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F.J.R. Verbruggen, T. Hofman
Control Systems Technology, Eindhoven University of Technology, Den Dolech 2, 5600 MB Eindhoven, The Netherlands
Email: f.j.r.verbruggen@tue.nl, t.hofman@tue.nl

1 Introduction

The market share of battery electric passenger cars is growing, already having reached a global stock of 2.0 million vehicles by the end of 2017 [1]. The same increased growth is seen in the number of battery electric buses and coaches. Up to recently, this trend was not yet visible in the truck sector. There seemed to be no general motivation to convert Diesel trucks into full-electric trucks. However, recently multiple truck manufacturers have announced full-electric versions of their trucks, where some have already reached the testing phase. In this work, an overview is given on the full-electric trucks that are being build or planned to be build. The main focus is on the battery size and the estimated range of the vehicles. Next to that, calculations are done to create insight in the battery pack weight and the influence on the cargo capacity of the vehicle.

2 Announced vehicle performance

A full overview of the specifications of the full-electric trucks announced by OEMs can be found in [2], discussing the battery size, E_b [kWh], electric motor sizes [kW] and the estimated vehicle range, R [km]. An estimate can be made for the energy consumption of the vehicles in [kWh/km], using

$$\textit{Energy consumption} = \frac{E_b}{R}. \tag{1}$$

These results are shown in Figure 1, showing an average energy use of 1.0 kWh/km for medium-duty trucks and 1.5 kWh/km for heavy-duty trucks. A small comment has to be made that most of the parameters are announced values and are not necessarily proven on the road.

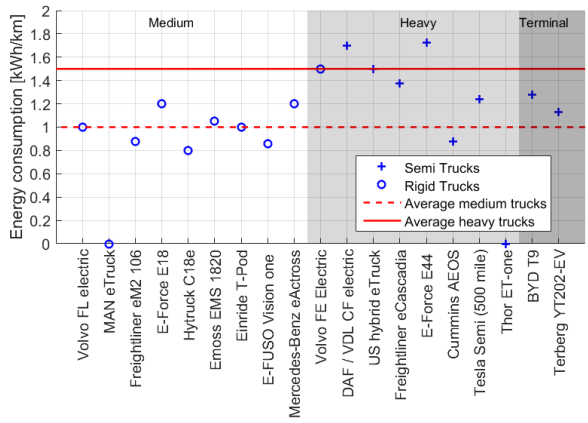

Figure 1: Estimation of the energy consumption of full-electric trucks announced by OEMs. o indicates the vehicle is a rigid truck, + is for a semi truck. [2]

3 Benchmark calculation on energy consumption

In order to quantify the values in Figure 1, calculations are done by converting a conventional 40 tons long-haul truck into a full-electric truck. Starting with a Diesel consumption of 35 L/100km (=3.65 kWh/km), assuming fixed efficiencies for both powertrains ($\eta_d = 0.33$ for the diesel powertrain and $\eta_e = 0.71$ for the electric powertrain), an estimate for the energy usage of the battery electric truck was made of $E_e = 1.72$ kWh/km [2].

4 Influence on cargo capacity

An important question for full-electric trucks is what the mass of the battery pack is, m_b in [kg]. This can be calculated for a given energy consumption, E_e, and required range, R, using

$$m_b = \frac{1000\, E_e\, R}{\rho_b}. \tag{2}$$

A battery density of ρ_{bat} =150 Wh/kg was used as value for present day bay batteries for the full battery pack.

Next, the question is how the battery pack mass will influences the total mass of cargo that can be transported by the vehicle, m_c in [kg]. Here is taken into account that when compared to a conventional truck, components can be left out, e.g., the ICE, etc. In total this difference is estimated at $\Delta m_{d\to e} = 2700$ kg. Assuming the total weight of the vehicle is fixed, because of road legislation, and that the mass of the base vehicle is equal for the conventional and full-electric truck, the difference in the cargo capacity of the vehicle can be calculated with

$$\Delta m_c = \Delta m_{d\to e} - m_b \tag{3}$$

In case of a required range of

- $R = 200$ km $\to \Delta m_c = 407$ kg, meaning more cargo can be transported by the full-electric version than the conventional vehicle.
- $R = 500$ km $\to \Delta m_c = -3033$ kg, less cargo can be transported by the full-electric version of the vehicle.

The break-even point with equal cargo capacity ($\Delta m_c = 0$) for both versions is at $R = 235$ km.

References

[1] IEA, "Global EV Outlook 2018: Towards cross-modal electrification," 2018

[2] F.J.R. Verbruggen, A.E. Hoekstra, and T. Hofman, "Evaluation of the state-of-the-art of full-electric medium and heavy-duty trucks," In the 31th International Electric Vehicle Symposium & Exhibition, Kobe, Japan, 2018