Master Thesis Project, 2022-2023

Techno-economic assessment of the scalability of electric powertrains for electric vehicles

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Context

Providing well-founded statements in the early stages of the development of an automotive project concerning the performance of the electric powertrain is overdemanding. This is because of the continuing change in requirements from one vehicle to another, the large design space of possible powertrain architectures, and the variety of components technology. Furthermore, the 2030 target of a 55% reduction in net greenhouse gas emissions (1990 as baseline) drives the automotive sector to design new vehicles and components at a rapid pace. In this context, the STeVE[1] project targets a reduction of the lead time of Electric Vehicles (EV) by accelerating the design process through a scaling methodology for the key components of electric powertrains: inverter [1]; electrical machine [2] and gearbox. The scaling methodology will allow defining high-level specifications of a wide range of EV, namely the energy consumption, components sizing, etc. Nevertheless, technical adequacy is not solely the relevant factor for the success of an automotive project. Assessing the Total Cost of Ownership (TCO) of powertrains is becoming a crucial factor for vehicle manufacturers. Trade-offs between all the possibilities of both technical suitability and cost are necessary to find the optimal solution [3]-[4], not for each component, but for the whole powertrain.

Objective

This master thesis aims to develop an "easy-to-use" method to find trade-offs between the energetic performance and the TCO of the powertrain to reduce the lead time of a new EV concept. For this aim, it is necessary to establish an up-to-date cost framework for the components of the electric powertrain. This framework should allow assessing the cost of different technology solutions for powertrain components and the sizing impact on the cost including, for example, 400V and 800V rated powertrains, different transmission technologies, etc. On top of that, the established framework should consider the cost of manufacturing steps required to produce a component. From a system perspective, the impact of system-level specifications on cost, such as maximal speed, acceleration time, mass, aerodynamic drag, etc., have to be assessed. The method should be flexible, generic and applicable to different classes of vehicles. This work could be a basis for a more global environmental-oriented assessment that takes into account the whole lifespan of the components and the availability/recyclability of the materials used.

Keywords

Electric vehicles, scalability, energy consumption, costs, design methodology, optimization, Energetic Macroscopic Representation

References

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[1] STeVE (Scalability of powerTrain for electrified Vehicles of an Eco-campus) is one of the projects of the CUMIN program (Campus of University with Mobility based on Innovation and carbon Neutral) of the University of Lille, which aims to develop a demonstrator campus, based on electro-mobility- https://cumin.univ-lille.fr/