ADVANCEFUEL

The impact of advanced biofuels

A new mobility system that facilitates reaching climate targets needs to take the palette of transport solutions into account. Liquid renewable fuels are especially suitable to decarbonise aviation and shipping. Their market uptake is feasible given supportive business cases enabled by a policy framework and sustainable feedstock.

Where can advanced biofuels contribute most to decarbonise different sectors?

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Transport is responsible for about one-fourth of global energy-related carbon emissions, therefore decarbonisation is of key importance to meet the 2015 Paris Agreement targets. The move towards greater electrification has been most prominent, and in most cases, the role of biofuels is ignored or not taken into account. Nonetheless, there is a lot of potential for liquid fuels produced from renewable raw material, but conversion pathways for advanced biofuels need to be further developed and improved in terms of economic feasibility. While looking for promising future fuels, different options should be compared in a fair and unbiased way based on complete life-cycle assessment (LCA) and techno-economic assessment (TEA). When looking at transportation from a global perspective, liquid biofuels are the only realistic solution in the aviation and maritime sectors, as well as in off-road and long-haul heavy-duty road transport where advanced biofuels can supply a significant portion of future demand. In the long-term (30-years timespan), there will be less interest in advanced biofuels for light-duty and commercial vehicles; global rail will be fully electrified; and the role of electrification will be much stronger for passenger cars.

What is the impact of advanced biofuels on road transport today and within the next decade in EU Member States?

Biofuels could play an important role in road transport and they already exist in the market. Ethanol is a good spark-ignition fuel, which is a component of gasoline. For instance, in E10 fuel, ethanol concentration varies and might reach 10% volume-based, which is still compliant with the EN 228 standard for gasoline fuel. For fossil diesel, we can find substitutes such as traditional biodiesel (FAME-type of fuel) or hydrotreated vegetable oil (HVO) from waste cooking oil, for instance; in spark- and compression-ignition fuels alike the alternatives

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being deployed are blending components. Globally, the majority of biofuels is produced in a conventional way via sugar fermentation (ethanol) or edible oils transesterification (biodiesel), and we barely see commercial-scale and competitive advanced biofuels. The role of advanced biofuels in transport is rather marginal.

The next decade is a perfect time to introduce advanced biofuels into the market as the fleet is dominated by ICE power-trains. However, lacking advanced biofuel production capacity, we cannot make a difference even though those new fuels could outperform fossil gasoline or diesel. **The questions are: will technology and policy allow for the more-competitive productions of advanced biofuels? And will favourable market-driven incentives emerge with regulation in the coming years?** By 2030, there will be slow uptake of advanced biofuels but beyond 2030 the forecast is more favourable: the average fleet in 2030 will most probably consist of currently sold vehicles, so beyond 2030 liquid fuels will be needed still in high volumes. This is why we expect more advanced biofuels in road transport beyond 2030 rather than in the next decade.

Regarding the current perception of internal combustion engines (ICE) and EU legislation, the "Diesel- gate" scandal created a bad reputation for diesel engines and ICEs in general. However, new technologies can reduce local emissions to minimum levels. Hence, NOx or particulate matter (PM) emissions are not an issue for newly sold vehicles compliant with New European emission standards such Euro6 limit. Therefore, if we use advanced biofuels compatible with aftertreament system, it is a very attractive future solution that is unfortunately not recognized by regulatory bodies. In EU legislation, the reductions of carbon emissions for different powertrains are compared based on tailpipe emissions only. This approach needs to be revised to promote using complete LCA or at least the well-to-wheel (WTW) approach instead. It may be that advanced biofuels are a more attractive solution than EVs in some cases.

What developments for advanced biofuels do you foresee by 2030 in the aviation sector?

Biofuels have already been approved for use in the aviation sector. Following ASTM certification, we can mention Fisher Tropsch synthetized isoparaffinic kerosene (FT-SPK), synthetized iso-paraffins (SIP), hydroprocessed fatty acid esters and fatty acids (HEFA) or alcohol-to-jet fuel (ATJ). These fuels can be used directly as kerosene blends in the concentration up to 50%, which is a positive indicator. On the other hand, the costs are higher when compared to standard fossil jet-A1 fuel but compliance with very stringent aviation requirements remains a convincing factor. The aviation sector solely depends on liquid fuels and no other solutions/powertrains seem to be viable options in the long-term. **The decarbonization of the aviation sector is possible by introducing advanced biofuels into the market.** This is happening at the moment but the total volumes of alternatives remain very low. Nevertheless, successful flights were performed multiple times on a commercial scale, which encourages future investments. **The market uptake of advanced biofuels in aviation is realistic, even before 2030.**

What role do renewable fuels play in the maritime sector and what is their expected development by 2030?

