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The FVV Transfer + Networking Event | Autumn 2022

Knowledge and technology transfer | New research programme

Science for a moving society

Future fuels and energy sources: transformation of the European mobility sector // see complete project data from p. 20

PROJECT 1452 · FVV Fuels Studies · Part IVb
RESEARCH PRIORITY Orientation study **EXPERT GROUPS** Board, Sustainable Power Systems **APPLICATIONS** Cars, Light, Medium and Heavy-duty Vehicles

Keynote: how quickly can we be **sustainable?**

Diversity is also essential in science, so that we can not only think openly about the future, but also enable an efficient and sustainable future. A critical view must be taken of banning specific technologies, as this is more likely to delay than accelerate the transition to CO_2-neutral powertrains. Another FVV study on the fuels of the future has analysed how greenhouse gas neutrality can be achieved as quickly as possible in the European transport sector, taking the ramp-up potential of individual technology pathways into account.

FVV gives insights into sustainable pathways to climate neutral mobility

The European automotive industry is facing many challenges – rising energy prices, shortages of raw materials and interrupted supply chains to name just a few. And the future is more than uncertain. Given these conditions, is it really a good idea to put all our eggs in one basket? Would greater diversification not produce benefits in terms of the sustainability and competitiveness of future powertrain technologies?

These were the questions examined in an extensive study entitled ›**Transformation of Mobility to the GHG-neutral Post-fossil Age**‹, which was published in October 2021. The results of a supplementary study were presented at FVV's Autumn Meeting in Würzburg.

It contains four key features:

- Greater focus on the road sector
- Addition of new combinations of powertrains and greenhouse gas-neutral energy carriers (plug-in hybrid electric vehicles and methanol-to-gasoline (petrol) drop-in fuel)
- Consideration of the technical potential for expansion of non-fossil transformation pathways for European road transport (EU27+UK)
- Examination of a technology mix that provides optimum support for the transition to greenhouse gas neutrality

In particular, the supplementary study takes into consideration the achievable ramp-ups of new vehicle technologies, the power generation and distribution infrastructure, and the raw material supply on a quantitative basis. The ramp-up potential of non-fossil transformation pathways is highly significant in order to adhere to the remaining theoretical greenhouse gas budget that applies in Europe in line with the Paris climate goals.

The new model-based optimisation and analysis framework applied in this study explicitly looks at the question of how the cumulative greenhouse gas emissions in the road sector in the EU27+UK could be minimised. The results show that a mix of carbon-neutral transformation pathways can considerably accelerate the transition to greenhouse gas neutrality compared to scenarios with a single technology option. A technology mix thus significantly reduces the cumulative greenhouse gas emissions over time.

The results can be summarised as follows:

- **A mix of carbon-neutral energy carrier/ powertrain pathways can speed up the transition to GHG neutrality for the EU27+UK road sector:** The study shows that all carbon-neutral pathways face bottlenecks of various kinds, constraining the maximal deployment rate for each individual technology. A mix of technologies can, therefore, accelerate the penetration of carbon-neutral energy carrier and powertrain technology pathways (›technology pathways‹) significantly [FIGURE 5+6]. A combination of technology pathways could thereby reduce cumulated GHG emissions significantly: For example, a scenario focussing on BEV (with domestic energy sourcing) as the only GHG-neutral technology pathway available yields to 39 % higher cumulated GHG emissions by 2050 compared to a mix of GHG-neutral technology pathways. This further translates in the single technology BEV pathyway only achieving a 76 % defossilisation rate of the EU27+UK vehicle stock until 2050 – while the GHG optimised mixed technology scenario allows to achieve carbon-neutrality (100 % defossolisation rate) by the year 2039 already.

- **The decisive factor to minimise GHG emissions is the fastest possible departure from fossil fuels – infrastructure and material bottlenecks need to be addressed quickly:** In order to minimise GHG emissions in the EU27+UK road sector infrastructure and material bottlenecks need to be addressed quickly. This holds in particular for the necessary scale-up of infrastructure and material availability across technologies.

