Effects of electromobility charging strategies on future investments in power plants in Austria's electricity sector

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Motivation and scientific question

In order to comply with the goals of the Paris Agreement, significant reductions in greenhouse gas emissions in the transport and energy sectors in Austria are necessary. Therefore Battery-electric vehicles (BEV) and vehicles with plug-in hybrid drives (PHEV) will replace cars with internal combustion engines.

This paper examines how different market penetrations by BEV and PHEV will affect investment costs in the energy sector in Austria up to the year 2050. The type of charging strategy and the number of vehicles in a country have an impact on the supply of electrical energy and the exchange of electrical energy between neighboring countries.

Methodical approach

The analysis is carried out with the open source optimization model Balmorel. The functionality of the model is enriched by an existing and partly extended electromobility add-on [1], which includes the energy requirement, usage behavior of the car fleet and three different charging strategies. The strategies differ in terms of their exibility with regard to the timing and amount of required charging energy, depending on the investment in new power plants.

When modeling the electricity system in Austria, the heating sector is omitted and it is assumed that electricity generation in Austria will be carbon neutral in the year 2030.

To model the exchange of electrical energy, the neighboring country Germany is included in the calculations. In order to show the effects of e-mobility on the electricity sector in Austria more clearly, the modeling of other neighboring countries is deliberately avoided.

In the scenarios developed, the assumed number of BEVs and PHEVs in Austria in 2050 is varied and the effects on investments in new power plant services for different charging strategies are observed. Furthermore, the model is being expanded so that a mix of charging strategies can also be used per year. This leads to a better approximation of the model to the real market penetration of flexible charging infrastructure.

Results and conclusion

The aim of this work is to clarify how different EV charging strategies affect investments in new power plant capacities. The number of BEVs in Austria is increased in the scenarios. The 25% scenario assumes that in 2050 25% of all passenger vehicles in Austria will be BEVs. In the 100% scenario, it is assumed that all cars, five million units, will be BEVs by 2050. An increased number of electrically powered vehicles leads to a greater demand for electricity and therefore to the need to build more power plants.

If you take passive charging (PC) as a reference and compare the installed capacities with the more flexible charging strategies SC and V2G, Figure 1 shows a reduction in the newly installed power plant capacities up to 41%.

Flexible charging strategies also have an impact on the use of volatile energy sources such as wind and sun, thereby reducing the use of fossil fuels. Figure 2 shows this change compared to passive charging (PC) for the 100% scenario. The use of the bidirectional charging strategy (V2G) leads to better use of wind and solar energy.

Flexible charging strategies are therefore to be preferred and the market penetration of these should be promoted through incentives or regulation.

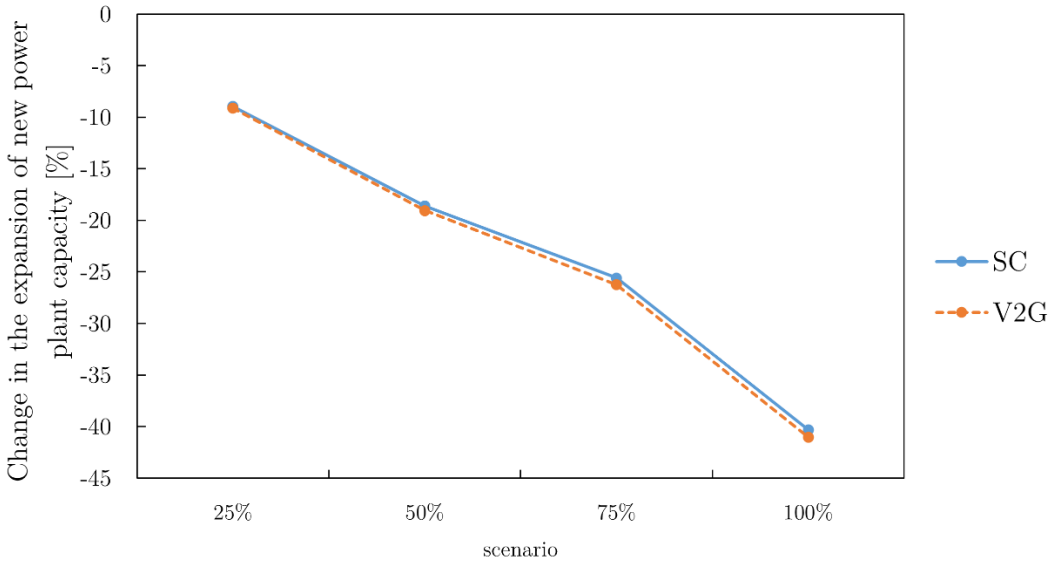

Figure 1: Change in the expansion of new power plant capacities in the various scenarios compared to the "passive charging" (PC) charging strategy

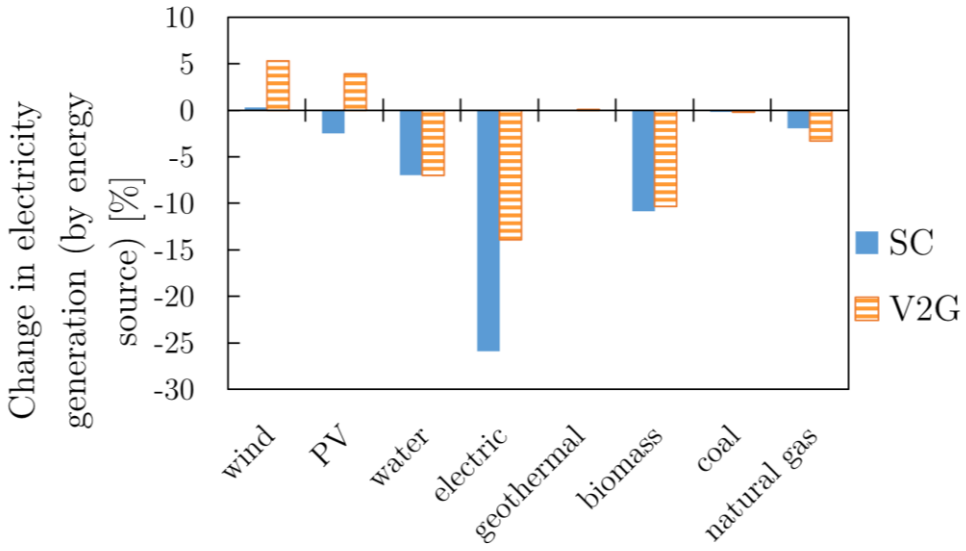

Figure 2: Change in electricity generation in the 100% scenario compared to the charging strategy "passive charging" (PC)

Litrature

[1] Gunkel, P. A., C. Bergaentzlé, I. Græsted Jensen und F. Scheller (2020).
From passive to active: Flexibility from electric vehicles in the context of transmission system development_. In: Applied Energy 277, S. 115526.
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