Driving uptake

Maturing the market for battery electric vehicles

Patrick Hall and Ryan Shorthouse

bright blue

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Executive summary

Today, transport is the UK's largest greenhouse gas (GHG) emitting sector, responsible for almost 28% of all GHG emissions in 2018. Cars have long accounted for the bulk of transport emissions, contributing over half of domestic GHG emissions emanating from the sector.

Whilst other economic sectors, such as industry and energy, have achieved sizeable emissions reductions in recent decades, the transport sector has made minimal progress. Deeper decarbonisation of the transport sector, particularly cars, is therefore essential if the UK is to meet its net zero emissions target by 2050. In recognition of this, the UK Government has recently announced a ban on the sale of new internal combustion engine (ICE) vehicles from 2030.

To decarbonise passenger vehicle transport across the UK, a greater uptake of battery electric vehicles (BEVs) is required. As Chapter One explains in detail, out of the five different types of ultra-low emission vehicles (ULEVs), BEVs are the most appropriate solution to decarbonising passenger vehicle transport as they produce zero tailpipe emissions.

Over the previous decade, the UK has seen an incremental increase in the percentage of newly registered passenger vehicles which are BEVs. At the end of 2020, 6.6% of all new passenger vehicle registrations were BEVs, making this the largest yearly increase in new BEV passenger vehicle registrations. But, relative to our international competitors, it is clear that the UK's BEV market remains somewhat nascent.

As Chapter One shows, Norway, Iceland and the Netherlands are the European countries that have experienced the highest uptake of BEVs as a proportion of new passenger vehicle registrations. In the case of Norway, it has the greatest market share of new BEV passenger vehicle registrations in the world (49.1% as of September 2020). Elsewhere, major global markets – notably China and the United States (specifically California) – have seen high year-on-year increases in BEV uptake as a proportion of passenger vehicle registrations. Policymakers in the UK need to learn lessons from these high-performing countries when it comes to catalysing the market for BEVs.

To deliver on its target of net zero emissions by 2050, and to ensure that the sale of new ICE vehicles has been fully phased out by 2030, the UK can and must do more to support the uptake of BEVs.

Focus of this research and methodology

In this report, we unearth and explain the key barriers to maturing the BEV market in the UK, presenting a comprehensive typology. The report assesses the types of policy interventions that have been and could be implemented to catalyse the market for BEVs in the UK, drawing on international examples. Finally, the report recommends original and credible policies to address the leading barriers and mature the market for BEVs.

This report focuses solely on BEVs, specifically passenger vehicles. This report does not focus on other types of ULEVs such as hybrid vehicles and fuel cell electric vehicles (FCEVs).

This report seeks to answer the following research questions:

1. How important is fully electrifying private transport to achieve net zero by 2050?
2. What are the key barriers to the uptake of BEVs?
3. What types of policies have been and could be implemented to catalyse the market for BEVs in the UK?
4. What policies would help mature the BEV market in the UK?

In order to answer these research questions, we employed a number of research methods, described in detail in Chapter Two. First, we conducted an extensive literature review to highlight the importance of curbing emissions from the transport sector in order to achieve net zero emissions by 2050 and identify the leading barriers to BEV uptake among households and businesses in the UK. Second, we consulted a number of leading academics, experts, decision makers and business representatives in the vehicle and energy industries. Third, we issued a public call for written evidence on maturing the market for BEVs and received 10 submissions from a range of organisations, which we include in the annex of this report.

These research methods enabled us to identify: the key barriers to BEV uptake in the UK among households and businesses (Chapter Three); the recent policies the UK Government has adopted to grow the market for BEVs (Chapter Four); and, the unique and additional policies adopted by governments in countries which are high-performing with regard to BEV uptake (Chapter Five).

Key barriers to BEV uptake in the UK

The barriers we identify to BEV uptake are for both households and businesses, although the evidence we use on barriers mainly relates to the views of households.

There are four key barriers to BEV uptake in the UK: upfront price; charging infrastructure; range anxiety; and, lack of vehicle choice.

Upfront price

Recent polling by the Society of Motor Manufacturers and Traders (SMMT) in August 2020 showed that the most popular reason for households not purchasing a BEV was the upfront price (52%).

When comparing the upfront price of the most popular new BEVs in the UK which have an ICE vehicle counterpart, in every instance the new ICE vehicle model is considerably cheaper. For example, the most popular – the MG ZS (Excite) – costs £25,495 for the BEV and £15,495 for the ICE counterpart, as of October 2020.

The disparity in price between BEVs and ICE vehicles is also apparent in the second hand market. Used BEVs are, on average, significantly more expensive than used ICE vehicles. Analysis of the second hand vehicle market has shown that the average price of a used BEV is £25,880, whilst this figure dips to £12,389 for petrol vehicles. This poses a risk that, in the push to decarbonise transport, less well-off households – which typically purchase vehicles from the second hand market – will be restricted to purchasing used ICE vehicles, which have a lower upfront price but cost more to run and are more heavily taxed than BEVs.

Price equivalency between new BEVs and ICE vehicles is forecast to occur around 2023, although this prediction has been made uncertain by Covid-19. The fall in price of BEVs is largely as a result of falling lithium-ion battery prices, which are a costly core component of BEVs. Lithium-ion battery costs have fallen from over $1,000 (£728) per kilowatt hour (kWh) in 2010 to $156 (£114) per kWh in 2019, and are forecast to fall to $100 (£73) by 2023 – the predicted tipping point for BEV and ICE vehicle price equivalency. Furthemore, lithium ion battery prices are predicted to more than halve in cost by 2030.

Crucially, however, when looking at the changes in upfront price and battery capacity of different models of the same BEV over time, it reveals a clear relationship between the two. Despite large reductions in the cost of batteries, there has not been large reductions in the upfront price of new BEVs over the past decade. This is due to 'up-speccing', where the cost reductions in lithium ion batteries have been reflected less in reduced new BEV prices for consumers but rather in increased specification of lithium ion batteries. In essence, vehicle manufacturers are using larger batteries with a greater kWh capacity, as consumers demand longer range.

But, price equivalency is now predicted soon because battery cost reductions will not always be lost to up-speccing, as there will eventually be no need to increase the range of BEVs as they near the optimal range for most consumers, which is estimated to be 200-300 miles. At the moment, the average range of BEVs in the UK is 192 miles.

Despite having a higher upfront price than ICE vehicles, BEVs typically have lower lifetime costs: they are cheaper to recharge than ICE vehicles are to refuel; have lower maintenance costs; and, benefit from favourable tax treatment. However, consumers largely make their purchasing decisions around vehicles based on the upfront price and do not sufficiently take into consideration the lifetime cost. As such, this psychology around cost considerations also acts as a barrier to BEV uptake.

Charging infrastructure

In the aforementioned polling which revealed the upfront price as the leading barrier to BEV uptake in the UK, 44% of drivers thought a lack of local chargepoints held them back from purchasing a BEV, making it the second largest barrier for households to BEV uptake.

Over the last decade, there has been significant growth in the number of public chargepoints in the UK, which has now reached over 34,000. Chargepoints have different speeds: slow, fast, rapid or ultra-rapid. For instance, a chargepoint located at a motorway services is likely to be a rapid chargepoint in order to recharge a BEV in as little time as possible, whereas an on-street chargepoint in a residential area – whereby a BEV is parked on the street and plugged into a chargepoint situated near the curb – is likely to be a slow or fast chargepoint.

Despite the growth in chargepoints, charging infrastructure remains a barrier to BEV uptake for three main reasons.

First, some evidence suggests there needs to be further increases in the number of public chargepoints on main roads, particularly to support a growing number of BEVs. The Committee on Climate Change (CCC) outlines that in a scenario of BEV uptake exceeding 20 million vehicles, almost 400,000 public chargepoints would be required, with the bulk of these being rapid chargers.

Second, for those households without off-street parking, there is a lack of on-street chargepoints. The need for on-street charging infrastructure is especially dramatic for London, where two thirds of all BEVs parking in residential areas overnight will require on-street charging in a high BEV uptake scenario.

Third, the perception that there is insufficient availability of public chargepoints.

Range anxiety

Range anxiety is seen as the third leading barrier to BEV uptake among households in the UK. Thirty eight percent of drivers in the aforementioned poll would not buy a BEV out of fear that they would run out of range on long journeys.

Comparing the driving range of the most popular BEVs in the UK with their ICE vehicle counterparts reveals BEVs have considerably less driving range. Nevertheless, the driving range of BEVs has improved in recent years, increasing from approximately 80-120 miles in 2010, to an average of 194 miles presently. In 2030, the average range of BEVs is predicted to be greater than 215 miles, owing to larger batteries. Long range BEVs with a driving range of greater than 400 miles already exist today, although they are typically very expensive.

Long range driving of BEVs may not be necessary when considering that prior to Covid-19, the average distance traveled each day in England was 6.8 miles, and the average commute was 10 miles. This has led to an assumption that range anxiety is a barrier based more on perception than actuality.

Yet, for exceptional journeys where a driver may need to travel for hundreds of miles, the range of a typical BEV (195 miles) may not be sufficient to get the driver to their destination without charging en route.

Lack of vehicle choice

A lack of vehicle choice has been flagged in consumer research as a barrier to BEV uptake in the UK, although to a lesser extent than the aforementioned barriers.

Currently, there are 97 different models of BEVs on the market in the UK, compared with over 400 ICE vehicles. As a result of the smaller variety, consumers wishing to purchase a BEV are less likely to find a vehicle which fits their requirements and preferences. However, new models of BEVs are forecast to come on to the market in years ahead, helping to erode lack of vehicle choice as a barrier to BEV uptake.

UK Government and the BEV market

The UK Government has recently implemented a series of policies aimed at addressing the key barriers to growing the BEV market. There are broadly four types of policies to catalyse the BEV market: fiscal, innovation, regulatory and behavioural policies.

Fiscal policies

The UK government currently provides a series of fiscal measures to support BEV uptake amongst households and businesses. This includes both grants and tax relief for both the purchasing of a BEV and the charging infrastructure that they require.
The leading UK-wide fiscal policies include:

- **Plug-in Car Grant.** A £3,000 grant offered towards the purchase of new vehicles which cost under £50,000, produce less than 50g of CO2 per kilometre and can travel a minimum of 70 miles without producing any tailpipe emissions.
- **Vehicle Excise Duty (VED) exemption.** An annual tax which is calculated on the basis of a vehicle's CO2 emissions. Vehicles producing zero tailpipe emissions pay no VED.
- **Reduced Benefit-in-Kind (BiK) tax.** BiK tax is paid on non-salary benefits included within an employee's remuneration package. For company cars, BiK tax bands are calculated on the basis of CO2 emissions. Vehicles producing zero tailpipe emissions incur no BiK tax, rising to 1% from 2021-22 and 2% from 2022-23.
- **Enhanced capital allowances.** A deduction of the capital costs of energy efficient and low carbon technologies off of business profits before tax is applied. Vehicles producing less than 50g of CO2 per

kilometre, encompassing BEVs, are eligible for 100% of their cost to be deducted from business profits in the first year.

- **Electric Vehicle Homecharge Scheme.** A grant of up to £350 (or 75% of total cost, whichever is lowest) for the purchase and installation of a chargepoint to be installed in a household.
- **Workplace Charging Scheme.** A grant of up to £350 (or 75% of total cost, whichever is lowest) for purchase and installation costs per chargepoint socket, allowing up to 40 sockets per applicant business.
- **Charging Infrastructure Investment Fund (CIIF).** A public-private investment into capital projects which support the increased uptake of BEVs.
- **Rapid Charging Fund.** Part of a £1.3 billion funding package from the UK Government to support chargepoint rollout across the UK, the Rapid Charging Fund is a £950 million fund for the rollout of rapid chargepoints, particularly in areas of anticipated future demand.
- **BEV battery production support.** The UK Government's 2020 Spending Review provided £500 million to support the production of BEV batteries in the UK. The UK Government has also made a £1 billion commitment to supporting UK-based BEV supply chains, including the development of a gigafactory.
- **On-street Residential Chargepoint Scheme.** A grant of up to £6,500 per chargepoint installation to support local authorities with the rollout of on-street chargepoints, with a limit of £100,000 for each project.

Innovation policies

Through R&D, the UK Government can foster innovation in the production and rollout of BEVs. Presently, the UK Government seeks to achieve this with large amounts of funding through several key R&D programmes, making innovation policy in effect a branch of fiscal policy. The leading UK-wide innovation policies include:

- **Automotive Transformation Fund.** £1 billion worth of R&D and capital funding for organisations in the automotive industry to create sustainable and competitive supply chains for BEVs in the UK.

- **Driving the Electric Revolution.** £80 million worth of R&D funding supporting the development of UK-based supply chains for clean and electrified transport, encompassing the components which make up the powertrain within a BEV.
- **Faraday Battery Challenge.** £317.75 million worth of R&D funding to support businesses and researchers to develop new and improved battery technologies.

Less significant amounts of R&D funding have also been supplied by the UK Government, including £36.7 million to create 'centres of excellence' to research electric transport solutions and to ensure that organisations, such as vehicle manufacturers, can access all necessary components to develop electric machinery, including BEVs. A further £12 million R&D funding has been set aside to support new battery technologies, as well as reducing battery charging times.

Regulatory policies

The UK Government has recently implemented and consulted on a series of regulations – which apply to vehicle manufacturers, building developers and some commercial landlords – designed to increase the number of BEVs on UK roads.

The leading UK-wide regulatory policies include:

- **2030 ICE vehicle phase-out.** A UK Government policy to ban the sale of new ICE vehicles by 2030. As part of this policy, the sale of new hybrid vehicles is to be phased out by 2035.
- **EU Regulation EC631.** Stipulates that manufacturers must meet a fleet-wide average emissions target for new passenger vehicles of 95g of CO2 per kilometre. For each gram per kilometre in excess of this target, manufacturers must pay an excess emissions premium of €95 (£84). Despite having left the EU, the UK has retained this

EU-derived vehicle CO2 standard as an interim measure before devising its own regulatory framework around vehicle CO2 emissions standards.

- **Charging infrastructure and building regulations.** Proposals included within a UK Government consultation outlining a mandatory number of chargepoints that would be installed in new residential and non-residential buildings, as well as buildings undergoing significant renovations.

Behavioural policies

Through behavioural science, the UK Government can shape policy to influence consumer attitudes to encourage increased awareness, approval and purchasing of BEVs. In reality, it is a branch of regulatory policy, since governments use rules to shift the choice architecture visible to consumers.

The leading UK-wide behavioural policies include:

- **Green flash on number plates.** Vehicles which produce zero emissions have a green flash on the left hand side of their number plate to make them more identifiable as zero emission vehicles.
- **New Car Environmental Label.** A label displayed alongside new vehicles on display in showrooms and at events, highlighting the vehicle's running costs, its emissions figures, and in the case of ULEVs (including BEVs), the vehicle's zero emission driving range.

Leading international approaches to growing the BEV market

Norway, Iceland and The Netherlands have seen a much higher uptake in BEVs than the UK. Additionally, China and California in the USA have had impressive growth in BEVs above and beyond that experienced by the UK, which warrants evaluation. These countries, of course, replicate some of the UK Government's policy approaches towards BEVs, so we do not explore those in this report. Our focus is on additional policies that the UK Government has not adopted, which may help to explain the more positive trends in BEV uptake witnessed in these countries.

Norway

With the largest market share of new BEV passenger vehicle registrations in the world, Norway is seen as the global leader of BEV uptake.

The Norwegian Government has stated that it is aiming for the end of new ICE vehicle sales by 2025, achieving this predominantly through fiscal measures, including:

- **VAT purchase exemption.** From 2001 to present, all purchases of BEVs are exempt from VAT, which is set at 25% in Norway (Norway can set its own VAT rates and eligibility as it has always been outside the EU).
- **VAT lease exemption.** Enacted in 2015, all leased BEVs are exempt from VAT.
- **Toll road and ferry charges exemption.** From 1997 to 2017, BEVs were exempt from all charges on toll roads or ferries.
- **Capped charges for toll roads, ferries and public parking.** From 1999 to 2017, BEVs were also exempt from paying for municipal parking. These exemptions have since been replaced in 2018 by 'the 50% rule', which mandates that local governments cannot charge BEVs more than 50% of the regular cost for ferries, toll roads and public parking.

As a result of Norway's fiscal incentives, new BEVs now tend to have a lower upfront price than their ICE vehicle counterparts. Research on public attitudes in Norway suggests that lower upfront price has been the strongest incentive for BEV uptake. However, Norway's policy approach to BEV uptake has been criticised as being expensive – costing the Norwegian Government 13.5 billion kr (£1.15 billion) a year – as well as favouring the wealthy.

Iceland

Iceland has the second largest market share of new BEV passenger vehicle registrations in Europe.

The Icelandic Government is committed to ending the sale of new ICE vehicles in 2030. The Icelandic Government, as well as the City of Reykjavik, have enacted a series of policies to support BEV uptake, including:

- **Reduction in petrol pumps.** The City of Reykjavik aims to reduce the number of fossil fuel petrol pumps by 50% by 2030, with the aim of them being almost entirely eradicated by 2040.
- **Tax exemptions.** Vehicles are exempt from import excise duty if they produce less than 80 grams of CO2 per kilometre, as well as being VAT exempt (Iceland's standard rate of VAT is 24%).
- **Free charging and parking.** The City of Reykjavik offers free BEV charging at 58 chargepoints across Reykjavik at certain on-street chargepoint locations and in public parking buildings. Parking at these locations is free for the first 90 minutes, thereafter drivers must pay standard parking prices.

There are also non-policy factors which support the uptake of BEVs in Iceland. First, Iceland has some of the lowest electricity prices in Europe and some of the highest fossil fuel prices in the world, making the running costs of BEVs significantly cheaper. Second, Iceland's small geography and concentration of its population in Reykjavik makes the rollout of a public charging network easier.

The Netherlands

The Netherlands has the third highest percentage of new BEV passenger vehicle registrations in Europe.

From 2030, the Dutch Government has a target of all new passenger vehicles being zero-emission vehicles (including BEVs), signalling the end of ICE and hybrid passenger vehicle sales. Several key policies help to deliver BEV uptake in The Netherlands, including:

- **Support for used BEVs.** A €2,000 (£1,771) grant is available for the purchase of a used BEV.
- **Support for leased BEVs.** A €4,000 (£3,542) grant for leasing a new BEV is provided, and a €2,000 (£1,771) grant for second hand leases, paid monthly into the leaseholders bank account over a four year period.
- **Demand-led on-street chargepoint scheme.** BEV drivers have the right to request a chargepoint to be installed near their place of residence or work via their municipality. Each request is assessed against its location, other nearby chargepoints, the walking distance to nearby chargepoints and their occupancy rate. If the request is approved, the chargepoint will then be installed, published on digital maps and nearby BEV drivers notified of its location.

With over 55,000 chargepoints, the Netherlands now has the greatest density of chargepoints in Europe.

California, United States

At a state level, California has experienced a much higher proportion of BEV uptake than the United States as a whole. In 2019, 5.3% of new passenger vehicle registrations were BEVs – considerably more than the UK, which only saw 1.8% of new passenger vehicle registrations being BEVs in the same year.

California's BEV uptake is predominantly driven by the state's unique flagship regulatory policy, the Zero Emission Vehicle (ZEV) Mandate. The ZEV Mandate requires vehicle manufacturers to produce a certain number of ZEVs (encompassing BEVs) each year, based on the total number of vehicles the manufacturer sells in the state. The more vehicles a manufacturer sells, the more ZEVs they are required to produce. The requirement on vehicle manufacturers is measured in terms of credits which equate to a percentage of total vehicle sales, which increases annually. For instance, in 2018, the credit requirement was 4.5%. By 2025, it will be 22%.

Credits are calculated based on a vehicle's zero emissions driving range, with longer driving ranges accruing more credits (up to a maximum of four). For vehicle manufacturers who fail to meet the requirements of the ZEV Mandate, they are penalised $5,000 (£3,640) per ZEV credit deficit. To aid in regulatory compliance, vehicle manufacturers can bank credits for future use or sell them to other vehicle manufacturers.

It is forecast that the zero emissions vehicles will account for a quarter of all new vehicle sales by 2024, rising to almost half (46.25%) by 2028, highlighting the efficacy of the ZEV Mandate.

California also uses high occupancy vehicle (HOV) lane access to incentive BEV uptake. Drivers of BEVs are eligible to purchase a sticker for their vehicle which permits them to use HOV lanes, regardless of whether they are taking additional passengers.

BEV uptake in California is also driven by state and federal-level rebates. California's Clean Vehicle Rebate Program provides rebates of up to $7,000 (£5,097) for the purchase or lease of a BEV depending on the purchaser's income and vehicle bought. At a federal level the US Government provides a tax credit of up to $7,500 (£5,461) for the purchase of a BEV, based on the kWh battery capacity of the vehicle.

China

China has maintained consistently higher proportions of new BEV passenger vehicle registrations than Europe and the United States (until it was overtaken by Europe in 2020), and in raw numbers, is the largest market for BEVs in the world.

China takes a regulatory approach to BEV uptake through its New Energy Vehicle (NEV) Mandate – similar to California's ZEV Mandate. The NEV Mandate requires vehicle manufacturers to attain a certain level of NEV production based on a credit system which is expressed as a percentage. It began in 2019 with a credit requirement of 10%, encompassing BEVs, FCEVs and plug-in hybrid electric vehicles

(PHEVs), increasing incrementally by 2% each year until 2023, where it stands at 18%.

Credits are calculated based on the vehicle's zero emission driving range, battery efficiency and weight (up to a maximum of six credits). Excess NEV credits cannot be banked for future use, but can be sold to other vehicle manufacturers, who equally can purchase NEV credits to rectify a deficit of credits. Should a vehicle manufacturer fail to meet the NEV Mandate requirements, Government approval of new vehicle types from the manufacturer will be denied.

China also uses its lottery system for the allocation of vehicle number plates to incentivise BEV uptake. BEVs are placed in a different pool to ICE vehicles when waiting for number plate allocation. As the BEV pool has less applicants and more licence plates, allocation of a number plate is quicker than it is for ICE vehicles.

New policies

In Chapter Six, we make eight recommendations to catalyse and mature the BEV market in the UK.

Policymakers face two important choices when considering how to mitigate the key barriers to BEV uptake. First, whether to adopt a more regulatory or fiscal approach, or a mixture, to drive BEV uptake. Second, on whether policy should focus on new or used BEVs, or both. We believe public policy in the UK should adopt both approaches and focuses.

A regulatory approach should provide the foundations to drive BEV uptake in the UK in the long-term. But, in the short-term, the nascent BEV market in the UK will still require an ambitious fiscal approach to act as a catalyst for BEV uptake. Other organisations have discussed the merits of different regulatory approaches the UK should take after Brexit, such as introducing a UK ZEV Mandate or permanently retaining and tightening the existing EU CO2 standards. We do not discuss them here. But, obviously, a strong regulatory regime needs to be established to mature the market in BEVs in the years ahead.

When developing policy recommendations, we applied four key tests that had to be met. First, policies must be evidentially grounded, drawing on examples in other countries and markets where positive trends in BEV uptake have been observed. Second, policies should be guided by fiscal realism, not greatly exacerbating government borrowing but nor being averse to carrying a realistic cost, given the seriousness of climate change and its environmental and economic consequences if left unmitigated. Third, policies should be progressive, supporting less well-off households in the electric transition and not penalising them. Fourth, policies should seek to saturate the market with BEVs in order to deliver emissions reductions in the transport sector and increase the supply of BEVs trickling down into the second hand market.

Fiscal policies

Recommendation one: Front-load the value of the Plug-in Car Grant so it equals £5,000 from April 2021 and then gradually reduce its value in regular intervals before being phased out completely from October 2023

To capitalise on nascent buyers, the Plug-in Car Grant should be front-loaded so its value is increased from £3,000 to £5,000 from April 2021 in order to support near-term demand, before being gradually decreased at regular intervals until it is phased out altogether in October 2023. In practice, this sets a clear 30 month trajectory for the complete phase out of the Plug-in Car Grant. It encourages households and businesses to purchase new BEVs as soon as possible, as delay only continuously reduces the amount of government subsidy available to them.

By front-loading the value of the Plug in Car Grant and gradually decreasing it over 30 months, this would prevent a demand cliff-edge where the grant suddenly ends, currently set for 2023. Furthermore, consumers would be encouraged to bring forward their purchase of a

BEV. This would support the saturation of the market to aid the second hand BEV market. The sooner new BEVs are purchased, the sooner they will trickle down into the second hand market, benefiting those on lower incomes. In essence, a final two-year window would be provided to consumers to benefit from the main fiscal subsidy for the purchase of new BEVs.

Recommendation two: Establish a Used Vehicle Plug-in Car Grant of at least £2,000 to support low income people into BEV ownership

To make BEV ownership more accessible for less well-off households, a Used Vehicle Plug-in Car Grant should be established, providing a grant of at least £2,000 for the purchase of a used BEV from the second hand market.

