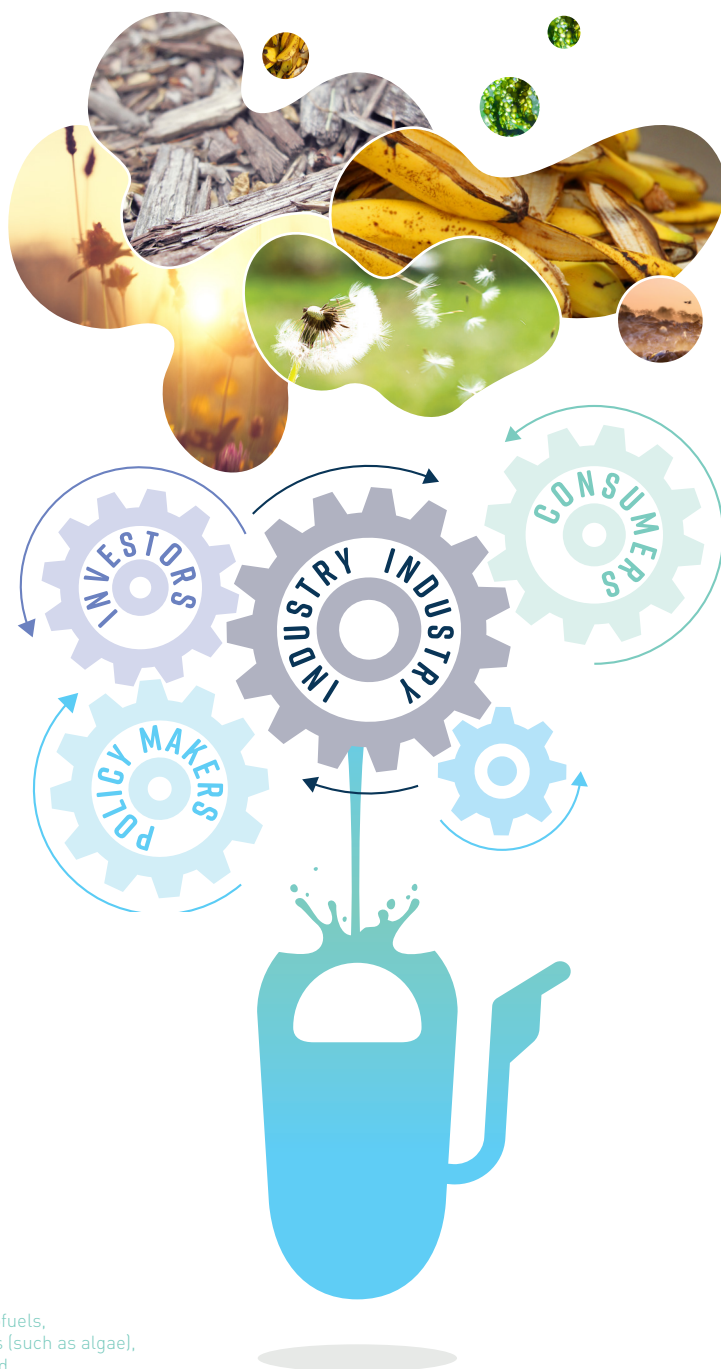


Clean fuels for all

EU REFINING INDUSTRY PROPOSES A POTENTIAL
PATHWAY TO CLIMATE NEUTRALITY BY 2050



2nd Generation biofuels,
Advanced biofuels (such as algae),
Waste, Solar, Wind

Table of contents

4	EU refining industry proposes a potential pathway to climate neutrality by 2050.
6	By 2050, at the latest, every litre of liquid fuel for transport could be net climate neutral, enabling so the decarbonisation of aviation, maritime and road transport.
8	To meet the 2050 climate-neutrality goal, we believe Europe and its consumers need a plan where low-carbon liquid fuels and electrification/ hydrogen in road transport sit side by side.
10	Our proposed pathway is ambitious. The good news is our transformation has already begun.
12	Policy principles
14	Annexe - EU Refineries: a story of transformation

EU refining industry proposes a potential pathway to climate neutrality by 2050.

Clean fuels for all



SOLAR: Low-carbon liquid fuels made from solar renewable energy are sustainable liquid fuels with no or very limited net CO₂ emissions during their production and use compared to fossil-based fuels.

The ambition of the European Union is to be climate neutral by 2050. The European refining industry supports the same ambition.

