HOW THE PACE OF ADOPTION OF ELECTRIC VEHICLE SMART CHARGING IMPACTS THE ENERGY SYSTEM?

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Overview

The widespread roll-out of electric vehicles (EV) is one important action sought by governments around the world to tackle climate change and to improve air quality in urban centres. However, this extensive rollout of EVs is likely to bring important challenges to the energy system, potentially requiring new generation capacity and network reinforcements (Su et al., 2019). It has been recognised that the timing ('smart' vs 'dumb') of EV charging could potentially increase or mitigate the undesired impacts of the EV rollout (Sanchez-Miralles et al., 2014). In the case of the UK, it is expected that most cars and vans will be electric by 2050. Also, it is expected that by 2050, 75% of EVs will be charged in a smart way (National Grid, 2019). Currently, EVs represent around 7% of newly registered cars in the UK (Statista, 2020) and it is assumed that most of them are charged in a 'dumb' way, in free 'on the street' charging. So the path to reach the expected 75% smart charging is not clear.

Many studies have been developed to analyse the impact of smart EV charging. However, most of them do not consider different smart charging adoption pathways and normally they only analyse the implications of a large penetration of EVs in the power sector, not considering, for example, the changes on emissions, fuel use and consumer costs. The work developed in this paper aims to provide insight on this issue, analysing the implications of a large penetration of EV under different smart chaging adoption pathways, using the UK TIMES energy system model. Preliminary results show that the speed in which smart charging is adopted can have important impacts on the level of network investments, and thus higher costs for the final consumer; where a slow adoption of smart charging could result in around 70% extra network investment costs, relative to a faster implementation of smart charging.

Methods

In this paper, three EV charging scenarios are analysed using the UK TIMES model. TIMES is a bottom-up techno-economic energy system-wide model, which considers all the processes of the energy system, and produces future energy scenarios based on a cost minimisation objective function. In all scenarios, a large EV penetration is assumed with a 75% of smart EV charging by 2050, based on National Grid's (the British TSO) Future Energy Scenarios 2019 (National Grid, 2019). The three analysed scenarios vary in the adoption rate of smart charging, reaching the 75% of smart charging by 2050 at different paces (see Figure 1).

The results of the different scenarios are compared across one another and with a base case where no EV uptake is implemented. The impact of the EV smart charging adoption pace is analysed in terms of network investments, fuel costs and emission reduction.

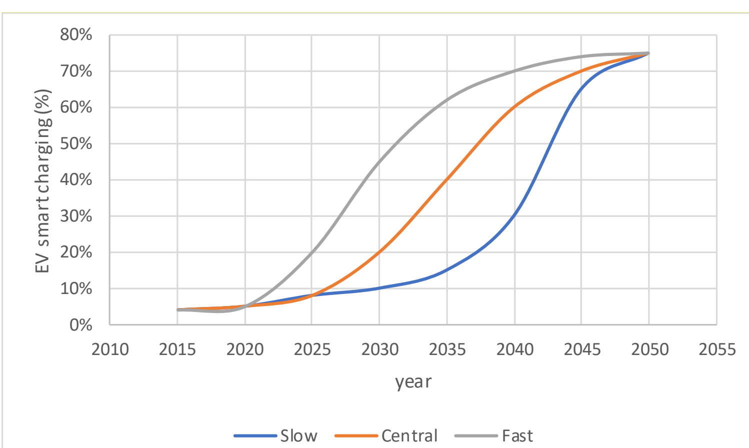

Figure 1. Considered EV penetration projection for all EV charging scenarios.

Results

Preliminary results show that these EV smart charging pathways produce very different results in terms of the timing and the level of network reinforcements. For example, Figure 2 shows the extra investments, relative to the base case, that need to be done on the network to accommodate the extra load produced by growing EV numbers. It can be noted that the investment patterns can change significantly in the different smart charging adoption scenarios, with the largest difference found in the slow adoption case (orange columns in Figure 2) with 60 – 70% higher investment costs than the other cases.

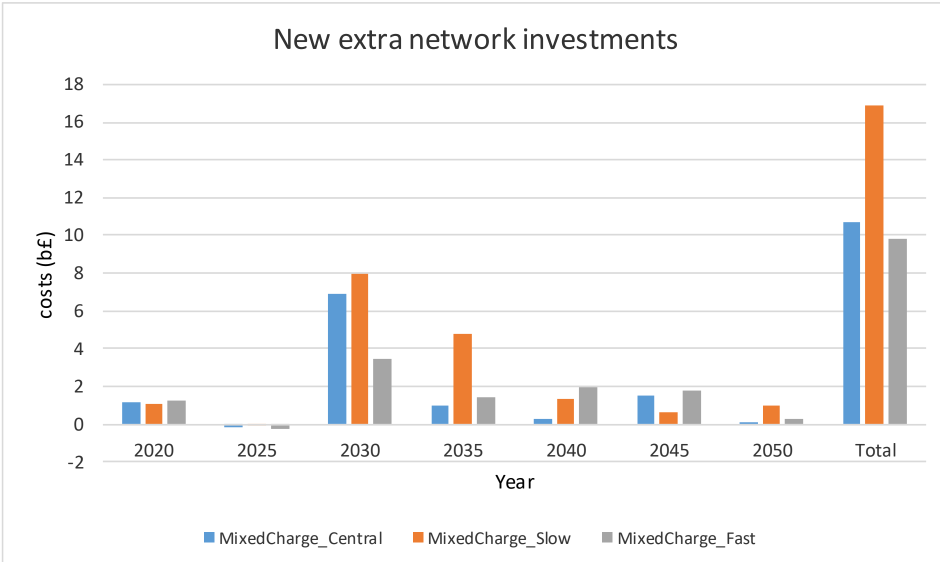

Figure 2. New extra network investments relative to the base scenario without EVs.

Additionally, the network investment costs are transferred to consumers as an increase in marginal costs (energy prices), so the 'fuelling' costs for car transport can be significantly different across scenarios. These and other relevant policy outcomes, such as emission reductions, are also important to take into account while designing energy tariffs and EV policies.

Conclusions

Even though the representation of the network in TIMES is limited, the study proposed in this paper provides some insight on the implications on network investments and energy costs of different EV smart charging adoption rates. An interesting result of this analysis is that not only the level of investment is affected, but the timing of those investments as well. This could have important implications for the economy, as large investments concentrated in a short period of time could create adverse effects in the economy due to labour and/or capital scarcity (Alabi et al., 2019). We believe that these scenarios provide a range of outcomes that may help policymakers and network operators to plan and find solutions that do not overburden consumers and facilitate the uptake of EVs.

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