To be eligible for the Used Vehicle Plug-in Car Grant, vehicles must have CO2 emissions of less than 50 grams per kilometre and a minimum zero emission driving range of 112 kilometres (70 miles), matching the eligibility criteria of the existing Plug-in Car Grant for new BEVs. In addition, vehicles must not cost more than £30,000 to prevent high-end luxury vehicles being subsidised. To be eligible for the Used Vehicle Plug-in Car Grant, vehicles could be purchased from a dealership to prevent subsidy fraud via private sales. In order to target the grant towards those whom it aims to support, only households or individuals which are considered low-income could be eligible for the grant.

The Used Vehicle Plug-in Car Grant should be permanent for the foreseeable future, lasting beyond our proposed trajectory for the existing Plug in Car Grant for new BEVs, but the value of it should be reviewed regularly to assess its efficacy and necessity.

Recommendation three: Enable enhanced capital allowances for businesses which purchase zero emission vehicles for the purpose of renting and leasing them

Businesses which purchase vehicles for the purpose of renting and leasing should be allowed to deduct the cost of the vehicle from business profits before tax in the first year, provided that the vehicle produces less than 50 grams of CO2 per kilometre and has a minimum zero emission driving range of 112 kilometres (70 miles). This allowance could automatically expire in five years, only renewed once an assessment has been made of its efficacy and necessity as the price of BEVs falls and their market penetration increases.

This would have a triple benefit for BEV uptake. First, as commercial fleet vehicles accounted for over half of new UK vehicle registrations in 2020, a greater number of BEVs would be registered on UK roads as renting and leasing companies are incentivised to purchase BEVs because of their status as tax-deductible. Second, by passing on the benefit of enhanced capital allowances, consumers who rent or lease a BEV would benefit from a cost saving of up to £20 a month. Third, as fleet vehicles have high turnover, these vehicles would trickle down relatively quickly into the second hand market, giving less-well off households more opportunities to purchase a BEV.

Regulatory policies

Recommendation four: Introduce a mandate immediately stating that all new vehicle purchases for the public fleet must be BEVs

The UK Government should introduce a mandate immediately stating that all new vehicle purchases for the public fleet, including central government vehicles and vehicles managed by local councils, must be BEVs. Whilst these vehicles would be more expensive to purchase than ICE vehicles, central and local governments would benefit from the lower lifetime costs associated with BEVs.

Such a mandate would increase the proportion of BEVs in the central and local government fleet, and when it comes time to renew their fleets once more, these BEVs would trickle down into the nascent second hand BEV market.

Recommendation five: Introduce an obligation on all local authorities to install on-street electric vehicle chargepoints within three months when requested by residents unless there are reasonable grounds for objecting, facilitated by an online system established and administered by the local authority

Currently, local authorities determine where on-street chargepoints will be installed in residential areas, funded in part through the On-street Residential Chargepoint Scheme. We recommend that this process should be demand-led, with an onus on local authorities to install on-street chargepoints when requested by residents within three months unless there are reasonable grounds for objection.

BEV drivers should be able to access an online portal established and administered by local authorities for making their request. Drivers would be required to show proof of purchase of a BEV to their local authority, before making a request through the online portal for the installation of a chargepoint near their place of residence. The request could be assessed on various criteria, for example whether the driver has access to off-street parking, the walking distance to other existing or planned chargepoints in that area and the occupancy rate of nearby chargepoints.

If the request is approved, the local authority would open a consultation period of six weeks, where stakeholders could challenge or propose amendments to the plan. Following this, and assuming no setbacks as a result of the consultation period, the chargepoint would then be published on a map and other nearby registered BEV drivers could be notified of its location before being installed. Local authorities could either own the chargepoints or tender out their ownership to a private organisation. The operation of the chargepoint could also be tendered out to a charging network.

Recommendation six: Make interoperability a condition for central and local government funding towards chargepoints

Unlike other countries, few cross-network agreements to facilitate interoperability exist in the UK. The UK Government provides significant amounts of funding for chargepoints through the CIIF, Rapid Charging Fund and to local authorities through the On-street Residential Chargepoint Scheme. By making central and local government funding for chargepoints conditional on the basis of providing interoperability, this would act as a catalyst for an increase in cross-network agreements and interoperability between charging networks. This would benefit chargepoint users by increasing the number of chargepoints that they could access using a single charging network subscription.

Recommendation seven: Require all petrol stations above a certain size to have at least three rapid chargepoints by 2023, funded in part by petroleum companies and in part by government

By 2023, petrol stations in the UK above a certain size should be required to have at least three rapid chargepoints, which would be financed in-part by petroleum companies. Setting a date of 2023 would provide petrol stations with ample time to lay the necessary cabling and complete the installation of a rapid chargepoint. Chargepoints should be rapid so that they are able to deliver a quick charge and keep time spent recharging to a minimum.

With a cost of between £20-40,000 per rapid chargepoint, petroleum companies – who ultimately own the trade-marks and business models of all petrol stations – can and should be able to make a reasonable contribution to their installation. Petroleum companies should be required to fund the installation of the chargepoints themselves in each relevant petrol station, whilst the UK Government could pay for the necessary grid connections through the existing Rapid Charging Fund.

By having at least three rapid chargepoints at every petrol station above a certain size, drivers can have security in knowing that they will be able to recharge their BEV almost wherever they can locate a petrol station, and wherever they may have previously refuelled their ICE vehicle. As such, this policy would aid in dispelling driver anxieties around there being a lack of charging infrastructure, as well as range anxiety.

Recommendation eight: Make the inclusion of estimated lifetime costs mandatory for all used as well as new vehicle sales alongside the retail upfront price

The inclusion of estimated lifetime vehicle costs should be made mandatory for all new and used vehicle sales alongside the retail price.

For used vehicles being sold privately or through dealerships, the Vehicle Certification Agency (VCA) should establish an online tool to calculate vehicles' running costs using vehicle information such as fuel tank and engine size, battery capacity, weight, average maintenance costs and taxation, as well as contemporary fuel and BEV charging prices. To make an easy comparison for consumers, the final figure should be displayed in pounds-per-100 miles. This VCA-accredited estimated figure must then be displayed along with the listed price of any vehicle for sale. This estimate could be provided for every model of every make of car.

By making the inclusion of estimated lifetime costs mandatory for all new and used vehicle sales alongside the listed price, consumers will take into consideration the lifetime costs, which typically favour BEVs over ICE vehicles, when deciding on purchasing a vehicle. Additionally, this would provide greater transparency for consumers to make informed choices, particularly when purchasing a used vehicle from the second hand market.

Conclusion

As the largest emitting sector in the UK responsible for almost a third of UK emissions, the transport sector must be decarbonised, especially cars which account for more than half of the sector's emissions.

Whilst the UK Government has taken steps to grow the market for BEVs and their uptake has been trending in the right direction over the last decade, there remains a long way to go before the UK's BEV market is comparable to that of other high-performing countries. It is imperative that the market for BEVs – both new and used – grows substantially over the next decade if the UK is to meet its legal net zero 2050 emissions target.

The policies put forward in this report are not exhaustive, but do present original and credible policy ideas to act as a catalyst to, and mature the market for, new and used BEV uptake in the UK.

Chapter 1: **Introduction**

In 2019, the UK became the first major economy to legislate net zero emissions by 2050, ending the UK's contribution to global warming.[1] Different sectors of the economy will need to embark on deep decarbonisation in order to achieve the 2050 target.

The Committee on Climate Change (CCC) – an independent body which advises the UK and devolved governments on reducing greenhouse gas (GHG) emissions – has set out five-yearly carbon budgets which set the limit of the amount of GHG emissions that the UK can produce in order to comply with this country's legal emissions target.[2] The first carbon budget ran from 2008 to 2012 and the last currently proposed sixth carbon budget will run from 2033 to 2037.[3] To date, the UK has met the requirements laid out in the first and second carbon budgets, and is on track to outperform the third.[4]

Prior to the COVID-19 pandemic, indicators were showing that the UK was not on track to meeting its legal obligations around carbon

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1. Department for Business, Energy & Industrial Strategy and The Rt Hon Chris Skidmore MP, "UK becomes first major economy to pass net zero emissions law", https://www.gov.uk/government/news/uk-becomes-first-major-economy-to-pass-net-zero-emissions-law (2019).
2. Committee on Climate Change, "Reducing UK emissions: 2019 progress report to parliament", (2019), 81.
3. Department for Business, Energy and Industrial Strategy, "Carbon budgets", https://www.gov.uk/guidance/carbon-budgets (2016); Committee on Climate Change, "Advice on the sixth carbon budget", https://www.theccc.org.uk/comingup/advice-on-the-sixth-carbon-budget/#:~:text=The%20Committee%20on%20Climate%20Change,during%20the%20period%202033%2D2037 (2020).
4. Committee on Climate Change, "Reducing UK emissions: 2020 progress report to parliament", (2020), 52.

reduction in its fourth and fifth carbon budgets which run from 2023 to 2027 and 2028 to 2032.[5] COVID-19 has resulted in economy-wide emissions reductions,[6] but it is too early to calculate the full extent of this whilst the pandemic is ongoing.[7] Because of this, it is now difficult to forecast exactly whether the UK will be on track to achieve its fourth and future carbon budgets.

Despite delivering emissions reductions, lockdowns as a result of COVID-19 are not a sustainable solution to decarbonising the UK's economy. When this pandemic comes to pass, emissions will likely return to similar pre-pandemic levels unless measures are taken now to avert this. The CCC has agreed that how the UK recovers from the pandemic will impact greatly on the pace of transition towards a low-carbon economy.[8] The Government has expressed that it intends to make the recovery from COVID-19 a green one.[9]

This report focuses on the decarbonisation of a particular sector of the UK economy: transport, and even more specifically, reducing emissions from cars. As the UK's largest GHG emitting sector, there is a growing need to embark on the deeper decarbonisation of transport. If the Government wants to deliver a green recovery from COVID-19, and in order to achieve the net zero 2050 target, surface transport must shift away from internal combustion engine (ICE) vehicles towards ultra-low emission vehicles (ULEVs), particularly battery electric vehicles (BEVs), instead. These vehicles are described in detail later in this chapter.

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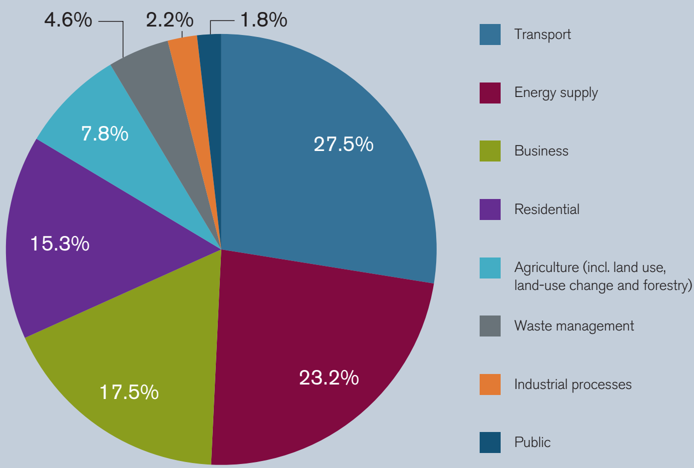
5. Green Alliance, "UK is off track in meeting its legal targets to cut carbon", https://www.green-alliance.org.uk/net_zero_policy_tracker_press_release.php (2020).
6. Committee on Climate Change, "Reducing UK emissions: 2020 progress report to parliament", (2019), 52.
7. Ibid.
8. Ibid., 13.
9. Prime Minister's Office, 10 Downing Street, Department for Transport, Department for Business, Energy and Industrial Strategy, The Rt Hon Boris Johnson MP, The Rt Hon Grant Shapps MP, and The Rt Hon Alok Sharma MP, "PM commits £350 million to fuel green recovery", https://www.gov.uk/government/news/pm-commits-350-million-to-fuel-green-recovery (2020).

The transport sector

Transport was responsible for almost 28% of all GHG emissions in 2018, the year which the latest figures are available, as Chart 1.1 below shows, with the bulk of this coming from cars.[10] In 2018, cars alone were responsible for 15% of the UK's total GHG emissions.[11] These emissions contain other harmful products such as particulate matter, carbon monoxide and nitrogen oxides, which also contribute to air pollution, the consequences of which are described in Box 1.1 below.

Chart 1.1. Sources of UK greenhouse gas emissions by sector, 2018



Source: Department for Business, Energy and Industrial Strategy, "2018 UK greenhouse gas emissions, final figures", 2020.

Cars have long accounted for the largest proportion of transport GHG emissions, and whilst there has been a dramatic improvement

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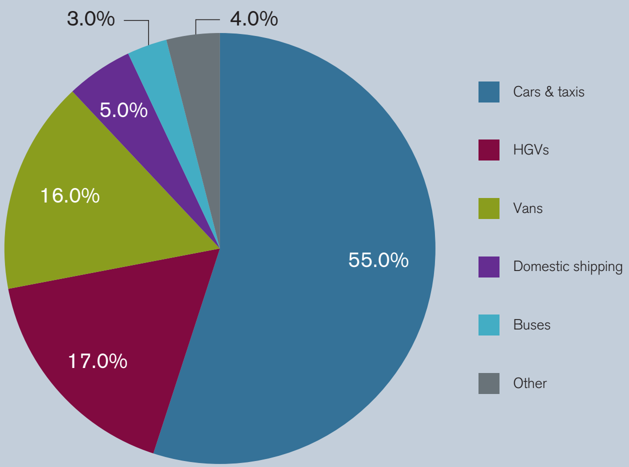
10. Department for Business, Energy and Industrial Strategy, "2018 UK greenhouse gas emissions, final figures", https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/862887/2018_Final_greenhouse_gas_emissions_statistical_release.pdf (2020), 14.
11. Department for Transport, "Decarbonising transport: setting the challenge", https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/878642/decarbonising-transport-setting-the-challenge.pdf (2020), 11-12.

in their efficiency, they have remained the largest source of transport GHG emissions since 1990 owing to their increased use over the last 30 years.[12] Cars, including taxis, were responsible for over half of domestic GHG emissions emanating from the UK transport sector in 2018, as shown in Chart 1.2 below.

Chart 1.2. Breakdown of transport emissions by transport type, 2018



Source: Department for Transport, "Decarbonising transport: setting the challenge", 2020.

Total UK GHG emissions have been trending downwards, falling 41% since 1990.[13] More recently, between 2008 and 2018, sectors such as industry and energy have achieved sizable emissions reductions, with the latter reducing emissions by more than 100MtCO2e in this period.[14] In contrast, emissions reductions for the transport sector over the same period are minuscule, and surface transport emissions

12. Department for Business, Energy and Industrial Strategy, "2018 UK greenhouse gas emissions, final figures", https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/862887/2018_Final_greenhouse_gas_emissions_statistical_release.pdf (2020), 14.
13. Committee on Climate Change, "Reducing UK emissions: 2020 progress report to parliament", (2020), 17.
14. Ibid., 72.

(which encompasses cars) actually increased from 2013 to 2018.[15] If the transport sector does not decarbonise quickly, it risks becoming a significant outlier in its contribution to the UK's GHG emissions total, as other sectors continue with deeper decarbonisation.

If the UK is to achieve its net zero 2050 target, emissions from the transport sector will need to be significantly reduced. The CCC have identified the transport sector as performing particularly poorly with regards to decarbonisation, in large part due to the slow uptake of ULEVs.[16]

Box 1.1. Vehicles and air pollution

As well as having a negative effect on carbon emissions, transport is one of the main sources of anthropogenic (man-made) air pollution.[17] As previous Bright Blue research has illustrated, transport is the leading cause of nitrogen oxides (NOx), as well as a significant minority contributor of particulate matter (PM) and carbon monoxide (CO) – all components of air pollution.[18]

ICE vehicles, particularly diesel vehicles, produce NOx and CO through the combustion process, as well as high amounts of PM. The abrasion of tyres, brakes and road surfaces also produces PM.

Air pollution has profoundly negative effects on human health. It is recognised as a carcinogen (it causes cancer), as well as causing heart disease, strokes, and chronic and acute respiratory diseases such as asthma.[19]

15. Ibid.; Committee on Climate Change, "Reducing UK emissions: 2019 progress report to parliament", (2019), 27.
16. Ibid., 52.
17. Department for Environment, Food and Rural Affairs, "Clean Air Strategy 2019", https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/770715/cleanair-strategy-2019.pdf (2019), 14.
18. Ryan Shorthouse and William Nicolle, "Emission impossible? Air pollution, national governance and the transport sector", Bright Blue http://brightblue.org.uk/wp-content/uploads/2019/08/Emission_Impossible_Final.pdf (2019), 45.
19. World Health Organisation, "Ambient (outdoor) air pollution", https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health (2018).

There is a significant economic cost associated with air pollution as well. Previously, Public Health England has estimated the cost of air pollution to be roughly £20 billion per annum.[20] One study has estimated that an individual car in London costs the NHS £8,000, and nationally the average cost of a car to the NHS over a 14 year lifespan is £1,640 (varied by the car's fuel type).[21]

ULEVs contribute significantly less towards air pollution as they either do not have an internal combustion engine, or are substantially more fuel efficient (in the case of hybrid electric vehicles). Whilst ULEVs produce little or no NOx and CO, they do still produce PM (as a result of tyres, brakes and road surface abrasion), albeit less than ICE vehicles.

The UK Government previously announced 2040 as the year that a ban on the sale of new ICE vehicles would come into effect, to support the decarbonisation of the transport sector. However, the 2040 phase-out date was widely criticised as being too late, and would mean that ICE vehicles sold just before the phase-out would still be on the roads beyond the net zero target date of 2050. As such, the UK Government has recently brought forward the ICE vehicle date to 2030, with a phase out date of 2035 for hybrid vehicles.[22]

Different types of ULEVs

As surface transport transitions away from ICE vehicles, different types of ULEVs need to and will become increasingly prevalent on UK roads, especially BEVs. To be considered a ULEV, a vehicle must use

20. Royal College of Physicians and Royal College of Paediatrics and Child Health, "Every breath we take: the lifelong impact of air pollution", https://www.rcplondon.ac.uk/file/2916/download?token=5dnlDovZ (2016), 6.
21. Ross Levin, Chen Lin and Zigan Wang, "Toxic emissions and executive migration", http://www.nber.org/papers/w24389#fromrss (2018).
22. Department for Business, Energy and Industrial Strategy and Prime Minister's Office, 10 Downing Street, "The Ten Point Plan for a Green Industrial Revolution", https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution/title (2020).

low carbon technologies and have tailpipe emissions of less than 75g of CO_2 per kilometre.[23] By way of reference, the latest data shows that the average petrol car in Europe emitted 123.5g of CO_2 per kilometre.[24] Table 1.1 below outlines the different types of ULEVs and explains the key characteristics of each.

Table 1.1. Different types of ULEVs[25]

Type of ULEV	Description
BEV – Battery Electric Vehicle	A vehicle powered entirely by one or more onboard batteries using an electric motor to drive the wheels, producing zero tailpipe emissions.
PHEV – Plug-In Hybrid Electric Vehicle	A vehicle which uses more than one means of propulsion and is capable of zero emissions driving (typically between 20-30 miles). PHEVs have a battery but it is usually smaller than batteries found in BEVs, as PHEVs can revert to conventional ICE power if needed to drive beyond the zero emission range. PHEVs need to be regularly recharged to maximise their zero emission capability.
HEV – Hybrid Electric Vehicle	With a typically smaller zero emission range than PHEVs, HEVs use an electric motor to work in tandem with a petrol or diesel engine. HEVs do not need to be plugged in, as the battery is charged by the engine and through regenerative braking.
MHEV – Mild Hybrid Electric Vehicle	A vehicle with a petrol or diesel internal combustion engine which is also equipped with an electric motor to allow the main engine to be switched off when the vehicle is coasting or braking. The electric motor can provide assistance to the engine, increasing the vehicle's efficiency. Their point of difference from HEVs is that unlike HEVs, MHEVs are not capable of zero emission driving.

23. Society of Motor Manufacturers and Traders, "Ultra low emission vehicles (ULEVs)", https://www.smmt.co.uk/industry-topics/technology-innovation/ultra-low-emission-vehicles-ulevs/ (2020).
24. European Environment Agency, "Monitoring CO2 emissions from passenger cars and vans in 2018", https://www.eea.europa.eu/publications/co2-emissions-from-cars-and-vans-2018 (2020), 14.
25. Society of Motor Manufacturers and Traders, "Fuel type & powertrain technology", https://www.smmt.co.uk/industry-topics/emissions/fuel-type-and-powertrain-technology/ (2020).

FCEV – Fuel Cell Electric Vehicle	A zero emission electric vehicle which uses fuel cells – and typically hydrogen – to generate power. Hydrogen is stored (either as a compressed gas or cryogenic liquid) in a tank, and combined with oxygen in the fuel cell to create electricity and power the vehicle. The only other byproducts are water and heat. With a long driving range and faster refuelling, hydrogen seems to be a promising solution for the decarbonisation of heavy goods vehicles (HGVs).

Up until December 2020, MHEVs were the most registered ULEV on UK roads with 180,132 registrations in 2020.[26] This was followed by HEVs at 110,117, BEVs at 108,205 and PHEVs at 66,877 registrations.[27] The number of registrations for FCEVs were minuscule.

There are a number of variables which determine the carbon intensity of each type of ULEV: how the vehicle's battery was produced; the carbon intensity of the electricity grid where the vehicle is being charged; the amount of zero emissions driving, with regard to hybrid vehicles, and, in the case of FCEVs, how the hydrogen being used to fuel the vehicle was produced – from fossil fuels, biomass (with or without carbon capture and storage) or low-carbon electricity.

BEVs and FCEVs are the cleanest types of ULEVs, even if BEVs are charged using high-carbon electricity or FCEVs fuelled by grey hydrogen. Assuming BEVs are charging on the UK electricity grid, life cycle emissions – factoring in all emissions associated with car production, and maintenance – are almost three times higher for ICE vehicles than BEVs.[28]

Given the UK Government's announcement that hybrid vehicles will be phased out in 2035, the focus of this report is on maturing the

26. Society of Motor Manufacturers and Traders, "Car registrations", https://www.smmt.co.uk/vehicle-data/car-registrations/ (2020).
27. Ibid.
28. Transport & Environment, "How clean are electric cars? T&E's analysis of electric car lifecycle CO2 emissions", https://www.transportenvironment.org/sites/te/files/downloads/T%26E%E2%80%99s%20EV%20life%20cycle%20analysis%20LCA.pdf (2020), 13.

market for zero emission vehicles (ZEVs), notably BEVs. This report explores the decarbonisation of passenger vehicles and as such FCEVs, despite being ZEVs, will not be the focus of this report given their more justifiable application for the decarbonisation of HGVs, as detailed in Box 1.2 below.

Box 1.2. Electric versus hydrogen

There is a debate on whether battery electric or hydrogen powered vehicles provide the most viable route for the decarbonisation of surface transport. This assessment depends on several factors including range, cost and refuelling.

Hydrogen powered vehicles typically have a driving range greater than 300 miles. The range of BEVs varies greatly depending on the model of vehicle. For instance, the UK's most popular BEV – the Nissan Leaf – has a range of 168 miles and the more expensive Tesla Model S Long Range Plus model can drive for up to 405 miles.[29] Generally, the average range of new BEVs on the market today is 192 miles.[30]

The choice of FCEVs is substantially smaller than BEVs, and they are typically more expensive as well. The cost of a FCEV or BEV does, of course, depend on the model of the vehicle, but there are significantly more lower cost options for BEVs that are available on the UK market compared to FCEVs. For example, there are two FCEV passenger vehicles on the UK market right now: the Hyundai Nexo and Toyota Mirai, both of which cost in excess of £60,000. By comparison, there are 100 models of new BEVs available in the

29. Nissan, "Nissan Leaf", https://www.nissan.co.uk/vehicles/new-vehicles/leaf.html#:~:text=FOR%20CITY%20DRIVING-,A%20range%20up%20to%20168%20Miles,drives%20to%20school%20and%20work. (2020); Tesla, "Model S", https://www.tesla.com/en_gb/models (2020).
30. Electric Vehicle Database, "Range of full electric vehicles", https://ev-database.uk/cheatsheet/range-electric-car (2020).

