40 µg/m³). The French overseas territories' stations are not shown in the map but can be found at <https://www.eea.europa.eu/data-and-maps/dashboards/air-quality-statistics>

Hans Bruyninckx, EEA Executive Director

Source: EEA, Air quality in Europe — 2018 report, October 2018

Traffic Access Regulations In Europe

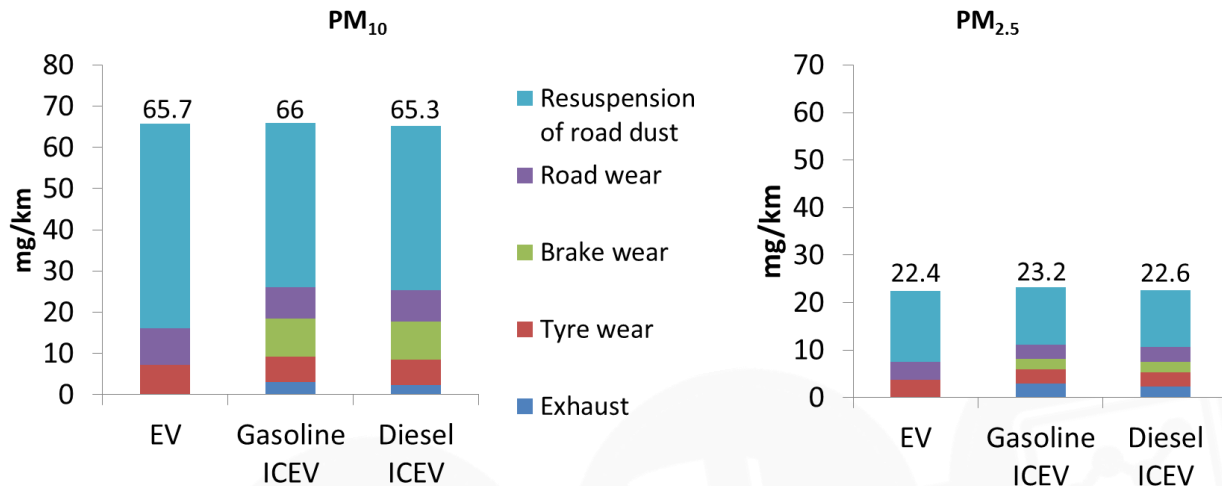
- Many cities struggling to achieve air quality standards
- Diesel cars seen as major contributor, exacerbated by VW issue
- Authorities being challenged in court and forced to accelerate air quality improvement plans
- City LEZs proliferating
- Intentions for outright bans in some cities
 - Paris intends to ban diesel cars from the center as of 2024 (and gasoline cars as of 2030)
 - Rome planning to ban diesel cars from the center as of 2024
 - German court decision allowing cities to establish diesel bans
 - Brussels plans to ban diesels as of 2030



Low emission zones (LEZ) for cars in the European Union.
Illustration: T&E

Electric vs Conventional Vehicle PM

- Total Tank-to-Wheels PM emissions from EVs are equivalent to those of modern conventional vehicles
 - EVs have higher non-exhaust emissions than conventional ICEVs, which offsets the lack of exhaust PM
 - Driven by the higher mass of EVs, primarily due to the battery pack



Comparison: Ford Focus, Honda Fit, Fiat 500, Kia Soul, VW Golf, Renault fluence

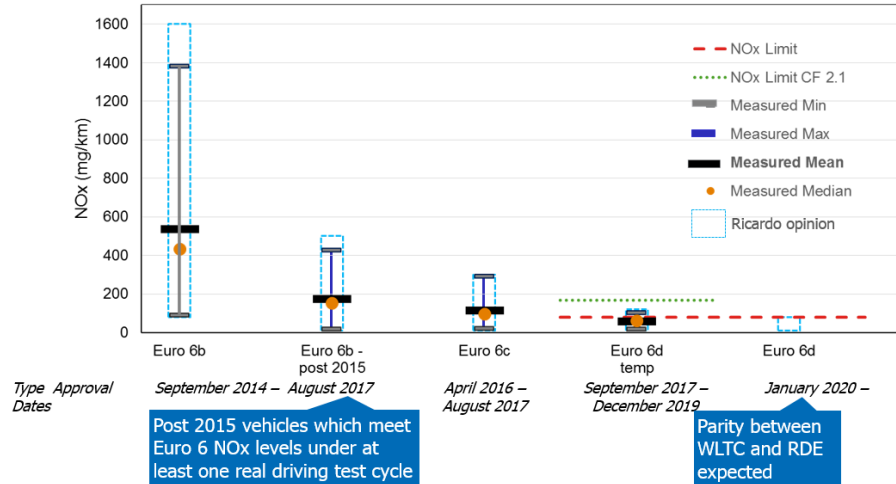
Avg. Mass of ICEV (kg)	Avg. Mass of EV (kg)	Difference for EV (%)
1310	1591	+ 21.5%

