Development of an Emission and Life Cycle Assessment (LCA) Tool for different Ride-Pooling Vehicle Types

Master‘s Thesis of Arpitha Gowda

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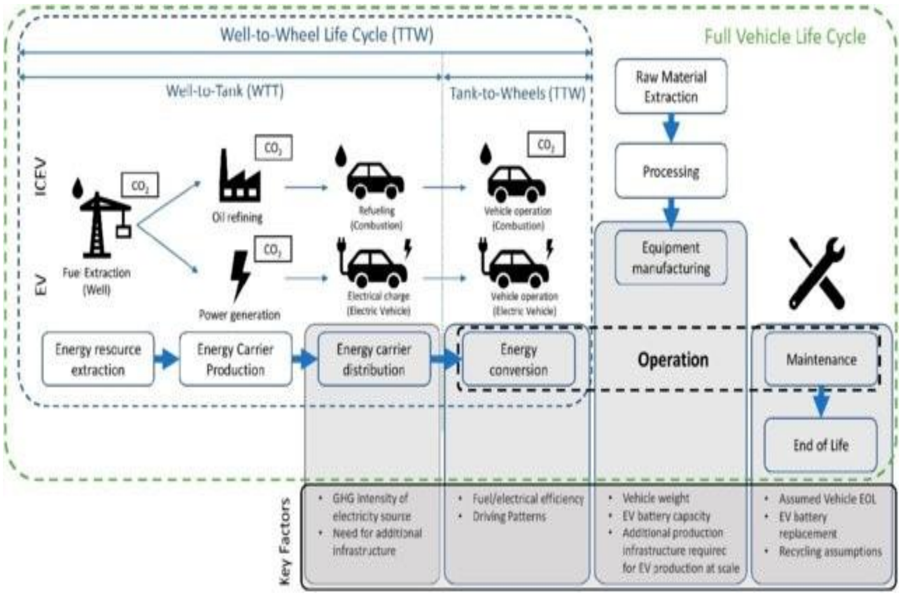

Fig. 1: Illustration of vehicle life cycle (Dillman et al.,2020)

Introduction

Increase in level of Greenhouse Gases (GHG) in the atmosphere induces complex switch in earth's climate and weather structure. Germany in the 2015 Paris summit has outlined an effective emission reduction procedure outlined as Climate Action Plan-2050. In order to reach these defined goals all sectors has to be given equal attention. Especially road transportation as it is contributing less emission reduction effects in the recent years. Therefore, Number of measures has been proposed among which, modal shift to electric vehicles (EVs) is prominent. However, the benefits of EVs is still uncertain and many questions are unanswered. This requires a detailed analysis regarding impact assessment of EVs in comparison to conventional vehicles. For this process, Life Cycle Assessment (LCA) is considered to be an effective methodology. Therefore, it's the aim of this master thesis to apply LCA methodology to assess and compare EVs with ICEVS in different ride pooling vehicle technologies.

Goal and Scope:

- Main aim of this study is to implement LCA methodology to assess the environmental impacts of different vehicle types of a ride pooling system i.e., passenger car, van, truck and rickshaw for both Internal Combustion Engine(ICE) and Battery Electric (BE) versions in every stage of life cycle, mainly focusing on use and after-life stages.
- Functional unit - Emissions in kilogram per one driven kilometre (Kg/Km)

System boundaries: Fig. 2 represents the system boundaries, all the processes that are mentioned out of the system are shown outside of the dotted lines which are marked with red arrows.

Inventory and Impact assessment: Data regarding each phase is collected as required for the analysis and processed as a part of inventory. The results are expressed in impact assessment steps.

