

Electric and hybrid powertrains are currently regarded as promising emerging technologies for propulsion of vehicles with potential to reduce greenhouse and other exhaust gas emissions from road transport (Nemry and Brons 2010; Sadek 2012). The scope consists of the methodological choices made to address the stated goal, ensuring that the conclusions of the study are sufficiently supported, for example in selection of technical scope, time horizon, and level of impact assessment. Others claim that the prospective for electric cars to reduce the environmental impacts of mobility is "substantially overrated" (Frischknecht and Flury 2011) or that they will lead to "significant increases in human toxicity" (Hawkins et al. 2013a). Few reviews have been carried out in the field of LCA of electric vehicles, synthesizing results and assessing the scope of the research field. In the most thorough, Hawkins et al. (2012) benchmarked 55 studies and surveyed what 51 of them cover in terms of scope compared to their own recommended practice and definition of a state-of-the-art complete LCA of electrified vehicles. The review commendably discusses and evaluates the datasets used in the research field, and identifies gaps in the inventories of the main components such as batteries, electric motors, and electronic equipment. It also presents an analysis of greenhouse gas (GHG) emissions for the complete life cycle across studies, including meta-analysis of the effect of assumptions regarding lifetime on impact from production of equipment and discussions on how battery production and use phase energy efficiency affect the results. Additionally, the history of life cycle assessments of electrified vehicle is summarized; various technical aspects of vehicle electrification such as charging management is described and uncertainty in results is discussed. Among conclusions, Hawkins et al. (2012) do not find any of the reviewed 51 studies to comply with their definition of how a complete state-of-the-art LCA of electrified vehicles should be conducted, and hence request more rigorous and complete inventories and studies. The quality of "stylized studies," described as studies based on rudimentary inventories and a low level of detail, is questioned. They conclude that electric vehicles have many benefits over conventional ones, but that the LCA literature on the subject "is complex." Overviews are also provided in a conference report by Frischknecht and Flury (2011), in an appendix to a case study by Ma et al. (2012) and an editorial by Althaus (2012). Althaus (2012) observes that results come out as diverging and that there is "a rather weak consensus" on the environmental performance of electric vehicles. The arguments are that electric powertrains are more energy efficient for propelling vehicles than conventional internal combustion engines fuelled by petrol or diesel, and that full electric propulsion does not emit tailpipe emissions (IAE 2011; Sadek 2012).