Environmental assessment of conventional and alternative vehicles and fuels in a Belgian context

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The transport sector plays a key role in the development of modern societies. It is essential to the development of all the economic activities. Because of the growing number of human beings and as a consequence the growing transport demand, modern societies have to develop transportation solutions which can conciliate the satisfaction of the population's needs and the protection of the environment. Developing clean transportation systems will require both technological innovations and policy measures. However, the policymakers and the vehicle manufacturers will need to know in advance the potential environmental benefit of their decisions and future products in order to better integrate the environmental dimension in their projects. Different regulations and standards have been developed to improve the ecological quality of both vehicles and fuels. Moreover the introduction of new vehicles on the market is submitted to strict vehicle homologation rules in terms of performance, safety and environment. Different technological improvements of conventional vehicles (petrol and diesel) have been made by vehicle manufacturers and engine scientists. New vehicle powertrains are also being developed in the automotive community. Full electric and hybrid electric drivetrains are the most promising technologies in this sector.

Different vehicle environmental assessment tools exist. However, only Life Cycle Assessment (LCA) can allow a detailed and comprehensive environmental assessment of vehicles. In this PhD, an LCA of conventional and alternative vehicles is performed in a Belgian context. The main goal of this study is to perform a comparative assessment of different vehicles (conventional and alternative) in order to promote the purchase and the use of clean vehicles in Belgium. The model includes all the life cycle steps (production, transport, use phase, maintenance and end-of-life). A dedicated modelling approach allowing the integration of all the Belgian registered vehicles in a single model has been developed. Vehicle homologation data are combined with the LCA methodology for that purpose. The most appropriate data for all the life cycle phases of all the considered vehicles have been gathered, treated and adapted when necessary. Data quality is systematically checked according to defined quality criteria. Because of the big number of parameters and information involved in the model, statistical tools are used to treat the LCI data in order to better reflect the diversity of situations and the influence of the variation of the modelling parameters on the LCA results. Range of values instead of average values have been used for the main parameters of the LCA model in order to have a global and detailed environmental picture of both individual and group (technology, segment, Euro emission regulation...etc.) of vehicles. This approach allows drawing strong conclusions which are based on most likely values instead of extreme values. Additionally, this approach is particularly time-efficient because it allows performing new vehicle LCA on the basis of the generic model by editing some few parameters. Furthermore, the model allows systematic sensitivity analysis. A list of environmental impact categories, which are considered to be relevant for this study by a follow-up committee, is set with respect to the International Reference Life Cycle Data System criteria. Because of the large variety of environmental impact categories, it is almost impossible and sometimes misleading to claim that a vehicle is better than the others from all viewpoints. Detailed LCA results including sensitivity analysis are produced for different vehicle technologies and segments of the Belgian market. Furthermore, the results of this study are crosschecked and validated with other comparable studies. Finally, the Ecoscore methodology, which is a Well-to-Wheel tool, has been validated with LCA results produced in this PhD.