More energy-efficient powertrains for hybrid and electric trucks

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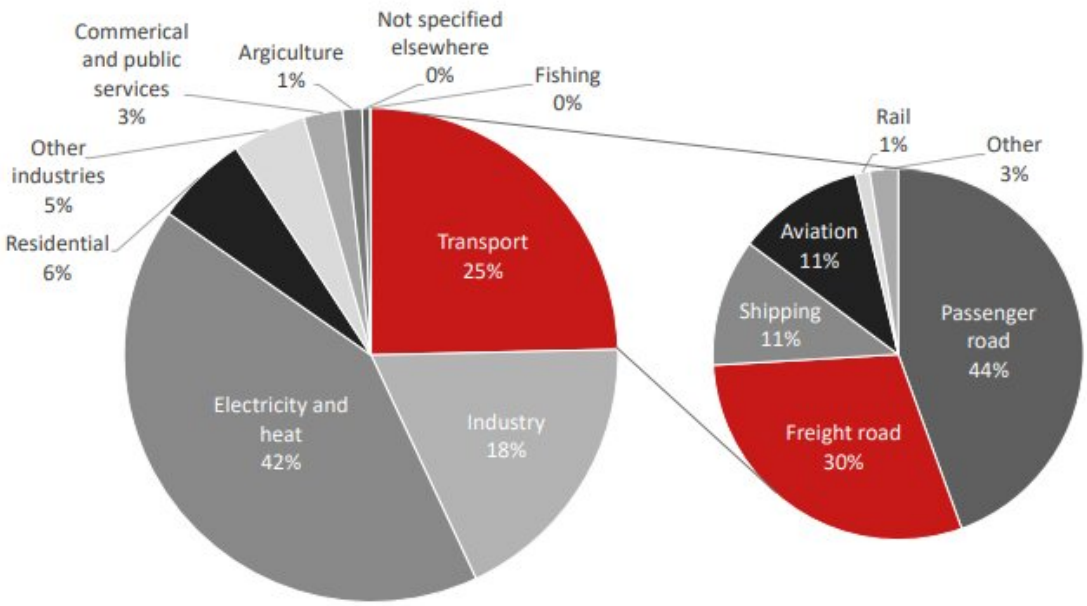

Figure 1.1: Global CO_2 emissions overview per sector in 2018 [5], including division per transport type [6].

Figure 1: Global emissions per sector. Credit: https://pure.tue.nl/ws/portalfiles/portal/169887108/thesis

In order to combat the rise in the average temperature on earth, the emission of greenhouse gases will have to be reduced. In the transport sector, one way to do this is to increase the energy efficiency of the

driveline of long-haul trucks. In recent years, several solutions have been introduced to improve the energy efficiency of these vehicles. Ph.D. student Frans Verbruggen used optimization studies to explore the potential of two of these promising technologies, bringing future, sustainable powertrains for trucks a step closer.

Verbruggen first focused on the technology to recover waste heat, also known as waste-heat recovery (WHR). With this technology, waste heat, which would otherwise be lost, can be partially recovered and converted into usable mechanical or electrical energy. In particular, he looked at the use of this technology in the powertrain of hybrid trucks. A hybrid truck is equipped with an electric machine and a battery to power the vehicle, in addition to an internal combustion engine.

Fuel and cost savings

Currently, it is common to design this type of system as a separate addition to the powertrain. In his research, Verbruggen looked at integrating the WHR system into the design of the rest of the powertrain to ensure an even further reduction in the vehicle's energy consumption.

The results showed a clear interaction between the design of the WHR system and the internal combustion engine, indicating the integration of the design of both systems in order to achieve a better design. Based on these findings, a scalable model for the WHR system design was created, which can be integrated into the optimization process of the complete powertrain. Results further show that the WHR system can be a fuel-saving and cost-efficient solution for hybrid trucks.

Distributed driveline most economical to operate

In addition, Verbruggen focused on battery electric powertrains for

trucks. In these vehicles there is no longer an internal combustion engine present and the energy to power the vehicle comes entirely from the battery. Verbruggen focused on the design of the powertrain for these types of vehicles. Using optimization studies, he gained insight into the influence of certain powertrain design choices on the energy consumption and total-cost-of-ownership of the vehicle.

For example, he compared design choices in the use of a central or distributed (individually driven wheels) type of powertrain, the number of electric machines and the number of gears in the transmission. Results for a long-haul truck show the advantage of using two gears over one gear resulting in a lower energy consumption and smaller electric motor. A distributed powertrain was found to be the design choice with the greatest effect on total-cost-of-ownership .

In addition to examining these design choices, Verbruggen also looked at the effect of the vehicle type (urban, distribution, long distance) and the use of an alternative optimization method for this type of study. Thus, his research paves the way for further and more in-depth studies for the design of future powertrains for long-haultrucks.

More information: Design of electrified powertrains for heavy-duty trucks. research.tue.nl/nl/publication … or-heavy-duty-trucks

Provided by Eindhoven University of Technology

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