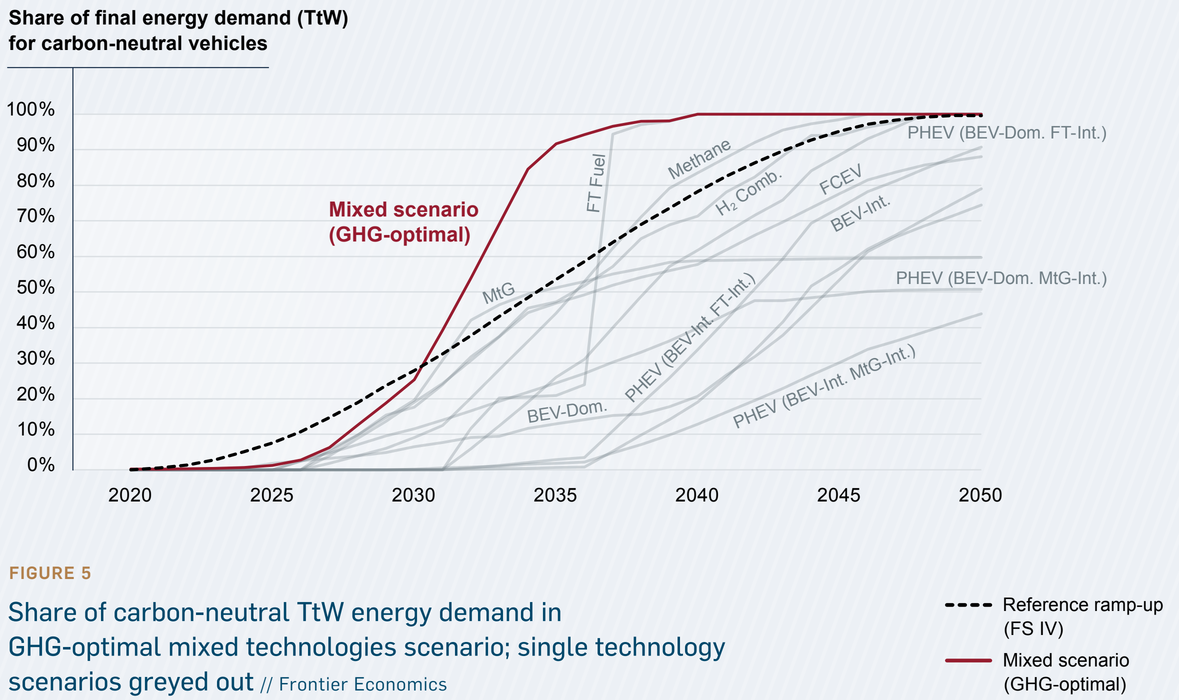

FIGURE 5

Share of carbon-neutral TtW energy demand in GHG-optimal mixed technologies scenario; single technology scenarios greyed out // Frontier Economics