UK, with an upfront price of £14,000 for the lowest priced model.[31] The average price for a BEV in the UK is £47,000.[32]

There are advantages and disadvantages to refuelling/charging a FCEV compared to a BEV. There are over 12,500 locations across the UK to charge a BEV whereas there are only 11 hydrogen refuelling stations for passenger vehicles, giving BEV drivers significantly more choice in where they refuel/recharge their vehicle compared to FCEV drivers.[33]

However, when filling a FCEV's tank with hydrogen, much like an ICE vehicle with petrol or diesel, it takes a matter of minutes rather than what can be an hours-long affair or more to recharge a BEV. On the other hand, BEVs are considerably cheaper to recharge than a FCEV is to refuel. A typical BEV equipped with a 60kWh battery would cost approximately £8.40 to recharge at home whereas the cost of refuelling a FCEV, such as the Hyundai Nexo, is approximately £63-95.[34]

The CCC has concluded that BEVs are best placed to deliver the bulk of the decarbonisation of passenger vehicles but that there is a role for hydrogen to play, particularly in relation to heavy duty transport such as lorries, buses, coaches and trains.[35] The ability to travel longer distances, refuel quickly, as well as store and carry large amounts of energy – all important components of heavy duty transport – favours hydrogen.[36]

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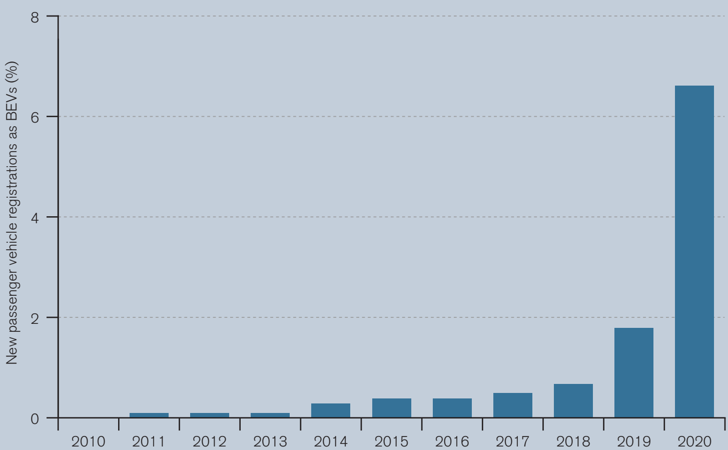
31. Electric Vehicle Database, "Price of full electric vehicles", https://ev-database.uk/cheatsheet/price-electric-car (2020).
32. Ibid.
33. Zap Map, "EV charging stats 2020", https://www.zap-map.com/statistics/ (2020); UK H2Mobility, "Refuelling stations", http://www.ukh2mobility.co.uk/stations/ (2020).
34. Pod Point, "Cost of charging an electric car", https://pod-point.com/guides/driver/cost-of-charging-electric-car (2020); Royal Automobile Club, "Hydrogen cars: are they the future?", https://www.rac.co.uk/drive/advice/buying-and-selling-guides/hydrogen-cars/ (2020).
35. Committee on Climate Change, "Hydrogen in a low-carbon economy", https://www.theccc.org.uk/wp-content/uploads/2018/11/Hydrogen-in-a-low-carbon-economy.pdf (2018), 47.
36. Ibid.

BEV uptake

Over the last decade, BEV uptake has increased in the UK and many other global markets. Chart 1.3 below depicts BEV uptake in the UK by showing the number of new BEV passenger vehicle registrations.

From 1994 until 2009, the number of registered BEVs on UK roads remained less than 1,500.[37] Given the minuscule amount of BEV passenger vehicles on UK roads over this time period, we do not include the percentage of BEV passenger vehicle registrations prior to 2010 in Chart 1.3.

Chart 1.3. Percentage of newly registered passenger vehicles in UK which are BEVs



Source: Data showing percentage of new BEV passenger vehicle registrations from European Alternative Fuels Observatory and Society of Motor Manufacturers and Traders. Data as of December 2020.

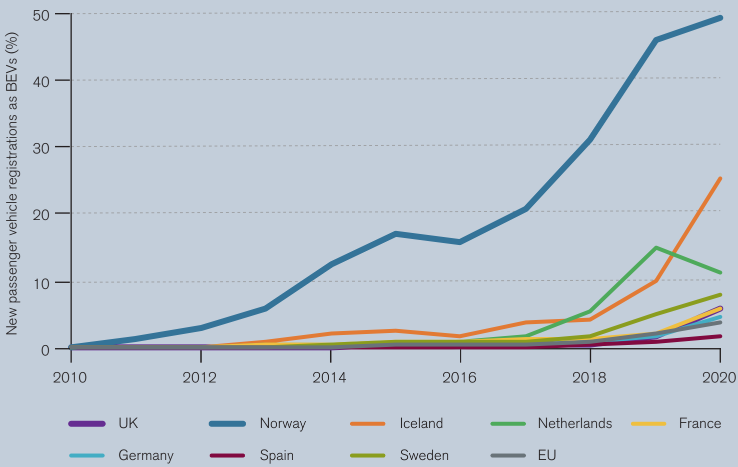
Growth in the registrations of new BEV passenger vehicles in the UK was relatively stagnant until towards the end of the last decade when they grew from 0.7% of new passenger vehicle registrations in 2018 to

37. Department for Transport Statistics, "VEH0203: Licenced cars at the end of the year by propulsion or fuel type: Great Britain and United Kingdom", https://www.gov.uk/government/statistical-data-sets/veh02-licensed-cars (2020).

1.8% the following year. 2020 has seen the largest yearly increase in new BEV passenger vehicle registrations in the UK, with a total of 6.6% of new passenger vehicle registrations being BEVs (as of December 2020).

Whilst BEV sales are trending in the right direction, as a percentage of the total market share of new passenger vehicle registrations, they remain under 10%. When comparing the UK's BEV uptake with other countries which have more mature BEV markets, it is clear that the UK's BEV market remains somewhat nascent. To easily draw comparisons of BEV uptake between different countries, we look at the percentage of new passenger vehicle registrations which are BEVs. This is illustrated in Chart 1.4 below.

Chart 1.4. Percentage of new BEV passenger vehicle registrations compared to other newly registered passenger vehicles (UK, Norway, Iceland, Netherlands, France, Germany, Spain, Sweden, EU), 2010 to 2020



Source: Data showing percentage of new BEV passenger vehicle registrations from European Alternative Fuels Observatory. Data as of September 2020.

Chart 1.4 highlights Norway, Iceland and the Netherlands as the top performing countries with regard to BEV uptake. Norway has the largest market share of new BEV passenger vehicle registrations by a substantial margin (over 20 percentage points more than its nearest competitor, Iceland). BEV uptake in Norway has steadily increased since 2010, gaining strong momentum from 2013 onwards. By 2016, 15.7% of new passenger vehicle registrations were BEVs. This then increased markedly, by more than 33 percentage points, to 49.1%, as of September 2020. Presently, Norway has the largest percentage of new passenger vehicle registrations for BEVs in the world.

Iceland also has a significant market share of new passenger vehicle registrations for BEVs. As of September 2020, 25.3% of newly registered passenger vehicles were BEVs. At the beginning of the previous decade, BEVs made up less than 1% of new passenger vehicle registrations until 2013. The BEV market in Iceland remained nascent until 2018, when new BEV passenger vehicle registrations then increased rapidly.

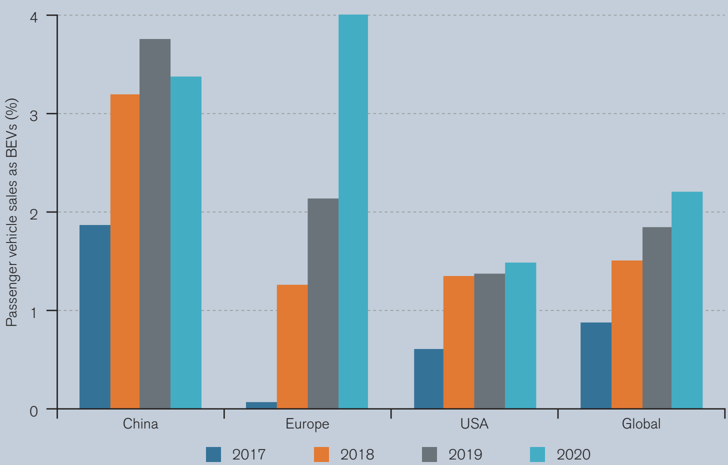
Similar to markets such as Norway and Iceland, the Netherlands has experienced incremental BEV uptake, particularly since 2017. Prior to 2016, BEVs made up less than 1% of new passenger vehicle registrations. But by September 2020, BEVs held an 11.4% market share of new passenger vehicle registrations.

Other European markets such as France, Germany and Sweden have followed similar trajectories, albeit to a lesser degree, in BEV uptake to the Netherlands, with the number of new BEV passenger vehicle registrations beginning to increase in 2018. However, new BEV passenger vehicle registration remains under 8% in all three countries. Spain is the worst performing market for BEV uptake out of the countries in Chart 1.4, with BEVs failing to achieve over 2% of new passenger vehicle registrations in any given year.

New registrations for BEV passenger vehicles across the EU as a whole remains below 5%. Until 2019, the percentage of new BEV passenger vehicle registration was higher across the EU on average than the UK, until the UK surpassed the EU's percentage of BEV passenger vehicle registrations in 2020 for the first time. But, compared to the three market leaders of BEVs in Europe – Norway, Iceland and the Netherlands – the UK is far behind. The UK can and must do more to support the uptake of BEVs.

Chart 1.4 drew a comparison across European countries on BEV uptake by new registrations. Chart 1.5 below looks at BEV sales as a percentage of total sales in the passenger vehicle market in key global markets – China, Europe (not just the EU), the United States and all markets globally. Owing to data limitations, particularly around BEV uptake in China, changes in BEV uptake are only shown from 2017 to 2020 (as of August 2020).

Chart 1.5. BEV sales as a percentage of total vehicle sales in the passenger vehicle market, 2017-2020



Source: Data showing BEV sales as a percentage of total vehicle sales from EV-volumes.com. Data as of August 2020.

Chart 1.5 shows that in the case of all key international markets except China, there has been a year-on-year increase in BEV sales as a proportion of passenger vehicle sales.

Globally, there has been a relatively uniform increase in the proportion of BEV sales. By comparison, the United States saw the percentage of BEV sales increase from 0.61% in 2017 to 1.36% in 2018, since then it has not changed significantly. Europe saw an exceptionally low proportion of passenger vehicle sales as BEVs in 2017 (0.08%) before experiencing larger increases in BEV sales from 1.26% in 2018 to

4% in 2020. China maintained consistently higher proportions of BEV sales than all other markets up until 2020, where it has been overtaken by Europe. The proportion of BEV sales in China increased from 1.87% in 2017 to 3.76% in 2019, before dropping to 3.38% as of August 2020.

We will explore the possible reasons for the trends in BEV uptake across the high-performing countries featured in Chart 1.4 and Chart 1.5 in greater detail in Chapter Five, including the policies adopted by each country to facilitate BEV uptake.

Focus of this report

This report unearths and explains the key barriers to maturing the BEV market in the UK. The report will then go on to assess the types of policy interventions that have been and could be implemented to catalyse the market for BEVs in the UK, drawing on international examples. Finally, the report recommends original and credible policies to address the leading barriers and mature the market for BEVs.

This report focuses solely on BEVs, specifically passenger vehicles. This report does not focus on other types of ULEVs such as hybrid vehicles and FCEVs.

This report seeks to answer the following research questions:

1. How important is fully electrifying private transport to achieve net zero by 2050?
2. What are the key barriers to the uptake of BEVs?
3. What types of policies have been and could be implemented to catalyse the market for BEVs in the UK?
4. What policies would help mature the BEV market in the UK?

The report is structured as follows:

- **Chapter two** outlines the methodologies used in developing this report, including a literature review, stakeholder consultation, and a call for written evidence.

- **Chapter three** examines the key barriers to the uptake of BEVs for households and businesses.
- **Chapter four** outlines the steps the UK Government has taken up until now to grow the market for BEVs.
- **Chapter five** focuses on several high-performing countries which have strong BEV uptake and the unique and additional policies adopted by their respective Governments to drive this.
- **Chapter six** puts forward original and credible policy recommendations for maturing the market for BEVs in the UK.

Chapter 2: **Methodology**

This report seeks to present a comprehensive typology of the current leading barriers to maturing the BEV market in the UK, identify and assess different policy interventions to catalyse it, drawing on international examples. This report concludes with original and credible policy recommendations to mature the market for BEVs.

Research techniques

We employed three research techniques in this project:

- **Literature review.** We conducted an extensive literature review to highlight the importance of curbing emissions from the transport sector in order to achieve net zero emissions by 2050 and identify the leading barriers to BEV uptake in the UK. The review also explored policies, drawing on domestic and international examples, designed to encourage BEV uptake. We looked at relevant academic journals, think tank reports, publications from industry groups and trade bodies, and government studies and datasets.
- **Stakeholder consultation.** Bright Blue consulted a number of leading academics, experts, decision makers and business representatives in the vehicle and energy industries.
- **Call for written evidence.** Bright Blue issued a public call for written evidence on maturing the market for BEVs. We received 10 submissions from a range of organisations. These are listed in the annex of this report.

Chapter 3: Key barriers to battery electric vehicle uptake in the UK

Chapter one identified trends in the BEV market in the UK relative to our international competitors, finding that although there has been growth, especially recently, we lag behind other countries. This chapter explores and explains in detail the leading barriers to BEV uptake in the UK.

These barriers to BEV uptake are for both households and businesses, although the evidence in this chapter on barriers mainly relates to the views of households. Businesses may place more emphasis on one barrier over another – for example, they may have greater concern around vehicle range than upfront price[38] – and there may be some unique barriers to uptake among commercial fleets, which are explored later in this chapter.

Upfront price

Upfront price is repeatedly highlighted in the evidence as the main barrier to BEV uptake for households. Recent polling of drivers commissioned by the Society of Motor Manufacturers and Traders (SMMT) in August 2020 found that the most popular reason for not

38. Office for Zero Emission Vehicles and Government Social Research, "Uptake of ultra low emission vehicles in the UK", https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/464763/uptake-of-ulev-uk.pdf (2015), 38.

purchasing a BEV was upfront price (52%).[39] Consumer research conducted by PricewaterhouseCoopers reinforces this, identifying that of the 60% of ICE vehicle drivers who were surveyed, the number one reason for not purchasing a BEV was due to the upfront price.[40]

Table 3.1 below takes the bestselling new BEVs in the UK which have an ICE vehicle counterpart and compares the upfront price of each, based on October 2020 prices. As the comparison must be made between the same model of vehicle, popular BEVs such as the Nissan Leaf are excluded as they do not have an ICE vehicle counterpart.[41]

In every case the upfront price of a new BEV was greater than its new ICE vehicle counterpart by a significant margin. The prices displayed in Table 3.1 are inclusive of the £3,000 reduction from the Plug-in Grant, the government subsidy introduced in 2011 and explained in greater detail in Chapter Four, showing that at the moment we are some way off price equivalency for BEVs and ICE vehicles.

Table 3.1. Comparison of the upfront price of the most popular new BEVs with their ICE vehicle counterparts

Vehicle (ICE)	Upfront price (Oct 2020)	Vehicle (BEV)	Upfront price (incl PiCG) (Oct 2020)	BEV 2020 sales share
MG ZS (Excite)	£15,495	MG ZS EV (Excite)	£25,495	44.7%
Hyundai Kona (SE)	£19,280	Hyundai Kona Electric (SE)	£33,095	34.5%
Peugeot 208 (Active)	£17,155	Peugeot e-208 (Active)	£29,025	21.3%

39. Society of Motor Manufacturers and Traders, "Billions invested in electric vehicle range but nearly half of UK buyers still think 2035 too soon to switch", https://www.smmt.co.uk/2020/09/billions-invested-in-electric-vehicle-range-but-nearly-half-of-uk-buyers-still-think-2035-too-soon-to-switch/ (2020).
40. PricewaterhouseCoopers, "Charging ahead – the need to upscale UK electric charging infrastructure", https://www.pwc.co.uk/power-utilities/assets/electric-vehicle-charging-infrastructure.pdf (2018), 7.
41. Electric versions of ICE vehicles are presently commonplace but will become less common as BEVs are more frequently built on electric-only platforms.

Peugeot 2008 (Active)	£20,590	Peugeot e-2008 (Active)	£32,065	15%
Mini (3-door hatch)	£16,200	Mini Electric (3-door hatch)	£24,900	9.6%
Volkswagen Golf (8 – Life)	£23,900	Volkswagen e-Golf	£28,075	6.1%
Vauxhall Corsa (SE)	£16,415	Vauxhall Corsa-e (SE NAV)	£27,665	6.1%

Source: Vehicle prices sourced from respective vehicles' manufacturer websites. Sales data supplied to the author by SMMT, EAFO, Marklines and EV-volumes.

Predictions around when price equivalency for new BEVs and ICE vehicles will occur vary, however BloombergNEF have cited 2023 as the year when this will occur.[42] Prior to the COVID-19 pandemic, Deloitte's analysis stated 2022 as the tipping point for price equivalency between new ICE vehicles and BEVs.[43] However, given this date was calculated using forecasts from 2019 which did not consider the eventuality of a global pandemic, Deloitte has since revised their analysis. They now conclude that over time BEV prices will continue to fall, and whilst it remains difficult to predict a specific date for when price equivalency will occur, this is likely to happen "sooner rather than later".[44] However, as Chart 3.2 further below shows, the price of new BEVs has, over the previous decade, either gradually increased or flatlined owing to the lithium ion batteries which power BEVs, as explained below.

42. BloombergNEF, "Battery pack prices cited below $100/kwh for the first time in 2020, while market average sits at $137/kwh", https://about.bnef.com/blog/battery-pack-prices-cited-below-100-kwh-for-the-first-time-in-2020-while-market-average-sits-at-137-kwh/ (2020).
43. Deloitte, "New market. New entrants. New challenges. Battery electric vehicles", https://www2.deloitte.com/content/dam/Deloitte/uk/Documents/manufacturing/deloitte-uk-battery-electric-vehicles.pdf (2019), 4.
44. Michael Woodward, Dr Bryn Walton, Dr Jamie Hamilton, Genevieve Alberts, Saskia Fullerton-Smith, Edward Day and James Ringrow, "Electric vehicles: setting a course for 2030", Deloitte, https://www2.deloitte.com/uk/en/insights/focus/future-of-mobility/electric-vehicle-trends-2030.html (2020).

Box 3.1. The second hand market

Many people, particularly those on modest incomes who cannot afford the upfront price of a new vehicle, purchase used vehicles from the second hand market.[45]

Out of the new and used vehicle markets, the latter is the larger market of the two. In 2020, there were over five million used passenger vehicle transactions. Contrastingly, there were 1.6 million new passenger vehicle registrations, with 108,205 of these being BEVs.[46]

In 2019 – prior to the market being disrupted by the effects of COVID-19 – almost eight million used passenger vehicle transactions occurred on the second hand market compared to little over 2.3 million new passenger vehicle registrations, 37,850 of which were BEVs.[47]

In 2020, 97.42% of used vehicle transactions were ICE vehicles, highlighting the dominance ICE vehicles have in the second hand vehicle market.[48] Used ICE vehicles are also considerably cheaper than used BEVs. An analysis of the second hand vehicle market has shown that the average price of a used BEV is £25,880, whilst this figure dips to £12,389 for petrol vehicles.[49]

Until price equivalency between ICE vehicles and BEVs is met, and this equivalency has trickled down into the second hand market, BEV ownership will remain difficult for many less well-off

45. Foresight and Government Office for Science, "Inequalities in mobility and access in the UK transport system", https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/784685/future_of_mobility_access.pdf (2019), 51.
46. Society of Motor Manufacturers and Traders, "Used car sales: Q3 2020", https://www.smmt.co.uk/2020/11/used-car-sales-q3-2020/ (2020); Society of Motor Manufacturers and Traders, "Car registrations", https://www.smmt.co.uk/vehicle-data/car-registrations/ (2020).
47. Ibid.
48. Ibid.
49. Richard Aucock, "Used car prices in largest-ever monthly increase", https://www.motoringresearch.com/used-cars/used-car-average-prices-august-2020/#:~:text=It%20means%20the%20average%20asking,one%20year%20in%20the%20marketplace, Motoring Research, (2020).

households.[50] Research in the UK has cautioned the risk of a reality for the foreseeable future where less well-off households remain restricted to purchasing second hand ICE vehicles, which have a lower upfront price, but are more expensive to run and are more heavily taxed.[51]

Box 3.2. Financing or leasing a vehicle

There are alternatives to the outright purchase of a new or used BEV, specifically financing options. A Personal Contract Purchase (PCP) enables households, after paying a deposit, to pay down part of the value of a vehicle over an agreed time period. For example, a household may put down a £2,000 deposit over a four-year time period. The finance company will calculate the value of the vehicle at the end of the agreed time period, for instance £5,000. The deposit and the vehicle's depreciation will then be subtracted from the vehicle's upfront price to establish the value of a loan (a household would owe £13,000 over four years for a vehicle worth £20,000). The household then gradually pays down this loan, but does not own the vehicle unless they choose to make a further payment on the remaining value of the vehicle at the end of the four-year time period (known as a 'balloon payment').

Leasing a vehicle – essentially a long-term rental car – is another alternative to the outright purchase of a vehicle for households. After paying an initial deposit, households will pay a monthly amount to the lender for the duration of the leasing contract. At the end of the contract the household returns the vehicle to the lender.

50. Foresight and Government Office for Science, "Inequalities in mobility and access in the UK transport system" ,https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/784685/future_of_mobility_access.pdf (2019), 51.
51. Giulio Mattioli, Karen Lucas and Greg Marsden, "Transport poverty and fuel poverty in the UK: From analogy to comparison", *Institute for Transport Studies* (2017), 101.

Through these financing options, households, particularly those which are less well-off, have an alternative to the outright purchase of a BEV which may make it easier for them to experience the benefits of going electric.

The role of lithium ion batteries

The high upfront price of new BEVs is predominantly, but not exclusively (as explained later), caused by the cost of the lithium ion batteries required to power BEVs. Box 3.3 below explains what a lithium ion battery is, their composition and how the capacity and cost of lithium ion batteries can be expressed in kWh.

Box 3.3. Lithium ion batteries

Lithium ion batteries are the same type of batteries found in smartphones, laptops and tablets, but obviously on a much larger scale in the case of BEVs. Battery composition may vary depending on the type of BEV, but it usually has three key components: the battery's cell, module and pack. Put simply, a series of cells form a module and a series of modules form a pack. The battery pack is then installed into the BEV and used to power the electric motor.

Cells are made up of a cathode, anode, separator and electrolyte encased in aluminium, providing electric energy through charging and discharging. Twelve cells make up a module, which assembles cells into a frame thereby protecting cells from external shocks, extreme temperatures and vibration which may be experienced when driving. Eight modules form part of the battery's pack, which also includes a battery management system and a cooling system to manage battery temperature and voltage. This is the final form of the battery which will be installed into a BEV.

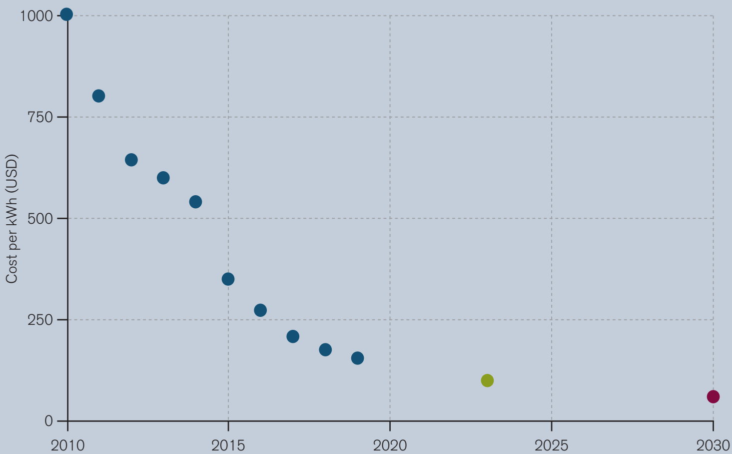
A lithium ion battery's capacity is expressed in kWh (the average battery capacity for a BEV in the UK is 60kWh).[52] Normally, the greater the kWh capacity in a BEV's battery, the further the BEV's range is. However, vehicle weight is also a factor. A heavier BEV will have a smaller range than a lighter BEV with the same battery capacity, as heavier vehicles require greater amounts of energy to propel them.

The production cost of lithium ion batteries can be measured in terms of cost per kWh. Batteries are a costly component in BEVs, giving them a higher upfront price.[53] For example, when taking the average cost of a lithium ion battery per kWh in 2019 ($156/£114)[54] and multiplying it by the average battery capacity for a BEV in the UK (60kWh), the battery would form a $9,360 (£6,815)[55] component of the vehicle.[56] Battery cost varies per vehicle based on the battery size and manufacturer.

Whilst lithium ion batteries are an expensive component of BEVs, their cost has fallen over time. Chart 3.1 below shows the dramatic changes in the average price of lithium ion batteries over the previous decade.

52. Electric Vehicle Database, "Useable battery capacity of full electric vehicles", https://ev-database.uk/cheatsheet/useable-battery-capacity-electric-car (2020).
53. David Coffin and Jeff Horowitz, "The supply chain for electric vehicle batteries", *Journal of International Commerce and Economics*, (2018), 4.
54. Currency conversion as of Jan 2021.
55. Ibid.
56. Bloomberg NEF, "Battery pack prices fall as market ramps up with market average at $156/kwh in 2019", https://about.bnef.com/blog/battery-pack-prices-fall-as-market-ramps-up-with-market-average-at-156-kwh-in-2019/ (2019); EVSpecifications, "2019 Volkswagen e-Golf SE – specifications and price", https://www.evspecifications.com/en/model/e1d178 (2019).