Our industry is transforming, and we have developed a comprehensive potential pathway¹ of how we, together with our partners, can contribute to meeting the 2050 climate neutrality challenge.

In concrete terms, based on the current technology knowledge and cost estimate, we outline a potential pathway to 2050 to develop low-carbon liquid fuels (LCLF)² for road, maritime and air transport. To deliver such pathway an investment estimated between €400 to €650 billion will be needed. Major investments, in addition to those already deployed, could start in the next years, with first-of-a-kind plants at industrial scale potentially coming into operation at the latest by 2025.

Our LCLF pathway shows how a 100 Mt CO₂/y reduction could be delivered in transport by 2035, equivalent to the CO₂ savings of 50 million Battery Electric Vehicles (BEVs) on the road, and how it could contribute to EU's climate neutrality by 2050.

LCLF will play a critical role in the energy transition and in achieving carbon neutrality in all transport modes, as the global demand for competitive liquid fuels is expected to progressively increase. Therefore, alongside electrification and hydrogen technologies, LCLF will remain essential beyond 2050, bringing important benefits to the European economy and society.

We stand ready to enhance our collaboration with policymakers, our value chains and other partners to create the right conditions and policy framework for investments in new technologies to address the climate challenge.

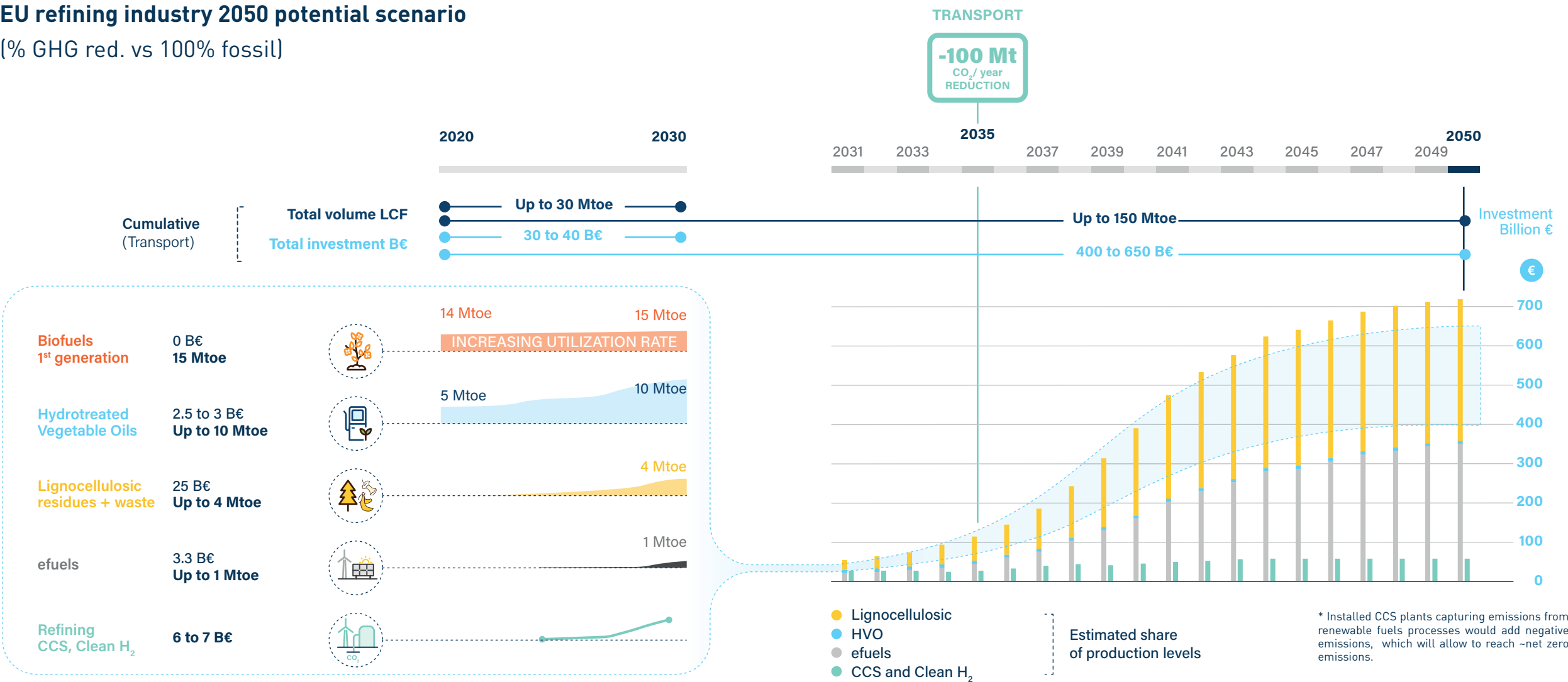
¹ This pathway is based on the Commission Clean Planet for All 1.5 Tech scenario.

