Analysis and optimization of the use of electric vehicles in the distribution sector of the Swiss Post

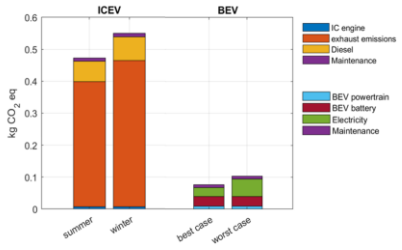
Lara Isler Sarué and Romana Paganini

Professor : Alcherio Martinoli
Assistant(s) : Pascal Stalder (SWISS POST) and Cyrill Baumann (DISAL)

With the increasing awareness that the global temperature rise must not exceed 1.5°C, many countries are making commitments to reach this goal. A climate-neutral Switzerland, i.e., net-zero emissions by 2050, is the Federal Council's climate goal. Therefore, the Swiss Post wants to reduce its CO_2 emissions, by shifting the fleet of the packaging delivery sector from diesel to electric vehicles. This project aims to evaluate and optimize this transition.

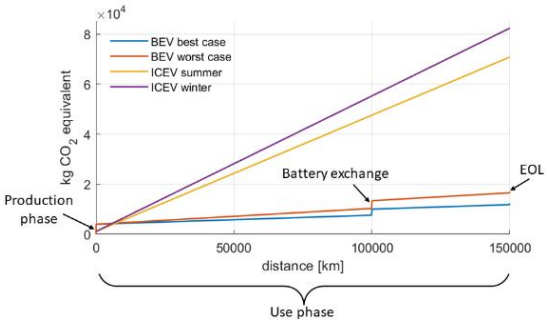
First, a life cycle assessment (LCA) compares internal combustion engine vehicles (ICEVs) with battery electric vehicles (BEVs), to investigate their related environmental impacts. Second, the charging costs are optimized by examining charging during off-peak and peak hours. Different charging stations are compared, to assess the most profitable option. From data provided by the Swiss Post of Geneva, one carries out a data analysis of ICEV delivery tours and electricity consumption.

Based on the data analysis, the BEVs are investigated to provide a viable alternative to the ICEVs due to many reasons. The average daily traveled distance per vehicle is only 18.1 km, and the average speed is low, which favors low power consumption. Furthermore, BEV recuperates energy during braking, which is an advantage when delivering packages with many stops.



CO_2 equivalent emissions per traveled kilometer

The results of the LCA as presented in the figure above, show that the BEV emits 0.4213 kg less CO_2-eq per km than the ICEV, meaning the Swiss Post saves 1.94 tons of CO_2-eq per vehicle per year. The carbon payback time is after 6'000-7'000 km, which corresponds to 1.3-1.5 years of vehicle use at the Swiss Post. This is visible in the lower graph on the right which shows the cumulative CO_2-eq emissions as a function of distance covered for a BEV and an ICEV, including production phase, use phase, and end of life (EOL). The production phase of the BEV has a non-negligible impact on the total CO_2-eq emissions, representing 30% of it, whereas the ICEV emits mainly during the use phase.



Cumulative CO_2-eq emissions as a function of distance

However, BEVs perform worse than ICEVs in many other environmental impact categories, e.g., freshwater toxicity with 77% of the impact being caused by the battery.

From the optimization results, a normal charger is always more profitable than a quick charger. Thanks to optimized charging of 100 BEVs with a normal charger, 36'000 CHF could be saved per year. Nevertheless, BEVs remain more expensive than ICEVs during their entire lifetime.

To make this transition more profitable, an option to increase the revenue related to the utilization of BEVs is the technology vehicle to grid (V2G), which consists of giving electricity from the BEV back to the power grid. With mean the remaining state-of-charge at the end of the day, a revenue of 1.27 CHF per day and vehicle is possible.

To conclude, BEVs are a good option when one aims to reduce CO_2 emissions. However, the environmental impacts on other environmental categories should not be neglected. Although the transition to electric vehicles is costly and needs some investments, costs can be minimized through optimized charging and potential revenue from V2G.