Analysis of European Vehicle Technology Development Based on the A3PS Roadmaps and Presentations at the Eco-Mobility Conferences

Introduction

The reduction of CO_2 and other pollutant emissions has become a central challenge for the automotive industry and their related research and development activities in recent years, due to new, stringent regulations implemented by the European Union and national governments aimed at protecting the environment and climate. The objective of this bachelor's thesis is to summarize and compare the roadmaps published by the Austrian Association for Advanced Propulsion Systems (A3PS) with the actual development of the mobility sector and selected ERTRAC reports, and to assess the influence of political decisions on the structure and content of the roadmaps.

The A3PS is a partnership of the Austrian Federal Ministry for Innovation, Mobility and Infrastructure, research institutions, and industry partners. Its main objective is to create a platform for discussing and analyzing current and future research, as well as development trends, in the Austrian automotive sector. To discuss and outline the relevant research and development demands, the A3PS hosts the annual international conference Eco-Mobility in Vienna and publishes roadmaps.

Structure and Development of the A3PS Roadmaps

The roadmaps provide an overview on relevant short-, medium- and long-term research and development trends, as well as needs of the Austrian automotive sector, including powertrains, renewable fuels and energy carriers, life cycle assessment, advanced powertrain integration technologies, and vehicle control systems.

In the 2011 roadmap, the relevant powertrains were divided into two categories: optimized internal combustion engines and alternative powertrains, including fuel cell, battery and hybrid electric vehicles. The 2015 and 2018 roadmaps both distinguished

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between advanced internal combustion engines, full and partial electric systems, and fuel cell electric vehicles. The 2022 roadmap; however, followed a completely different structure, with the three categories: battery electric powertrain technologies, fuel cell technologies and hybrid automotive powertrains. For the first time, the internal combustion engine was not listed separately but exclusively as part of hybrid powertrain systems. This restructuring can be attributed to the introduction of the European Green Deal (2019) and the Fit for 55 package (2021) by the European Union, as new fleet emission regulations for passenger and light-duty vehicles set a 100% CO_2 emissions reduction target from 2035 onwards.

Comparing the Roadmaps Projections to the actual Development of the Road Transportation Sector

Compared to the actual development of the mobility sector in both Austria and the European Union, the roadmaps correctly projected the increasing electrification of passenger vehicles. Among new registrations, hybrid and battery-electric passenger cars have gained a significant market share in recent years. This aligns well with the need for research and development activities in battery and electric powertrain architectures, as emphasized in the roadmaps. Fuel cell technologies have been extensively discussed in the roadmaps; however, the number of fuel cell electric vehicles has remained negligible. Although the number of alternatively powered cars has steadily increased, among the total vehicle fleet in both Austria and the European Union, the internal combustion engine remains the most dominant powertrain technology as projected by all roadmaps.

For depot-bound heavy-duty operations, hybrid and battery electric vehicles are considered suitable by the roadmaps. Additionally, city buses are mentioned as an early market for fuel cell vehicles. Nevertheless, diesel engines have remained dominant in both new registrations and the existing fleet of trucks and buses. Vehicles powered by natural gas and biomethane were also mentioned in the 2011, 2015 and 2018 roadmaps to potentially reduce emissions. However, the number of these vehicles has remained small in both the European Union and Austria.

The roadmaps highlight that renewable fuels and carbon-neutral energy carriers offer the largest potential for reducing greenhouse gas emissions. Regarding sustainable fuels the

roadmaps list among others the increasing importance of HVO as a substitute for fossil diesel and the transition towards more advanced feedstocks for FAME biodiesel and bioethanol to avoid conflicts with food production. Other biofuels such as biomethane, Fischer-Tropsch fuels from biomass, bio methanol, OME, DME, and algae-based fuels are also listed in various roadmaps. The potential and importance of hydrogen as a renewable energy carrier for reducing CO_2 emissions are also discussed extensively from 2015 onwards. As of 2025, only FAME biodiesel, bioethanol, and HVO are widely used in road transport. To increase the adoption of renewable energy in road transport, the European Union implemented the Renewable Energy Directive II, which is identified in the roadmaps as a key driver for the development and introduction of sustainable fuels and energy carriers.

Analysis of the ERTRAC Roadmaps

At the European level, the European Road Transportation Research Advisory Council (ERTRAC) serves as a strategic platform for research activities related to road transportation. Compared to the roadmaps published by the A3PS, the selected ERTRAC reports provide a more in-depth assessment of the relevant renewable energy carriers and powertrain technologies. However, the content and the conclusions reached by both organizations are consistent with each other, which can be seen as both the 2022 ERTRAC and A3PS roadmaps list the internal combustion engine, solely fueled by sustainable fuels as part of hybrid powertrains and difficult to decarbonize heavy-duty applications.

Analysis of the Presentations of the Eco-Mobility Conferences

The Eco-Mobility conference, hosted annually by the A3PS, features presentations on the automotive industry's current and future research activities related to advanced and sustainable mobility. Battery and hybrid electric systems have been the focus of numerous presentations over the years. Similarly to the A3PS roadmaps fuel cell technologies and hydrogen as a sustainable energy carrier have been extensively discussed in many presentations. Despite the internal combustion engine remaining the most dominant powertrain technology in road transport, the share of presentations since 2010 featuring this subject is small.

Conclusion

Overall, the A3PS correctly anticipated the increasing electrification of road transport and the continued strong presence of the internal combustion engine, especially for heavy-duty applications. Although hydrogen and fuel cell electric vehicles have been extensively discussed, these technologies have not yet been rolled out on a large scale. It can be concluded that the introduction of the new European fleet emission regulations and the Renewable Energy Directive II are key drivers for the development of advanced powertrains and renewable energy carriers.

This executive summary is derived from the bachelor thesis of Peter Straubinger at the Vienna University of Technology. Please contact A3PS if you are interested in this document.

Graphic depiction of the actual change of the mobility sector, compared to the projections listed in the A3PS roadmaps; own illustration