CHARGE OPTIMIZATION OF PRIVATELY AND COMMERCIALLY USED ELECTRIC VEHICLES AND ITS INFLUENCE ON OPERATIONAL EMISSIONS

Steffen Fattler, Forschungsstelle für Energiewirtschaft e. V., +49 89 158121-57, sfattler@ffe.de
Simon Pichlmaier, Forschungsstelle für Energiewirtschaft e. V., +49 89 158121-41, spichlmaier@ffe.de
Matthias Schulz, Forschungsstelle für Energiewirtschaft e. V., +49 89 158121-71, mschulz@ffe.de

Overview

In course of the German Energiewende (fade-out of nuclear power and simultaneously reaching an 80–95 % reduction of carbon emissions until 2050) the German energy system is currently undergoing a radical transformation. Whereas the decarbonisation of the electricity sector by the increasing expansion of renewable energies has shown some progress in the past years, the emissions of the transport sector are remaining on a constantly high level. To address this electric vehicles (ev) are becoming more and more popular both in politics as well as the automotive industry as a means to reducing carbon emissions. The operational emissions of ev strongly depend on the point in time when the cars are charged and the coinciding electricity generation mix. Increasing shares of renewable and volatile generators in the generation mix result in a higher fluctuation of specific emissions per kWh of electricity. Thus load management strategies will become more and more important. The scope of this analysis is therefore the modelling of charging profiles of privately and commercially used ev under varying boundary conditions and the comparison of the resulting operational emissions.

Methods

In [1] the effect of various charge optimization modes on the operational emissions of privately used ev was analysed. As a basis for this analysis the MiD2008 [2] dataset on mobility behaviour in Germany was used. Being one of the most substantial surveys on mobility behaviour in Germany the dataset consists of daily movement profiles of the German residential population. In the paper a methodology was developed to merge these individual daily profiles to coherent and statistically correct annual movement profiles based on their mobility characteristics. Altering variables like battery capacity, charging infrastructure, charging behaviour and load management strategies charging curves where then derived from these movement profiles. Based on those charging curves sensitivities where analysed focusing on the resulting operational emissions in the years 2013 and 2030. In this paper the same methodology is applied to the dataset of the survey KiD2010 [3]. The KiD2010 represents the mobility behaviour of commercially used vehicles, hence allowing a comparison of the effectiveness of charging optimization between those two areas of the transport sector. With only 10.4 % of all registered vehicles the commercial fleet is relatively small but still accounts for about one third of overall road traffic. Furthermore 55 % of all ev in Germany are currently registered to a commercial owner making it all the more important to take a closer look at the mobility behaviour and the influence of a possible electrification of this fleet.

Results

Figure 1 shows the resulting specific emissions of two of the calculated annual moving profiles for the years 2013 and 2030 comparing a direct charging with a charging mode optimized on the specific emissions in the electricity mix.

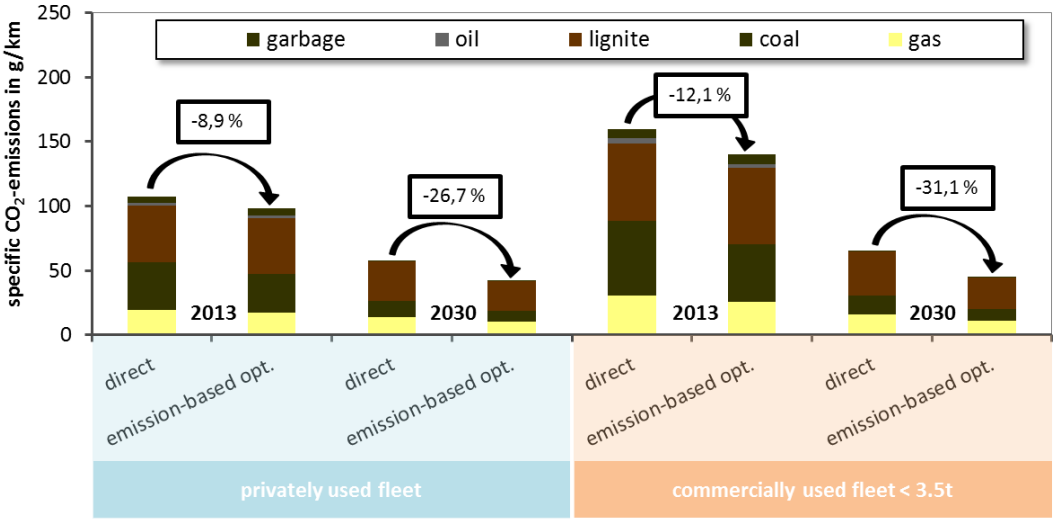

Figure 1: *Comparison of the specific CO2-emissions of direct charging compared to an emission-based optimization of charging in the years 2013 and 2030*

The emission based optimization of charging points leads to reduced specific emissions in all cases. The possible reduction increases with increasing shares of renewable energies in the generation mix (2013→2030). Furthermore the optimization seems to have a bigger effect on the fleet of commercially used vehicles. Further explanations and analysis of these coherences will be depicted in the full paper.

Conclusions

In the paper an extensive analysis of the relevant parameters concerning operational emissions of ev is carried out. With increasing shares of volatile renewable energies in the generation mix an optimized charging of ev is having an increasing impact on the resulting operational emissions. Furthermore the effectiveness of such a charging optimization depends on the individual movement behaviour and specifically the times when the cars are actually parked, explaining the significant difference between privately and commercially used vehicles. With the increasing expansion of volatile renewable energies in the German energy system load management will become more and more important. This paper gives an overview of the relevant coherences concerning the electrification of the transport sector and the related operational emissions of ev.

References

[1] Fattler, Steffen; Böing, Felix; Pellinger, Christoph: Ladesteuerung von Elektrofahrzeugen und deren Einfluss auf betriebsbedingte Emissionen in: IEWT 2017 - 10 . Internationale Energiewirtschaftstagung Wien, https://eeg.tuwien.ac.at/eeg.tuwien.ac.at_pages/events/iewt/iewt2017/html/files/abstracts/196_Fattler_abstract_2016-10-28_22-05.pdf. TU Wien, 2017

[2] Follmer, Robert; Gruschwitz, Dana; Jesske, Birgit; Quandt, Sylvia; Lenz, Barbara; Nobis, Claudia; Köhler, Katja; Mehlin, Markus: Mobilität in Deutschland 2008 - Struktur – Aufkommen – Emissionen – Trends. Bonn: infas Institut für angewandte Sozialwissenschaft GmbH, 2010

[3] Wermuth, Manfred Prof. Dr.: Kraftfahrzeugverkehr in Deutschland 2010 (KiD 2010) - Schlussbericht. Braunschweig: Verkehrsforschung und Infrastrukturplanung GmbH, 2012