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Role of minimizing passenger car energy intensity for climate targets

The climate target of 2° C can be expressed as a global CO_2 Budget, which we are not allowed to exceed. Decarbonization of passenger car transport plays a crucial role due to its high dependence on fossil fuel. Electrified propulsion technologies are the best option to reduce CO_2 emissions, but it takes time to increase their market and fleet shares. Until a fully electrified fleet is established, minimizing energy demand of conventionally propelled vehicles provides a valuable lever for emission reductions.

We investigate the impact of vehicle mass reduction on the specific energy demand for different powertrains, based on logged vehicle trips. These field measurements account for various driving styles and road topology.

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Introduction

How important are vehicle measures, for example. lightweighting, to decarbonize passenger cars? Are these measures even necessary in the context of electrified transport?

With the current Swiss electricity mix, the best option to decarbonize transport is to use electricity directly in the propulsion of vehicles. But a fleet replacement will require time (see figure 1). In order to minimize the accumulated emissions in the transition phase to an electrified fleet, supporting actions are necessary. This is where improved vehicle design to minimize energy demand can have an impact.

We investigate the impact of vehicle design measures for different powertrains, based on field measurements accounting for topology and different driving styles. We present the work on the example of lightweighting.

Point of Access

The current Swiss fleet consists mainly of conventional vehicles. Battery electric vehicles gain market shares, but it takes time to achieve a reasonably large fleet share. Figure 1 illustrates a penetration scenario of BEVs (Source: EBP). Vehicle design measures, such as lightweighting are available for all cars (blue area), regardless of their powertrain technologies.

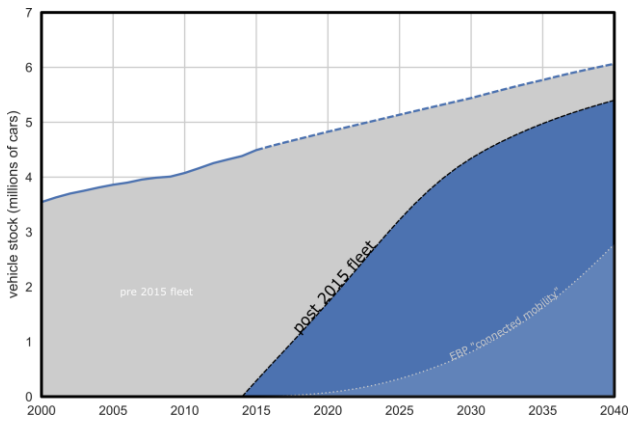
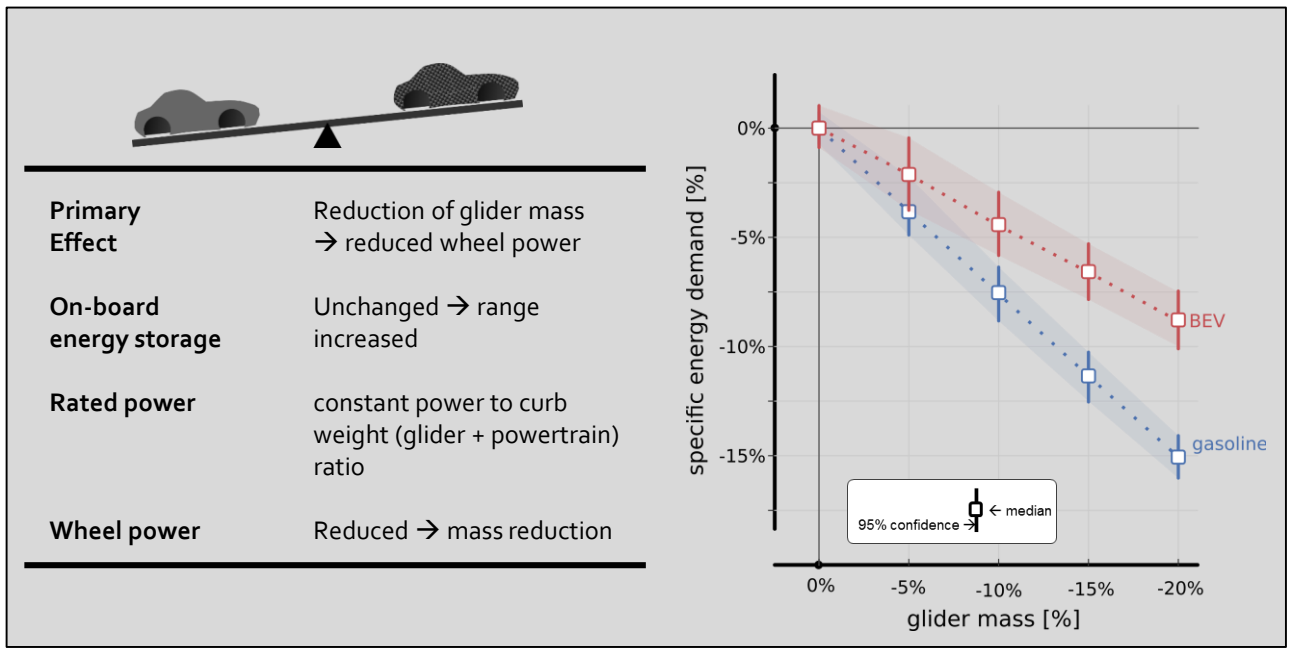


Figure 1: Vehicle stock evolution: different scenarios of battery electric vehicles uptake

Vehicle energy demand

The project ESMOBIL-RED investigates vehicle energy demand of alternative propulsion technologies. It focuses on the difference between normative demand from a dynamometer test bench and the actual one on the road. Five vehicles were monitored over more than two years gathering usage and driving data. At the same time, rolling test bench measurements were performed to derive energy demand models of various drivetrains.
With these tools, we can estimate the impact on vehicle designs, e.g. lightweighting on the energy demand for different powertrains. The figure below shows the effect of reduced glider mass. Conventional vehicles benefit more than battery electric ones, due to reduced recuperation potential. Different driving styles impact the energy demand reduction.
Reduced energy demand always implies increased range assuming an unchanged on-board energy storage. For BEVs, this means range can be increased without modifying the battery.

Energy demand reduction through vehicle lightweighting



Conclusions

Pluggable vehicles take time to penetrate the fleet, which is why additional measures are needed in the meantime to minimize accumulated emissions from passenger transport. Vehicle design measures can be applied to all vehicles, i.e. every new car entering the fleet.

The purposes of vehicle measures for conventional vehicles is always to minimize CO_2 emissions. Their impact on specific energy demand reduction is higher compared to electrically propelled vehicles. While for battery electric vehicles, reducing specific energy demand can interfere with the powertrain design. Range anxiety can be addressed by keeping the battery size constant for lighter vehicles or less battery per vehicle is needed for the same range, which can reduce vehicle costs.

References

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