Chart 3.1. Average lithium ion battery cost per kilowatt hour (kWh) in USD, 2010 to 2030



Source: Lithium ion battery cost data from BloombergNEF

As Chart 3.1 illustrates, since 2010, the average cost of lithium ion batteries has fallen over 85% from $1,000 (£728)[57] per kWh in 2010 to $156 (£114)[58] in 2019. Sharp reductions in cost occurred between 2010 and 2015 ($350/£255)[59], with reductions slowing from the middle of the decade through to 2019.

The reduction in cost can be attributed to several factors which reduce manufacturing expenditure, including evolving supply chains and simplified battery pack designs. With increasing demand across different countries and global markets for new BEVs, as illustrated in Charts 1.4 and 1.5, a growing number of lithium ion batteries are required. Battery manufacturers are constructing more production plants in regions such as China, Europe and the United States. This

57. Currency conversion as of Jan 2021.
58. Ibid.
59. Ibid.

reduces the costs associated with international logistics, such as transportation and import duties.[60]

Battery pack designs are being simplified as well. Vehicle manufacturers are beginning to standardise them across different models of BEVs, with the same battery pack design able to be scaled up or down, depending on the size of the vehicle. Vehicle manufacturers are also beginning to procure cells from multiple different suppliers, which in turn is increasing the standardisation of cell design. Without the need to redesign battery packs to fit different models of BEVs, the manufacturing costs of lithium ion batteries are reduced.[61]

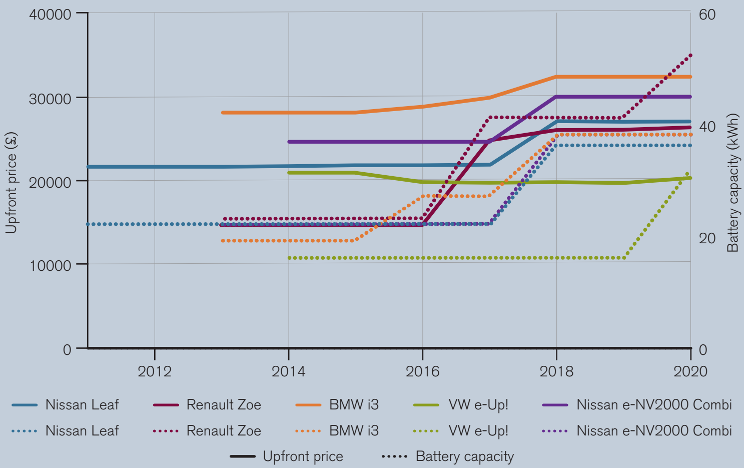
As Chart 3.1 above also shows, BloombergNEF forecasts that by 2023, lithium ion battery prices will be almost $100 (£73)[62] per kWh, the price point at which vehicle manufacturers are predicted to be able to produce BEVs at the same price as ICE vehicles.[63] By 2030, the cost of a battery will be $61 (£44)[64] per kWh.[65] This will more than halve the component cost of a lithium ion battery for BEVs, further reducing BEVs' upfront price and making them even more competitively priced against ICE vehicles.

Importantly, despite large reductions in the cost of batteries, there has not been a large reduction in the upfront price of new BEVs. This is due to 'up-speccing', where the cost reductions in lithium ion batteries have been reflected less in reduced new BEV prices for consumers but rather in increased specification of lithium ion batteries. In essence, vehicle manufacturers are using larger batteries with a greater kWh capacity, as consumers demand longer range.

60. Bloomberg NEF, "Battery pack prices fall as market ramps up with market average at $156/kwh in 2019", https://about.bnef.com/blog/battery-pack-prices-fall-as-market-ramps-up-with-market-average-at-156-kwh-in-2019/ (2019).
61. Ibid.
62. Currency conversion as of Jan 2021.
63. Bloomberg NEF, "Battery pack prices cited below $100/kwh for the first time in 2020, while market average sits at $137/kwh", https://about.bnef.com/blog/battery-pack-prices-cited-below-100-kwh-for-the-first-time-in-2020-while-market-average-sits-at-137-kwh/ (2020).
64. Currency conversion as of Jan 2021.
65. Bloomberg NEF, "Electric vehicle outlook 2020", https://bnef.turtl.co/story/evo-2020/page/6/1?teaser=yes (2020), 1.

Chart 3.2 below shows the changes in the upfront price and kWh battery capacity of the five earliest new BEVs on the UK market and their subsequent models from 2011 through to 2020. The dotted lines are indicative of the changes in battery capacity, whilst the solid lines track the changes in upfront price. The five earliest BEVs on the UK market were selected so as to be able to observe changes in upfront price and battery capacity over a longer period of time. Note that these vehicle models do not feature in Table 3.1 as they do not have an ICE vehicle equivalent.

Chart 3.2. Changes in the upfront price and battery capacity of the earliest new BEVs on the UK market, 2011 to 2020



Source: Upfront price and battery capacity data from Electric Vehicle Database.

Overall, Chart 3.2 shows that the upfront price of BEVs has not decreased over the previous decade and identifies a relationship between the upfront price of a BEV and its battery capacity. Essentially, though producing batteries is becoming cheaper, putting downward pressure on consumer prices, the battery capacity of these BEVS is increasing, putting upward pressure on the upfront prices.

The Nissan Leaf was one of the first BEVs to enter the UK market in 2011 with newer models being released in 2015 and 2018. The upfront price remained largely unchanged in 2015 but increased by £5,165 in 2018. The battery size of the 2011 and 2015 model did not change. However, corresponding with the increased upfront price of the 2018 model was an increase in the Nissan Leaf's battery capacity.

The Renault Zoe came to market in the UK in 2013 with an upfront price of £14,495 with a 23kWh battery capacity. In 2017, the newer model Zoe was released equipped with a 41kWh battery and consequently carried a higher upfront price of £24,520. The following year Renault released a later model of the Zoe with the same kWh battery capacity and no significant price change. The latest 2020 model of the Renault Zoe has an upfront price of £26,170 and a 52 kWh battery.

The new Nissan e-NV2000 Combi's upfront price increased between 2014 and 2018, as the battery capacity grew. The upfront price of the BMW i3 grew incrementally throughout the release of the 2016, 2017 and 2018 models, as the battery capacity progressively grew. In the case of the VW e-Up!, the upfront price actually reduced for the release of the 2016 model, before marginally increasing with the release of the 2020 model when the battery capacity increased.

Of course, battery capacity is not the sole determinant of changes to the upfront price of new BEVs. Other factors include the production volume of the vehicle produced: typically, the more vehicles that are produced the lower the production cost is. Also, factors include research and development and new vehicle technologies, and the cost of raw materials for other components of the vehicle. All these impact on the production cost of a vehicle and subsequently affect the vehicle's upfront price, but the data above shows how strongly the upfront price is correlated with the battery capacity.

Battery cost reductions will not always be lost to up-speccing, as there will eventually be no need to increase the range of BEVs as they near the optimal range for most consumers, which is estimated to be

200-300 miles.[66] At the moment, the average range of BEVs in the UK is 192 miles.[67]

Predictions of falls in the upfront price of new BEVs are grounded in the fact that as we near the optimal range with increasing battery capacity in new BEVs, upfront price reductions can be achieved through falling battery costs whilst battery capacity remains the same.

Lifetime cost versus upfront price

Despite the higher current prices, when considering the total cost of ownership of a vehicle, BEVs are in fact often a cheaper option than ICE vehicles.[68] Total cost of ownership, otherwise known as lifetime cost, is an estimate of the total running costs associated with a vehicle, such as fuel (or charging) prices, maintenance costs and vehicle taxation.

First, on charging and fuel prices. The savings that can be made between charging a BEV and refuelling an ICE vehicle depends on the make and model of each respective vehicle. Nonetheless, to charge a BEV equipped with the average BEV battery size of 60kWh to travel 100 miles would cost £6.50. By comparison, a new petrol vehicle would typically cost £10.74 in fuel to travel 100 miles.[69]

Second, on maintenance costs. Powertrains – the main components of a vehicle which generate power and deliver it to the wheels – have about 20 moving parts in a BEV, considerably less than the several hundred found in ICE vehicles.[70] As such, the maintenance costs on BEVs are typically lower than ICE vehicles. A study by automotive data

66. The Behavioural Insights Team and Transport Research Laboratory, "Driving and accelerating the adoption of electric vehicles in the UK", https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/914111/driving-and-accelerating-the-adoption-of-electric-vehicles-in-the-uk.pdf (2020), 15.
67. EV Database, "Range of full electric vehicles", https://ev-database.uk/cheatsheet/range-electric-car (2020).
68. Green Alliance, "Going electric: how everyone can benefit sooner", https://www.green-alliance.org.uk/resources/going_electric_how_everyone_can_benefit_sooner.pdf (2019), 8.
69. Calculation made by the author assuming the average fuel economy of a new petrol vehicle in the UK (9.5 litres per 100mi) using November 2020 fuel prices and data from Pod Point for the cost of a 100mi charge at a rapid charger in a BEV with a 60kWh battery.
70. Green Alliance, "Going electric: how everyone can benefit sooner", https://www.green-alliance.org.uk/resources/going_electric_how_everyone_can_benefit_sooner.pdf (2019), 16.

experts, cap hpi, found that BEVs on average cost 23% less than ICE vehicles to maintain over a three year period (or 60,000 miles).[71]

Third, on tax. Most obviously, unlike ICE vehicles, BEVs, of course, pay no fuel duty, which as of November 2020 was charged at 57.95 pence per litre. Unlike ICE vehicles, BEVs benefit from an exemption on vehicle excise duty (VED). As such, the on-road taxation cost is zero for BEVs, whilst ICE vehicles pay more, depending on tailpipe CO2 emissions and value of the vehicle. Included within VED is an ongoing annual road tax rate of £150, however BEVs remain exempt from this charge as well.

BEV ownership can also bring about savings through Benefit-in-Kind (BiK) taxation. BiK tax is paid by employees on non-salary benefits they receive as part of their remuneration. For employees who receive a company car as part of their remuneration package, BiK tax will be applied based on the employees income tax band, the value of the vehicle and its tailpipe CO2 emissions. Vehicles which produce no tailpipe CO2 emissions, such as BEVs, will be subject to a BiK tax rate of just 1% in 2021, whilst ICE vehicles may be subject to a BiK tax rate of up to 37%.

All the tax benefits that BEV ownership attracts in the UK will be discussed in greater detail in Chapter Four.

Despite BEVs having a typically lower lifetime cost, research by the Behavioural Insights Team highlights that consumers largely make their purchasing decisions around vehicles based on the upfront price and do not sufficiently take into consideration the lifetime cost.[72] As such, this psychology around cost considerations also acts as a barrier to BEV uptake.

71. Analysis from internal cap hpi reporting, published with permission from cap hpi.
72. The Behavioural Insights Team and Transport Research Laboratory, "Driving and accelerating the adoption of electric vehicles in the UK", https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/914111/driving-and-accelerating-the-adoption-of-electric-vehicles-in-the-uk.pdf (2020), 25-26.

Charging infrastructure

SMMT's recent poll, mentioned earlier in this chapter, found that 44% of drivers thought lack of local chargepoints held them back from purchasing a BEV – the second largest barrier to BEV uptake for households after upfront price.[73] PricewaterhouseCoopers' consumer research, also aforementioned, reinforces the issue of charging availability in BEV uptake. Of the 60% of ICE vehicle drivers surveyed who would not consider purchasing a BEV as their next vehicle, the number two reason for not doing so was due to availability of charging or lack thereof (22%), second again to upfront price.[74]

Consumer confidence in the availability of charging infrastructure is critical for BEV uptake. To date, the UK now has over 34,000 public chargepoints across more than 12,000 locations.[75] Any chargepoint which is accessible to the general public is considered a public chargepoint irrespective of who owns the chargepoint – for example, a public body or private organisation. Chargepoints have different speeds. For instance, a chargepoint located at a motorway services is likely to be a rapid chargepoint in order to recharge a BEV in as little time as possible, whereas an on-street chargepoint in a residential area – whereby a BEV is parked on the street and plugged into a chargepoint situated near the curb – is likely to be a slow or fast chargepoint. Table 3.2 below identifies and describes the four different types of BEV charging speeds in the UK.

73. Society of Motor Manufacturers and Traders, "Billions invested in electric vehicle range but nearly half of UK buyers still think 2035 too soon to switch", https://www.smmt.co.uk/2020/09/billions-invested-in-electric-vehicle-range-but-nearly-half-of-uk-buyers-still-think-2035-too-soon-to-switch/, (2020).
74. PricewaterhouseCoopers, "Charging ahead – the need to upscale UK electric charging infrastructure", https://www.pwc.co.uk/power-utilities/assets/electric-vehicle-charging-infrastructure.pdf (2018), 7.
75. Zap Map, "EV charging stats 2020", https://www.zap-map.com/statistics/ (2020).

Table 3.2. Different types of BEV charging speeds

Type of ULEV	Description
Slow	Typically draws 3kW of power and takes 8-12 hours for a full charge (this can vary depending on the charging unit and the BEV). Most home charging is slow charging, as a standard house socket can support slow charging.
Fast	Draws 7kW of power, and takes 3-5 hours for a full charge. Most on-street chargepoints use fast charging.
Rapid (DC/AC)	Uses direct current (DC) or alternating current (AC), with approximately 50kW and being able to charge a BEV in around one hour. Rapid chargepoints are typically situated at petrol station forecourts and on key routes.
Ultra-rapid	A subset of rapid charging capable of delivering up to 350kW – designed to charge a BEV as quickly as possible and bring the charging time down to 10-15 minutes. Like rapid chargepoints, ultra-rapid chargepoints are typically situated at petrol station forecourts and on key routes.

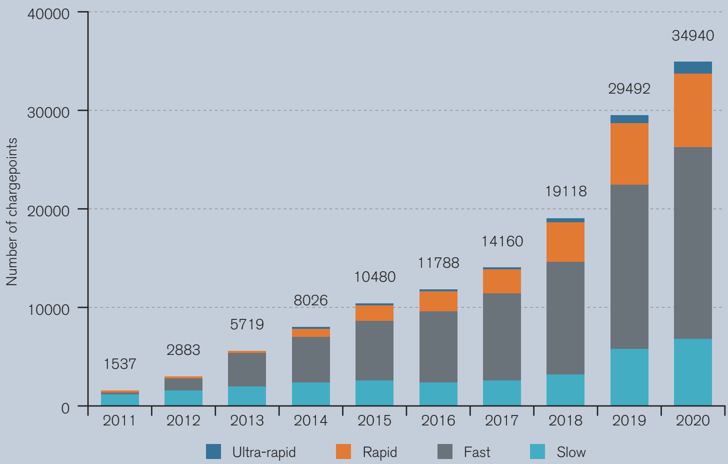
Source: Next Green Car, "EV charging – locate charging points across the UK", (2020).

Over the last decade, the UK has seen significant growth in the number of chargepoints, particularly fast and rapid chargers. Chart 3.3 below shows the evolution of the number of different types of public chargepoints across the UK since 2011.

As Chart 3.3 below shows, since 2011, the UK has seen over a 2,000% increase in the number of public chargepoints. Growth in the number of chargepoints has been so significant that the UK now has more chargepoint locations than petrol stations.[76]

76. Energy Institute, "Energy insight: transport – fuel: number of petrol stations in the UK (dss18a)", https://knowledge.energyinst.org/search/record?id=58946 (2019).

Chart 3.3. Number of different types of public chargepoints in the UK 2011-2020



Source: Zap Map, "EV charging stats 2020", (2020). Data as of November 2020.

Box 3.4. Charging networks and interoperability

When recharging their BEV, drivers are faced with a wide variety of charging networks to choose from.

Chargepoints can be owned by charging network companies themselves or by a public body such as a local authority, who then tenders out the operation of the chargepoint to a charging network company. A series of charging network companies own different chargepoints across the country. Polar, Ubitricity and Pod Point are the three largest chargepoint owners in the UK, all possessing more than 10% ownership of public chargepoints and collectively holding over a 30% market share.

The UK consumer is thus faced with a variety of charging networks to choose from, each with their own forms of access and payment.

Because of the lack of agreements between charging network companies, they must often have several different cards and apps to pay for and maintain an account with one of several different chargepoint network companies. This is due to a lack of interoperability, which makes chargepoint access and payment more difficult for consumers.

An interoperable BEV charging system would mean that consumers are not constrained by only being able to charge at a chargepoint operated by a network with which they have a subscription. Instead, they would be able to charge at a number of different chargepoints (depending on those which belong to a roaming hub or have peer-to-peer agreements and allow interoperability), with suppliers making up the difference in price.

Subscription charges for charging vary between the different networks. For instance, Polar charges £7.85 per month for subscribed access to their chargepoints, whilst a subscription to Source London costs £4 a month.

Consumers could, of course, pay for charging services by simply using their credit card across all different charging providers. This is known as 'ad hoc' charging – accessing chargepoints without a pre-existing contract. The drawback to this is that in many instances, ad hoc charging costs more to the consumer than other means of payment – for example, payment through a charging network's card or app.

Despite the growth in public chargepoints, charging infrastructure does remain a barrier to BEV uptake. The lack of consumer confidence in ample charging infrastructure seems to flow from three factors. First, some evidence suggests there needs to be further increases in the number of public chargepoints on main roads, particularly to support a growing number of BEVs. Second, for those households without off-street parking, there is a lack of on-street chargepoints. Third, the perception that there is insufficient availability of public chargepoints.

Public chargepoints on main roads

In its Road Investment Strategy, the UK Government made a commitment that 95% of locations across England's Strategic Road Network – a series of motorways and significant A roads administered by Highways England – would be within 20 miles of a chargepoint (rapid, where possible) by 2020.[77] This target has been surpassed, with over 97% of the strategic road network now within 20 miles of a rapid chargepoint.[78] In this sense, a low number of public chargepoints on main roads is actually currently not really a barrier.

Nevertheless, as the number of BEVs increases, a greater number of chargepoints will need to be provided along motorways and main roads. And there is research showing the deficit of charging infrastructure in the UK from the International Council on Clean Transportation (ICCT). Specifically, it shows the relationship between BEV uptake and the need for more public chargepoints. The ICCT modelled two scenarios of BEV uptake – one with a greater level of uptake than the other – demonstrating that as the number of BEVs increases, so does the occupancy rate of public chargepoints.[79] As such, more public chargepoints will be required as the number of BEVs grows.

Looking into the future, in its Sixth Carbon Budget, the CCC outlines that in a scenario of BEV uptake exceeding 20 million vehicles, almost 400,000 public chargepoints would be required, with the bulk of these being rapid chargers.[80] As Chart 3.3 above shows, despite significant growth in the number of chargepoints over the last decade, substantially more would be required.

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77. Department for Transport, "Road investment strategy: for the 2015/16-2019/20 road period", https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/408 514/ris-for-2015-16-road-period-web-version.pdf (2015), 58.
78. Arup, "Creating a sustainable future for the strategic road network in England", https://www.arup.com/projects/highways-england-rapid-electric-vehicle-charge-points-programme (2021).
79. Michael Nicholas and Nic Lutsey, "Quantifying the electric vehicle charging infrastructure gap in the United Kingdom", The International Council on Clean Transportation, https://theicct.org/sites/default/files/publications/UK-charging-gap-082020.pdf (2020), 11-13.
80. Committee on Climate Change, "The sixth carbon budget: The UK's path to net zero", (2020), 98.

Homes with no off-street parking

Whilst there are calls for a greater number of public chargepoints overall, one particular area of charging infrastructure which poses a challenge to BEV uptake is homes without off-street parking. For those who live in homes with no off-street parking, a lack of nearby charging infrastructure is a significant barrier to BEV ownership.

Off-street parking provides BEV owners with the opportunity to install their own BEV chargers on their premises, such as in a garage, driveway or private parking bay. But about a third of homes in England do not have off-street parking.[81] If homes do not have off-street parking, BEV drivers are reliant on either on-street charging infrastructure or 'at destination' chargepoints located in places such as the workplace, supermarket or shopping centres.

The number of chargepoints by region and local authority reveals the postcode lottery when it comes to accessing on-street charging infrastructure near drivers' homes. London had the greatest availability of chargepoints, with 57.3 chargepoints per population of 100,000. However, this varies significantly between different London boroughs. For example, Havering only has 5 chargepoints for every 100,000 people whilst in Kensington & Chelsea, this figure is 197.9.[82]

The North East and South East of England have 30.4 and 27 chargepoints per population of 100,000 respectively, whilst the West Midlands and Yorkshire and the Humber both have the poorest ratio in England of 17.30 chargepoints per population of 100,000.[83]

The need for on-street charging infrastructure is especially dramatic for London, where two thirds of all BEVs parking in residential areas

81. Ministry of Housing, Communities & Local Government, "English housing survey: stock condition, 2016", https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/880323/Stock_condition_-_REVISED_APRIL_2020_FINAL.pdf (2016), 9.
82. Department for Transport, "EVCD_01: Publicly available electric vehicle charging devices by local authority, July 2020", https://www.gov.uk/government/statistics/electric-vehicle-charging-device-statistics-july-2020 (2020).
83. Ibid.

overnight will require on-street charging in a high BEV uptake scenario.[84]

The perception of a lack of charging infrastructure

The Behavioural Insights Team have argued that a lack of public chargepoints can often be more of an issue of perception than reality for several reasons. First, petrol stations are more visible than chargepoints, and better signposted as well, making them appear more prevalent than chargepoints.[85] Second, the nature of charging a BEV is vastly different to an ICE vehicle; rather than going to a petrol station, most BEV charging takes place at home.[86] Furthermore, consumers may over-stress the importance of public chargepoint availability, as we are accustomed to refuelling this way with ICE vehicles.[87]

These three factors show that charging infrastructure is a barrier facing potential BEV owners and there is a need to continue increasing the number of public chargepoints as BEV uptake grows, particularly in areas where homes do not have off-street parking.

Range anxiety

Charging infrastructure does affect an interrelated barrier to BEV uptake: range anxiety. This is the fear that a BEV will run out of charge before reaching either a chargepoint or its destination, leaving the driver stranded. Range anxiety can stem from either a lack of charging infrastructure, actual or perceived, or a BEV being equipped with a battery which has limited driving range. In the previously referenced SMMT polling, 38% of drivers would not buy a BEV out of fear that they would run out of range on longer journeys – the third largest

84. Transport for London, "Plug-in electric vehicle uptake and infrastructure impacts study", http://content.tfl.gov.uk/ev-uptake-and-infrastructure-impacts-study-updated-nov-2016.pdf (2016), 41.
85. The Behavioural Insights Team and Transport Research Laboratory, "Driving and accelerating the adoption of electric vehicles in the UK", https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/914111/driving-and-accelerating-the-adoption-of-electric-vehicles-in-the-uk.pdf (2020), 151.
86. Ibid., 3
87. Ibid.

barrier for households to purchasing a BEV.[88]

To highlight the disparity in driving ranges – based on a full tank of fuel or charging of a battery – between BEVs and ICE vehicles, Table 3.3 below compares the driving range of the most popular BEVs with their ICE vehicle counterparts. As with Table 3.1, popular BEVs such as the Nissan Leaf have been excluded as they do not have an ICE vehicle equivalent. As Table 3.3 below illustrates, in each comparison between an ICE vehicle and its BEV equivalent, the driving range for the BEV is considerably less than the ICE vehicle.

Table 3.3. Comparison of the range of the most popular BEVs with their ICE vehicle counterparts

Vehicle (ICE)	Range (approx)[89]	Vehicle (BEV)	Range
MG ZS (Excite)	410mi	MG ZS EV (Excite)	163mi
Hyundai Kona (SE)	365mi	Hyundai Kona Electric (SE)	278mi
Peugeot 208 (Active)	461mi	Peugeot e-208 (Active)	217mi
Peugeot 2008 (Active)	468mi	Peugeot e-2008 (Active)	206mi
Mini (3-door hatch)	295mi	Mini Electric (3-door hatch)	140-145mi
Volkswagen Golf (8 – Life)	516mi	Volkswagen e-Golf	144mi
Vauxhall Corsa (SE)	435mi	Vauxhall Corsa-e (SE NAV)	209mi

Source: Respective vehicles' manufacturer websites.

88. Society of Motor Manufacturers and Traders, "Billions invested in electric vehicle range but nearly half of UK buyers still think 2035 too soon to switch" https://www.smmt.co.uk/2020/09/billions-invested-in-electric-vehicle-range-but-nearly-half-of-uk-buyers-still-think-2035-too-soon-to-switch/ (2020).
89. Vehicle range given as approximate figure only. Range may vary depending on driving conditions i.e city or motorway driving. Calculated using combined mpg (WLTP).

Despite the disparity in driving range between BEVs and their ICE vehicle counterparts seen in Table 3.3, BEV range has increased substantially in recent decades. For example, most BEV models in 2010 had a driving range between 80-120 miles.[90] Today, the most popular BEVs featured in Table 3.2 above have driving ranges between 140-278 miles.

Looking ahead to 2030, BEVs are predicted to have an average driving range of 217-248 miles, owing to larger batteries (70-80 kWh).[91] However, some BEVs (especially those on the lower-end of the market) may not be equipped for long range driving as they will be equipped to favour affordability (having smaller batteries to save on cost).[92] For drivers looking for longer range, options are already available today such as the Tesla Model S with a range of 405 miles.[93] Yet, at a cost of £74,980 (as of November 2020), this remains an expensive option for long range electric driving.

