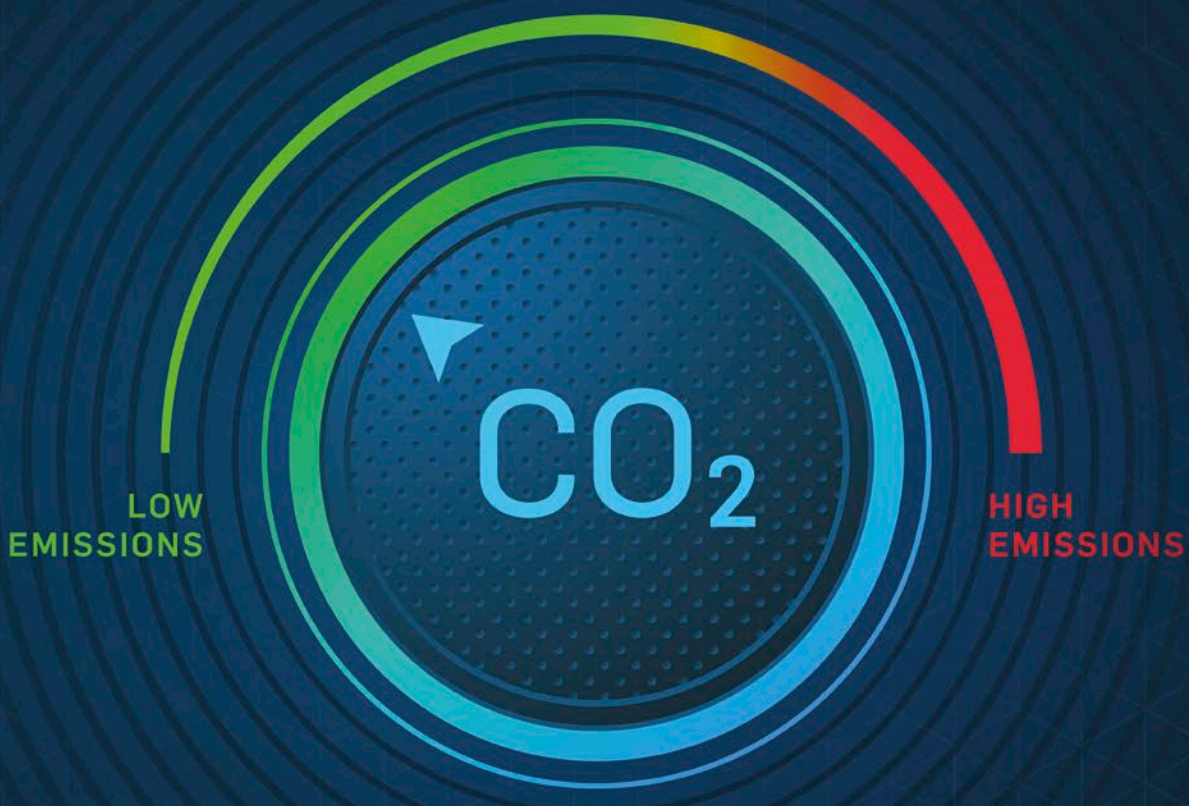
Energy accounting for the climate



The new, fourth fuel study published by FVV expands the framework of the previous studies in a number of ways: alongside societal costs and various environmental factors, it also compares the cumulative CO_2 emissions for various energy sources and powertrains and demonstrates how these emissions stack up against the CO_2 budget set for Europe. This analysis shows that it will not be possible to meet the 1.5-degree target without taking existing vehicles into account.

The overall result is all that matters //

Whether or not CO_2 neutrality is achieved in the year 2050 has no bearing on whether the goals set out in the Paris Agreement are met; what matters is the absolute volume of greenhouse gases emitted up to that point. The aim of the new study is to develop technological paths that will enable the European transport sector to meet the Paris climate objective.

Unlike in many other studies on this topic, project manager Ulrich Kramer's team decided to adopt a holistic cradle-to-grave approach that factored in all relevant emissions, from vehicle production and the creation of a sustainable energy supply through to use and recycling. The study also included emissions generated by the creation of the infrastructure, such as the construction of wind turbines, electrolysers and charging columns. Using this approach, the study calculated the cumulative emissions of six energy sources and seven powertrain technologies up to the year 2050. The study – for which around 60 FVV member companies supplied data and contributed their expertise – was conducted by Frontier Economics, a consultancy firm specialising in energy issues, in partnership with the Heidelberg-based Institute for Energy and Environmental Research (ifeu), which provided information on the environmental impact of each technology path and calculated the available CO_2 budget.

