

Technical annex: Power system effects of electric vehicles

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Power system effects of electric vehicles

The National Infrastructure Commission asked Aurora Energy Research to deliver modelling of the power system, looking at the costs of different generation mixes under given system flexibility and demand assumptions, including heat and transport demand.

Their report to the Commission, *Power System Modelling, Impact of Renewables*¹ has been published alongside the *National Infrastructure Assessment*. This note provides further detail on the modelled system impacts of electric vehicles and the assumptions underlying the Commission’s approach.

Modelling assumptions

Under the Commission’s assumptions, power demand in the transport sector is largely driven by electric passenger cars and vans. The pathway for electric vehicle uptake was provided to Aurora by the Commission and is based on current electric vehicle stock, following a standard s-shaped innovation curve leading to 100 per cent of vehicle sales by 2025 and 100 per cent of stock by 2040 (Figure 1).

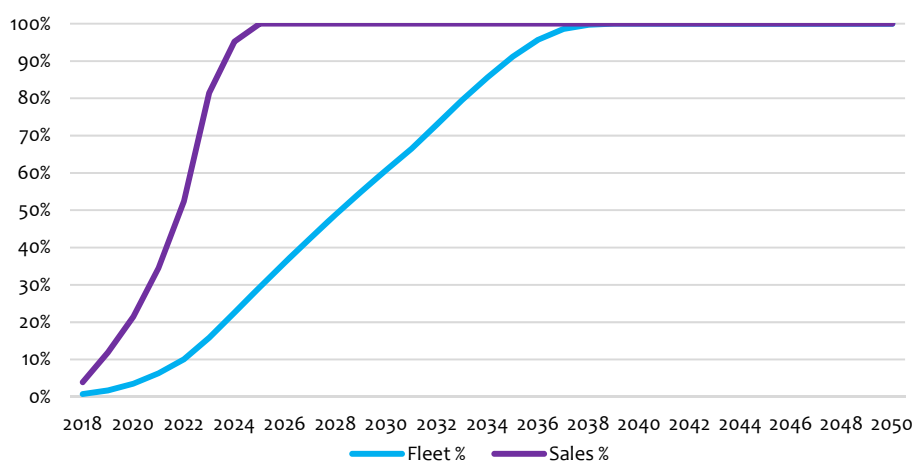


Figure 1: Electric vehicle sales and stock assumptions Aurora’s modelling for the Commission

This is a faster uptake than projections which are based on historic rates of electric vehicle adoption and expected battery cost reductions. The Commission’s assumptions for this modelling are based on historic rates of technological displacement by new substitute technologies.² They are not intended to be a forecast.

The uptake curves shown in Figure 1 were used in the modelling but do not reflect the Commission’s recommendations on charging point rollout to enable 100 per cent electric vehicle sales by 2030. The modelling assumes faster electric vehicle rollout to understand the power sector implications should fast uptake occur.

For simplicity, electric vehicles refer only to battery electric vehicles, and plug-in hybrids are not assumed to be part of the fleet. This avoids having to make additional uncertain assumptions on the amount of time hybrid vehicles use electricity or petrol/diesel.

Vehicle to grid transfer, where car batteries can provide power back to the grid, is assumed to be used by 80 per cent of vans and 10 per cent of passenger vehicles. This additional flexible capacity can be used whenever required – this implicitly assumes that most electric vehicles are plugged in when they are not being driven.

Smart charging is assumed to be used, meaning consumers follow price signals to charge electric vehicles primarily overnight, avoiding adding to the evening peak and thereby helping to smooth out the daily electricity demand shape.

Effects of electric vehicles on the power system

Under Aurora’s modelling and the Commission’s assumptions, electric vehicles increase average annual demand by 26 per cent by 2050 (Figure 2).