Source: EM, based on Timmers

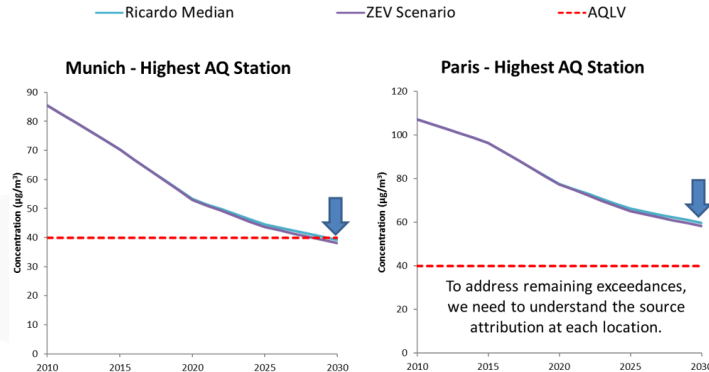
NOx Emissions

- Newest diesel vehicles achieve NOx emissions standards under real driving conditions

Diesel NOx under real world test conditions (From Concawe Project completed by Ricardo)



- EVs achieve very little additional air quality improvement over and above fully compliant ICEVs



*Concawe Project completed by Aeris Europe

Key Messages

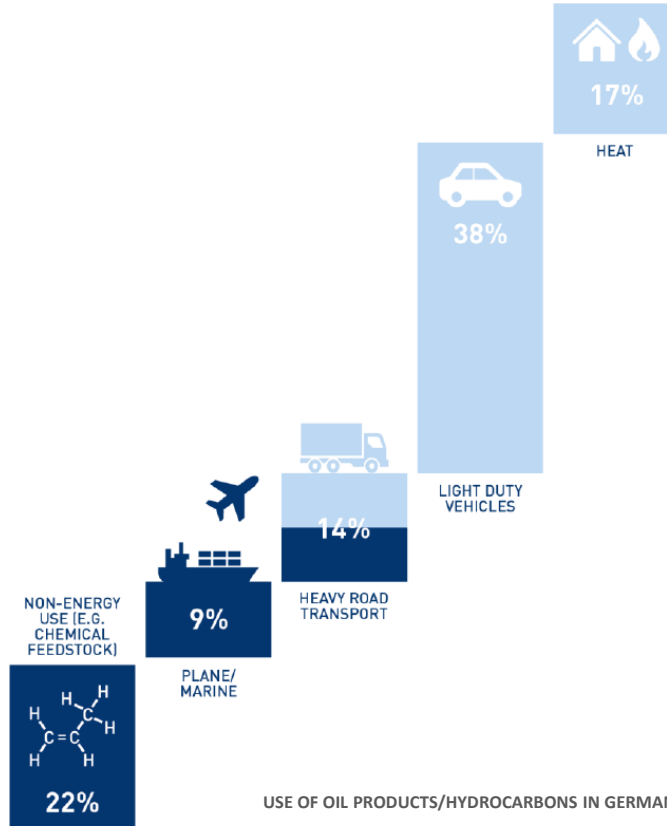
- The overall GHG impact is very dependent on the GHG intensity of the energy used in manufacture, use, and recycling – for ALL vehicles
- Electric Vehicles can be low GHG, but so can advanced hybrid ICE vehicles
- City air quality problems have multiple causes. Must focus on all sources
- The latest “Euro 6d” emission class Gasoline and Diesel cars are extremely clean
- The choice of new cars makes almost no difference to future air quality in cities

