SPATIAL DISTRIBUTION OF ELECTRIC VEHICLES IN SWITZERLAND

Gracia Brückmann, ETH Zurich, gracia.brueckmann@istp.ethz.ch
Fabian Willibald, ETH Zurich, fabian.willibald@istp.ethz.ch
Victor Blanco-Gonzalez, ETH Zurich, victor.blanco@istp.ethz.ch

Overview

To reach the targets of the Paris agreement, Switzerland has set its goal to reduce greenhouse gas emissions by 75-80% until 2050 (compared to 1990). As transportation is the major carbon contributor (32% of overall emissions in Switzerland), electrification of the transportation sector has become a priority. At the same time, the Swiss population is projected to grow by about two million inhabitants until 2050. This is expected to substantially increase mobility, as the average Swiss travels 23.8 km by car each day (BFS 2015) and this value stays constant over time.

One way of lowering emissions, would be a more widespread use of electric vehicles (EVs). They are already on the market, but sales in Switzerland are very low. The question why the current uptake of EVs is so low in Switzerland is a puzzling one, especially as the country is among the richest in GDP/capita, and it's citizens are generally interested in preserving the environment. They are also supportive of public policies that deal with transportation noise and pollution within cities (Wicki, Huber, Bernauer 2018).

Nevertheless, an eventual increase in EV uptake and subsequently in electricity demand can lead to problems in electricity distribution, if not accounted for. This challenge can be exacerbated due to the uneven spread of EVs over space, or over the energy grid. It is therefore important to know in advance, which patterns EV uptake is likely to follow, in order to leapfrog the risk of spatial accumulation of EV owners and EV recharging at peak times with its associated peak energy demand.

This paper investigates the spatial distribution of EV uptake in Switzerland's canton of Zurich. The canton of Zurich is chosen as Switzerland's largest city is located there, and the canton also includes sub-urban and rural areas. In our contribution, we show the significance and strength of correlation between EV ownership and infrastructural characteristics like the distribution of charging stations or connection to public transport, as well as demographic characteristics of residents.

It is well recognised that the neighborhood matters. The green neighborhood effect is for example working through social networks, which also play key roles in the promotion of EV uptake. Kahn (2007) measures the green neighborhood effect by the neighborhood's Green Party's share of registered voters. The presence and visibility of charging infrastructure is also a key determinant in the decision to purchase an EV.

Axsen, Goldberg, and Bailey (2016) also find EV adoption is likely to be influenced by recharge access, with a focus on in-home-recharge access. We therefore use communities' share of single-family homes (detached houses) as a proxy for the possibility to charge at home by installing recharging facilities in the garage, or the carport.

In a Canadian comparison between EV and ICEV owners, Axsen, Goldberg, and Bailey (2016) identify several significant differences in household characteristics between those two user groups. Especially income and education are both positively correlated with EV uptake. We estimate that on the community level, higher income (or wealth) as well as higher education is on average positively associated with EV uptake.

Our preliminary findings show very high correlations between many of the variables explaining the number of electric vehicles in the communities studied. Until the presentation, we will work with methods that disentangle these effects and give precise estimates of which neighbourhood charactersitcs lead to higher numbers of EVs registered.

Methods

We are using a Generalied Linear Model of the Poisson family with the number of EV-holders per municipality as the dependent variable and demographic and infrastructural variables as explanatory variables to model the spatially explicit distribution of EV holders. The spatial unit is at the scale of municipalities in the canton of Zurich. As the share of electric vehicles in Switzerland is still quite low there are many municipalities with zero or only very few registered EVs. Therefore, we get a highly skewed, overdispersed distribution of EV-holders on a municipality scale. As the basic Poisson assumption that the variance of the distribution equals the mean is violated through overdispersion we must take advantage of a special family of count-data models, namely hurdle-, and zero-inflated models.

The high correlation of the variables that influence EV uptake is another methodological challenge we will address.

Results

We will present result on the spatially-explicict factors that drive EV uptake in the Swiss canton of Zurich. Our results can help local and national energy providers as well as government authorities to plan and manage the future distribution of power supply in order to guarantee the security of supply.

Conclusions

We abstain from drawing early conclusions from the preliminary findings. However we are confident that our research will point out differences in spatial structure, community characteristics as well as infrastructure factors that drive EV uptake. This model will facilitate the management of future energy demand induced by electric vehicle ownership.