However, such long range driving may not be necessary when considering distances travelled by most people on a daily basis. For instance, prior to COVID-19, the average distance travelled each day in England was 6.8 miles and the average commute to work had been a distance of around 10 miles.[94] When considering the range of the BEVs identified in Table 3.3, distances of more than 10 miles can easily be achieved even without a full charge.

This has led to an assumption that range anxiety is, in many cases, a perceived issue rather than an actual one. Behavioural research has noted that by providing consumers with a better understanding of real-world range needs, their concerns around the range of BEVs may

90. Houses of Parliament, "Electric vehicles", https://www.parliament.uk/documents/post/postpn365_electricvehicles.pdf (2010), 1.
91. International Energy Agency, "Global EV outlook 2020", https://www.iea.org/reports/global-ev-outlook-2020 (2020).
92. Ibid.
93. Tesla, "Model S", https://www.tesla.com/en_gb/models (2020).
94. Department for Transport, "Commuting trends in England: 1988-2015", https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/877039/commuting-in-england-1988-2015.pdf (2015), 43; Department for Transport, "Trips: Distance travelled and time taken: England, 1972/73 onwards", https://www.gov.uk/government/statistics/national-travel-survey-2019, (2019).

be alleviated.[95]

Yet, for exceptionally long-distance journeys where a driver may need to travel for hundreds of miles, the range of a typical BEV (195 miles) may not be sufficient to get the driver to their destination without charging en route.

Ultimately, BEVs remain more than able to cover typical daily travel distances, so in this sense range anxiety is a barrier based on perception rather than actuality for BEV uptake. But, for drivers wanting to undertake exceptionally longer journeys beyond the range of a typical BEV, range anxiety could well be a barrier based on actuality.

Lack of vehicle choice

Lack of vehicle choice was not flagged as a barrier to BEV uptake in the SMMT polling that we have used to identify other barriers to BEV uptake for households in this report. However, it has been noted as a barrier to BEV uptake in other research that has been conducted.[96] Most recently, a poll conducted in 2020 of UK residents looked at the barriers to buying a BEV, finding that 75% of respondents felt the limited choice of BEVs was a barrier to them purchasing one.[97] However, lack of choice came sixth out of the eight barriers to BEV uptake in the study, with planning long journeys, lack of charge points and upfront price being the top three, echoing our analysis in this chapter.

Currently, there are 97 different models of BEVs on the market in the UK compared with over 400 different models of ICE vehicles.[98] In

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95. Behavioural Insights Team and Transport Research Laboratory, "Driving and accelerating the adoption of electric vehicles in the UK", https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/914111/driving-and-accelerating-the-adoption-of-electric-vehicles-in-the-uk.pdf (2020), 15.
96. Transport & Environment, "Carmakers failing to hit their own goals for sales of electric cars", https://www.transportenvironment.org/sites/te/files/publications/2017_09_Carmakers_goals_EVs_report_I.pdf (2017).
97. Device Pilot, "Pain points: EV charging in the UK from 2021 and beyond", https://info.devicepilot.com/hubfs/PAIN%20POINTS%20-%20EV%20charging%20in%20the%20UK%20from%202021%20and%20beyond.pdf (2020), 18.
98. Electric Vehicle Database, "Price of full electric vehicles" https://ev-database.uk/cheatsheet/price-electric-car (2020); Department for Transport, "VEH0120: Licenced vehicles by make and model: Great Britain and United Kingdom" https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/942370/veh0120.ods (2020).

contrast to the large variety of ICE vehicles, by having a smaller range of BEV models to choose from, consumers are less likely to find a BEV which meets their requirements and preferences.

Despite the availability of different models for BEVs being considerably less than ICE vehicles, the number of different models is forecast to increase in coming years as the number and types of BEVs which come to market grows. In 2021, 22 new models of BEV are expected to come to market, 30 more in 2022 and an additional 33 in 2023.[99] This increase in the variety of different models will help to erode lack of choice as a barrier to BEV uptake over time.

Box 3.5. Commercial fleet vehicles

Most new vehicle registrations actually go to commercial fleets rather than households. Commercial fleets also have a high turnover of vehicles. This means that fleet vehicles will be a strong source of supply for used BEVs being sold on the second hand market, the importance of which was discussed in Box 3.2 earlier.

In 2020, commercial fleet vehicles accounted for 52.1% of all new passenger vehicle registrations in the UK, compared with 45.8% coming from private individuals and households.[100] After a period of between three and five years, commercial fleet vehicles typically enter the second hand market. For commercially leased fleet vehicles, this timeframe is even smaller with a turnover of every 38 months on average, and new rental vehicles even less so, being kept on fleet for approximately one year before being released.[101] In 2019, commercial fleet vehicles accounted for 22% of used vehicle

99. European Federation for Transport and Environment AISBL, "Electric surge: carmakers' electric car plans across Europe 2019-2025", https://www.transportenvironment.org/sites/te/files/publications/2019_07_TE_electric_cars_report_final.pdf (2019), 9.
100. Society of Motor Manufacturers and Traders, "Car registrations", https://www.smmt.co.uk/vehicle-data/car-registrations/ (2020).
101. Figures supplied by, and published with permission from, the BVRLA.

transactions.[102]

Given the important role commercial fleets can play in increasing the uptake of BEVs and their supply to the second hand market, it is unsurprising the UK Government has used a series of policy measures – notably Enhanced Capital Allowances and Benefit-in-Kind (BiK) taxation – to incentivise businesses to purchase BEVs, as will be discussed in further detail in Chapter Four.

In addition to the barriers to BEV uptake already outlined in this chapter, a lack of supply of available BEVs to purchase has been cited as a leading barrier to BEV uptake amongst businesses for commercial fleets.[103]

Conclusion

This chapter has explored the leading barriers to BEV uptake in the UK, mostly of new vehicles but they could also apply to used vehicles too, which those on modest incomes are more reliant on. The barriers relate to both households and businesses. We identified upfront price, charging infrastructure – particularly homes with no off-street parking – and range anxiety as the leading barriers. The focus of this report later on is to provide original and credible policy ideas to act as a catalyst for BEV uptake, in part by addressing these leading barriers.

The UK Government has attempted to mitigate these barriers through a range of different policies in recent years. The following chapter outlines in detail the different specific policies which the UK Government has adopted in recent times to try and grow the BEV market in the UK.

102. Ibid.
103. EV100, "UK electric fleets coalition", https://www.theclimategroup.org/media/7361/download, (2020).

Chapter 4: UK Government and the battery electric vehicle market

The previous chapter identified and examined the leading barriers to BEV uptake in the UK for both households and businesses. This chapter dissects the UK Government's recent policy approach towards tackling these barriers and growing the BEV market.

Typology of policy levers

There are broadly four types of policies to catalyse the BEV market: fiscal, innovation, regulatory and behavioural policies.

Fiscal policy uses revenue collection and expenditure from government to influence economic outcomes. As explained later in this chapter, the UK Government commonly uses grants as part of its fiscal policy towards incentivising BEV uptake. These grants can be provided to both households and businesses. Government can also use revenue collection to incentivise BEV uptake. By providing various forms of tax relief, for example, the upfront and ongoing costs associated with BEVs are reduced, making them more attractive to households and businesses.

Innovation policy is a branch of fiscal policy, since it uses government funding to enable research and development (R&D), which may tackle sector-specific challenges. Through R&D funding, the government can help to foster innovation in the BEV sector, improving the various components of the vehicles themselves, as well as the wider BEV ecosystem.

Regulatory policy uses regulations and laws to direct or control the behaviour of both households and businesses. In the case of BEVs, regulatory policy is used to achieve specific outcomes, notably – as will be seen later in this chapter – the increase in production of BEVs from vehicle manufacturers and the future proofing of new buildings for BEV uptake.

Behavioural policy – a branch of regulatory policy – is centred around human decision making, and uses psychology, cognitive science and social studies to create policy which influences human behaviour to choose more desirable behaviour. By applying behavioural science, the government can influence perceptions, making BEVs more appealing to consumers.

Importantly, specific policies can be characterised in many different categories. However, for the purpose of this report, we will place recent government policies into the discrete fiscal, innovation, regulatory and behavioural policy categories.

Whilst this chapter focuses on UK-wide policy on BEVs and not policies from the devolved administrations, Box 4.1 below briefly summarises unique policies emanating from the Scottish Government.

Box 4.1. BEVs and the Scottish Government

Through its Low Carbon Transport Loan, the Scottish Government supports the uptake of BEVs with an interest-free loan of up to £35,000 for the purchase of new BEVs. This must be repaid over a period of six years and in order to be eligible, consumers must not already own another BEV.[104]

In addition to interest-free loans, to support BEV uptake, the Scottish Government has also developed and owns its own charging

104. Greener Scotland, "Grants and funding for electric cars", https://www.greenerscotland.org/greener-travel/greener-driving/grants-and-funding (2020).

network: ChargePlace Scotland. ChargePlace Scotland has over 1,500 chargepoints across Scotland, and some chargepoints on the network are free for BEV drivers to recharge.[105]

Fiscal policies

The UK government currently provides a series of fiscal measures to support BEV uptake amongst households and businesses. This includes both grants and tax relief for both the purchasing of a BEV and the charging infrastructure that they require.

BEV purchasing support for households

The Plug-in Grant is the flagship subsidy offered by government. The grant subsidises the cost of purchasing new BEVs so that consumers are offered a discounted price to market value.

Vehicles must meet the government's emissions standards in order to be eligible for the Plug-in Grant, which varies in size depending on the type of vehicle. For cars, a maximum of £3,000 (or 35% of the total vehicle cost, whichever is lowest) is available as a grant for their purchase if they have CO2 emissions of less than 50g per kilometre and can travel a minimum of 70 miles without producing any emissions.[106] To be eligible for the grant, cars must also cost less than £50,000.[107]

The maximum amount of grant available and emissions criteria differs for mopeds, motorcycles, taxis, vans, large vans and trucks. However, in all of these instances, the grant will pay for up to 20% of the purchase price (or the maximum level of grant available, whichever is lowest). Mopeds and motorcycles are eligible for grants of up to £1,500, whilst

105. ChargePlace Scotland, "Over 1500 electric vehicle charge points in Scotland", https://chargeplacescotland.org/news/over-1500-electric-vehicle-charge-points-in-scotland/ (2020).
106. Gov UK, "Low-emission vehicles eligible for a plug-in grant", https://www.gov.uk/plug-in-car-van-grants (2020).
107. Ibid.

purpose-built taxis and vans can receive grants of £7,500 and £8,000 respectively. Large vans and trucks can receive grants up to a maximum of £20,000, but there are limits based on the number of orders placed.[108]

The Plug-in Grant was originally established in 2011, offering a £5,000 grant for eligible ULEVs (as it previously included PHEVs). Since then, the available grant has decreased over time, and most recently in its 2020 Budget, the UK Government decreased the maximum grant amount available to £3,000.[109] From its inception until March 2020, it has provided in excess of £800 million to support over 200,000 new ULEV purchases.[110] In the Prime Minister's recent *Ten Point Plan for a Green Industrial Revolution*, the UK Government confirmed £582 million in funding for the Plug-in Grant, extending the grant on current terms to 2023.[111]

On tax relief, as flagged in Chapter Three, the main instrument the UK Government uses to incentivise BEV uptake is Vehicle Excise Duty (VED). It is an annual tax paid on owning a vehicle, and is broken down into two payments. The first tax payment occurs upon registering a vehicle and is based on the vehicle's CO2 emissions. The more CO2 per kilometre a vehicle produces, the higher the VED for the first registration payment will be. As BEVs produce zero tailpipe emissions, they pay no VED for the first registration payment.[112]

The second payment occurs 12 months after the first registration payment, and is ongoing on a once yearly basis. For ICE vehicles, the payment is £150 per year, with an additional payment of £325 if the registered vehicle has a list price greater than £40,000.[113] Hybrid

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108. The grant is available for the first 200 orders placed on eligible vehicles: BD Auto eDucato (4.25 tonnes), FUSO eCanter and the Paneltex Z75. Thereafter, a maximum grant of £8,000 will apply. Grants worth £20,000 are restricted to 10 vehicle purchases per customer.
109. Department for Transport and Office for Zero Emission Vehicles, "Update on plug-in vehicle grants following today's budget", https://www.gov.uk/government/news/plug-in-vehicle-grants-update-following-todays-budget#:~:text=Starting%20Thursday%2012%20March%20(2020,making%20the%20switch%20for%20longer. (2020).
110. Ibid.
111. Department for Business, Energy and Industrial Strategy and Prime Minister's Office, 10 Downing Street, "The Ten Point Plan for a Green Industrial Revolution", https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution/title (2020)..
112. Gov UK, "Vehicle tax rates", https://www.gov.uk/vehicle-tax-rate-tables (2020).
113. Ibid.

vehicles make a slim saving on VED, being charged £10 less per year than ICE vehicles at £140.[114] However, hybrid vehicles are still subject to the additional £325 payment if their list price fits the criteria. BEVs are exempt from the second and ongoing yearly payment on the grounds that they produce zero tailpipe emissions.[115] They are also exempt from paying the additional £325, even if they have a list price greater than £40,000.[116] As such, drivers who own a BEV could save up to a maximum of £475 a year by driving a zero emission vehicle as opposed to an ICE vehicle.

The UK Government also uses Benefit-in-kind (BiK) taxation to incentivise BEV uptake amongst individuals driving company cars. It is paid by employees each month on non-salary perks included in their remuneration package, such as a company vehicle which is used for private use. Hence, BiK tax is also known as the 'Company Car Tax'.

To work out how much BiK tax drivers will pay, the value of the vehicle (including VAT, delivery charges and optional extras, minus first-year registration fees and VED) is multiplied by the BiK percentage band which the vehicle sits in. The BiK percentage band is determined by the vehicle's CO2 emissions.[117] This figure is then multiplied by the driver's income tax band to provide the amount of BiK tax owed by the employee.

In July 2019, the UK Government announced that company car drivers would pay no BiK taxes in the 2020-2021 year if they drove a zero emission vehicle – encompassing BEVs.[118] This tax relief applies to individuals within a business, not the business itself.

Rates will increase, albeit only slightly, from 2021-2022, meaning drivers of BEV company car vehicles will pay just 1% in BiK tax, and 2%

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114. Ibid.
115. Ibid.
116. Ibid.
117. The BiK percentage band increases incrementally from 0% for vehicles that produce zero emissions, up to 37% for vehicles which produce more than 170g of CO2 per kilometre.
118. HM Treasury, "Review of WLTP and vehicle taxes", https://www.gov.uk/government/publications/review-of-wltp-and-vehicle-taxes?utm_source=4d91d7f1-6a54-443b-996e-979ecc2f1b72&utm_medium=email&utm_campaign=govuk-notifications&utm_content=immediate (2019).

from 2022-2023.[119] Box 4.2 below provides an example of how BiK tax is calculated on an ICE vehicle and its BEV counterpart, and highlights the tax savings that can be made by company car drivers going electric.

Box 4.2. Calculation of BiK taxation on an ICE vehicle and its BEV counterpart

The following example compares the BiK tax owed on a petrol Hyundai Kona SE with its BEV counterpart, the Hyundai Kona Electric (SE) (as featured in Table 3.1), over the 2020-2021 period. In this scenario, it assumes the driver is on a higher income tax rate of 40%.

Vehicle make and model: Hyundai Kona SE

Vehicle value: £19,280

CO2 emissions: 145g CO2 per kilometre – placing it in the 32% BiK band

Individual's income tax rate: 40%

BiK tax owed: Vehicle value x BiK band = Y
Y x Individual's tax rate = BiK tax owed per annum

£19,280 x 32% = £6,170
£6,170 x 40% = **£2,468**

Vehicle make and model: Hyundai Kona Electric (SE)

Vehicle value: £33,095

CO2 emissions: 0g CO2 per kilometre – placing it in the 0% BiK band

Individual's income tax rate: 40%

BiK tax owed: Vehicle value x BiK band = Y
Y x Individual's tax rate = BiK tax owed per annum

£33,095 x 0% = £0
£0 x 40% = **£0**

119. Ibid.

As demonstrated in the example above, by opting for the electric model of the Hyundai Kona over the petrol edition, a company car driver on a 40% income tax rate would save **£2,468** a year (£205.66 a month). For drivers on a basic income tax rate of 20%, the saving would be slightly less (£1,234). Those on an additional income tax rate of 45% would save £2,776 by choosing the electric model over the petrol edition.

BEV infrastructure support for households

The Office for Zero Emission Vehicles (OZEV), a unit within government supporting the growth of the zero emission vehicles market, operates an Electric Vehicles Homecharge Scheme, providing a maximum of £350 (or 75% of total cost, whichever is lowest) for the purchase and installation of a chargepoint to be installed in a household.[120] To be eligible for the Electric Vehicles Homecharge Scheme, applicants must provide evidence of ownership, lease or primary use of a ULEV – including BEVs – and have the installation completed by an OZEV approved installer.[121] Once an application to the Electric Vehicles Homecharge Scheme has been approved, applicants have four months to carry out the chargepoint installation.[122] For every additional BEV, a household can make another application to the Electric Vehicles Homecharge Scheme. Since its inception in 2014, the Electric Vehicle Homecharge Scheme has provided more than £43 million in grants, supporting the installation of over 75,000 household chargepoints.[123]

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120. Office for Low Emission Vehicles, "Electric vehicle homecharge scheme", https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/873887/evhs-guidance-for-customers.pdf (2020), 3.
121. Ibid.
122. Ibid.
123. Department for Transport, "OLEV grant scheme statistics", https://www.whatdotheyknow.com/request/597062/response/1432381/attach/3/Final.pdf?cookie_passthrough=1 (2019), 2.

BEV purchasing support for businesses

Like households, businesses also benefit from the Plug-in Car Grant and zero VED, should they purchase a BEV. However, enhanced capital allowances are an additional fiscal measure for these businesses.

Enhanced capital allowances allow businesses to deduct the cost of energy efficient and low carbon technologies off of their profits before tax is applied. This includes low-carbon vehicles, which businesses can claim capital allowances on when they are bought and used as part of their business. The rate which can be claimed is dependent on the CO2 emissions of the car and date of purchase.

Since April 2018, if a newly purchased car produces less than 50 grams of CO2 per kilometre, thereby encompassing BEVs, the full cost of the car can be deducted from business profits before tax in the first year.[124] One hundred percent of the cost can only be deducted in the first year. Previously, the 100% cost deductible criteria for cars from April 2015 to April 2018 was 75 grams of CO2 per kilometre or less. Between April 2013 to April 2015, the criteria was set at 95 grams of CO2 per kilometre or less, and prior to this from April 2009 to April 2013, the 100% deductible criteria for a car was 110 grams of CO2 per kilometre or less.[125]

Box 4.3 below provides an example of how the 100% cost deductible criteria could apply to a business which purchases a BEV.

Box 4.3. Calculation of the 100% cost deductible criteria of BEVs from business profits before tax

The following scenario compares the amount of tax owed by a business with a turnover of £300,000 when purchasing a BEV with a business of the same turnover which purchases an ICE vehicle. We use the Hyundai Kona (SE) and Hyundai Kona Electric (SE) (both featured in Table 3.1) as the vehicles for this example.

124. Gov UK, "Claim capital allowances", https://www.gov.uk/capital-allowances/business-cars (2020).
125. Ibid.

Total business turnover: £5,000,000

Vehicle make and model: Hyundai Kona SE

Vehicle value: £19,280

CO2 emissions and cost deductible eligibility: 145g CO2 per kilometre – not eligible for tax deduction

Corporate tax rate: 19%

Tax owed: (Total business turnover – tax deductions) x 19% = tax owed

£5,000,000 x 19% = **£950,000**

Total business turnover: £5,000,000

Vehicle make and model: Hyundai Kona Electric (SE)

Vehicle value: £33,095

CO2 emissions and cost deductible eligibility: 0g CO2 per kilometre – eligible for 100% tax deduction

Corporate tax rate: 19%

Tax owed: (Total business turnover – tax deductions) x 19% = tax owed

(£5,000,000 – £33,095) x 19% = **£943,711.95**

As exemplified in the scenario above, a business with a total turnover of £5,000,000 which opts for the electric model Kona over the petrol edition will pay **£6,288.05** less in tax on their total turnover.

BEV infrastructure support for businesses

Similar to the Electric Vehicles Homecharge Scheme, OZEV operates a Workplace Charging Scheme, providing a grant to businesses, charities or public authorities which can be used to reduce the cost of installing BEV chargepoints for their staff.

The Workplace Charging Scheme grant is a maximum of £350 (or 75% of total cost, whichever is lowest) for purchase and installation costs per chargepoint socket, allowing up to 40 sockets per applicant business, since the amount of government subsidy is capped at £14,000.[126] Prior to April 2020, the Workplace Charging Scheme provided a maximum grant of £500 per chargepoint socket but this was limited to 20 sockets per applicant business.

To be eligible for the Workplace Charging Scheme, applicants must have off-street parking, express intention for the use of BEVs (if none already are in use), and have the chargepoint installed by an approved OZEV installer.[127] Once an application to the Workplace Charging Scheme is approved, OZEV provides the applicant with a voucher eligible to be used within 180 days of issue, which can be redeemed by an OZEV approved installer.[128] Since the introduction of the scheme in 2016, over 1,300 vouchers have been redeemed, with the scheme issuing over £1.7 million in grants to support this.[129]

In addition, in the 2017 Autumn Budget, HM Treasury unveiled the UK Government's Charging Infrastructure Investment Fund (CIIF). The CIIF provides public-private investment into capital projects which support the increased uptake of BEVs. This includes physical chargepoints, chargepoint software, grid connections and battery storage solutions. £200 million was put into the CIIF by the government, matched by private sector funding. As a government subsidy for businesses to install chargepoints, the CIIF seeks to contribute to the expansion of publicly accessible BEV charging infrastructure across the UK whilst, over time, making capital gains from increasingly frequent use of charging infrastructure as BEV uptake grows.[130] It is managed

126. Office for Zero Emission Vehicles, "Workplace charging scheme: guidance for applicants, chargepoint installers and manufacturers", https://www.gov.uk/government/publications/workplace-charging-scheme-guidance-for-applicants-installers-and-manufacturers/workplace-charging-scheme-guidance-for-applicants-chargepoint-installers-and-manufacturers (2020).
127. Ibid.
128. Ibid.
129. Department for Transport, "OLEV grant scheme statistics", https://www.whatdotheyknow.com/request/597062/response/1432381/attach/3/Final.pdf?cookie_passthrough=1 (2019), 3.
130. HM Treasury and Infrastructure and Projects Authority, "Details of the operation of the charging infrastructure investment fund", https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/834758/Details_of_the_operation_of_the_CIIF.pdf (2019), 1-2.

and invested on a commercial basis by independent private sector fund manager, Zouk Capital.

In the UK Government's 2020 Spending Review, £1.3 billion was set aside to support the rollout of charging infrastructure. Included within this funding is £950 million earmarked for the Rapid Charging Fund, providing a portion of the funding to help chargepoint owners – as explained in Box 3.3 earlier – with the cost of connecting rapid chargepoints to the electricity grid.[131] Funding would be targeted particularly towards areas of anticipated future demand for rapid charging, where it is not currently commercially viable for businesses to install a rapid chargepoint or upgrade an existing connection. The timing and process of delivery for this funding is yet to be confirmed by government.

The UK Government's 2020 Spending Review also contained a commitment of almost £500 million to support the development and large-scale production of BEV batteries. This funding commitment will be applicable for the next four years.[132] As part of the Prime Minister's recent *Ten Point Plan for a Green Industrial Revolution*, a £1 billion commitment to supporting the electric transition and supply chains was made, including the development of Gigafactories – factories which produce batteries for BEVs at scale – in the UK.[133]

Box 4.4. The On-street Residential Chargepoint Scheme

There is also a fiscal measure to support local authorities with increasing charging infrastructure. In 2016, OZEV (then OLEV) established the On-street Residential Chargepoint Scheme as a fiscal measure to assist local authorities with the procurement and installation of on-street charging infrastructure.

131. HM Treasury, "Spending review 2020", https://www.gov.uk/government/publications/spending-review-2020-documents/spending-review-2020 (2020).
132. Ibid.
133. Department for Business, Energy and Industrial Strategy and Prime Minister's Office, 10 Downing Street, "The Ten Point Plan for a Green Industrial Revolution", https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution/title (2020).

The scheme invites local authorities to make an application to receive part funding (75%) towards chargepoint procurement and installation, which can cost local authorities anywhere between £1,000-4,000 for a fast charger or £20,000-40,000 for a rapid charger.[134] OZEV provides up to £6,500 per chargepoint installation, with a limit of £100,000 for each project (any application above these limits will be considered on a case by case basis).[135]

The UK Government has committed £20 million to the On-street Residential Chargepoint Scheme for the period of 2020-2021.[136] To date, the On-street Residential Chargepoint Scheme has supported the installation of over 800 sockets in on-street chargepoints.[137] To be eligible for funding through the On-street Residential Chargepoint Scheme, chargepoints must be located in residential areas where there is a lack of off-street parking. Data on the number and nature of chargepoints which this scheme has supported has been withheld owing to commercial sensitivities.