Liquid Fuels and Products

RENEWABLE
HYDROCARBONS:
TECHNOLOGY- OPTION IN
COMPETITION WITH OTHER
OPTIONS

RENEWABLE
HYDROCARBONS
NECESSARY IN THE
LONG-TERM

appr.
40%



USE OF OIL PRODUCTS/HYDROCARBONS IN GERMANY 2016

Source: Prognos AG, Berlin

Aviation and Energy Storage

Boeing 787



230 tons
at take-off

Jet fuel



100 tons¹

Electric battery

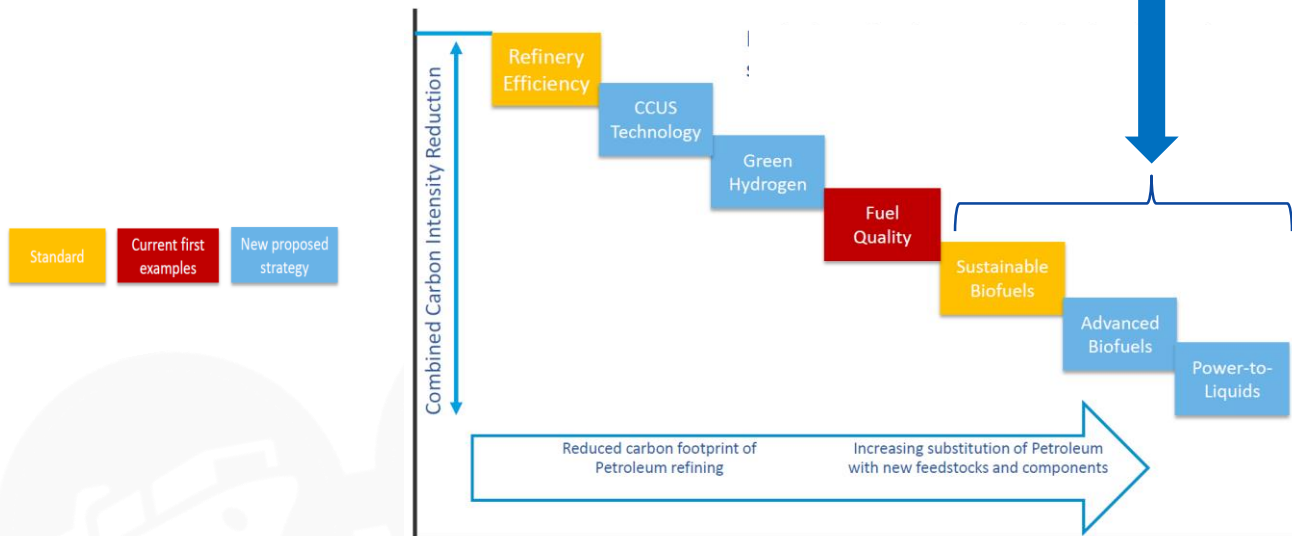
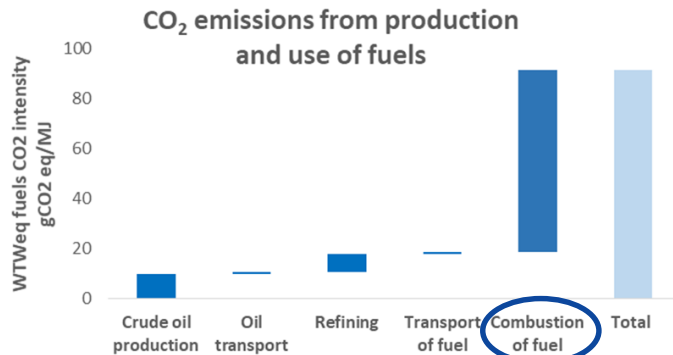


2000 tons¹

(1) <http://www.latimes.com/business/la-fi-electric-aircraft-20160830-snap-story.html>

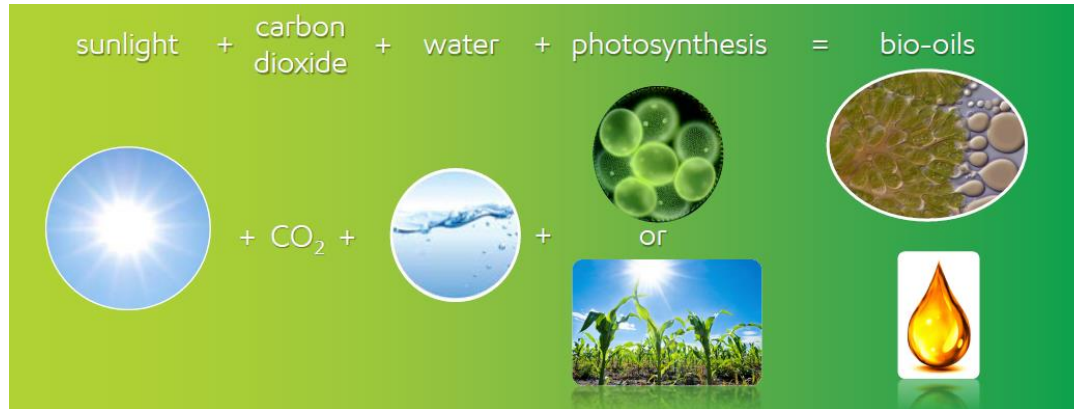
Low Carbon Liquid Fuels: Fuels Europe Vision

Multiple technologies can be deployed together to give significant reduction in carbon intensity of liquid fuels

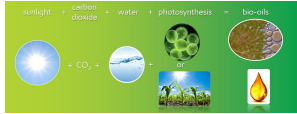


The technologies are being developed....

Algae, a biofuel for tomorrow

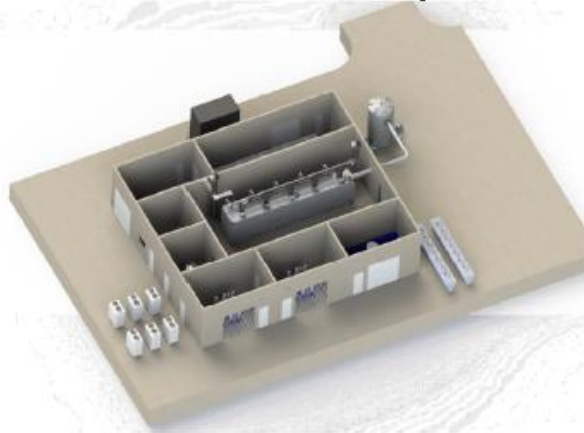


The technologies are being developed....