The most important result was that regardless of which of the 42 studied technology paths Europe selects, the continent will exceed its greenhouse gas budget by 2032 through transport emissions alone. This is because vehicles that are already in circulation – and that will no longer exist by 2050 – account for the majority of emissions. Regardless of the scenario, if the rate of introduction remains the same, these vehicles will account for around 70 per cent of the overall emissions. Kramer concludes: »The faster a technology or a mix of technologies can replace the use of fossil fuels in the transport sector, the better it will be for our climate. The rate at which sustainable energy is rolled out in the transport sector is key to achieving the CO_2 targets.«

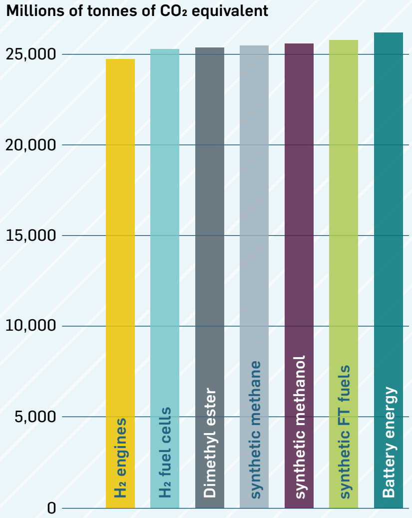
At identical rates of introduction, the various technology paths will all generate roughly the same level of cumulative CO_2 emissions between 2021 and 2050: there is just a 14 per cent difference between the most climate-friendly scenario – switching to green hydrogen and using it in combustion engines – and the least beneficial scenario, which is the use of Fischer-Tropsch fuels produced in Germany. Delaying or accelerating the introduction of any of these technology paths will drastically alter the rankings. »This is why it is essential to take the potential rates of introduction into account if we want to define efficient climate strategies,« explains Kramer.

Photo: Fajar, Adobe Stock

The study also highlights significant differences between the technologies in numerous other areas. The amount of energy required for the transport sector, for example, varies between 2,000 and 10,000 terawatt hours, with battery-powered electric vehicles – predictably – performing best. However, the study also shows that if synthetic fuels are produced in sunny or windy regions outside Europe, fuel cells only require around twice as much energy as purely battery-powered mobility, while combustion engines need three to four times as much. Furthermore, to run vehicles on electricity alone in a completely sustainable energy system, a huge amount of electrolysis capacity is required to safeguard the energy supply for transport during ›dark periods‹ where there is no sun or wind. By 2050, relying solely on electric mobility from domestic sources would require us to establish electrolysis capacity of around 1,000 gigawatt hours – almost as much as we would need if we were to exclusively use fuel cells. Other paths require up to 2,200 gigawatts of installed capacity. To put these figures in context, the EU is currently planning to build 40 gigawatts of electrolysis capacity by 2030, to cover all sectors.

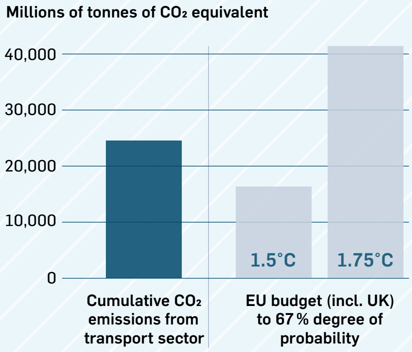
If we add up all the costs of building the required infrastructure incurred by 2050 along with the additional costs of alternative powertrains, the economic picture looks completely different: the most cost-effective way to achieve climate-neutral transport is to use methanol generated with green electricity as an energy source. The option of using sustainably produced Fischer-Tropsch diesel and petrol in existing vehicles comes in at number three in the rankings. The most expensive option

Cumulative greenhouse gas emissions for the European transport sector, 2021 to 2050



→ If we consider all of the greenhouse gas emissions from the entire energy chain and the creation of energy infrastructure, there are only minor differences between the various energy sources.

Comparison of cumulative greenhouse gas emissions up to 2050 with the EU budget (incl. UK)



→ Regardless of which alternative energy sources and converters are chosen, existing vehicles account for the majority of total emissions generated by the transport sector.

is battery-powered mobility, followed by a combination of hydrogen and fuel cells. »This is because of the high additional costs of the vehicle, which dominate the overall costs,« explains Kramer. »However, it is good to know that the complete defossilisation of the European transport sector can be achieved at a cost of no more than one per cent of the European gross national product per year over a period of 30 years.«

The authors of the study were also tasked with identifying potential bottlenecks that could arise in the process of getting the various paths up and running. Land use is not an issue for any of the technology paths, partly because none of the scenarios investigated involved using biomass as a primary energy source for road transport. The situation is somewhat different when it comes to the raw materials required for a full electrification of the transport sector. At the very least, if this solution were to be scaled up rapidly – as would be preferred given the meagre remaining CO_2 budget – there is a potential for bottlenecks to arise in the lithium and cobalt supply chain for batteries. For fuel cell powertrains, the high volumes of platinum required could become a bottleneck.

According to project manager Kramer, the fact that the new, fourth fuel study published by FVV bases its projections on 100-per cent scenarios in which we rely solely on one solution gives it a decisive advantage over other studies: »This is the only way we can properly compare the carbon footprint and costs along the entire energy chains, including the required infrastructure.« The data obtained from this analysis could be used to calculate the impact of mixed scenarios at a later stage. »I think it would be sensible to conduct a follow-up study to look in detail at the timing bottlenecks we could encounter during the introduction of the various energy and powertrain paths,« says the expert. »This study should also consider the feasible rate at which the use of synthetic fuels in existing vehicles can be ramped up.« One thing is already very clear from the FVV study: »Modelling the entire energy system is the only way to obtain valid results.«

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