

ENABLING THE ACCELERATION OF ELECTRIC VEHICLE ADOPTION



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SUMMARY:

- **Electric vehicle uptake is accelerating as we move from early adopters to the majority.**
- **To reach its net-zero target, the UK Government will need to support this transition.**
- **Sufficient, accessible and affordable charging will be key to unlocking EV adoption for groups who will not be able to follow the current charging model.**
- **A lack of charging infrastructure for regular use remains a barrier to adoption, particularly for residents who can't charge at home.**
- **The first step in removing this barrier is identifying where such residents live and the most valuable locations for charging solutions.**
- **Policy to reduce the cost of electricity for charge point operators and incentivise DSOs to offer affordable network upgrades would greatly improve the financial viability of charge points to service those without off-street parking.**

1 INTRODUCTION

In the face of climate change, the UK government has pledged to end the sale of new fully internal combustion engine vehicles from the year 2030 and hybrids from 2035¹. This commitment has come at the same time as many vehicle manufacturers have announced they are transitioning all their lines to electric vehicles.

Currently, electric vehicles across England make up less than 1% of the total vehicle fleet², but in 2021, according to SMMT data, nearly 12% of new vehicle sales were battery electric³. However, we are still a long way off the objective of all vehicle sales being hybrid or fully electric in 9 years and the ultimate goal of an entirely low-emission vehicle fleet.

2 NOUGHT TO ONE HUNDRED IN 40 YEARS

Forecasting the adoption of emerging technologies is notoriously difficult. An S-curve is commonly used to demonstrate the uptake of new technologies, for example, the mobile phone, the washing machine, and even the original petrol car⁴. It is simple in that the analysis considers historical data to model future uptake. Using data from the Department for Transport, the S-Curve Adoption Tool for Electric Vehicles ([SCATE](#)) has been used to forecast the adoption of electric vehicles within the UK, shown in **Figure 1**. (*next page*). While the present briefing focuses on the total number of vehicles and charging infrastructure needs in the UK, a similar S-curve analysis has been conducted for sales of EVs globally⁵. The four main adopter groups according to S-curve methodology are marked on Figure 1.

1 <https://www.gov.uk/government/news/government-takes-historic-step-towards-net-zero-with-end-of-sale-of-new-petrol-and-diesel-cars-by-2030>

2 <https://www.gov.uk/government/collections/vehicles-statistics>

3 <https://www.smmt.co.uk/vehicle-data/evs-and-afvs-registrations/>

4 <https://ourworldindata.org/technology-adoption>

5 The Shape and Pace of Change in the Transport Transition, UCL Institute of Sustainable Resources and We Mean Business coalition, May 2021