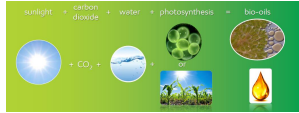


REFHYNE Project, 10 MW PEM Electrolyser

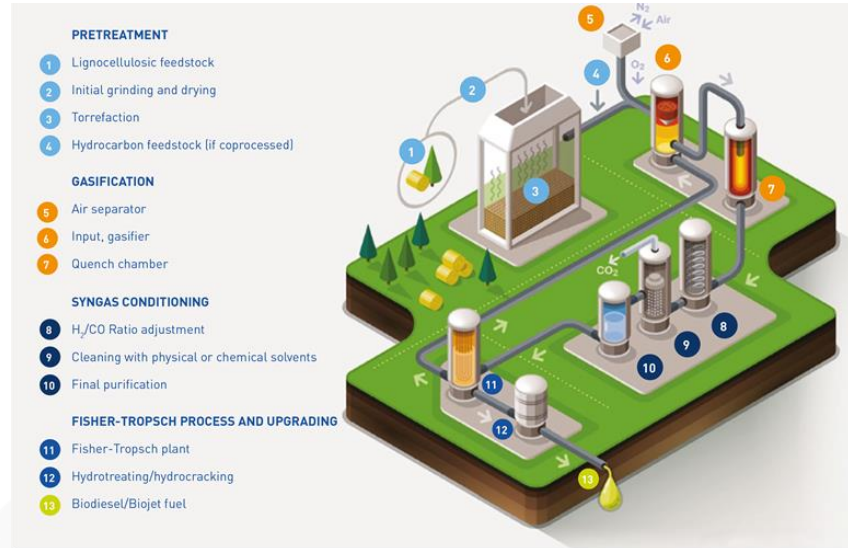
10 MW electrolyser



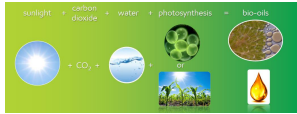
The technologies are being developed....



BioTfuel, producing biofuels via thermochemical conversion



The technologies are being developed....



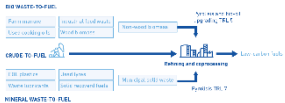
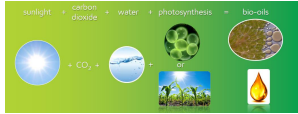
Waste-to-Fuel

BIO WASTE-TO-FUEL

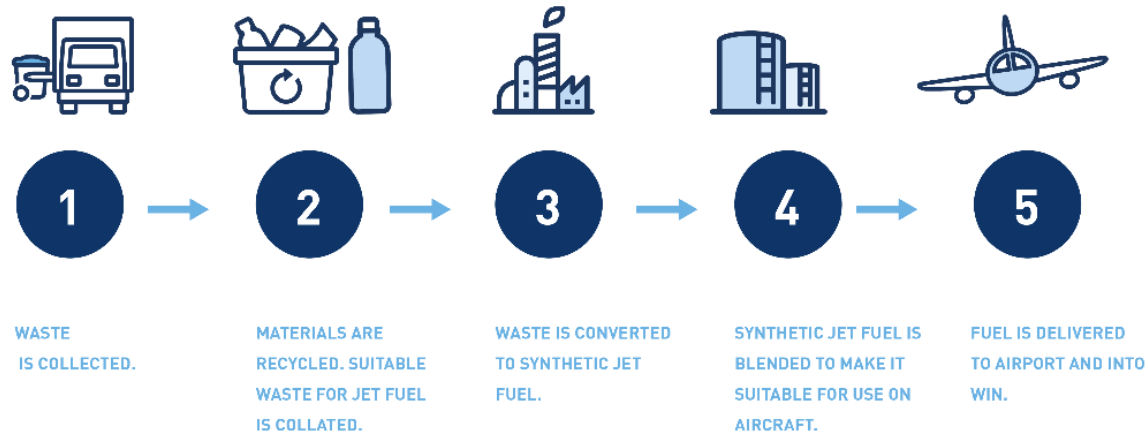


MINERAL WASTE-TO-FUEL

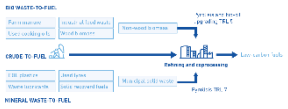
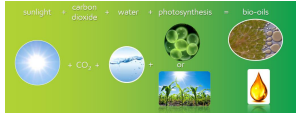
The technologies are being developed....



Fulcrum BioEnergy, Municipal Waste-to-Fuel

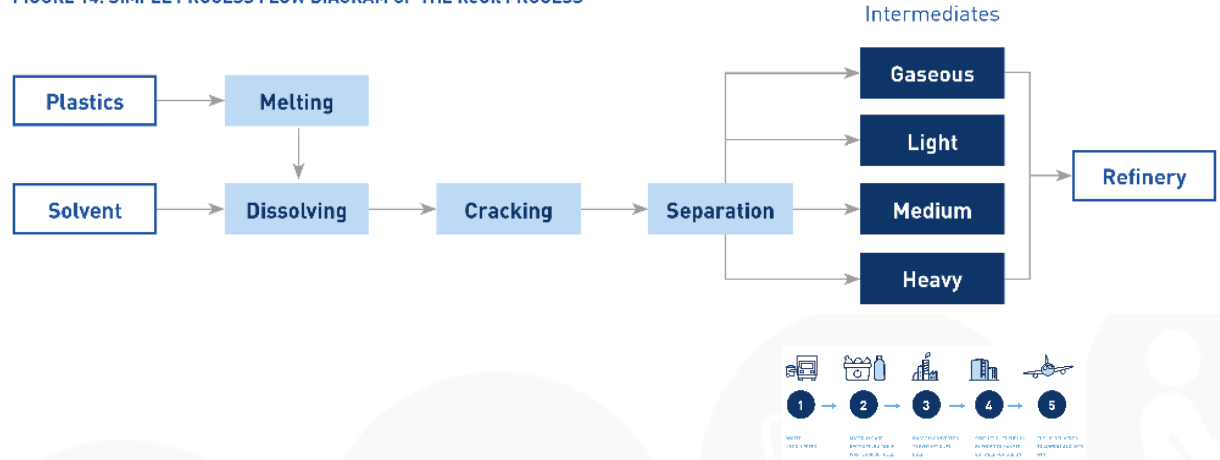


The technologies are being developed....