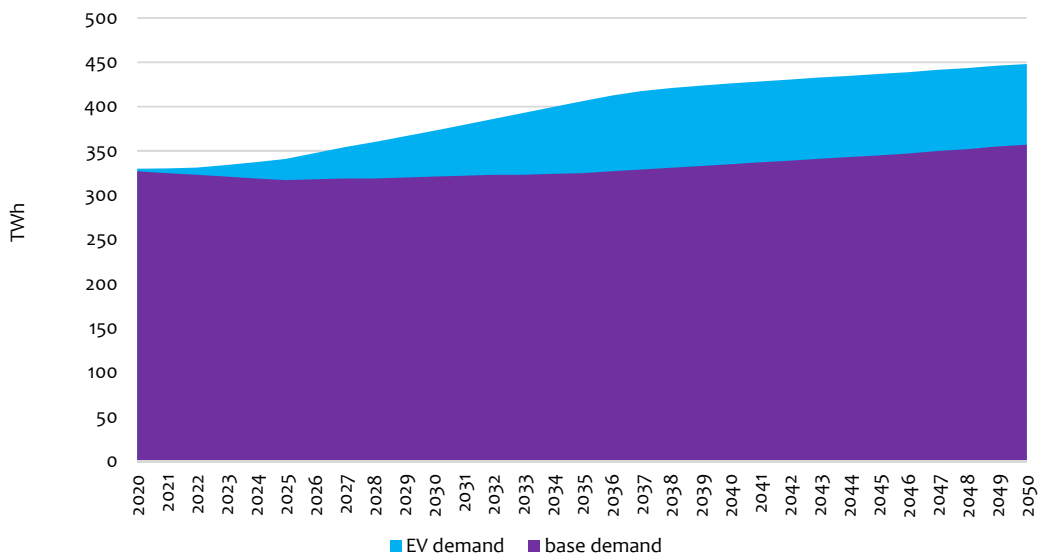


Figure 2: Addition of EVs to base power demand (excludes heat demand)

Despite the increase in average annual demand, smart charging means electric vehicles help to smooth the daily demand profile – demand is closer to its peak during more of the day, reducing spare capacity (Figure 3).

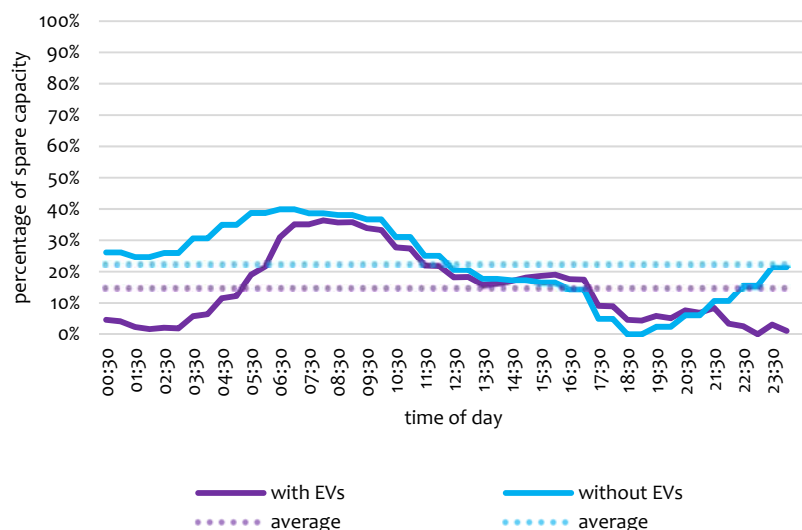


Figure 3: Percentage of spare capacity with and without EVs in January 2050³

The vehicle-to-grid assumption leads to an additional 11 GW of flexible generation capacity by 2050.⁴

These findings show the potential benefits of electric vehicles to the power system, based on Commission assumptions. There is significant uncertainty when modelling over the long term, and detailed results would vary for a different set of assumptions. Specific figures should not be given undue weight.

End notes

¹ Aurora’s report is available on the Commission’s website.

² This approach was based on that used in the IMF working paper, *Riding the Energy Transition: Oil Beyond 2040*, for the US, which uses the decrease in horse ownership in the first half of the twentieth century to project the rate of decrease in conventional car ownership.

³ Calculated by the Commission using Aurora’s modelling outputs. The percentage of spare capacity is the inverse of demand at each half hour over average daily peak demand.

⁴ See page 42 of Aurora’s report.