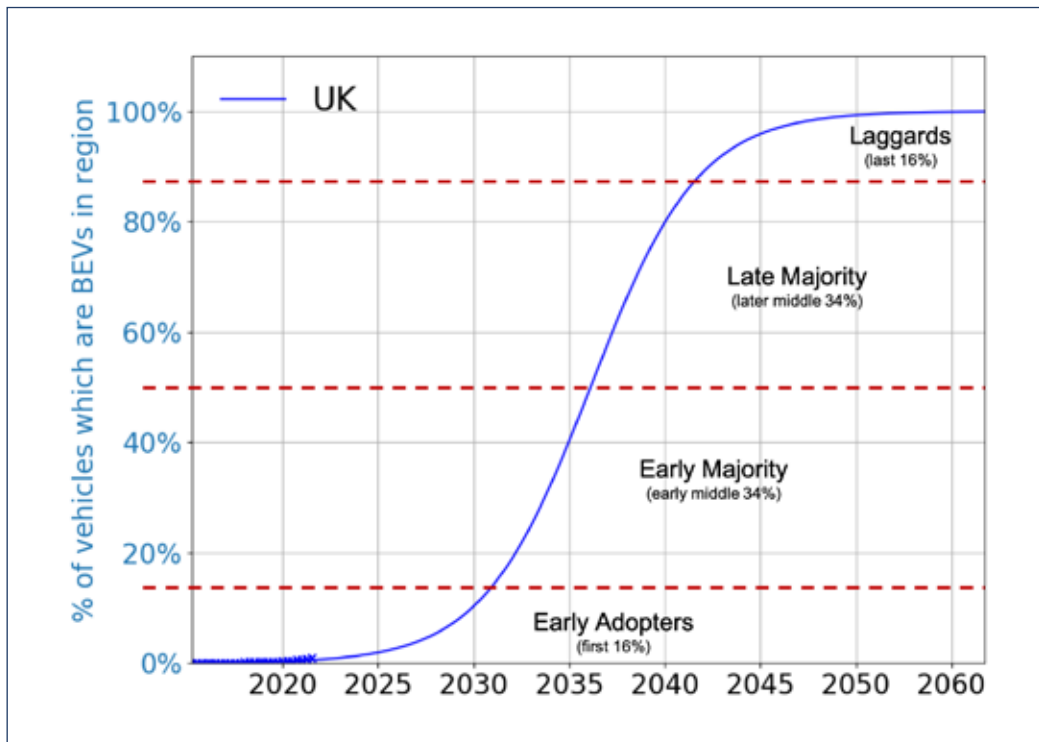


Figure 1. S-curve forecast of battery electric vehicle (BEV) uptake in the UK, showing adopter groups

Although electric vehicles accounted for practically nought percent of the UK fleet in 2015, Figure 1 shows that by circa 2055, 100% of vehicles in the UK will be electric.

Electric vehicles could go from 20% to 80% of the UK fleet in just 8 years, Figure 2 shows.

Furthermore, when it comes to forecasts of recent green technology, there has been a tendency to underestimate the rate of adoption. For example, in the case of the installation of solar generation, the International Energy Agency (IEA) forecasts underestimated installation significantly⁶. In 2011, the IEA forecast that in 2020 the global solar capacity would reach 175 GW. Instead, this was achieved 6 years earlier in 2014 and the global capacity of solar generation in 2020 was over 700 GW⁷ – four times greater.

It is important that the UK does not underestimate the speed of transition and fail to prepare for the number of electric vehicles which may soon be populating our roads. By simulating the S-curve using historic data from different years, it is possible to see whether the S-curve predictions have progressed over this time.

Figure 2 (*next page*) shows the S-curve forecasts for 2019 and 2020, demonstrating that the forecast changed in 2020 with the uptake of electric vehicles outstripping the previous 2019 prediction.

