sccer mobility
Swiss Competence Center for Energy Research
Efficient Technologies and Systems for Mobility

In cooperation with the CTI
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Integrated assessment of future mobility – SCCER Mobility & THELMA results

These results are part of a continuation of Project THELMA within the SCCER Mobility by the Laboratory of Energy Systems Analysis of the Paul Scherrer Institute. THELMA stands for **T**ec**H**nology-centered **EL**ectric **M**obility **A**ssessment, a project aimed at understanding the multi-criteria sustainability implications of widespread electric vehicle use in Switzerland. In the first phase, various indicators such as costs, environmental impacts, and severe accident risks are quantified for nearly 3000 vehicle types and energy chains per vehicle kilometer. In the next phase of the project, which is extended in cooperation with the SCCER Mobility, a Multi-criteria Decision Analysis framework is created in order to better understand the tradeoffs associated with different proportions of advanced powertrain vehicles in the future passenger car fleet.

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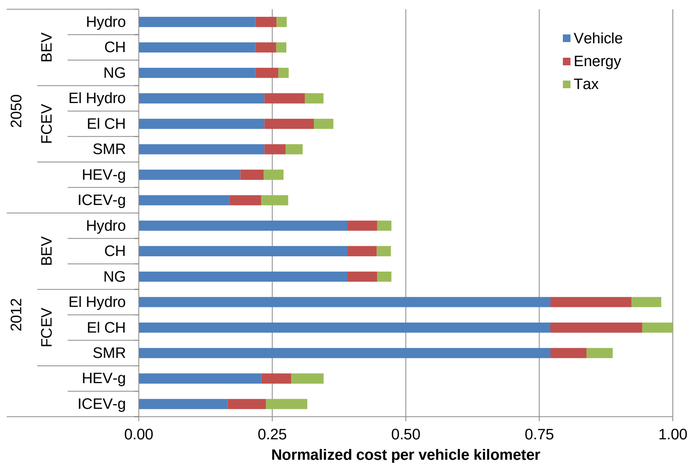
Introduction

Nearly 3000 different vehicle types, combining different vehicle classes, drivetrains, and energy supply chains, are evaluated employing Life Cycle Assessment (LCA), Cost Assessment (CA) and Risk Assessment (RA). Multi-Criteria Decision Analysis (MCDA) is applied to car fleet options with different proportions of advanced technologies as well as different ways that the energy system could develop.

The fleet development is based on s-shaped market penetration curves for electric vehicles to meet the final sales target in 2050. Battery vehicle sales are allocated to drivers with the highest economic payback based on multi-agent transport simulation (MATSim) driving profiles, while all other drivetrains were evenly distributed to the remaining drivers.

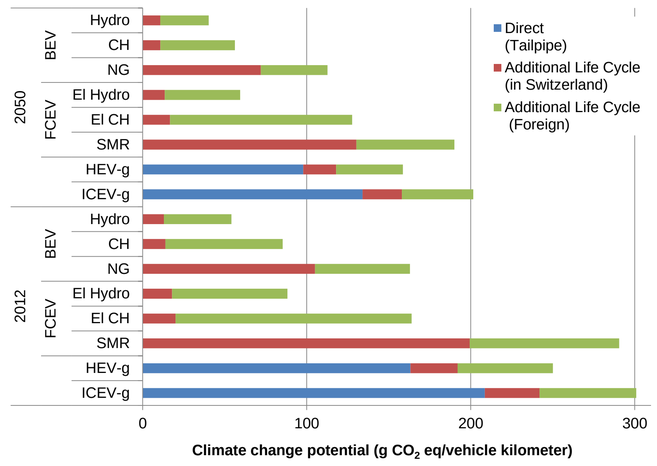
Vehicle Costs

Vehicle costs are shown here broken into three categories representing the owner's total internal costs. 'Vehicle' represents purchase and maintenance costs to the owner, 'Energy' considers the cost of fuel or electricity, and 'Tax' represents the equivalent energy based value of the 2012 gasoline tax applied to all fuels.