Innovation policies

Through R&D, the UK Government can foster innovation in the production and rollout of BEVs. Presently, the UK Government seeks to achieve this with large amounts of funding through several key R&D programmes. This makes innovation policy a branch of fiscal policy in reality.

In September 2020, together with Innovate UK, the UK Government announced that £12 million would be set aside to support a series

134. Office for Zero Emission Vehicles, "On-street Residential Chargepoint Scheme guidance for local authorities", https://www.gov.uk/government/publications/grants-for-local-authorities-to-provide-residential-on-street-chargepoints/grants-to-provide-residential-on-street-chargepoints-for-plug-in-electric-vehicles-guidance-for-local-authorities (2020).
135. Ibid.
136. Ibid.
137. Data supplied by the Department for Transport.

of funding competitions for "some of the most promising [BEV] technologies." One specific aim of the funding is to support battery technology research to significantly reduce the amount of time it takes to charge a BEV.[138] The specific funding competitions themselves are yet to be unveiled.

In July 2020, through the Department for Business, Energy and Industrial Strategy, Innovate UK and the Department for International Trade, a large-scale funding competition in conjunction with the Advanced Propulsion Centre (a UK-based non-profit organisation) was opened.[139] Called the Automotive Transformation Fund, it provides a share of £1 billion in R&D and capital funding for organisations in the automotive industry to create sustainable and competitive supply chains for BEVs in the UK.[140] The fund is particularly looking to target funding towards R&D and capital investment focused on battery technology, motor and drives, power electronics, fuel cells and the recycling of ULEV components.[141] The funding competition round for the Automotive Transformation Fund has now closed.

To support innovators in developing and testing green electric machinery that can be applied to some of the UK's hard-to-abate sectors, the UK Government unveiled £36.7 million of R&D funding in March 2020. £30 million of the funding is to be used to create four new 'centres of excellence' – located in Newport, Nottingham, Strathclyde and Sunderland – composed of organisations and individuals who are 'climate change pioneers'. These centres of excellence will aim to create electrified solutions to air, sea and road mobility.[142] The remaining

138. Department for Transport, Office for Zero Emission Vehicles, Innovate UK, Highways England and the Rt Hon Grant Shapps MP, "Supercharging the future of driving this #WorldEVDay", https://www.gov.uk/government/news/supercharging-the-future-of-driving-this-worldevday (2020).
139. Automotive Transformation Fund, "ATF briefing scope", https://www.apcuk.co.uk/app/uploads/2020/07/ATF-Briefing-Scope-v3.pdf (2020), 1.
140. Ibid.
141. Ibid., 2.
142. Department for Business, Energy and Industrial Strategy, Department for Transport, The Rt Hon Alok Sharma MP and Rachel Maclean MP, "Government backs cleaner planes, ship and automobiles with £37 million boost", https://www.gov.uk/government/news/government-backs-cleaner-planes-ships-and-automobiles-with-37-million-boost (2020).

£6.7 million of R&D funding was awarded to 14 projects which would ensure organisations, such as vehicle manufacturers, could access all necessary components to develop electric machinery, including BEVs.

The UK Government has also committed R&D funding for upscaling and advancing the production, use and recycling of batteries used in BEVs. The UK Government has recently invested £317.75 million into the Faraday Battery Challenge, which was launched in 2017 and allows UK-based businesses and researchers to apply for funding to develop new and improved battery technologies.[143] So far, projects which have received funding have sought to improve battery life and range, as well as the recycling, reuse and remanufacturing of batteries at the end of their life.[144]

A little longer ago, in 2016, the UK Government, Innovate UK and UK Research & Innovation launched the Industrial Strategy Challenge Fund. With £2.6 billion of public money, matched by £3 billion in private funding, to invest in R&D helping to overcome societal and environmental challenges the fund is broken down into four themes: clean growth; aging society; artificial intelligence and data economy; and, future of mobility.

Contained within each theme is a series of 'challenges', where organisations can apply for R&D funding if their research aims are consistent with the aims of the challenge. As part of the future of mobility theme, one particular challenge – called Driving the Electric Revolution – aims to support the development of UK-based supply chains for clean and electrified transport, encompassing the components which make up the powertrain within a BEV.[145] The 'Driving the Electric Revolution' challenge is supported by up to £80 million in R&D funding.

143. UK Research and Innovation, "Future of mobility", https://www.ukri.org/our-work/delivering-economic-impact/industrial-strategy-challenge-fund/future-of-mobility/ (2020).
144. Ibid.
145. Ibid.

Regulatory policies

The UK Government has recently implemented and consulted on a series of regulations – which apply to vehicle manufacturers, building developers and some commercial landlords – designed to increase the number of BEVs on UK roads.

As already discussed in Chapter One, to send a clear signal of decarbonisation to vehicle manufacturers, the UK Government initially established 2040 as the year that a ban on the sale of new ICE vehicles would come into effect. However, the 2040 date was met with criticism, with the CCC concluding that it would leave approximately 9.8 million ICE vehicles and PHEVs on UK roads in 2050.[146] In the Prime Minister's recently published *Ten Point Plan for a Green Industrial Revolution*, the UK Government announced that the phase out date for ICE vehicles would be brought forward to 2030. Hybrid vehicles would continue to be allowed to be sold until 2035, provided that they "can drive a significant distance with no carbon coming out of the tailpipe".[147] This is the flagship piece of government regulation with regards to BEVs.

There are other regulations on vehicle manufacturers to increase the production of BEVs, originally derived from the EU. As a former EU member state, the UK was bound by EU Regulation EC631. This regulation came into effect in January 2020, repealing and replacing the former EC443 CO2 regulation, which sets a limit on the emissions for each vehicle manufacturer's overall fleet. This new EU Regulation EC631 means vehicle manufacturers will need to produce and sell more low emission vehicles to bring down their fleet average CO2 so they are consistent with the regulation. However, whilst EU Regulation EC631 has superseded EC443, it recasts the existing CO2 emissions standards from 2020-2024, as were set out in EC443. From 2025 onwards, EC631

146. Committee on Climate Change, "Net zero – technical report", (2019), 148.
147. Department for Business, Energy and Industrial Strategy and Prime Minister's Office, 10 Downing Street, "The Ten Point Plan for a Green Industrial Revolution", https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution/title (2020).

sets out new CO2 emissions targets for vehicle manufacturers,[148] but as the UK has fully left the EU, it is not bound by these new targets unless the UK Government chooses to adopt them.

The UK Government has indicated that following its departure from the EU, it will pursue vehicle emissions regulations at least as ambitious as arrangements under the EU, as well as the retention of penalties laid out in the regulations.[149] However, as an interim measure before devising its own regulatory framework around vehicle CO2 emissions standards, the UK has retained the EU-derived vehicle CO2 emissions standards. Further information regarding post-EU emissions regulations will be outlined in a 2021 government green paper.[150]

In the UK, consistent with the EU-derived regulations, from 2021, manufacturers must meet a fleet-wide average emissions target for new passenger vehicles of 95g of CO2 per kilometre.[151] Previously, this target was set at 130g of CO2 per kilometre. By way of comparison, a vehicle must produce less than 75g of CO2 per kilometre to be considered a ULEV. Strong penalties have been put in place for manufacturers if they fail to meet these targets. For each gram per kilometre in excess of this target from this target, manufacturers must pay an excess emissions premium of €95 (£84).[152] [153] If manufacturers do not change their sales mix to reduce emissions, they will be face significant financial penalties. Exemptions from the regulation are made for 'niche' vehicle

148. The new targets will require Vehicle manufacturers to reduce their car fleet average CO2 emissions by 15% from 2025 onwards and 37.5% from 2030 onwards (as calculated from a 2021 baseline).
149. HM Government and Department for Transport, "The road to zero: next steps towards cleaner road transport and delivering our industrial strategy", https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/739460/road-to-zero.pdf (2018), 2; Department for Transport, "Decarbonising transport: setting the challenge", https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/878642/decarbonising-transport-setting-the-challenge.pdf (2020), 21.
150. Department for Business, Energy and Industrial Strategy and Prime Minister's Office, 10 Downing Street, "The Ten Point Plan for a Green Industrial Revolution", https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution/title (2020).
151. European Commission, "Reducing CO2 emissions from passenger cars – before 2020", https://ec.europa.eu/clima/policies/transport/vehicles/cars_en#tab-0-0 (2020).
152. Currency conversion as of Jan 2021.
153. European Commission, "Reducing CO2 emissions from passenger cars – before 2020", https://ec.europa.eu/clima/policies/transport/vehicles/cars_en#tab-0-0 (2020).

manufacturers which produce less than 300,000 vehicles a year, expiring in 2028.[154]

The regulation incentivises the production of ULEVs. 'Super-credits' apply to vehicle manufacturers which produce ULEVs. In 2021, a ULEV counts for 1.67 vehicles, and 1.33 vehicles in 2022, before super-credits are disbanded in 2023.[155] By counting for more than one vehicle, ULEVs can help to drastically lower manufacturers' fleet-average CO2 emissions.

To meet the target, vehicle manufacturers are able to jointly pool together.[156] For example, if manufacturer A was going to exceed the 95 gram target, whilst manufacturer B was going to come considerably under it, they could combine their fleet-wide average emissions to be accredited together, and manufacturer A would purchase the difference required in credits from manufacturer B.[157]

As well as regulations on vehicle manufacturers, the UK Government has been consulting on changes to building regulations which would mandate the installation of new BEV chargepoints by developers and some commercial landlords. Box 4.5 below outlines the proposals included in the government consultation and how they would apply to both new and existing residential and non-residential buildings.

Box 4.5. Consultation on BEV charging infrastructure and building regulations

In July 2019, the UK Government opened a public consultation seeking views on proposed changes to building regulations

154. European Commission, "CO2 emission performance standard for cars and vans (2020 onwards)", https://ec.europa.eu/clima/policies/transport/vehicles/regulation_en (2020).
155. From 2025, vehicle manufacturers who exceed the production target percentage of ULEVs – which in the case of cars is set at 15% of the fleet by 2025 and 35% of the fleet from 2030 onwards – will receive a higher average CO2 emissions limit, making it easier for the manufacturer to comply with the regulation.
156. European Commission, "CO2 emission performance standard for cars and vans (2020 onwards)", https://ec.europa.eu/clima/policies/transport/vehicles/regulation_en (2020).
157. In doing so, manufacturers must still adhere to EU rules of competition law.

regarding requirements for BEV charging infrastructure to be installed in new and existing buildings.[158] The proposals included within the consultation were categorised as being applicable to either residential or non-residential buildings.

Under the proposals for residential buildings, every new building with a parking space must have an electric vehicle chargepoint. This would also apply to buildings undergoing significant changes to convert them into a dwelling. Furthermore, every existing residential building that has more than 10 parking spaces, and is undergoing significant renovation, must have cable routes for chargepoints installed in each parking space.[159]

The proposals for non-residential buildings state that every new building, and an existing building undergoing major renovation, with more than 10 parking spaces must have one chargepoint and cable routes for electric vehicle chargepoints installed for every one in five parking spaces. In addition, all existing non-residential buildings with more than 20 parking spaces must have one electric vehicle chargepoint by 2025, regardless of whether or not they are undergoing major renovation.[160] This means the regulation would fall on any commercial landlord who owns a large building.

The rationale behind these proposals is to future-proof housing and developments to ensure that infrastructure will support BEV uptake as it increases over the coming decade. Moreover, there is a cost saving of roughly £1,100 to be made by installing an electric vehicle chargepoint when building from new as opposed

158. As building regulations are a devolved issue, this consultation applied only to England.
159. HM Government, "Electric vehicle charging in residential and non-residential buildings", https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/818810/electric-vehicle-charging-in-residential-and-non-residential-buildings.pdf (2019), 20-21.
160. HM Government, "Electric vehicle charging in residential and non-residential buildings", https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/818810/electric-vehicle-charging-in-residential-and-non-residential-buildings.pdf (2019), 27-29.

to retrofitting it later to an existing dwelling or development.[161] The consultation has since closed and further announcements from Government are expected shortly.

Behavioural policies

Through behavioural science, the UK Government can shape policy to influence consumer attitudes to encourage increased awareness, approval and purchasing of BEVs. In reality, it is a branch of regulatory policy, since governments use rules to shift the choice architecture visible to consumers.

The Department for Transport and OZEV commissioned the Behavioural Insights Team – an organisation which uses behavioural science to create and assess government policy – to produce, and assess the potential impact of, a series of behavioural policy recommendations which would help to drive BEV uptake. A number of these have been implemented, or are in the process of being so, by the UK Government.

In June 2020, the current Transport Secretary, the Rt Hon Grant Shapps MP, announced that from the autumn of 2020, vehicles which produced zero emissions would have a green flash on the left hand side of their number plate in order to make them more identifiable as BEVs.[162] This is grounded in two ideas.

First, it allows local authorities to easily identify BEVs, which could theoretically make it easier for them to offer incentives such as cheaper parking or free parking in order to incentivise their uptake. Indeed, local councils including Haringey, the City of Westminster and The Royal Borough of Kensington and Chelsea offer discounted public

161. Ibid., 9, 28.
162. Department for Transport, Office for Zero Emission Vehicles and The Rt Hon Grant Shapps MP, "Green number plates get the green light for a zero emission future", https://www.gov.uk/government/news/green-number-plates-get-the-green-light-for-a-zero-emission-future#:~:text=The%20plates%20will%20be%20identifiable,while%20also%20promoting%20economic%20growth. (2020).

parking for BEVs.[163]

Second, it increases the vehicles' prevalence on the road to other drivers. Road users often underestimate the prevalence of BEVs because they can sometimes be difficult to distinguish from any other conventional vehicle.[164] By being more prevalent on the road, it normalises the idea of BEVs on UK roads, thereby encouraging road users to shift to a BEV.[165] Furthermore, commercial vehicles such as taxis, couriers or car clubs would be able to showcase their environmental credentials and corporate responsibility.[166]

The New Car Environmental Label, introduced by the government in 2020, was designed by the Low Carbon Vehicle Partnership, a public-private partnership supporting the transition to low carbon vehicles, in conjunction with the Department for Transport and the Vehicle Certification Agency (VCA). The New Car Environmental Label must be displayed alongside new vehicles on display in showrooms or at events, and highlights the vehicle's running costs, its emissions figures, and in the case of ULEVs (including BEVs), the vehicle's zero emission driving range.[167] This allows consumers to compare the lifetime not just upfront price of different vehicles – as well as their environmental credentials – and thereby make a more fully informed decision when purchasing a new vehicle. It also reveals the savings that can be made on running costs and reductions in emissions by going electric. The Fuel Economy Label existed prior to the New Car Environmental Label

163. Haringey London, "Electric vehicles", https://www.haringey.gov.uk/parking-roads-and-travel/travel/electric-vehicles (2020); City of Westminster, "Electric vehicles", https://www.westminster.gov.uk/electric-vehicles (2020); The Royal Borough of Kensington and Chelsea, "Electric vehicles", https://www.rbkc.gov.uk/parking-transport-and-streets/visitors/visitor-parking/electric-vehicles (2020).
164. Department for Transport, "Consultation on the introduction of green number plates for ultra low emission vehicles", https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/840685/consultation-on-the-introduction-of-green-number-plates-for-ultra-low-emission-vehicles.pdf (2019), 10.
165. Ibid., 11.
166. Ibid.
167. Low Carbon Vehicle Partnership, "New car environmental label shows car buyers the way to lower running costs and emissions", https://www.lowcvp.org.uk/news,new-car-environmental-label-shows-car-buyers-the-way-to-lower-running-costs-and-emissions_4077.htm (2020).

being unveiled in April 2020, but did not include ULEVs zero emission driving range.

The UK Government also revealed in September 2020 that it was considering further behavioural policies to encourage BEV uptake amongst the public. Box 4.6 below explains the two additional behavioural policies being considered by the UK Government.

Box 4.6. Behavioural policies being considered by the UK Government

Although not yet Government policy, the current Transport Secretary has stated that the UK Government is considering measures such as having dedicated BEV parking spaces which are painted green, and electric vehicle chargepoints located at popular tourist sites as well as locations such as supermarkets.[168] Local authorities could offer lower or free parking for BEVs parked within the green parking spaces, and the electric vehicle chargepoints could be situated in the most convenient locations at tourist sites and supermarkets. The purpose of such policies is to raise the profile of BEVs, highlighting the benefits that are incurred as a result of driving a BEV – cheaper parking, adequate charging opportunities, and more conveniently situated parking spaces – instead of an ICE vehicle. Of course, in the case of electric vehicle chargepoints in popular destinations, this is also a regulatory measure to increase availability of chargepoints and relieve the barrier of range anxiety.

Conclusion

The UK Government has four main types of policy levers it can pull to increase BEV uptake: fiscal; innovation; regulatory; and, behavioural

168. Department for Transport, Office for Zero Emission Vehicles, Innovate UK, Highways England and the Rt Hon Grant Shapps MP, "Supercharging the future of driving this #WorldEVDay", https://www.gov.uk/government/news/supercharging-the-future-of-driving-this-worldevday (2020).

policy. Among these levers, the government relies heavily on a mixture of fiscal and regulatory policies. In particular, it is the 2030 ICE vehicle phase out date and the Plug-in Car Grant which serve as the UK Government's flagship policies on BEV uptake.

With nine years remaining until the 100% ban on the sale of conventional new ICE vehicles takes effect, further policies are needed to expedite the uptake of new BEVs. Other markets globally are witnessing more positive trends in BEV uptake than the UK, owing largely to their policy frameworks around BEVs. The following chapter analyses key global markets which have seen positive uptake in BEVs, and the unique policies used by their respective governments to help deliver this.

Chapter 5: Leading international approaches to growing the battery electric vehicle market

The previous chapter looked at the fiscal, innovation, regulatory and behavioural policies that have recently been implemented by the UK Government to drive the growth in the BEV market. This chapter unearths and explains unique and additional policies in other countries that have led the way in BEV growth.

Chapter One highlighted comparable countries which have seen a much higher uptake in BEVs than the UK – notably Norway, Iceland and The Netherlands. In addition, China and the United States, specifically California, have had impressive growth in BEVs above and beyond that experienced by the UK, which warrants evaluation. These places, of course, replicate some of the UK Government's policy approaches towards BEVs; so we do not explore those here. The focus of this chapter is on additional policies that the UK Government has not adopted, which may help to explain the more positive trends in BEV uptake witnessed in these countries.

Norway

From 2013 onwards, Norway has witnessed a significant growth in BEV registrations, and now has the largest market share of new BEV passenger vehicle registrations in the world. Chart 1.4 earlier showed that in Norway in 2019, BEV passenger vehicles accounted for 45.9% of new passenger vehicle registrations, whilst in the UK this figure was 1.8%. Norway has consistently outperformed the UK with regards to BEV uptake, and the disparity between the two markets has only widened in recent years. As of September 2020, almost half of all new passenger vehicle registrations in Norway were BEVs.

Norway has an ambitious date for the end of sales of new ICE vehicles: 2025.[169] The Norwegian Government aims to have all new vehicle sales beyond this date to be zero emission vehicles, including BEVs. However, Norway aims to achieve this date through fiscal measures, as opposed to an outright ban on new sales of ICE vehicles. This typifies the Norwegian approach: based more on carrots, through generous fiscal measures, than sticks, through regulation, although these of course exist.

Since the 1990s, various Norwegian Governments have been introducing a range of policies to encourage BEV uptake, some of which are unique and additional to what the UK does, as summarised in Box 5.1 below.

Box 5.1. List of unique and additional policies from the Norwegian Government to facilitate the uptake of BEVs[170]

Fiscal

- From 2001 to present, all purchases of BEVs are exempt from VAT, which is set at 25% in Norway (Norway can set its own VAT rates and eligibility as it has always been outside the EU).
- Enacted in 2015, all leased BEVs are exempt from VAT.
- From 1997 to 2017, BEVs were exempt from all charges on toll roads or ferries.
- From 1999 to 2017, BEVs were also exempt from paying for municipal parking. These exemptions have since been replaced in 2018 by 'the 50% rule', which mandates that local governments cannot charge BEVs more than 50% of the regular cost for ferries, toll roads and public parking.

169. Norwegian Ministry of Transport, "Norway is electric", https://www.regjeringen.no/contentassets/c71b8a47da1048e19c3515750d1c7e9f/norway-is-electric_november19.pdf (2019).
170. Norsk elbilforening, "Norwegian EV policy", https://elbil.no/english/norwegian-ev-policy/ (2020).

Behavioural

- From 2005 to present, BEVs have been allowed to drive in bus lanes

Incentives which are still active – such as VAT exemptions, the 50% rule and bus lane access – will remain until 2021, when they will be reviewed by the Norwegian Government, taking into consideration the development of the BEV market in Norway. These measures become fiscally unsustainable the higher the proportion of new BEV users.

Table 3.1 earlier illustrated upfront price as a barrier to purchasing a BEV in the UK, and as part of it showed that a new Volkswagen e-Golf is over £4,000 more expensive than the conventional Golf. In keeping with the example of the Volkswagen Golf and e-Golf, when all of Norway's fiscal policies for vehicle purchasing and registration are applied, the new e-Golf becomes the more affordable option to buy of the two. This is illustrated in Table 5.1 below.

Table 5.1. Upfront price breakdown of a new Volkswagen Golf and Volkswagen e-Golf (Norway) as of September 2020[171]

Tax and price	Volkswagen Golf	Volkswagen e-Golf
Import price	22,510	33,730
Registration tax (CO2) (113 g/km)	4,440	–
Registration tax (NOx)	210	–
Registration tax (weight)	1,750	–
Scrap deposit	250	250
VAT (25%)	5,630	–

171. Norsk elbilforening, "Volkswagen Golf in Norway – from diesel to electric", https://elbil.no/volkswagen-golf-in-norway-from-diesel-to-electric/ (2020).

Retail price	**€34,780 (£30,793)[172]**	**€33,980 (£30,085)[173]**
Retail price (UK)	£23,900	£28,075

When Norwegians were surveyed as to what incentives would motivate them to buy a BEV, over 80% of respondents claimed tax exemptions were the most significant motivators, showing purchase cost reduction to be the strongest inventive at promoting BEV uptake.[174]

Research on the Norwegian BEV market has shown that incentives to reduce the upfront price of BEVs and even them out with the upfront price of ICE vehicles, notably the VAT exemption, have been the most effective policies at driving BEV uptake. Furthermore, incentives which provide BEV drivers with advantages over ICE vehicle drivers – reduced charges on toll roads and ferries, cheaper public parking and bus lane access – are considered to be of reasonable monetary value to Norwegians, and as such are important policy levers in driving BEV uptake.[175]

Despite having the largest market share of new BEV passenger vehicle registrations globally, the Norwegian policy approach to BEV uptake is not without its criticisms. First, some argue that it favours the wealthy, as those who cannot afford a brand new vehicle must purchase from the second hand market, which is still dominated by ICE vehicles.[176] They therefore miss out on the ongoing generous fiscal policies for BEV drivers, as Box 6.1 showed.

Second, there are concerns around the cost of all these policies. The

172. Currency converted Jan 2021.
173. Ibid.
174. Kristin Ystmark Bjerkan, Tom E. Nørbech, Marianne Elvsaas Nordtømme, "Incentives for promoting battery electric vehicle (BEV) adoption in Norway", *Transportation Research Part D: Transport and Environment* (2016), 169-180.
175. Erik Figenbaum, "Perspectives on Norway's supercharged electric vehicle policy", *Environmental Innovation and Societal Transitions*, (2016), 30.
176. David Nikel, "Electric cars: why little Norway leads the world in EV usage", https://www.forbes.com/sites/davidnikel/2019/06/18/electric-cars-why-little-norway-leads-the-world-in-ev-usage/#287e474213e3 Forbes, (2019).

Norwegian Government's own estimations place the cost of all their policies which support BEVs at 13.5 billion kr (£1.15 billion)[177] a year.[178] The cost of these incentives will grow alongside an increase in new BEV passenger vehicle registrations, which is why the Norwegian Government has scaled back some incentives in the past and will likely do so in the future.

Iceland

In 2012, Iceland and the UK had similar percentages of BEVs making up the market share of new passenger vehicle registrations as shown in Chart 1.4. But as of September 2020, over a quarter of all new passenger vehicle registrations in Iceland were BEVs, giving it the second largest market share of new BEV registrations in Europe.

Iceland has sent a clear signal to vehicle manufacturers that the future of its vehicle market lies in BEVs. The Icelandic Government has committed to banning the sale of new ICE vehicles beyond 2030, and the City of Reykjavik aims to reduce the number of fossil fuel petrol pumps by 50% by 2030, with the aim of them being almost entirely eradicated by 2040.[179]

The Icelandic Government provides unique and additional fiscal policies to lower the upfront price of BEVs. Vehicles are exempt from import excise duty if they produce less than 80 grams of CO_2 per kilometre, as well as being VAT exempt (Iceland's standard rate of VAT is 24%).[180] However, these tax exemptions are to be reviewed imminently.