⁶ The Future of Solar Energy, MIT, 2015

⁷ Fraunhofer Photovoltaics Report, 2021

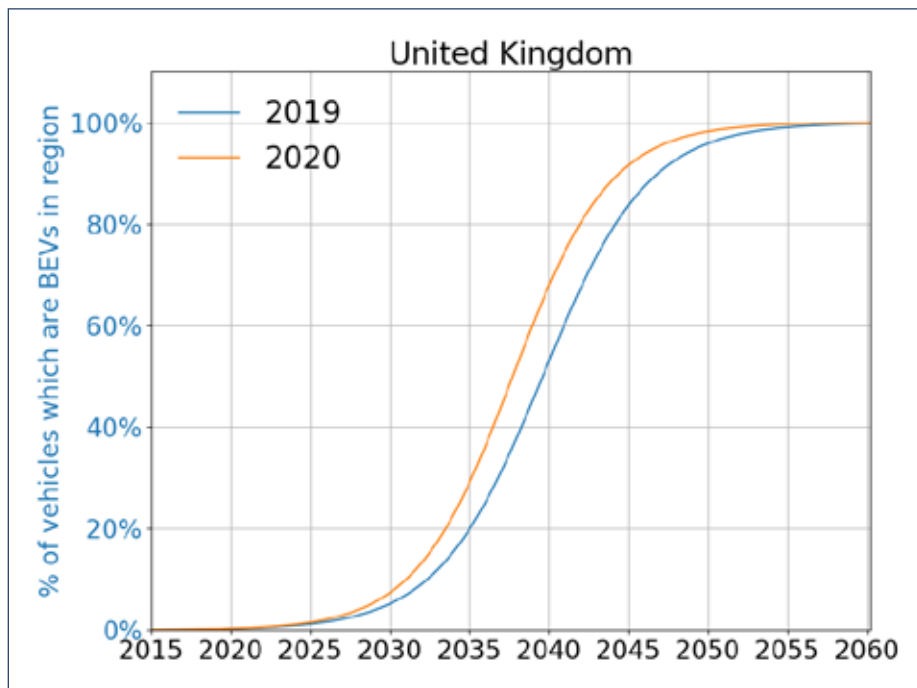


Figure 2. Change in the S-curve forecast from 2019 to 2020

This means that the transition is underway and already occurring faster than expected. Policy makers and businesses alike must be cognisant not to underestimate this transition.

In absolute terms, the 2020 S-curve forecast equates to there being around 30 million electric vehicles on the road by 2040, compared to the 300 thousand on UK roads today. One hundred times more.

Government policy can help support electric vehicle adoption by the majority group. Understanding what motivates or impedes the switch from fossil fuel to battery electric vehicles is an essential part of preparing for this transition.

3 ENABLING CHARGING FOR THOSE IN THE MAJORITY

So far, electric vehicle adoption has been dominated by a group referred to as the “early adopters”. To meet the Government’s target, adoption of electric vehicles will need to extend from these early adopters to almost all car drivers, in other words, the majority and laggards. This comes with challenges, dominated by the following four: purchase cost, range anxiety, environmental concerns, and lack of charging infrastructure⁸. Each of which are being overcome. Purchase costs of electric vehicles are expected to be at price parity with the petrol equivalents this decade⁹; range anxiety is being tackled by larger batteries, highway rapid charging, and consumer experience; and environmental concerns are being dispelled by clear public messaging¹⁰. Therefore, this brief focuses on the final challenge: lack of charging infrastructure, particularly for those who cannot charge at home.

8 Biresselioglu, M.E., Kaplan, M.D. and Yilmaz, B.K., 2018. Electric mobility in Europe: A comprehensive review of motivators and barriers in decision making processes. *Transportation Research Part A*, 109, pp.1-13.

9 <https://www.theguardian.com/business/2021/may/09/electric-cars-will-be-cheaper-to-produce-than-fossil-fuel-vehicles-by-2027>

10 <https://about.bnef.com/blog/the-lifecycle-emissions-of-electric-vehicles/>

Industry reports¹¹ indicate that 90% of current electric vehicle drivers in the UK, aka the early adopters, usually charge their vehicles privately. For most, this means charging at home using domestic electricity often while parked in a driveway or attached garage. This is not going to be possible for everyone in the majority group. According to the National Travel Survey and British Household Survey, approximately 30% of car drivers usually park on-street; which is more common in neighbourhoods of dense housing. In such places, even if one is able to park on-street outside their house, charging cables trailing across pavements is something Local Authorities and Government are trying to discourage and avoid.

For those without access to home charging, another available option is the expanding network of rapid chargers, of which there are over 4,900 across the UK¹². However, consistent use of rapid chargers is: expensive, likely to cost twice as much as home charging¹³; time consuming to travel to, as they are generally located on motorways or strategic roads and may be in use on arrival; and may accelerate battery degradation¹⁴.

Thus, there is a clear need for local charge points, within walking distance of residents' homes, where charging slots can be booked in advance and electricity offered at an affordable price.

4 THE QUESTION IS "WHERE": USING GECCO TO SELECT CHARGE POINT LOCATIONS

As mentioned, at least 30% of drivers will not have access to private charging at home and will rely on public chargers. The location of these charge points must be carefully considered, they must be close to residential areas so that they are not inconvenient to access and should offer the charge point operators sufficient market to make the venture favourable. Car parks are a promising venue for these public EV chargers.