² Low-carbon liquid fuels are sustainable liquid fuels from non-petroleum origin, with no or very limited net CO₂ emissions during their production and use compared to fossil-based fuels.

By 2050, at the latest, every litre of liquid fuel for transport could be net climate neutral, enabling so the decarbonisation of aviation, maritime and road transport.

In concrete terms, our potential pathway includes:

EU refining industry 2050 potential scenario
(% GHG red. vs 100% fossil)



Outlined below is the pathway to enable by 2050 aviation, maritime transport, and all new and old road transport vehicles, including hybrid or ICE, to be climate neutral.

Based on the work of our industry to date, we are ready to hit the ground running. This pathway will require an estimated €30 to €40 billion investment over the next ten years and the creation of a number of biofuel and e-fuel plants that could produce up to 30 MToe/y in

2030, with the first-of-a-kind biomass-to-liquid and e-fuel plants coming into operation no later than 2025.

By 2050, availability of 150 Mtoe of LCLF would cut over 400 Mt CO₂/y. Add Carbon Capture & Storage (CCS) and the capture of emissions in biofuel production, and, in combination with electrification and hydrogen technologies, road transport reaches climate neutrality.

To meet the 2050 climate-neutrality goal, we believe Europe and its consumers need a plan where low-carbon liquid fuels and electrification/hydrogen in road transport sit side by side.



WIND: Low-carbon liquid fuels made from wind renewable energy are sustainable liquid fuels with no or very limited net CO₂ emissions during their production and use compared to fossil-based fuels.

Clean fuels for all

LCLF will smooth the deployment cost of electric energy distribution and fast charging infrastructure in road transport, by providing flexibility and alternative sources of low-carbon energy using mainly existing facilities.

They will reduce the pressure and cost of achieving complete fleet turnover to ensure climate neutrality, also supporting a just transition across Europe.

LCLF will give customers a choice between low-carbon technologies, ensuring that carbon neutrality is accessible to all, as LCLF will, for the foreseeable future, provide a low-cost solution compared to the alternatives.

EU citizens demand more options in the transition to carbon neutral mobility, a 2019 [survey](#) with responses from 10,000 European citizens has shown, and call on their governments to support the development of multiple clean vehicle technologies.

LCLF will provide strategic security of supply, with typically 90 days of energy supply stored within European facilities, since these fuels can be stored in exactly the same manner as fossil fuels.

Once the lead market of road transport has spearheaded the development and deployment of low-carbon technologies, the new fuels will be available for the progressive decarbonisation of aviation and maritime fuels, enabling so to achieve climate neutrality of these sectors by 2050.

Importantly, our pathway will also help maintain European industrial strength and jobs in the automotive sector. We see our future in a transformation of our manufacturing processes that will create European leadership in critical low-carbon technologies that will be exported around the world. Essential industrial solutions including green and blue hydrogen and CCS can also be advanced and scaled up for the benefit of many other industries.

Our proposed pathway is ambitious.
The good news is our transformation
has already begun.



WASTE: Low-carbon liquid fuels made from waste are sustainable liquid fuels with no or very limited net CO₂ emissions during their production and use compared to fossil-based fuels.

Clean fuels for all

A combination of critical technologies must be deployed in many plants across Europe to deliver LCLF at scale.

These include sustainable 1st Generation bio-fuels, advanced biofuels, biomass-to-liquid, hydrogenation of vegetable oils/waste & residues, and e-fuels, to replace fossil CO₂ by biogenic or recycled CO₂, as well as CCS and clean hydrogen applied in refineries, to reduce the carbon footprint of fuels manufacturing.

The EU refining industry is already engaged in a low-carbon transition. We are uniquely positioned to keep driving the development of these technologies, but we will not be able to achieve this alone.

Realistically, the success of our journey will also depend on investor confidence and political vision and engagement. Notably, with a view to building the necessary market demand and start rolling out our investments in the next years, we call on EU policymakers to launch a high-level dialogue in 2020 with a view to creating a policy framework that enables:

1. The creation of a market for LCLF, providing an incentive to fuels with a lower carbon footprint with respect to conventional ones. The CO₂ standards in vehicles would need to factor-in the actual CO₂ benefits provided by LCLF compared to fossil fuels.

