Electrification of Heavy-Duty Transport in Sweden

A transport system completely powered by renewable energy seems to be within reach. Improved performance and rapidly decreasing costs in areas like renewable energy technologies, electricity storage and electromobility is promoting this development. Policies regulating CO_2 emission performance standards for heavy duty vehicles have been adopted within the EU and in the Swedish context a phase-out of fossil fuels has been proposed.

The discussion on the most suitable substitute for fossil fuels has been going on for decades. The key energy carriers and technologies typically discussed are biofuels used in internal combustion engine vehicles, electricity used in battery electric vehicles, and hydrogen used in fuel cell electric vehicles. More costly synthetic fuels, such as electro-fuels or biofuels produced using gasification, are other options. However, the pace of electrification will be one important factor in determining the demand for different fuels as well as batteries. Electrifying vehicles is done by replacing current vehicles over time, which means that the age and turnover of the fleet play major roles in determining how fast the fleet can be electrified.

Understanding changes in material flows and lifecycle greenhouse gas emissions related to the electrification of heavy-duty vehicles are relevant for stakeholders in the automotive industries as well as for policymakers. The project will provide valuable input to the Mistra Carbon Exit research program (www.mistracarbonexit.com). Mistra Carbon Exit has the aim to analyze and demonstrate how supply chains of buildings, infrastructure and transportation can be transformed to comply with the Swedish target of net-zero GHG emissions by the year 2045, at the latest.

Aim and method

The Master thesis project aims to develop future scenarios for the electrification of heavy-duty vehicles. The scenarios will be used to understand the impact of heavy-duty vehicle electrification on the carbon footprint of Swedish heavy transport as well as demand for batteries, battery materials, hydrogen (if fuel cells are used) and biofuels to achieve fossil-free transports for the remaining fleet. Current research has been focused on analyzing these aspects using prospective lifecycle assessment for Swedish passenger cars by designing a vehicle fleet turnover model. In this thesis project, a similar model would be developed for the Swedish heavy-duty vehicle fleet. A simple lifecycle assessment model has previously been developed for one truck and could be used as a starting point for modelling the fleet. Interaction with relevant industrial actors, e.g., Volvo and Scania, is encouraged.

Persons involved in the project

Supervisor: Johannes Morfeldt (johannes.morfeldt@chalmers.se), Physical Resource Theory, Chalmers
Co-supervisor: Julia Hansson, IVL Swedish Environmental Research Institute
Examiner: Daniel Johansson, Physical Resource Theory, Chalmers

Apply to this proposal by submit a CV and a short description on how you aim to tackle the problem. Basic understanding of Swedish in order to interpret government documents is preferred, but not required.

Background reading

Wolff et al. (2020). Scalable Life-Cycle Inventory for Heavy-Duty Vehicle Production. Sustainability, 12. https://www.mdpi.com/2071-1050/12/13/5396

Morfeldt, J., Davidsson Kurland, S., & Johansson, D. J. A. (2021). Carbon footprint impacts of banning cars with internal combustion engines. Transportation Research Part D: Transport and Environment, 95, 102807. https://doi.org/10.1016/J.TRD.2021.102807