Fiscal policies to support BEV uptake are also provided at a local

177. Currency converted Jan 2021.
178. Norwegian Ministry of Transport, "Norway is electric", https://www.regjeringen.no/contentassets/c71b8a47da1048e19c3515750d1c7e9f/norway-is-electric_november19.pdf (2019).
179. Ministry for the Environment and Natural Resources, "Iceland's climate action plan for 2018-2030", https://www.government.is/library/Files/Icelands%20new%20Climate%20Action%20Plan%20for%202018%202030.pdf (2018), 4; City of Reykjavik, "Reykjavik and climate", https://reykjavik.is/en/reykjavik-and-climate (2020).
180. Sandra Wappelhorst and Uwe Tietge, "Iceland is one of the world's most interesting electric vehicle markets", https://theicct.org/blog/staff/iceland-ev-market-201807 International Council on Clean Transportation, (2018).

government level. The City of Reykjavik offers free BEV charging at 58 chargepoints across Reykjavik at certain on-street chargepoint locations and in public parking buildings. Parking at these locations is free for the first 90 minutes, thereafter drivers must pay standard parking prices.[181]

Other factors, beyond government policy, have supported Iceland's high uptake of BEVs including energy prices and geography. Iceland has some of the lowest electricity prices in Europe, and some of the highest fossil fuel prices in the world, making the lifetime cost of driving a BEV considerably cheaper compared to an ICE vehicle.[182]

Geographically, Iceland is 305 miles east to west and 185 miles north to south at its widest points, but 80% of the land is uninhabited.[183] As such, unlike countries such as the UK where the population is more sparsely spread, in Iceland BEV charging infrastructure is only required in 20% of the country's landmass as well as on main roads. In particular, charging infrastructure is required in Reykjavik, where over half of Iceland's population of 350,700 reside.[184]

The Netherlands

Until the middle of the previous decade, BEV uptake in The Netherlands was sluggish, as Chart 1.4 illustrated. However, from 2016 onwards, BEV uptake incrementally increased, compared to the UK BEV market which remained stagnant. The Netherlands currently has the third highest percentage of new BEV passenger vehicle registrations in Europe.

From 2030, the Dutch Government has a target of all new passenger vehicles being zero-emission vehicles (including BEVs), signalling the

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181. City of Reykjavik, "Charging stations for electric cars in parking garages", https://reykjavik.is/frettir/hledslustodvar-fyrir-rafbila-i-bilastaedahusum (2018).
182. Eurostat, "Electricity price statistics", https://ec.europa.eu/eurostat/statistics-explained/index.php/Electricity_price_statistics (2020); Global Petrol Prices, "Gasoline prices", https://www.globalpetrolprices.com/gasoline_prices/ (2020).
183. Visit Iceland, "Iceland geography", https://visiticeland.com/article/iceland-geography (2020).
184. CIA World Factbook, "Iceland", https://www.cia.gov/library/publications/the-world-factbook/geos/ic.html (2020).

end of ICE and hybrid passenger vehicle sales.[185]

Unique and additional fiscal policies from the Dutch Government have supported BEV uptake in the Netherlands. In 2020, a €2,000 (£1,771)[186] grant for the purchase of a second hand BEV by private individuals was introduced, and is set to remain in place until 2025.[187] Applications for the grant can be made online via the Netherlands Enterprise Agency (RVO). Individuals can only apply for the grant once the purchase of the vehicle is completed. The upshot of this fiscal policy is that it supports BEV uptake through the second hand market, aiding those who want to make the transition to a BEV but are not financially able to purchase a new vehicle.

The Dutch Government also provides grants for the leasing of BEVs. A €4,000 (£3,542)[188] grant for leasing a new BEV is provided, and a €2,000 (£1,771) grant for second hand leases, paid monthly into the leaseholders bank account over a four year period.[189] In order to receive a grant on the lease of a BEV, the vehicle must be registered in the driver's name for a minimum period of four years as part of the lease agreement. For all purchase and leasing BEV grants, the BEV must have a minimum range of 120 kilometres and the list price of the BEV must not be less than €12,000 (£10,625)[190] or greater than €45,000 (£39,842).[191]

The Netherlands uses regulatory policy to target chargepoint rollout in areas of public demand for BEV charging infrastructure.

185. Government of the Netherlands, "Measures to reduce greenhouse gas emissions", https://www.government.nl/topics/climate-change/national-measures (2020).
186. Currency converted Jan 2021.
187. Rijksoverheid, "Electric vehicle subsidy scheme final; applications from 1 July", https://www.rijksoverheid.nl/actueel/nieuws/2020/06/04/subsidieregeling-elektrisch-rijden-definitief-aanvragen-vanaf-1-juli (2020).
188. Currency converted Jan 2021.
189. Rijksdienst voor Ondernemend Nederland, "Subsidy for the lease of a new electric passenger car", https://www.rvo.nl/subsidie-en-financieringswijzer/sepp/subsidie-aanvragen/subsidie-lease-nieuwe-elektrische-personenauto (2020); Rijksdienst voor Ondernemend Nederland, "Subsidy for the lease of a used electric passenger car", https://www.rvo.nl/subsidie-en-financieringswijzer/sepp/subsidie-aanvragen/subsidie-lease-gebruikte-elektrische-personenauto (2020).
190. Currency converted Jan 2021.
191. Ibid.

In cities such as Amsterdam, demand-led on-street charging allows for the strategic installation of chargepoints in areas where they are needed.

BEV drivers have the right to request a chargepoint to be installed near their place of residence or work via their municipality.[192] To do this, a BEV driver makes a request to their municipality. Their request is assessed to determine whether a new chargepoint is needed in that location, taking into consideration the walking distance to the nearest existing or planned chargepoint, the occupancy rate for nearby chargepoints and the verdict of previous requests made in the area. Following approval, there is a six week period where stakeholders can challenge or propose amendments to the chargepoint's installation. The chargepoint will then be installed, published on digital maps and nearby BEV drivers notified of its location.[193] The municipality owns the chargepoint and tenders out its installation and operation through procurement.

Today, across the City of Amsterdam there are over 3,800 chargepoints.[194] In the Netherlands, there are altogether more than 55,000 public chargepoints.[195] This is almost 20,000 more public chargepoints than currently exist in the UK, in a country approximately one sixth the size of the UK. The Netherlands has the greatest density of chargepoints in Europe.

Overall, the Netherland's success in BEV uptake can be put down to the efficacy of Government policy encouraging drivers to go electric. Research across different BEV markets in the EU member states finds

192. Rijksdienst voor Ondernemend Nederland, "Charging points for electric transport", https://www.rvo.nl/onderwerpen/duurzaam-ondernemen/energie-en-milieu-innovaties/elektrisch-rijden/laadpunten (2020).
193. Interreg Europe, "Amsterdam's demand driven charging infrastructure", https://www.interregeurope.eu/policylearning/good-practices/item/1699/amsterdam-s-demand-driven-charging-infrastructure/ (2018).
194. Ibid.
195. Rijksoverheid, "Government encourages more environmentally friendly driving", https://www.rijksoverheid.nl/onderwerpen/auto/overheid-stimuleert-milieuvriendelijker-rijden (2020); ANWB, "Where are charging stations located?", https://www.anwb.nl/auto/elektrisch-rijden/waar-staan-de-oplaadpunten (2020).

that the Netherlands has one of the highest rates of BEV adoption thanks to measures which incentivise their uptake.[196]

United States – California

The BEV market in the United States remains less developed than other major global markets such as Europe and China, as Chart 1.5 shows. But, at a state level, California has experienced a much higher proportion of BEV uptake than the United States as a whole. In 2019, 5.3% of new passenger vehicle registrations were BEVs.[197] This is considerably more than the UK, which only saw 1.8% of new passenger vehicle registrations being BEVs in 2019. As of October 2020, 6.1% of new vehicle registrations in 2020 were BEVs in California.[198]

BEV uptake in California is driven by the state's unique flagship regulatory policy, the Zero Emission Vehicle (ZEV) Mandate. Introduced in 1990, the ZEV Mandate acts as a catalyst for BEV production by requiring vehicle manufacturers to produce a certain number of ZEVs (encompassing BEVs) each year, based on the total number of vehicles the manufacturer sells in the state.[199] The more vehicles a manufacturer sells, the more ZEVs they are required to produce. The requirement on vehicle manufacturers is measured in terms of credits which equate to a percentage of total vehicle sales, which increases annually. For instance, in 2018, the credit requirement was 4.5%. By 2025, it will be 22%.[200]

The ZEV Mandate splits vehicle manufacturers into three categories: small-volume, intermediate-volume and large-volume. Vehicle manufacturers which sell fewer than 4,500 vehicles a year in California are classified as small-volume,[201] and are exempt from having to meet

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196. Jose Cansion, Antonio Sanchez-Braza, and Teresa Sanz-Diaz, "Policy instruments to promote electro-mobility in the EU28: A comprehensive review", *Sustainability*, (2018), 19.
197. California New Car Dealers Association, "California auto outlook", https://www.cncda.org/wp-content/uploads/Cal-Covering-4Q-19.pdf (2019), 2.
198. Ibid.
199. California Air Resources Board, "Zero-emission vehicle program", https://ww2.arb.ca.gov/our-work/programs/zero-emission-vehicle-program/about (2020).
200. Ibid.
201. Based on the previous three year average sales.

the ZEV Mandate credit requirements.[202] Vehicle manufacturers which sell in excess of 4,500 vehicles a year in the state but fewer than 20,000 are classified as intermediate-volume manufacturers, and must meet the ZEV Mandate credit requirements but can do so using PHEVs or ZEVs.[203] Large-volume manufacturers are vehicle manufacturers selling more than 20,000 vehicles a year in California, and must meet the ZEV Mandate credit requirements by producing a minimum percentage of ZEVs, excluding PHEVs.[204]

To encourage vehicle manufacturers to produce ZEVs with longer range, vehicles are eligible for more credits if they have a greater amount of zero emission range. For ZEVs (encompassing BEVs), credits are calculated using the following equation: 0.01 x (zero emission range) + 0.50, meaning that if a ZEV has a zero emission range of 200 miles, it would be eligible for 2.5 credits under the ZEV Mandate.[205] A maximum of four credits can be earned per ZEV, equating to 350 miles zero emission driving range. ZEVs with less than 50 miles of zero emission driving range are not eligible for credits.

For vehicle manufacturers who fail to meet the requirements of the ZEV Mandate, they are penalised $5,000 (£3,640)[206] per ZEV credit deficit.[207]

In order to aid vehicle manufacturers in being consistent with the

202. California Code of Regulations, "§ 1962.2. Zero-Emission Vehicle Standards for 2018 and Subsequent Model Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles", https://govt.westlaw.com/calregs/Document/I505CA51BB0AD454499B57FC8B03D7856?viewType=FullText&originationContext=documenttoc&transitionType=CategoryPageItem&contextData=(sc.Default) (2020).
203. Ibid.
204. The minimum amount of ZEVs which must be produced by large-volume manufacturers increases incrementally by 2% each year, starting from 2% in 2018 through to 16% by 2025. Large-volume manufacturers can then make up the remaining credits using PHEVs.
205. California Code of Regulations, "§ 1962.2. Zero-Emission Vehicle Standards for 2018 and Subsequent Model Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles", https://govt.westlaw.com/calregs/Document/I505CA51BB0AD454499B57FC8B03D7856?viewType=FullText&originationContext=documenttoc&transitionType=CategoryPageItem&contextData=(sc.Default) (2020).
206. Currency converted Jan 2021.
207. International Council on Clean Transportation, "Overview of global zero emission vehicle mandate programs", https://theicct.org/sites/default/files/publications/Zero%20Emission%20Vehicle%20Mandate%20Briefing%20v2.pdf (2019), 14.

ZEV Mandate, they are able to bank credits for use in future years when they may struggle to meet the required amount of the credits, or sell them to other manufacturers who are struggling to be compliant.[208]

A forecast on ZEV sales in California by EV analysis and consulting firm, EV Adoption, shows ZEVs accounting for a quarter of all new vehicle sales by 2024, rising to almost half (46.25%) by 2028, highlighting the efficacy of the ZEV Mandate.[209]

Another regulatory policy used by California's State Government to encourage BEV uptake is single-driver high-occupancy vehicle (HOV) lane access for BEVs. Access to a HOV lane typically requires drivers to be carrying passengers. However, drivers of BEVs who have an annual income of less than $150,000[210] (£109,223)[211] are eligible to purchase a sticker for their car from the Department of Motor Vehicles which permits them to drive in HOV lanes regardless of whether they are driving alone or with passengers.[212] This enables BEV drivers to reduce their journey time, as HOV lanes typically have less traffic in them than other vehicle lanes.

Each year, the colour of the stickers provided to BEV drivers changes so that HOV lane access is limited to the first four years of purchase. For instance, since January 2020, the Department of Motor Vehicles has been issuing orange stickers for eligible vehicles. Orange stickers will be valid until January 1st, 2024.

Drivers purchasing a second hand BEV which has previously been issued with a sticker are eligible to purchase a new sticker, provided they have a combined household income of less than $65,760[213] (£47,883).[214] This allows lower income households which purchase a

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208. Ibid., 4.
209. Loren McDonald, "EV sales forecast", EVAdoption, https://evadoption.com/ev-sales/ev-sales-forecasts/ (2019).
210. The income cap for eligibility is $150,000 for individuals, $204,000 for head-of-household filers and $300,000 for joint filers.
211. Currency converted Jan 2021.
212. California Clean Vehicle Rebate Project, "High-occupancy vehicle (HOV) lane access", https://cleanvehiclerebate.org/eng/ev/incentives/hov-lane-access (2020).
213. Ibid.
214. Currency converted Jan 2021.

BEV second hand to also benefit from single-driver HOV lane access. Research conducted across the United States has identified HOV lane access as an effective incentive at driving BEV uptake, increasing BEV sales on average by 14.5%.[215]

BEV uptake in California is also driven by fiscal policy, specifically state and federal-level rebates. California's Clean Vehicle Rebate Program provides rebates of up to $7,000 (£5,097)[216] for the purchase or lease of a BEV.[217] The level of rebate an individual receives is calculated on the basis of the vehicle purchased and individual's income. Those who are ineligible for the rebate include single individuals earning over $150,000 (£109,223)[218] per annum, $204,000 (£148,542)[219] for those filing for a rebate that are head-of-household and $300,000 (£218,445)[220] for joint-filers.[221]

In addition to the state-level rebate, at a federal level the US Government provides a tax credit of up to $7,500 (£5,461)[222] for the purchase of a BEV, based on the kWh battery capacity of the vehicle.[223] However, the tax credit is reduced after the vehicle manufacturer has produced and sold 200,000 eligible vehicles in the US.[224]

China

China has maintained consistently higher proportions of new BEV passenger vehicle registrations than Europe and the United States, until

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215. Easwaren Narassihim and Caley Johnson, "The role of demand-side incentives and charging infrastructure on plug-in electric vehicle adoption: analysis of US states", *Environmental Research Letters* (2018), 3, 6, 8; Cabell Hodge, Barbara O'Neill and Kamyria Coney, "Effectiveness of electric vehicle policies and implications for Pakistan", *National Renewable Energy Laboratory* (2020), 18.
216. Currency conversion as of Jan 2021.
217. California Clean Vehicle Rebate Project, "About CVRP", https://cleanvehiclerebate.org/eng/about-cvrp (2020).
218. Currency conversion as of Jan 2021.
219. Ibid.
220. Ibid.
221. California Clean Vehicle Rebate Project, "Income eligibility", https://cleanvehiclerebate.org/eng/income-eligibility#income-cap (2020).
222. Currency conversion as of Jan 2021.
223. Internal Revenue Service, "Plug-in electric drive vehicle credit (IRC 30D)", https://www.irs.gov/businesses/plug-in-electric-vehicle-credit-irc-30-and-irc-30d (2020).
224. Ibid.

it was overtaken by Europe in 2020. As Chart 1.5 earlier demonstrated, the proportion of new BEV passenger vehicle registrations in China in 2019 was 3.76%, compared to 1.8% in the UK. In raw numbers, over 950,000 new BEVs were registered in China in 2019 – more than quadruple the amount of BEVs registered in the United States and over double the number of BEVs registered in Europe that same year – making China the largest market for BEVs in the world.[225]

Previously, the Chinese Government had opted for a fiscal policy approach to driving BEV uptake but has recently pivoted from that position to a more regulatory one with the adoption of a New Energy Vehicle (NEV) Mandate,[226] similar to California's ZEV Mandate, in 2019.

Formerly, the Chinese Government provided subsidies to vehicle manufacturers for the production of BEVs. In the past these have ranged from ¥30,000 (£3,378)[227] to ¥60,000 (£6,756)[228] per vehicle depending on the vehicle's zero emission driving range and the energy density of its battery.[229] However, the Chinese Government is shifting away from subsidies as the NEV Mandate comes into effect.

China's NEV Mandate is similar to California's ZEV Mandate. It applies to the passenger vehicle market – specifically, BEVs, FCEVs and PHEVs – and is overseen by the Ministry of Industry and Information Technology (MIIT). Like the Californian ZEV mandate, the NEV mandate requires vehicle manufacturers to attain a certain level of NEV production based on a credit system which is expressed as a percentage. The NEV Mandate began in 2019 with a credit requirement of 10%, encompassing BEVs, FCEVs and PHEVs, increasing incrementally by 2% each year until 2023, where it stands at 18%.[230]

225. Data supplied to the author by EV-volumes.com
226. The term NEV is used by the Chinese Government and includes BEVs, PHEVs and FCEVs.
227. Currency conversion as of Jan 2021.
228. Ibid.
229. Anders Hove and David Sanderlow, "Electric vehicle charging in China and the United States", Columbia University Center on Global Energy Policy, https://energypolicy.columbia.edu/sites/default/files/file-uploads/EV_ChargingChina-CGEP_Report_Final.pdf (2019), 13.
230. Gasgoo, "China's NEV credit ratios from 2021 to 2023 required to be 14%, 16,%, 18%", http://autonews.gasgoo.com/china_news/70017270.html (2020).

The NEV Mandate applies to vehicle manufacturers selling more than 30,000 passenger vehicles a year.[231] Vehicle manufacturers can acquire credits based on the vehicle's zero emission driving range, battery efficiency and weight. For BEVs, credits are calculated using the following equation: 0.012 x driving range + 0.8. An adjustment factor of 0.5, 1 or 1.2 is then multiplied to the sum of this equation, giving the number of credits that can be earnt.[232] A maximum of six credits can be earnt per vehicle.

Excess NEV credits cannot be banked for future use like they can as part of California's ZEV Mandate. However, like California's ZEV Mandate, credits under the NEV Mandate can be sold to other vehicle manufacturers, who equally can purchase NEV credits to rectify a deficit of credits should the manufacturer not meet the credit requirements.[233]

However, if a vehicle manufacturer fails to meet the NEV Mandate requirements, the MIIT does not fine them as in the case of California's ZEV Mandate, but denies approval of new vehicle models from the manufacturer which do not meet specific fuel consumption standards, as discussed in Box 5.3.[234] This will only be lifted once the vehicle manufacturer rectifies their credit deficit.

Box 5.3. China's Corporate Average Fuel Consumption (CAFC) regulation

Corporate Average Fuel Consumption (CAFC) standards for passenger vehicles exist alongside the NEV Mandate, which

231. International Council on Clean Transportation, "Overview of global zero emission vehicle mandate programs" ,https://theicct.org/sites/default/files/publications/Zero%20Emission%20 Vehicle%20Mandate%20Briefing%20v2.pdf (2019), 7.
232. Adjustment factor 1.2 if conditions 1 and 2 are met. Adjustment factor 1 if one of either conditions 1 or 2 are met. Adjustment factor 0.5 if neither conditions 1 or 2 are met. Y = energy consumption (kWh/100 km), m = vehicle curb weight (kg). Condition 1: $Y \leq 0.014*m+0.5$ ($m \leq 1000$); $Y \leq 0.012*m+2.5$ ($1000 < m \leq 1600$); $Y \leq 0.005*m+13.7$ ($m > 1600$). Condition 2: $Y \leq 0.0098*m+0.35$ ($m \leq 1000$); $Y \leq 0.0084*m+1.75$ ($1000 < m \leq 1600$); $Y \leq 0.0035*m+9.59$ ($m > 1600$).
233. International Council on Clean Transportation, "Overview of global zero emission vehicle mandate programs", https://theicct.org/sites/default/files/publications/Zero%20Emission%20 Vehicle%20Mandate%20Briefing%20v2.pdf (2019), 7.
234. Ibid.

requires the fleet average fuel consumption of all vehicles produced by a manufacturer to be equal to or less than the target average set under the CAFC standards. In 2020, this is set at five litres per 100 kilometres, tightening to four litres per 100 kilometres in 2025.[235] Passenger vehicles with a zero emission driving range of more than 50 kilometres are counted five times, disproportionally driving down vehicle manufacturers' average fuel consumption and incentivising them to produce more ZEVs, including BEVs.

If a vehicle manufacturer fails to meet their CAFC obligations, they can offset this with excess NEV Mandate credits, thereby linking China's CAFC regulation to the NEV Mandate.[236] In doing so, this allows for vehicle manufacturers to continue to sell ICE vehicles with greater levels of fuel consumption through overcompliance and excess credits from the NEV Mandate, which risks undermining the CAFC regulation.

The allocation of vehicle licence plates is another regulatory policy which encourages BEV uptake in China. A lottery system for vehicle licence plates is used in China at a municipal level, and BEVs are placed in a different licencing pool than ICE vehicles. In Beijing, drivers of ICE vehicles can end up waiting years to receive a licence plate, which deprives them of the right to drive, whereas because BEVs are placed in a separate pool with less applicants and more licence plates, it is much quicker to receive a licence plate for a BEV.

For example, in Beijing in 2016, 2.7 million people registered for a licence plate with only 90,000 being available for ICE vehicles.[237] In

235. Keith Howard and Ping Zhu, "China's ever-tightening fuel consumption regulations", Lubrizol 360, https://360.lubrizol.com/2019/Chinas-Ever-Tightening-Fuel-Consumption-Regulations (2019).
236. The International Council on Clean Transportation, "China's new energy vehicle mandate policy (final rule)", https://theicct.org/sites/default/files/publications/ICCT_China-NEV-mandate_policy-update_20180111.pdf (2018), 2.
237. Anders Hove and David Sanderlow, "Electric vehicle charging in China and the United States", Columbia University Center on Global Energy Policy, https://energypolicy.columbia.edu/sites/default/files/file-uploads/EV_ChargingChina-CGEP_Report_Final.pdf (2019), 13.

other municipalities, such as Shanghai, obtaining a licence plate for a BEV is free whereas ICE vehicles must pay £8,950.[238]

Research from China suggests that licence plate restrictions on ICE vehicles are effective at driving BEV uptake.[239] A survey conducted by the China Automotive Technology and Research Centre found that 95% of consumers in Shanghai would postpone or withdraw their plans to go electric if the no licencing restrictions were abolished.[240] By reducing costs and waiting times to obtain a licence plate for BEVs compared with ICE vehicles, municipalities in China are encouraging consumers to switch to purchasing BEVs.

Conclusion

Internationally, governments in other countries that have seen high BEV uptake are using a blend of policies – both fiscal and regulatory, to differing extents – to achieve this, which go above and beyond those used in the UK.

Evidently, to catalyse the BEV market and attain higher BEV uptake comparable with the countries explored in this chapter, the UK needs to consider additional policies. The next chapter will put forward policy recommendations – in part based on the success of such policies in other countries – for the UK to mature the market for BEVs.

238. Ibid.
239. Wenbo Li, Ruyin Long, Hong Chen, Feiyu Chen, Xaio Zhengand Muyi Yang, "Effect of policy incentives on the uptake of electric vehicles in China", *Sustainability* (2019), 14.
240. Ibid.

Chapter 6: **New policies**

This report so far has shown that progress towards increasing the numbers of BEVs on UK roads has been relatively slow over the last decade and the market for BEVs remains nascent. New policies and fresh thinking is required, drawing on successful international examples, to catalyse and mature the BEV market in the UK. That is the focus of this chapter.

This chapter focuses on policies to address the leading barriers identified in Chapter Three to BEV uptake in the UK: upfront price, charging infrastructure and range anxiety. There are other barriers to BEV uptake which will need addressing, but we do not have the time and capacity to consider all of these in this report. As such, our policy proposals will just focus on solutions to addressing these three principal barriers.

Policy choices

There are two important policy choices facing policymakers when considering how to mitigate the three leading barriers to BEV uptake. First, whether a more fiscal (carrot) or regulatory (stick) approach, or a mixture, is taken to mature the BEV market. Second, on whether policy should focus on new or used BEVs, or both.

As Chapter Five outlined, the governments in high-performing countries have used a mixture of regulatory and fiscal approaches, to differing extents, to facilitate BEV uptake. California's ZEV Mandate, China's NEV Mandate and the EU's vehicle CO2 standards are all examples of regulatory approaches facilitating BEV uptake across major global markets. Fiscal support, typically in the form of grants or favourable tax treatment, has also acted as carrots for incentivising drivers to go electric.