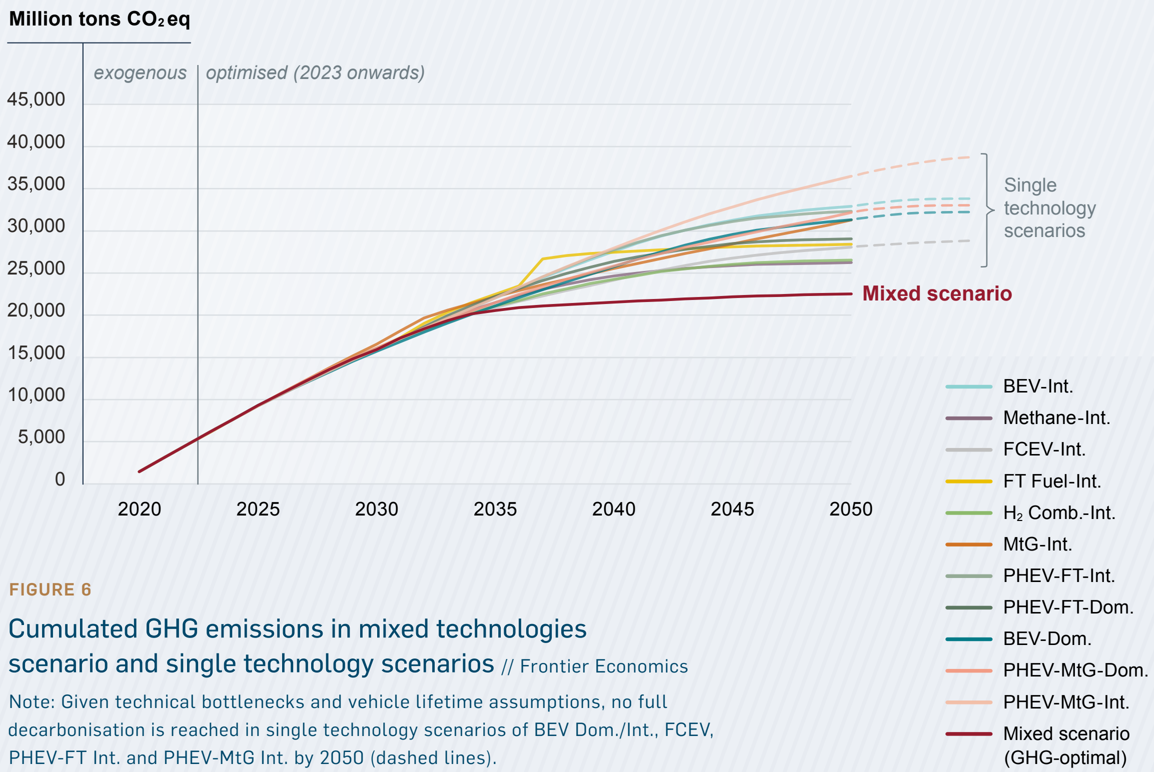

FIGURE 6

Cumulated GHG emissions in mixed technologies scenario and single technology scenarios // Frontier Economics

Note: Given technical bottlenecks and vehicle lifetime assumptions, no full decarbonisation is reached in single technology scenarios of BEV Dom./Int., FCEV, PHEV-FT Int. and PHEV-MtG Int. by 2050 (dashed lines).

- **E-fuels provide a unique technology option to carbon-neutrally operate the existing fleet:** Backward compatible energy carriers such as e-gasoline and e-diesel (e. g. via Methanol-to-Gasoline and Fischer-Tropsch pathways) allow a quick defossilisation of the existing vehicle fleet once they become available at large scale. Despite long lead times for setting up synthesis plants, they can, therefore, accelerate overall GHG reductions.

- **Banning ICE vehicles from 2035 would lead to higher GHG emissions than necessary:** While a defossilisation of the EU27+UK road sector could also be achieved without ICE vehicles, this would in turn increase cumulated emissions and cumulated total costs, as it further reinforces dependencies on critical technical bottlenecks and limits the option to accelerate further defossilisation through compatible synthetic energy carriers (e-gasoline, e-diesel) to any existing ICE vehicle fleet.[1]

- **Shifting the heavy-duty segment towards carbon-neutral technology pathways is a big lever to enable significant GHG emission savings:** While heavy-duty vehicles only make up for approx. 2 % of the EU27+UK vehicle stock, they account for approx. 45 % of today's overall total fuel consumption of the European road sector.[2] Therefore, they hold an enormous potential for GHG emission savings. //

[1] We note that in the ICE ban scenarios considered in this study it is still possible to operate the existing legacy fleet with e-fuels until the end of their lifetime, see Section 6.2. In contrast, new vehicles registered after an effective ICE ban (i. e. in 2035) cannot be operated with e-fuels and therefore rely on technology pathways excluding internal combustion engines. While this approach may seem unrealistic under the current EU ›Fit for 55‹ policy approach, it is consistent with our general assumption in this study assuming ideal financial and legal conditions for all powertrain technologies available.

[2] Assessment by Frontier Economics based on ACEA data. See ACEA (2022a), ›Vehicles in use Europe 2022‹, https://www.acea.auto/files/ACEA-report-vehicles-in-use-europe-2022.pdf (last accessed: 08.09.2022).

See also:
Further information in the science story »How quickly can we be sustainable?«
→ www.fvv-net.de/en/

DR.-ING. ULRICH KRAMER

Our modelling approach ventures a look into the future and shows what is possible from a technological point of view and what would be reasonable with respect to the ultimate goal. However, it is not a forecast. // FVV

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AUTHOR

Richard Backhaus, Wiesbaden

EDITORS

Petra Tutsch und
Martin Nitsche, FVV

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Transfer // Industrial Collective Research (IGF) empowers companies to solve joint research and technology problems on a science-based approach. It provides access to a continuous stream of new knowledge they can use to create their own products, processes and services. Industrial research and development benefits from the fact-/field-based collaboration with the science community, universities and non-profit research institutions, on the future of technology. This creates innovative power in industry and excellence in research, teaching and learning.

Networking // The research implemented by the FVV is based on a long-term cooperation between the partners. In spring and autumn, around 300 experts meet regularly at the FVV Transfer + Networking Events. This report from the science series FVV Prime**Movers.** Technologies. summarises the main results.

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Lyoner Strasse 18 | 60528 Frankfurt / M. | Germany
+49 69 6603 1345 | info@fvv-net.de

www.fvv-net.de