Vehicle Climate Change Impacts

Here we show the life cycle climate change impacts per vehicle kilometer for selected mid-sized cars and energy chains. Results are separated into direct tailpipe emissions, other emissions that occur in Switzerland, and other emissions that occur globally due to Swiss passenger cars.



Drivetrains: ICEV-g= gasoline Internal Combustion Engine Vehicle, HEV-g= gasoline Hybrid Electric Vehicle, FCEV=Fuel Cell Electric Vehicle, BEV=Battery Electric Vehicle.
Electricity: CH= Swiss consumption mix electricity. Hydro= Hydroelectricity, NG= Natural gas combined cycle. **Hydrogen:** SMR= Steam Methane Reforming, EL= Electrolysis using Swiss consumption mix electricity.

Fleet Climate Change Impacts

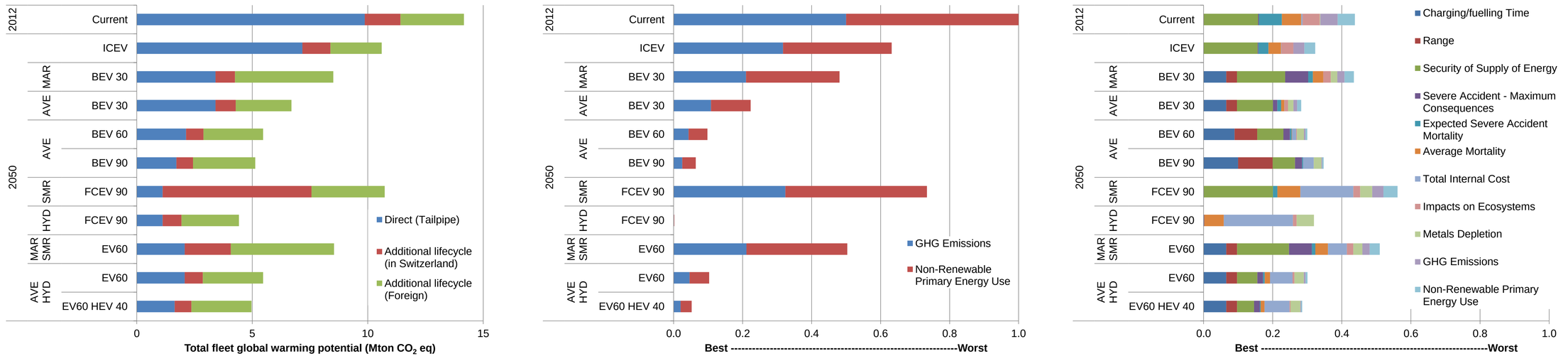
The life cycle climate change impacts of the entire passenger car fleet in 2012 and, for selected scenarios, 2050 are shown below. Compared to the base year, the total GHG emissions caused by Swiss passenger cars in 2050 are estimated to decrease by 25%-65%, depending on the penetration rate of advanced powertrain vehicles and the development of the energy system.

Simple MCDA Result

Here we show a simple MCDA result considering only life cycle GHG emissions and non-renewable primary energy consumption valued equally. These two criteria correspond to the two core goals of the Swiss energy transition. When only these two indicators are considered, scenarios with high proportions of advanced drivetrains and renewable energy chains perform best.

Complex MCDA Result

This figure presents a more complex fleet level MCDA result considering many indicators with equal ranking between environmental, economic, social, security of supply and utility criteria. This broader evaluation exhibits a more differentiated picture and indicates some challenges for advanced mobility with respect to sustainability goals.



Drivetrains: ICEV= Internal Combustion Engine Vehicles, BEV=Battery Electric Vehicles, FCEV=Fuel Cell Electric Vehicles, EV= ½ BEV, ½ FCEV, HEV= Hybrid Electric Vehicles. Numbers are % of fleet in 2050. Remainder of fleet is ICEV. **Electricity:** Supply is renewables strategy. AVE= Charging is average generation mix, MAR= Charging is marginal generation mix. **Hydrogen:** SMR= Steam Methane Reforming, HYD= Electrolysis using Swiss Hydropower.

References

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