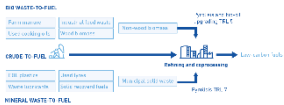
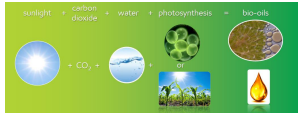


ReOil, Plastics-to-Fuels & Feedstocks

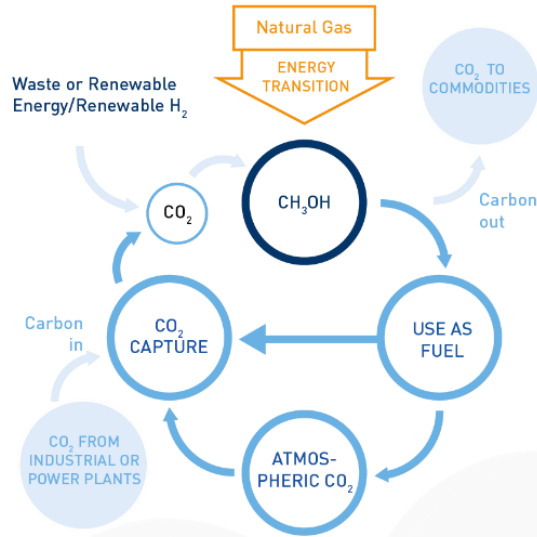
FIGURE 14: SIMPLE PROCESS FLOW DIAGRAM OF THE ReOil PROCESS



The technologies are being developed....

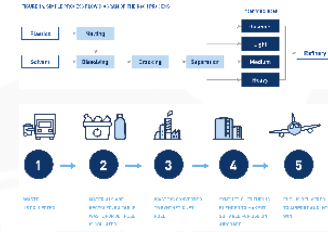


Methanol Economy

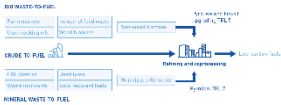
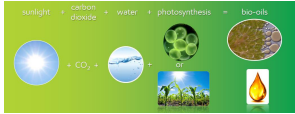


CO₂ concentration in wet flue gases

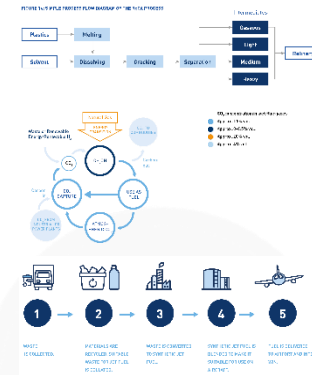
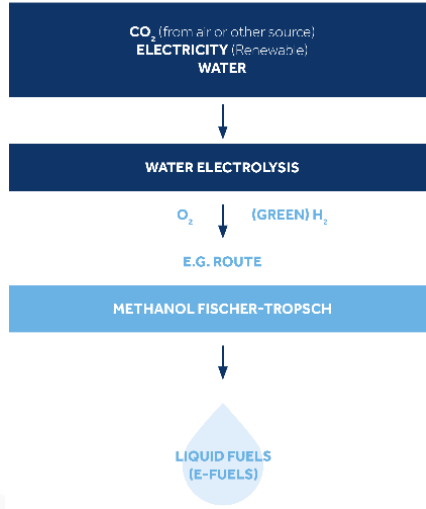
- Approx. 11% vol.
- Approx. 8-8.5% vol.
- Approx. 20% vol.
- Approx. 4% vol.



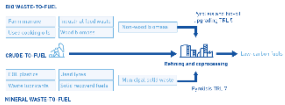
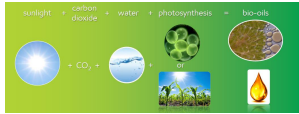
The technologies are being developed....



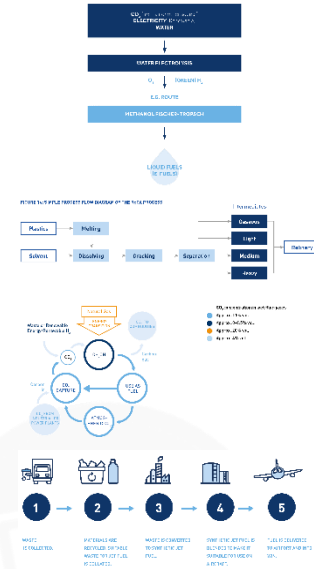
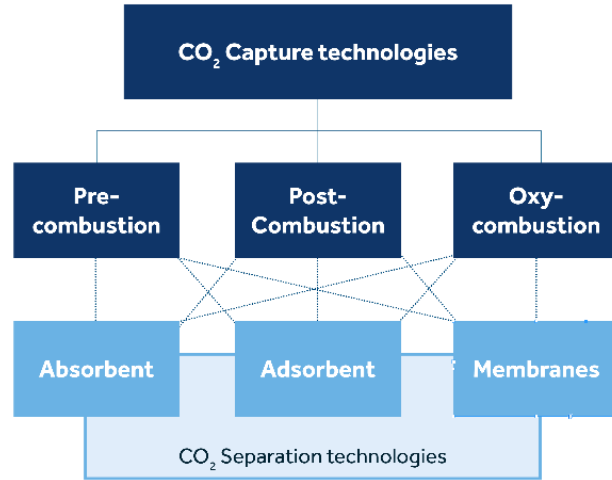
Sunfire, Power-to Liquid



The technologies are being developed....