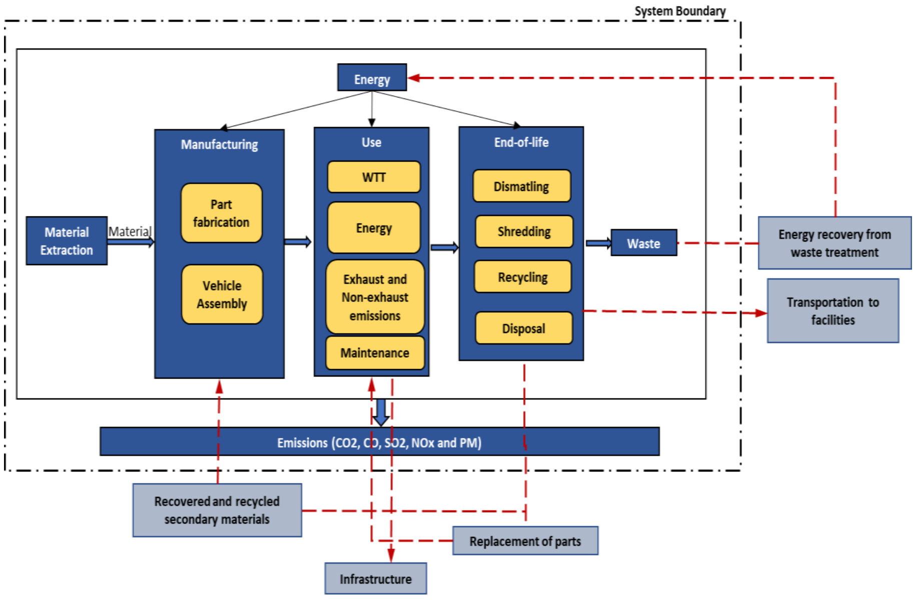

Fig. 2: Schematic representation od system boundaries

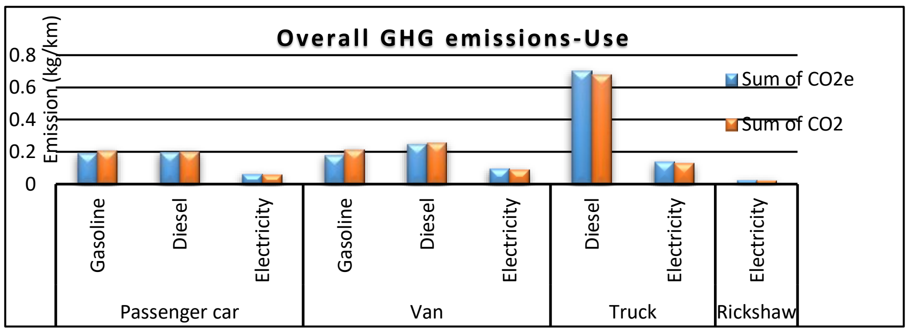

Fig. 3: Use phase GHG emissions inclusive of all processes

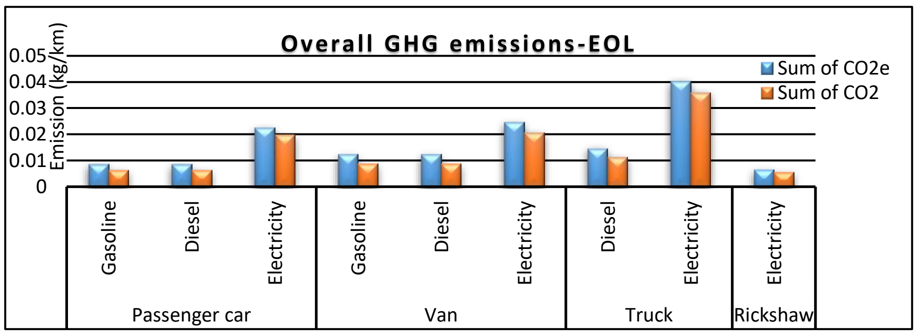

Fig. 4: EOL phase GHG emissions inclusive of all processes

Conclusions: In conclusion, every phase of this life cycle assessment has different outcomes in comparing BEVs with ICEVs. BEVs show higher impacts in well-to-tank (WTT) and end-of-life(EOL) stages. Therefore, it is very clear that BEVs are not always beneficial in every process and in every life cycle stage. Further enhancement in clean energy mix, efficient production and recycling processes and policy implications of BEVs is necessary in order to reduce climate change impacts.

Limitations: Study limited only to German point of view and most often the data used is outdated due to unavailability of recent data. Inconsistency in results due to combination of various sources in some processes and exclusion of infrastructure and transport emissions in use and EOL respectively. Another major impact is the application cut-off approach in EOL which does not include material re-use and recovery.

Reference: Dillman et al., (2020). Review and Meta-Analysis of EVs: Embodied Emissions and Environmental Breakeven. Sustainability 12 (2020), 9390, 28.