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Comparison of Hydrogen and Electrification Perspectives in Decarbonizing the Transport Sector

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Abstract : The transport sector is currently responsible for approximately 1/3 of greenhouse gas emissions in Europe. In the wider context of achieving carbon neutrality of the global energy system, different alternatives are available to decarbonizethe transport sector. In particular, while electricity is already the most consumed energy commodity in rail transport, battery electric vehicles are one of the zero-emissions options on the market for road transportation. On the other hand, hydrogen-based fuel cell vehicles are available for road and non-road vehicles. The European Commission is strongly pushing toward the integration of hydrogen in the energy systems of European countries and its widespread adoption as an energy vector to achieve the Green Deal targets. Furthermore, the Italian government is defining hydrogen-related objectives with the publication of a dedicated Hydrogen Strategy. The adoption of energy system optimization models to study the possible penetration of alternative zero-emitting transport technologies gives the opportunity to perform an overall analysis of the effects that the development of innovative technologies has on the entire energy system and on the supply-side, devoted to the production of energy carriers such as hydrogen and electricity. Using an open-source modeling framework such as TEMOA, this work aims to compare the role of hydrogen and electric vehicles in the decarbonization of the transport sector. The analysis investigates the advantages and disadvantages of adopting the two options, from the economic point of view (costs associated with the two options) and the environmental one (looking at the emissions reduction perspectives). Moreover, an analysis on the profitability of the investments in hydrogen and electric vehicles will be performed. The study investigates the evolution of energy consumption and greenhouse gas emissions in different transportation modes (road, rail, navigation, and aviation) by detailed analysis of the full range of vehicles included in the techno-economic database used in the TEMOA model instance adopted for this work. The transparency of the analysis is guaranteed by the accessibility of the TEMOA models, based on an open-access source code and databases.

Keywords : battery electric vehicles, decarbonization, energy system optimization models, fuel cell vehicles, hydrogen, open-source modeling, TEMOA, transport
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