The role of biofuels in marine transport is marginal. In the past, a few tests were made but economic unfeasibility prevailed. Price is the most important factor hindering the market uptake of biofuels in the maritime sector. Maritime shipping is a global market and the main regulatory body International Maritime Organization (IMO) does not have any specific fuel-related requirements while speaking about carbon emission reductions. There are more stringent regulations regarding sulfur and NOx in some emission control areas (ECA). However, the sector is gradually changing and a good example is the global sulfur cap limiting sulfur content of bunker fuel starting in 2020. The IMO's initial strategic GHG reduction plan should be finalized soon. More stringent regulations regarding CO2 emissions are needed in maritime transport in the coming years. There is also the related question of who will pay for higher transportation costs? In the maritime

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transport market, it is hard to compete with fossil fuels, especially when taking into account the Heavy Fuel Oil (HFO)usage, which is a residual and dirty but at the same time very cheap fuel.

More refined fuels are needed in aviation and road transportation because with current production capacity we cannot provide fuels to the maritime sector within next decade. Maritime shipping is losing its competitive edge with the aviation and road sectors, where end-user is willing to pay more for the final fuel product. Therefore, I do not foresee a significant impact of renewable fuels in the shipping in the next decade. To be more realistic, we need to be patient and wait for some optimistic signs from the market dominated by fossil fuels such as HFO or marine diesel oil (MDO). Market shifts are on the horizon with the hot topic of the “sulfur cap” and there are different ways to meet low-sulfur requirements, such as low sulfur MDO, gaseous fuels, HFO with suitable aftertreatment system (scrubbers), and biofuels. Unfortunately, advanced biofuels are at the very end of this list, mainly due to their higher price levels, which remains a massive obstacle. There will be no significant impact of advanced biofuels in shipping by 2030 but beyond new technological solutions and legislation will provide greater optimism.

What future do you see for the end use performance of advanced renewable liquid fuels?

Advanced biofuels have the potential to outperform fossil-based fuels. Renewable alcohols such as methanol, ethanol or butanol could benefit from higher octane ratings. It is interesting that methanol was used as a racing fuel due to higher performance related to its physicochemical properties, mainly high octane number and heat of evaporation. There are also some drawbacks in comparison to reference gasoline, for example cold start problems during wintertime. However, engine technology development brings solutions and in the future the full potential of biofuels could be exploited. In the case of alcohols, those are simple molecules and the production process is of secondary importance. Therefore, it does not matter for the end-use performance whether ethanol is produced in a conventional or an advanced way.

Looking at diesel consumption, HVO (which is a paraffinic fuel) performs very well in engines and can significantly reduce PM emissions and decrease fuel consumption. Modified engines should be able to explore the potential of high fuel reactivity. However, upgrading bio-oil is a very important aspect when producing advanced biofuels for compression-ignition engines. Looking more generally on the fuel properties, **it is not an easy task to design new fuels compatible with existing infrastructure and engines.** Drop-in characteristic of the fuel allowing for the introduction of renewable fuel without any changes in the whole infrastructure is something desired and recommended by OEMs (Engine manufacturers). When it comes to the fuel physicochemical properties, calorific value (LHV) should be checked. It would be very beneficial to have LHV around 35 MJ/l what is not always the case for biofuels. LHV together with density determines the volume of storage tank. Then there are plenty of other properties related to usability aspects of the fuel in internal combustion engine (ICE) dependent on the final application. Here we can mention fuel reactivity, cold flow properties, viscosity, and lubricity. **It is also very important to look at the specifications while blending renewable components with fossil-based gasoline or diesel.** Ultimately, beyond the specifications and technicalities mentioned here, the end-use performance matters a lot too – and it is essential for us, as the final consumers, to be more sustainable!

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