Behavioural and innovation policies are also used to facilitate BEV uptake, as explained and exemplified in Chapter Four. Because behavioural policy usually depends upon different regulations in order to shift consumer perceptions, we consider them to be aligned to a regulatory approach. Innovation policy typically relies upon significant sums of money which support various R&D projects, and as such, we consider it aligned to a fiscal approach.

Previous Bright Blue research investigated whether the public favoured a more regulatory or fiscal approach towards reducing overall emissions in the pursuit of net zero 2050. The findings suggest that the public marginally favours a fiscal (carrot) approach over a regulatory (stick) one for both individuals (49% and 34% respectively) and businesses (45% and 38% respectively).[241]

Both regulatory and fiscal approaches each carry their own advantages and disadvantages with respect to BEV uptake. A regulatory approach does not entail great cost on government, and ultimately taxpayers. Regulations can be altered to benefit BEV drivers and in doing so, make the prospect of BEV ownership more attractive. Regulation can also drive an increase in BEV production through production targets for vehicle manufacturers and stringent CO2 emissions standards for vehicles. However, the downside to this is that regulations can be regressive towards the households or businesses that they implicate.

A fiscal approach provides more support for households and businesses than a regulatory approach, through a series of grants and tax

241. Anvar Sarygulov, "Going greener? Public attitudes to net zero", Bright Blue, http://brightblue.org.uk/wp-content/uploads/2020/10/Going-Greener-FINAL.pdf, (2020), 42-43.

relief. However, this comes at a financial cost. As the BEV market grows, fiscal approaches become increasingly expensive for governments. It is because of this that Norway and Iceland are reviewing their fiscal approaches in years ahead.

As the UK has left the EU, it is no longer bound by the regulatory frameworks associated with EU membership, such as the CO2 emissions standards for passenger vehicles. As an interim measure, the UK Government has committed to maintaining existing CO2 standards that were in place when it was a member of the EU, until it decides upon its own regulatory approach to decarbonising road transport.

A regulatory approach should provide the foundations to drive BEV uptake in the UK in the long-term. But, in the short-term, the nascent BEV market in the UK will still require an ambitious fiscal approach to act as a catalyst for BEV uptake. Other organisations have discussed the merits of different regulatory approaches the UK should take after Brexit, such as introducing a UK ZEV Mandate or permanently retaining and tightening the existing EU CO2 standards. We do not discuss them here. But, obviously, a strong regulatory regime needs to be established to mature the market in BEVs in the years ahead.

As discussed in Box 3.1, less well-off households typically source their vehicles from the second hand market. Until price equivalency between ICE vehicles and BEVs is reached, and this trickles down into the second hand market, there will be few low-priced, used BEVs in comparison to ICE vehicles.

The common characteristics of a private BEV owner include being affluent, well-educated, middle-aged and male.[242] A Business, Energy and Industrial Strategy (BEIS) Committee session has previously noted the exclusivity around the ability to purchase a BEV, and recognised the need for mechanisms to support less well-off households into

242. Brook Lyndhurst for the Department of Transport, "Uptake of ultra low emission vehicles in the UK", https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/464763/uptake-of-ulev-uk.pdf (2015), 8-10.

BEV ownership.[243]

In other countries, such as the Netherlands, fiscal policy provides support for both the purchase and leasing of second hand BEVs, as was detailed in Chapter Five. It is important that less well-off households are not left behind in the electric transition, and as such, policies to bolster the second hand market are critical. Focussing on the used market will achieve both better progressive and environmental outcomes, especially compliance with the UK's new, legal net-zero target. Key to achieving this is the saturation of the new vehicle market with BEVs, which over time will trickle down into the second hand market. Additionally, fiscal policies can support BEV uptake in the second hand market until price equivalency with ICE vehicles is reached.

Policy approach

In developing policy recommendations to tackle the three leading barriers to new and used BEV uptake, we applied four key tests that had to be met:

- **Evidentially grounded.** The transport sector's significant contribution to climate change, particularly from cars, is evident. A robust policy framework from government to significantly increase EV uptake in the UK is therefore critical. However, such a policy framework should be devised from evidence, particularly examples in other countries and markets, where positive trends in BEV uptake have been observed.
- **Fiscal realism.** During the COVID-19 pandemic, levels of government expenditure have been at their highest since the Second World War. It is important that, where possible, policies do not greatly exacerbate government borrowing particularly during

243. House of Commons, "Business, Energy and Industrial Strategy Committee: Electric vehicles: driving the transition: Fourteenth report of session 2017-19", https://publications.parliament.uk/pa/cm201719/cmselect/cmbeis/383/383.pdf (2018), 21.

a time of a growing budget deficit. Nevertheless, climate change is a threat which poses serious environmental and economic consequences for the UK if left unmitigated. As such, this report is not averse to proposing policies which carry a realistic cost.

- **Progressivity.** Policies to act as a catalyst and mature the market for BEVs should be financially progressive. Policies should give consideration to supporting less well-off households in the electric transition, and not penalising them, so that they are not denied access to experiencing the benefits of BEV use and ownership.
- **Saturate the market.** Policies should seek to saturate the market for new vehicles with BEVs. Not only would this deliver emissions reductions in the transport sector, but also increase the supply of BEVs that trickle down into the second hand market. This would give less well-off households, which typically buy vehicles from the second hand market, greater accessibility towards BEV ownership, resulting in both positive social and environmental consequences.

The policies we propose are not exhaustive, but they do offer original and credible policy ideas. Other organisations have proposed plausible policies which the Government should of course consider adopting. However, we do not repeat those policies here. Ultimately, we hope that this report will be one of many which the Government will consider when establishing a longer-term policy framework for further new and used BEV uptake in the UK.

Fiscal policies

Recommendation one: Front-load the value of the Plug-in Car Grant so it equals £5,000 from April 2021 and then gradually reduce its value in regular intervals before being phased out completely from October 2023

Currently, BEVs have a higher upfront price than their ICE vehicle counterparts, as Table 3.1 earlier showed. To reduce the upfront price of new BEVs and make them more accessible for consumers to purchase, the UK Government has introduced the Plug-in Car Grant, which currently provides a grant of £3,000 towards the purchase of a new ULEV, as described in Chapter Four. The Plug-in Car Grant is available to ULEVs, but the strict emissions requirements means in reality only BEVs are now eligible for support.

Whilst the Plug-in Car Grant has been extended until 2023, the value of the grant in this period is still open to being changed at any given moment. This creates uncertainty for vehicle manufacturers, dealers and consumers alike. In addition, given predictions around BEVs reaching price equivalency with ICE vehicles in the mid-2020s, it is appropriate to establish a trajectory for the complete phase out of the Plug-in Car Grant.

To capitalise on nascent buyers, the Plug-in Car Grant should be front-loaded so its value is £5,000 from April 2021 in order to support near-term demand, before being gradually decreased at regular intervals until it is phased out altogether in October 2023. In practice, this sets a clear 30 month trajectory for the phase out of the Plug-in Car Grant. It encourages households and businesses to purchase new BEVs as soon as possible, as delay only continuously reduces the amount of government subsidy available to them.

Chart 6.1 below illustrates this different trajectory, with an example assumption of the Plug-in Car Grant being reduced by £500 every three months.

Chart 6.1. Proposed Plug-in Car Grant pathway, front-loaded from £5,000 in April 2021 and gradually reducing by £500 every three months

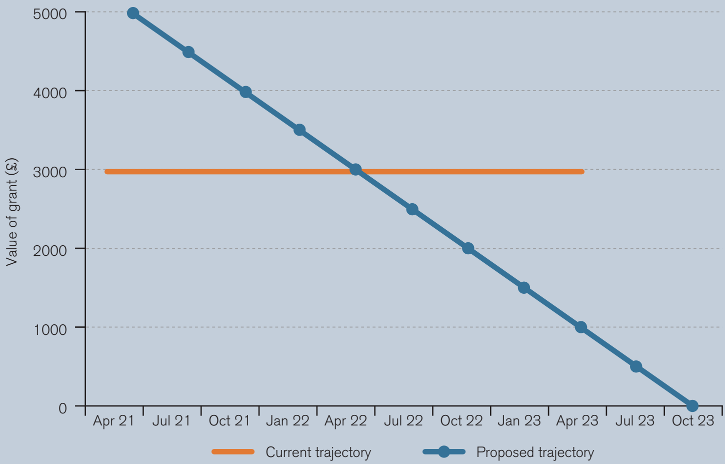

Chart 6.1 shows the existing value and duration of the Plug in Car Grant of £3,000 currently extended to 2023, as represented by the red line. By front-loading the value of the Plug in Car Grant and gradually decreasing it over 30 months, this would prevent a demand cliff-edge where the grant suddenly ends.

By front-loading the Plug in Car Grant, consumers would be encouraged to bring forward their purchase of a BEV. This would support the saturation of the market to aid the second hand BEV market. The sooner new BEVs are purchased, the sooner they will trickle down into the second hand market, benefiting those on lower incomes. In essence, a final two-year window would be provided to consumers to benefit from the main fiscal subsidy for the purchase of new BEVs.

Recommendation two: Establish a Used Vehicle Plug-in Car Grant of at least £2,000 to support low income people into BEV ownership

The upfront price for BEVs remains high relative to ICE vehicles in both the new and second hand vehicle markets, as explained in Box 3.1 earlier. For less well-off households, which typically purchase vehicles from the second hand market, this is a barrier to BEV ownership.

To make BEV ownership more accessible for less well-off households, a Used Vehicle Plug-in Car Grant should be established, providing a grant of at least £2,000 for the purchase of a used BEV from the second hand market, emulating the Netherland's fiscal support for second hand BEV purchases. Incidentally, France also provides similar fiscal support of €1,000 (£885)[244] for the purchase of a second hand BEV.[245]

To be eligible for the Used Vehicle Plug-in Car Grant, vehicles should have CO2 emissions of less than 50 grams per kilometre and a minimum zero emission driving range of 112 kilometres (70 miles), matching the eligibility criteria of the existing Plug-in Car Grant for new BEVs. In addition, vehicles should not cost more than £30,000 to prevent high-end luxury vehicles being subsidised.

To be eligible for the Used Vehicle Plug-in Car Grant, vehicles could be purchased from a dealership to prevent subsidy fraud via private sales. In order to target the grant towards those whom it aims to support, only households or individuals which are considered low-income could be eligible for the grant.

The Used Vehicle Plug-in Car Grant should be permanent for the foreseeable future, lasting beyond our proposed trajectory for the existing Plug in Car Grant for new BEVs, but the value of it should be reviewed regularly to assess its efficacy and necessity as BEVs get closer to price equivalency with ICE vehicles.

244. Currency conversion as of Jan 2021.
245. Erwan Benezet and Philippe Martinat, "Djebbari announces an ecological bonus of 1000 euros for the purchase of a used electric vehicle", Le Parisien, https://www.leparisien.fr/economie/djebbari-annonce-un-bonus-ecologique-de-1000-euros-pour-l-achat-d-un-vehicule-electrique-d-occasion-11-10-2020-8400741.php (2020).

Recommendation three: Enable enhanced capital allowances for businesses which purchase zero emission vehicles for the purpose of renting and leasing them for at least five years

Enhanced capital allowances allow businesses to deduct the cost of buying low-carbon vehicles, including BEVs, from business profits before tax is applied, as explained in Chapter Four. If a vehicle produces less than 50 grams of CO2 per kilometre, thereby encompassing BEVs, the vehicle's total cost can be deducted before tax in the first year. However, this fiscal incentive does not extend to businesses which purchase low-carbon vehicles for the purpose of renting and leasing them to other businesses and consumers.

Commercially leased fleet vehicles have a high turnover of every 38 months on average, and new rental vehicles are kept on fleet for approximately one year before being released.[246] As such, they are a strong source of supply for vehicles in the second hand market. Commercial fleet vehicles accounted for 22% of used vehicle transactions in 2019.[247] But, given BEVs are excluded from being tax-deductible for businesses which purchase them for the purposes of renting and leasing, such businesses are not incentivised to purchase BEVs. As a result, less BEVs trickle down into the second hand market.

Businesses which purchase vehicles for the purpose of renting and leasing should be allowed to deduct the cost of the vehicle from business profits before tax in the first year, provided that the vehicle produces less than 50 grams of CO2 per kilometre and has a minimum zero emission driving range of 112 kilometres (70 miles). This allowance could automatically expire in five years, only renewed once an assessment has been made of its efficacy and necessity as the price of BEVs falls and their market penetration increases.

This would have a triple benefit for BEV uptake. First, as commercial

246. Figures supplied by, and published with permission from, the BVRLA.
247. Ibid.

fleet vehicles accounted for over half of new UK vehicle registrations in 2020, a greater number of BEVs would be registered on UK roads as renting and leasing companies are incentivised to purchase BEVs because of their status as tax-deductible.[248] Second, by passing on the benefit of enhanced capital allowances, consumers who rent or lease a BEV would benefit from a cost saving of up to £20 a month.[249] Third, as fleet vehicles have a shorter life cycle, these vehicles would trickle down relatively quickly into the second hand market, giving less-well off households more opportunities to purchase a BEV.

Regulatory policies

Recommendation four: Introduce a mandate immediately stating that all new vehicle purchases for the public fleet must be BEVs

Public fleet vehicles present an opportunity to bolster the second hand market for BEVs. There are approximately 25,000 central government fleet vehicles and 50,000 vehicles managed by local councils in the UK.[250] In its 2017 Budget, the UK Government made a commitment to having 25% of government department fleet vehicles electric by 2022.[251]

However, this is unambitious and will result in a smaller number of BEVs trickling down into the second hand market than if a stronger commitment was made. Elsewhere, countries such as New Zealand have mandated that all new vehicle purchases for the public fleet must now be BEVs or hybrid vehicles.[252]

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248. Society of Motor Manufacturers and Traders, "Car registrations", https://www.smmt.co.uk/vehicle-data/car-registrations/ (2020).
249. Figures supplied by, and published with permission from, the BVRLA.
250. Nick Collins, "Government cars go electric", The Telegraph https://www.telegraph.co.uk/news/uknews/road-and-rail-transport/10973594/Government-cars-go-electric.html (2014); Gareth Roberts, "UK council fleet drops below 50,000 vehicles", Fleet News https://www.fleetnews.co.uk/news/2015/2/9/uk-council-fleet-drops-below-50-000-vehicles/54766/ (2015).
251. HM Treasury, "Autumn budget 2017", https://www.gov.uk/government/publications/autumn-budget-2017-documents/autumn-budget-2017 (2017).
252. New Zealand Parliament, "Wednesday, 2 December 2020 – volume 749", https://www.parliament.nz/en/pb/hansard-debates/rhr/combined/HansD_20201202_20201202 (2020).

The UK Government should introduce a mandate immediately stating that all new vehicle purchases for the public fleet, including central government vehicles and vehicles managed by local councils, must be BEVs. Whilst these vehicles would be more expensive to purchase than ICE vehicles, central and local governments would benefit from the lower lifetime costs associated with BEVs, as explained in Chapter Three.

Such a mandate would increase the proportion of BEVs in the central and local government fleet, and when it comes time to renew their fleets once more, these BEVs would trickle down into the nascent second hand BEV market. This would give less-well off households more opportunities to purchase a BEV.

Recommendation five: Introduce an obligation on all local authorities to install on-street electric vehicle chargepoints within three months when requested by residents unless there are reasonable grounds for objecting, facilitated by an online system established and administered by the local authority

For BEV drivers whose households do not have access to off-street parking, they are reliant upon publicly available chargepoints in order to charge their BEV. Unless there is an on-street chargepoint near their house, they are unable to charge their BEV whilst at home, presenting a major barrier to BEV uptake, as explained in Chapter Three.

Currently, local authorities determine where on-street chargepoints will be installed in residential areas, funded in part through the On-street Residential Chargepoint Scheme, as discussed in Chapter Four. We recommend that this process should be demand-led, with an onus on local authorities to install on-street chargepoints when requested by residents within three months unless there are reasonable grounds for objection, mirroring the demand-led on-street chargepoint scheme in the Netherlands, as explained in Chapter Five.

BEV drivers should be able to access an online portal established and administered by local authorities for making their request. Drivers would be required to show proof of purchase of a BEV to their local authority, before making a request through the online portal for the installation of a chargepoint near their place of residence. The request could be assessed on various criteria, for example whether the driver has access to off-street parking, the walking distance to other existing or planned chargepoints in that area and the occupancy rate of nearby chargepoints.

If the request is approved, the local authority would open a consultation period of six weeks, where stakeholders could challenge or propose amendments to the plan. Following this, and assuming no setbacks as a result of the consultation period, the chargepoint would then be published on a map and other nearby registered BEV drivers could be notified of its location before being installed.

Local authorities could either own the chargepoints or tender out their ownership to a private organisation. The operation of the chargepoint could also be tendered out to a charging network. All chargepoints across a borough or district would, if the recommendation below is implemented, be easily accessible regardless of charging network because of interoperability. But, if this was not implemented, any new on-street chargepoints in the borough should be grouped under a single tender to one charging network. This would ensure that all chargepoints within a borough or district would be accessible via the same charging network.

A demand-led, online on-street chargepoint scheme such as this would ensure that households with no off-street parking are not constrained by a lack of charging infrastructure when purchasing a BEV, and can have confidence that a chargepoint will be installed relatively quickly near their place of residence if charging opportunities are not already available to them. Additionally, such a scheme would ensure that chargepoint installation is targeted towards areas where they would be utilised.

Recommendation six: Make interoperability a condition for central and local government funding towards chargepoints

By having interoperable chargepoints, BEV drivers are not restricted to only charging at a chargepoint operated by networks which they have a subscription or membership to. Whilst this restriction is not a leading barrier to BEV uptake, interoperability between charging networks would make it easier for BEV drivers to access chargepoints operated by different charging network companies.

Interoperability occurs when BEV drivers can access a chargepoint operated by a charging network which they do not have a subscription to, using their existing subscriptions to other charging networks. This is facilitated by peer-to-peer agreements between different charging network companies or a roaming hub, and suppliers settle the difference in price between them.

Some countries, such as Norway, require at least ad hoc access to charging if network companies wish to receive government financial support for the installation of chargepoints. In California, this is a legal requirement. The Californian Electric Vehicle Charging Stations Open Access Act prohibits any charging network company from implementing a subscription fee or requiring organisational membership in order to access charging.[253] In other words, it requires charging network companies to provide ad hoc access at all their chargepoints. Similarly, in Germany, organisations which wish to receive government funding for the hardware and connection costs of chargepoint installation must ensure that the chargepoint allows roaming for all customers.[254]

Unlike other countries such as the Netherlands and Germany, few cross-network agreements to facilitate interoperability exist in the UK. The UK Government provides significant amounts of funding

253. California Legislature, "AB-1424 electric vehicle charging stations open access act", https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201920200AB1424 (2019).
254. Renewable Energy Association, "REA position paper: The interoperability of public charging networks in the UK", https://live.r-e-a.net/wp-content/uploads/2019/10/HI-RESInteroperability-report.pdf (2019), 30.

for chargepoints through the CIIF, Rapid Charging Fund and to local authorities through the On-street Residential Chargepoint Scheme, as described in Chapter Four. By making central and local government funding for chargepoints conditional on the basis of providing interoperability, this would act as a catalyst for an increase in cross-network agreements and interoperability between charging networks. This would benefit chargepoint users by increasing the number of chargepoints that they could access using a single charging network subscription.

Recommendation seven: Require all petrol stations above a certain size to have at least three rapid chargepoints by 2023, funded in part by petroleum companies and in part by government

Despite there being more chargepoints than petrol stations in the UK, drivers continue to perceive there being a lack of charging infrastructure, as outlined in Chapter Three. Furthermore, research by the Behavioural Insights Team suggests that drivers think of recharging a BEV in the same way as they do refuelling an ICE vehicle.[255]

By 2023, petrol stations in the UK above a certain size should be required to have at least three rapid chargepoints, which would be financed in-part by petroleum companies which ultimately own the trade-marks and business models of all petrol stations. Setting a date of 2023 would provide petrol stations with ample time to lay the necessary cabling and complete the installation of a rapid chargepoint. Chargepoints should be rapid so that they are able to deliver a quick charge and keep time spent recharging to a minimum.

With a cost of between £20-40,000 per rapid chargepoint, petroleum companies – who ultimately own the trade-marks and

255. The Behavioural Insights Team and Transport Research Laboratory, "Driving and accelerating the adoption of electric vehicles in the UK", https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/914111/driving-and-accelerating-the-adoption-of-electric-vehicles-in-the-uk.pdf (2020), 4.

business models of all petrol stations – can and should be able to make a reasonable contribution to their installation, in an effort to decarbonise passenger vehicle transport and support BEV uptake. Petroleum companies should be required to fund the installation of the chargepoints themselves in each relevant petrol station, whilst the UK Government could pay for the necessary grid connections through the existing Rapid Charging Fund, described in detail in Chapter Four.

It should be noted that large petroleum companies, such as Shell and BP, have already begun rolling out rapid chargepoints in petrol stations at some locations. Furthermore, in June 2020, Germany announced a similar policy requiring all petrol stations to provide a chargepoint. However, this will be financed through Germany's €130 billion COVID-19 economic recovery plan.[256] We believe a part-industry, part-government funded approach is preferable.

By having at least three rapid chargepoints at every petrol station above a certain size, drivers can have security in knowing that they will be able to recharge their BEV almost wherever they can locate a petrol station, and wherever they may have previously refuelled their ICE vehicle. As such, this policy would aid in dispelling driver anxieties around there being a lack of charging infrastructure, as well as range anxiety.

Behavioural policies

Recommendation eight: Make the inclusion of estimated lifetime costs mandatory for all used as well as new vehicle sales alongside the retail upfront price

Consumers focus on the upfront price of BEVs and as such, their higher upfront price relative to ICE vehicles serves as a barrier to BEV uptake. However, BEVs typically always have a lower lifetime cost than

256. Christoph Steitz and Edward Taylor, "Germany will require all petrol stations to provide electric car charging", Reuters, https://www.reuters.com/article/us-health-coronavirus-germany-autos/germany-forces-all-petrol-stations-to-provide-electric-car-charging-idUSKBN23B1WU (2020).

ICE vehicles when also taking into account the cost of recharging/refuelling, maintenance costs and vehicle taxation, as explained and evidenced in Chapter Three.

The New Car Environmental Label, as discussed in Chapter Four, provides consumers in vehicle showrooms with information on running costs, carbon emissions and, in the case of ULEVs (including BEVs), zero emission driving range, when purchasing a new vehicle. Whilst this does emphasise the large savings that can be made by going electric, this is only applicable to new vehicle sales.

The inclusion of estimated lifetime vehicle costs should be made mandatory for all new and used vehicle sales alongside the retail price. For used vehicles being sold privately or through dealerships, the Vehicle Certification Agency (VCA) should establish an online tool to calculate vehicles' running costs using vehicle information such as fuel tank and engine size, battery capacity, weight, average maintenance costs and taxation, as well as contemporary fuel and BEV charging prices. To make an easy comparison for consumers, the final figure should be displayed in pounds-per-100 miles. This VCA-accredited estimated figure must then be displayed along with the listed price of any vehicle for sale. This estimate could be provided for every model of every make of car.

By making the inclusion of estimated lifetime costs mandatory for all new and used vehicle sales alongside the listed price, consumers will take into consideration the lifetime costs, which typically favour BEVs over ICE vehicles, when deciding on purchasing a vehicle. Additionally, this would provide greater transparency for consumers to make informed choices, particularly when purchasing a used vehicle from the second hand market.

Conclusion

As the largest emitting sector in the UK responsible for almost a third of UK emissions, the transport sector must be decarbonised, especially cars which account for more than half of the sector's emissions.

Whilst the UK Government has taken steps to grow the market for BEVs and their uptake has been trending in the right direction over the last decade, there remains a long way to go before the UK's BEV market is comparable to that of other high-performing countries. It is imperative that the market for BEVs – both new and used – grows substantially over the next decade if the UK is to meet its legal net zero 2050 emissions target.

The policies put forward in this report are not exhaustive, but do present original and credible policy ideas to act as a catalyst to, and mature the market for, new and used BEV uptake in the UK.

Annex:
Written evidence

Evidence from Chargepoint

Click here to read the submission

Evidence from Electromobility UK

Click here to read the submission

Evidence from Energy UK

Click here to read the submission

Evidence from Finance & Leasing Association

Click here to read the submission

Evidence from Liquid Gas UK

Click here to read the submission

Evidence from Ombudsman Services

Click here to read the submission

Evidence from Scottish & Southern Electricity Networks

Click here to read the submission

Evidence from Shell

Click here to read the submission

Evidence from Zip Car

Click here to read the submission

As the UK's largest emitting sector, decarbonising transport is critical to achieving net zero emissions by 2050. Over half of all emissions emanating from the transport sector come from passenger vehicles. As such, the uptake of battery electric vehicles, which produce zero emissions, is essential to curbing emissions from the transport sector.

This report examines the key barriers to battery electric vehicle uptake among households and businesses in the UK and explores policies adopted both in the UK and abroad to catalyse the battery electric vehicle market. It concludes by recommending new policies to mature the market for battery electric vehicles in the UK.

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