Regional diffusion of electric vehicles in Sweden and Germany and the impact on the electric grids (Masterarbeit)

Autor: Daniel Theodor Rother
Erstprüfer: Univ.-Prof. Dr.-Ing Aaron Praktiknjo
Betreuung: Christina Kockel

Abstract
In order to limit global warming countries have committed themselves to reduce their emission of greenhouse gases. With the transportation sector accounting for a large amount of these pollutants, countries have formulated targets to replace the number of fossil-fuel based vehicles by electric vehicles (EVs) in the coming years. The increasing number of EVs and their charging are expected to increase peak loads and electricity demand in electric grids. Predictions about the market diffusion of EVs across national regions offer one possibility to assess the regional impact of charging on electric grids.

In this master thesis the regional market diffusion of EVs and their impact on the electric grid for Germany and Sweden is modelled for the year 2030. To model the regional market diffusion a multiple regression model is developed based on previous research conducted by the Fraunhofer Institute for Systems and Innovation Research. The coefficients of the regression model are calculated with the least squares method using regional historical data on the EV stock, population size, area, gross domestic product (GDP), employment number, number of charging stations and new vehicle registrations for both countries. The regression model is then used to predict the future share of EVs by making assumptions on the future development of the explanatory variables of the regression model.

The regional impact of the predicted share of EVs on the electric grid is modelled using an existing reference network model developed by the division of Energy Technology, the department of Space, Earth and Environment at the Chalmers University of Technology, which is capable of generating synthetic electric low-voltage grids. A direct charging scenario is assumed, where all EVs get charged at home. The residential charging profiles of the EVs are based on Global Positioning System (GPS) measured driving profiles.

The analysis finds the largest market diffusion of EVs in NUTS-3 regions with a high GDP and large populations size for both Sweden and Germany by 2030. A scenario for 2030 of 80% new EV registrations to conventional car registration is assumed and a significant diffusion into rural areas for both countries observed. As a result, grid violations are mainly found in rural and urban areas for both countries, while Sweden shows a significantly larger number of violations than found for Germany.