The **G**eospatial **E**valuator for electric vehicle **C**harging in **C**ar parks **O**vernight, **GECCO**, is a tool developed by the authors to identify car park locations where electric vehicle chargers will be more valuable in meeting the overnight charging needs of residents without off-street parking. **Figure 3** (*next page*) shows an example of the output from GECCO, showing car parks in yellow, surrounded by a catchment area which is 400m (often known as the pedestrian shed) shown in pink, relevant buildings (those which are not likely to have off-street private parking) in purple, and relevant buildings on narrow roads in pink. Details of the analysis can be found on GitHub along with the analysis code¹⁵ for use in QGIS.

11 Deloitte. 2019. Hurry up and... wait | The opportunities around electric vehicle charge points in the UK.

12 <https://www.zap-map.com/statistics/#points>

13 <https://www.rac.co.uk/drive/electric-cars/charging/how-much-does-it-cost-to-charge-an-electric-car/>

14 Bhagavathy, S.M., Budnitz, H., Schwanen, T., and McCulloch, M.D., Impact of Charging Rates on Electric Vehicle Battery Life, Findings, 21459, 2021

15 <https://github.com/EPGOxford/GECCO>

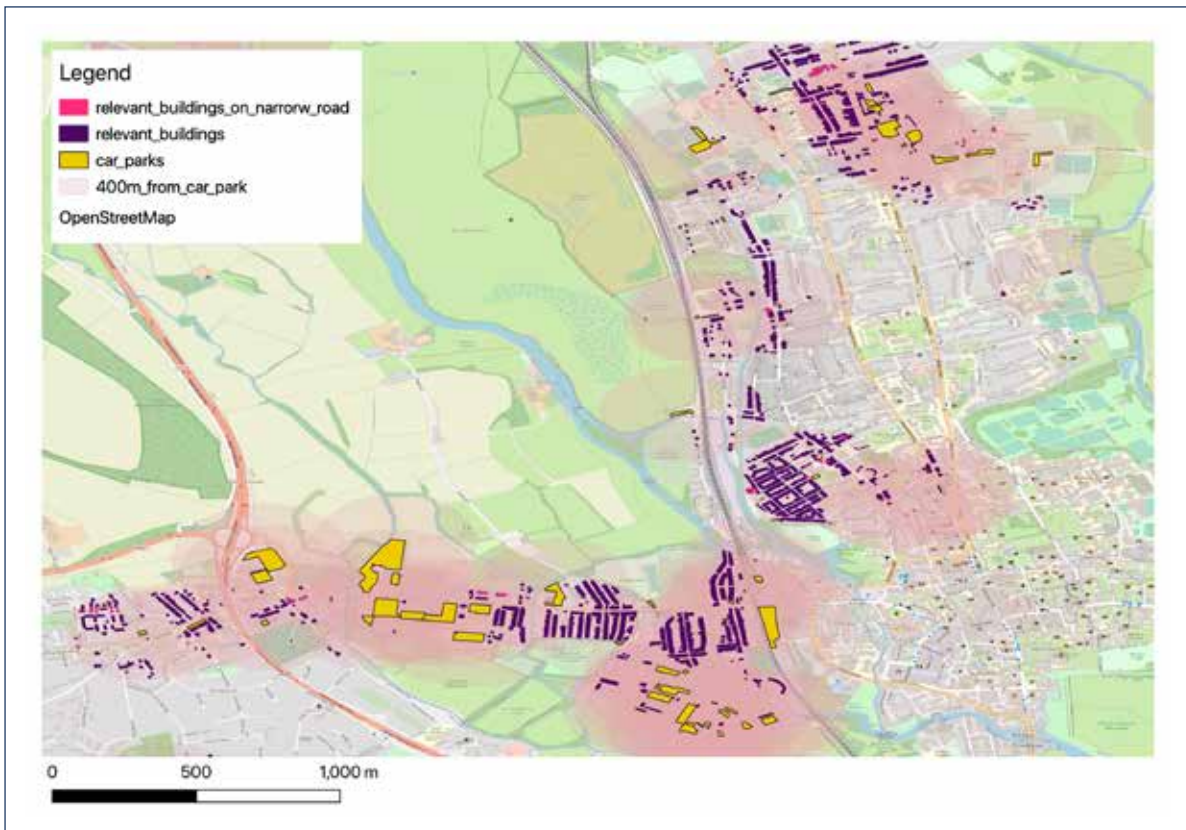


Figure 3. Example of the output from GECCO for Oxford.