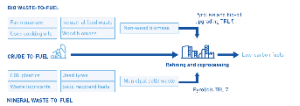
On-board Carbon, Capture & Storage



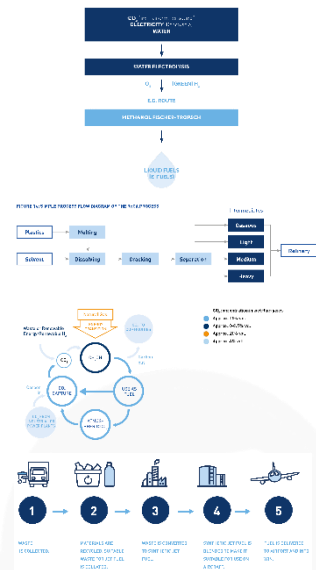
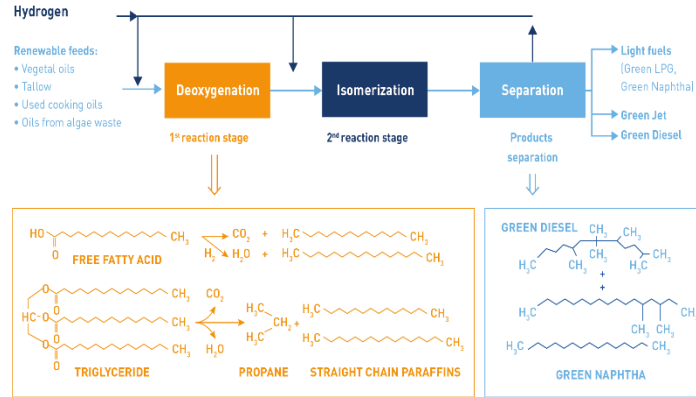
The technologies are being developed....



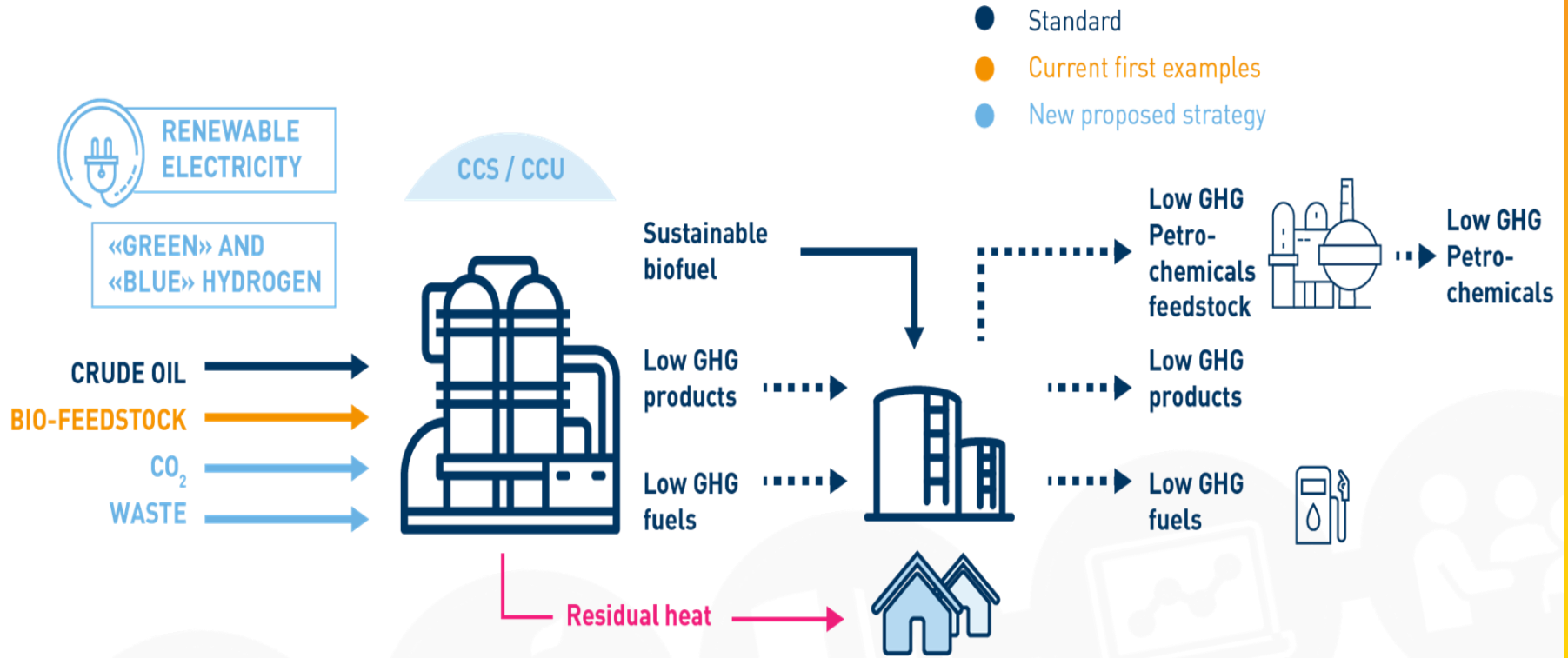
REFHYNE
CLEAN REFINERY HYDROGEN FOR EUROPE



