ASSESSING THE IMPACTS OF LARGE EV PENETRATION IN THE UK – ANALYSIS OF NETWORK INVESTMENTS AND CHANGES IN FUEL USE

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Overview

As a part of their actions to tackle climate change and air quality concern, a number of countries around the world are pushing ambition targets for the decarbonisation of transport. One of such actions is the widespread roll-out of uselectric vehicles (EV). In the case of the UK, the Government has set the target of all new cars and vans to be effectively zero direct emission by 2040 (UK Government, 2018).

A large penetration 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 also been recognised that the timing (‘smart’ vs ‘dumb’) and location (at home vs at a centralised charging point) of EV charging could potentially increase or mitigate the undesired impacts of the EV roll-out (Sanchez-Miralles et al., 2014).

Many studies have been developed to address some of these challenges. However, most of them fail to analyse the implications of a large penetration of EVs outside the power sector, not considering, for example, the changes on 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 unders different chaging scenarios, using the UK TIMES energy system model, and discussing best practices on informing energy policy. Note that this analysis does not give a full wider-economy picture, but it is a key step along that path. We find that the location and ‘smartness’ of the charge have important impacts on network investments and final consumer energy costs. For instance, centralised charge could represent around one third on network reinforcement costs in comparison with the decentralised case.

Methods

In this paper, four types of 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. These scenarios vary in where the charging take place and the ‘smartness’ of the charge. Decentralised charging is assumed to occur at distribution level (i.e. charging is done at home or at work in the city), whereas centralised charging is assumed to occur before the distribution level. ‘Dumb’ charging consist in charging at peak hours, when people come back from work and electricity demand is highest, and ‘Smart’ charging only occurs when it is cheaper to do so (mostly overnight).

All these scenarios consider the same EV penetration projection as shown in Figure 1, based on National Grid’s Future Energy Scenarios (National Grid, 2018).

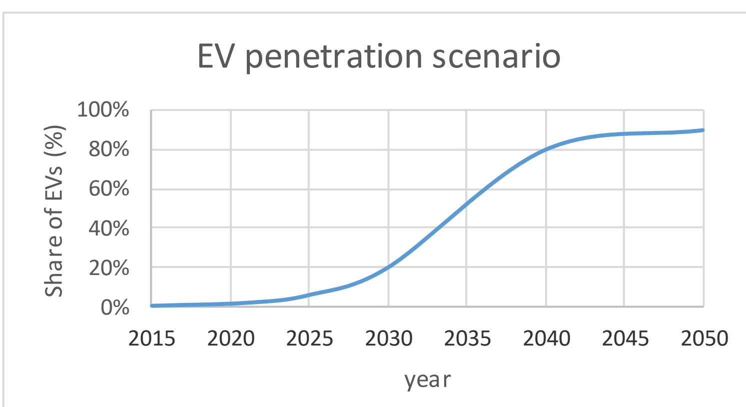

Figure 1. Considered EV penetration projection for all EV charging scenarios.

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 charging approach is analysed in terms of network investments, fuel costs and energy savings.

Results

Preliminary results show that these EV charging scenarios produce very different results in terms of network reinforcements and overall fuel costs for car transport. For example, Figure 2.a 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 between scenarios, with the largest difference found in the decentralised dumb charge case (yellow checked columns in Figure 2).

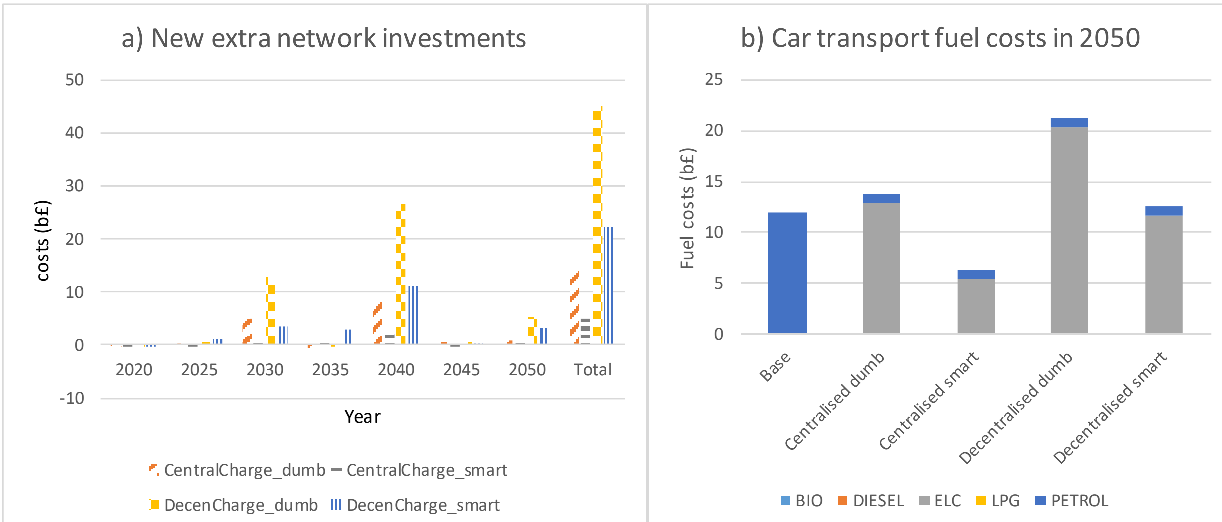

Figure 2. a) new extra network investments relative to the base scenario and b) total car transport fuel costs in 2050.

Additionally, fuel costs for car transport are significantly different across scenarios (see Figure 2.b), where the costs in 2050 for the decentralised 'dumb' charge is more than double than in the centralised 'smart' charge. These difference in cost reflect the extra network investment needed, which is passed to the final consumers as an increase in marginal costs (energy prices). These outcomes 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 types of EV charging options. For instance, an interesting result of this analysis is that the decentralised 'smart' case is more costly than the centralised 'dumb' case, which suggest that the location of EV charging might be more important in reducing overall costs than the 'smartness' of charge. 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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