2. Support mechanisms for investors, both in terms of access to public and private funds, and of favourable fiscal treatment, as well as very low or zero taxation for low-carbon fuels, to facilitate fuel pricing that is both socially acceptable and able to make a business case for investments. This also implies that the EU taxonomy for sustainable activities must fully recognise the strategic importance of the transformation of the refining industry.

3. The mitigation of investor risk through robust, stable, science-based sustainability criteria for all feedstock and processes, as well as ensuring the stability of the regulations impacting feedstock availability, demand of LCLF, and capital and operating costs.

Meanwhile, we are in close dialogue with multiple industries to build the necessary value chains and assets.

Agriculture, chemicals, forestry, waste and recycling, including many SMEs, will participate in these value chains. Academia, car and truck industries, aviation and maritime, and customer groups will all have a role in developing the markets with the right definitions and parameters. Civil society at large will have to be engaged through an open, transparent and fact-based dialogue.

**With low-carbon liquid fuels,
European refiners are ready to contribute
to climate-neutral transport.**

Policy principles

Clean fuels for all



BIOMASS: Low-carbon liquid fuels made from biomass are sustainable liquid fuels with no or very limited net CO₂ emissions during their production and use compared to fossil-based fuels.

The EU refining industry stands ready to step up collaboration with other industries and with EU policymakers, to take bold climate action together. In order to deliver climate neutral transport by 2050, we urge EU policymakers to establish a high-level dialogue in 2020 with all concerned stakeholders to create the necessary policy framework. The following key policy principles are central to delivering our 2050 climate-neutral ambition and should serve as a starting point for discussion:

- The creation of a market for low-carbon fuels, with a significant carbon-price signal, is a prerequisite to unlock investments in low-carbon technologies and fuels. In road transport, this could be achieved through:
 1. Either a dedicated cap and trade mechanism on emissions from road fuels, with biogenic and recycled CO₂ counting as zero, with the fuel supplier as obligated party;
 2. Or a Well-to-Wheel (WTW) carbon intensity standard for fuels, with the fuel suppliers as obligated party and the possibility to trade credits between them.
- The CO₂ standards in vehicles must be amended, whereby the actual Tank-to-Wheel (TTW) approach currently in place is corrected by taking into account the CO₂ footprint of fuels. The responsibility of Original Equipment Manufacturers (OEMs) and of fuel suppliers should remain separate on the respective targets (in particular, OEMs will retain a TTW target), but the overall CO₂ reduction in road transport should be a combination of the two. This is essential in that it would enable:
 1. The technology strategy of the European automotive industry to benefit from the

potential to provide climate-neutral mobility with Internal Combustion Engine (ICE)-based vehicle platforms;

2. Consumers to access a more accurate representation of the CO₂ intensity of their mobility choices.
- All overlapping fuel policies should be reformed or simplified, such as Fuel Quality Directive (FQD) which regulates the GHG intensity of fuels brought into the market, and the Renewable Energy Directive (RED) which mandates a share of renewable content in transport fuels.
 - Fuel taxation should be revised by accounting for the carbon-intensity, to incentivise investments in advanced renewable fuels. Zero or very low tax for low-carbon fuels would achieve the double objective of keeping fuel prices socially acceptable and making a business case for investments.
 - Investors should be put in the best conditions to risk their capital, by:
 1. Ensuring regulatory stability for the economic life-time of their investment. This can be achieved by adopting robust, science-based sustainability criteria for feedstocks and processes in the first place. When, however, new regulations come into force, investments already in place must be protected from detrimental effects through grandfathering measures.
 2. Protecting the investments from carbon-leakage, resulting from competition with less regulated non-EU industry.
 3. Allowing access to public and private funds for climate-related investments as well as favourable fiscal treatment.

EU Refineries: a story of transformation

The petroleum refining industry and the distribution network of oil products have been operating in Europe for well over 100 years. We have continuously evolved, adapting to market and regulatory demands, while providing reliable and affordable energy, as well as many other products and services that are essential to society.