Bio-refinery

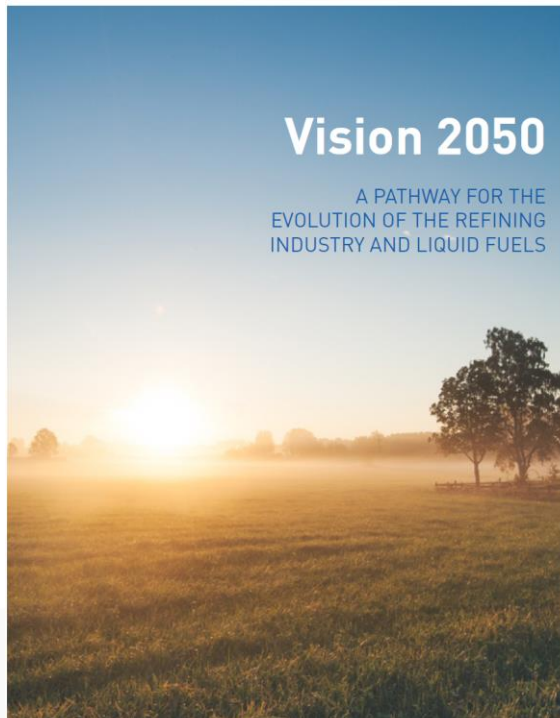


The Refinery as an Energy Hub within an Industrial Cluster

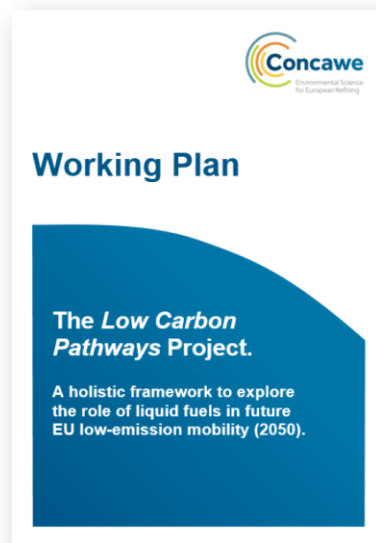


Publications

<https://www.fuelseurope.eu/vision-2050/>



<https://www.concawe.eu/publications/>



Policy Asks

- Want refinery and fuels low-carbon transition included in EU industrial and technology strategies
- Want policy framework for long-term investor confidence
- Retain refineries' economic viability despite aggressive international competition
- While strengthening our reputation / retaining seat at table
 - Stronger communication of work on climate solutions

Summary

- Our industry and products will need to change to meet changing EU societal needs and expectations
- Our industry has an exciting innovation agenda, with many promising technologies
- We will need liquid fuels, and the industry to provide them for the long term
- Our industry can and should be part of the long term future, helping to meet energy, climate and air quality goals
- We have a lot to share with our customers and policy makers, and we must tell a compelling story

Electrification Challenge

EU

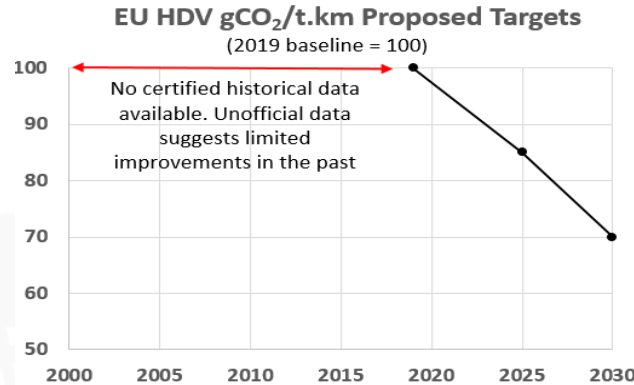
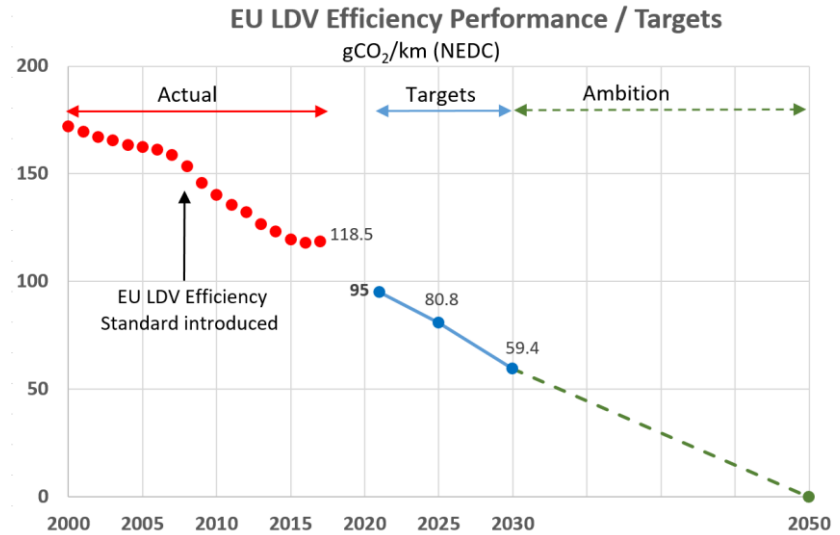
- Want transformation to zero emission vehicles
- Directives/Regulations incentivize electrification