It is evident that there are several large car parks along the Botley Road (bottom of the map), which are not within the catchment area for many buildings. However, other car parks in that region and in the Jericho area (in the centre-right of the map) look to be surrounded by many relevant households of interest. Visualising the results in this way not only assists with identification of promising car parks for charge point installation, but also enables competition assessment by identifying areas which could be over-served by car parks if they were all to install charge points.

Although there are many business challenges to overcome when installing and operating electric vehicle charge points, two of the main hurdles are:

- the cost of electricity to charge point operators, where VAT is charged as 20% compared to 5% on domestic electricity demand; and
- ensuring there is sufficient electricity network capacity at the site to provide the necessary charging power.

Policy measures to cap the cost of electricity or reduce the VAT rate for charge point operators could greatly assist with financing of charge point installation. Smart charging and flexibility services can reduce the need for network reinforcements. In addition, policies to incentivise Distribution System Operators (DSOs) to provide affordable network reinforcement, will assist in the instances where network capacity does need to be increased.

Implications	
For Policy Makers	For Charging Providers and Operators
Electric vehicle uptake will not be linear and may be faster than expected. Appropriate policy to support this acceleration in uptake is necessary.	In the coming years, charging solutions for those without off-street parking will increase in importance. Thus, the market for electric vehicle charging infrastructure that serves local communities will expand rapidly over the next 25 years.
Local, affordable, public charging for those without off-street parking will be needed a safe, short walk away from residents' homes, where a charger can be booked and guaranteed.	Local, affordable, public charging for those without off-street parking will be needed a safe, short walk away from residents' homes, where a charger can be booked and guaranteed.
Policies that provide support to electric vehicle charging service providers will facilitate the uptake of electric vehicles and assist in meeting the UK net-zero target.	Certain charge point locations may be more lucrative than others and there is value in identifying these locations as margins are slim.
Policy measures can assist in reducing the cost of electricity for charge point operators, encourage smart charging, and incentivise DSOs to offer affordable network reinforcement.	Charge point operators will need to work with local authorities, car park operators, DSOs and customers to provide optimised solutions that will work in a range of local contexts.

About the Project

This note was produced as part of the **Park and Charge Oxfordshire Project**, an **Innovate UK** funded Real World Demonstrator for electric vehicle charging for public spaces (Project Number 105428) involving **Zeta Group, Urban Integrated Limited ([ui!]uk), Oxfordshire County Council** and the **University of Oxford**. The commercial partners have created **EZ-Charge** to operate the charging hubs.

Part of this note is based upon:

Katherine A. Collett, Sivapriya M. Bhagavathy, Malcolm D. McCulloch, Forecast of electric vehicle uptake across counties in England: Dataset from S-curve analysis, Data in Brief, Volume 39, 2021, 107662. <https://doi.org/10.1016/j.dib.2021.107662>

(Forthcoming) Katherine A. Collett, Sivapriya M. Bhagavathy, Malcolm D. McCulloch, Geospatial Analysis to Identify Promising Car Parks for Installing Electric Vehicle Charge Points using GECCO.

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About the Energy and Power Group

The Energy and Power Group (EPG) has been part of the Department of Engineering Science at the University of Oxford for more than a decade. Our vision is to transform the world's energy arena by making it efficient, clean, accessible and affordable for everyone on the planet. We aim to catalyse planetary-compatible social and economic growth in low-, medium-, and high-income countries, through research in energy systems. To tackle the challenges ahead, EPG has a holistic

and interdisciplinary approach that combines technology innovation, environmental impact and social demand and acceptability. This allows us to understand and shape how energy systems are generated and utilised. Renewable energy research and community are at the heart of what we do. We look at applications such as cooling, electric vehicles and on- and off-grid systems. Working closely with local partners, is key to help us develop solutions that are fit for purpose. Our research is underpinned by academic purpose to share knowledge that will contribute towards our vision.