Early R&D examples and some cases of deployment show the industry's engagement and capabilities at different stages of the value chain:

- Companies with EU refining operations are blending biofuels into road transport fuels according to EU regulations and international specifications. In many cases, they are also currently engaged in the production or co-processing of "drop-in" biocomponents for blending beyond regulatory mandates. This will improve the quality and sustainability of the fuels. Different hydrotreated vegetable oil (HVO) processes, all based on petroleum refining know-how, have been developed by oil companies and technology providers (Axens-IFP, Honeywell-UOP, Neste, Haldor Topsoe, Eni).
- The next generation of advanced biofuels is already being developed, and some refining companies are already involved in R&D projects exploring different pathways:
 1. Lignocellulosic biomass (straw, forest residues) can be transformed into biofuel in different ways. For example, thermochemical conversion is being explored as a process to convert

biomass first into syngas and then into a hydrocarbon mixture that can be used to produce second-generation biodiesel and bio-jet fuel (see **BioTfuel** project).

2. The Waste-to-Fuel technology is a promising area for accomplishing one of the objectives of the circular economy. The industry is engaging in relevant R&D activities to contribute effectively to this goal (see **BP/Fulcrum** and **ReOil/R-crude** projects). Similarly, the **FORGE Hydrocarbons** project, financed by Shell, transforms waste fats and oils into renewable jet fuel, diesel and naphta, with a 90% lower CO₂ footprint compared to conventional fuels (see also: **ENI's bio-refinery in Gela**, home to a waste-to-fuel plant).
3. There are examples of very significant and promising R&D projects for the development of third-generation biofuels. These have superior sustainability credentials both in terms of reducing GHG emissions and their impact on land use and ecosystems (see **ExxonMobil/Synthetic Genomics** project).
4. Conventional refineries (whose feedstock is crude oil) can be transformed into "biorefineries" for the production of a different range of biofuels and other products from biomasses. There are real examples of potential routes that could be followed (see **Eni** and **Total** projects).

- Several refineries are engaged in projects aimed at using or producing so-called "green hydrogen", i.e. hydrogen produced from renewable electricity (see **REFHYNE** project and relatedly **ReWest100** project, supplying green H₂ and e-kerosene for Hamburg Airport. Additional projects include the H₂ **Nukleus** by BP, **Gigastack** by Phillips66, and **HyNet Consortium** by Essar). This provides the double advantage of lowering emissions from fuels and other refining products, while at the same time allowing the storage of excess renewable electricity generated when supply exceeds demand. **One such project, established by Shell in the Port of Rotterdam, transform green electricity into renewable H₂ to be used to lower the GHG footprint of fuel produced in the nearby Pernis Refinery.** Hence, this technology also has the potential to strengthen the EU refining industry's leadership position in the deployment of future low-carbon solutions such as PTL and H₂ for mobility. A project initiated by **Repsol** in the **port of Bilbao** and its surrounding area in which 60 million euros will initially be invested, involves building **one of the largest net zero emissions synthetic fuel production plants** in the world, based on green hydrogen generated with renewable energy. These new fuels produced by using **water and CO₂ as the only raw materials**, can be used in internal combustion engines in cars, as well as in airplanes, trucks, and other machinery.
- The development of alternative fuels for production and for distribution is also an area of high interest for companies operating in the downstream petroleum industry. A project to produce methanol is being developed by **Eni/Fiat Chrysler** project. The alternative fuel is made from methanol from natural gas (15 %v/v) and ethanol from renewable sources, which are

then blended with oil refinery streams) and the deployment of a hydrogen refuelling station in Germany are notable examples (see **Shell/ITM Power** project).

- Another important example of the contribution that refineries can provide to a low-carbon society is waste heat from refineries used for civil heating (so-called "district heating") (**MiRO** project). Many oil companies are also researching and planning the implementation of CCS systems, where CO₂ emitted from industrial activities (including refineries) is collected and stored in safe and permanent reservoirs (usually depleted oil or gas reservoirs). Amongst those are the **Northern Lights** project (Equinor, Shell, Total), as well as the **CCUS Net Zero Teeside** project (Shell, Total, BP, ENI).
- In product distribution, some service stations are making available a wide range of alternative fuels and energy to drivers. They are also using self-generated renewable energy to make the service stations themselves energy- and carbon-neutral. These are likely to increase significantly, as new products are developed.
- Joint innovative business approaches in transport: the refinery and distribution industries are contributing jointly, together with other stakeholders, to several initiatives that could have an impact on consumers' lifestyles. An example is initiatives in urban car-sharing (see **Eni Enjoy** project).

These low-emission technologies are at different readiness levels. They will generate demand for sustainable raw materials, increase their process efficiency, and bring costs down through economies of scale.

Clean fuels for all