Countries

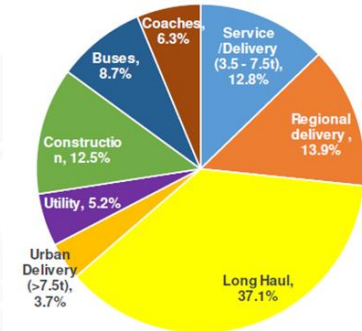
- Big subsidies/incentives for EVs
- Intentions to ban internal combustion engine

Other

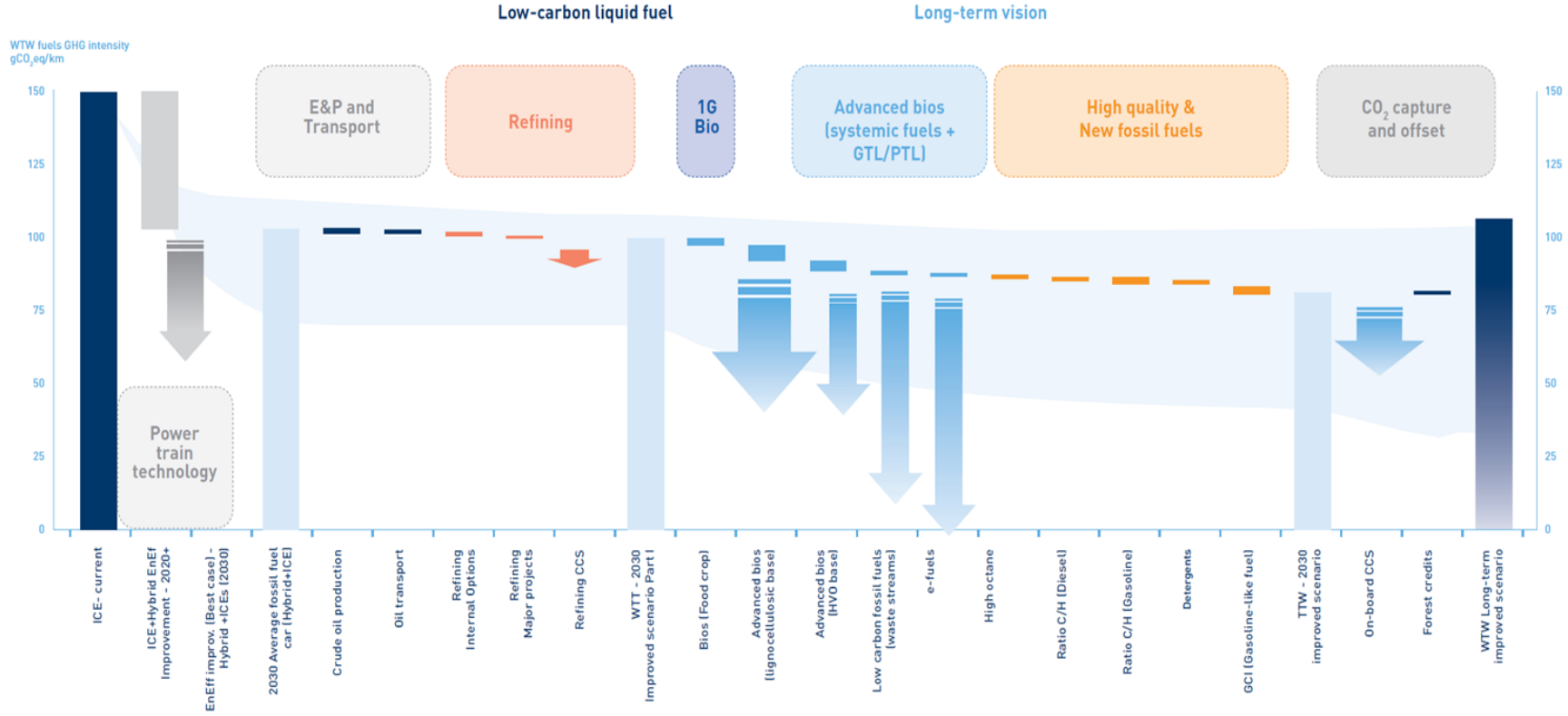
- OEMs shifting emphasis from ICE to EV
- Biofuels considered a partial/interim solution for LDV, and somewhat discredited



EU HD Energy Demand by Application



Low Carbon Liquid Fuels: Fuels Europe Vision



Source: Concawe, Low Carbon Pathways, April 2018.

Policy Framework: A Proposal

