House of Commons Library

Electric vehicles and infrastructure

By Lewis Pickett
James Winnett,
Dominic Carver, and
Paul Bolton

20 December 2021

Contributing Authors
Noel Dempsey, Social and General Statistics;
Paul Bolton, Social and General Statistics

Image Credits
House of Commons Library

Disclaimer
The Commons Library does not intend the information in our research publications and briefings to address the specific circumstances of any particular individual. We have published it to support the work of MPs. You should not rely upon it as legal or professional advice, or as a substitute for it. We do not accept any liability whatsoever for any errors, omissions or misstatements contained herein. You should consult a suitably qualified professional if you require specific advice or information. Read our briefing 'Legal help: where to go and how to pay' for further information about sources of legal advice and help. This information is provided subject to the conditions of the Open Parliament Licence.

Feedback
Every effort is made to ensure that the information contained in these publicly available briefings is correct at the time of publication. Readers should be aware however that briefings are not necessarily updated to reflect subsequent changes.

If you have any comments on our briefings please email papers@parliament.uk. Please note that authors are not always able to engage in discussions with members of the public who express opinions about the content of our research, although we will carefully consider and correct any factual errors.

You can read our feedback and complaints policy and our editorial policy at commonslibrary.parliament.uk. If you have general questions about the work of the House of Commons email hcenquiries@parliament.uk.

Contents

Summary

The UK has committed to Net-Zero carbon emissions by 2050. Transport is currently the largest emitting sector of the UK economy, responsible for 27% of total UK greenhouse gas emissions. Over half the UK's transport emissions (55%) come from cars.

Electric vehicles (or EVs) offer one method of reducing emissions. In May 2019, the Committee for Climate Change (CCC) suggested that all new vehicles should be electrically propelled by 2035, if not sooner, to achieve the Net Zero target.

The UK Government is accelerating the transition to zero emission cars and vans. In November 2020, as part of the Government's 10 point plan for a green industrial revolution, the Prime Minister announced that the sale of new petrol and diesel cars would be phased out by 2030 and that all new cars and vans would be zero emission by 2035.

This briefing paper provides an overview of the transition to zero emission vehicles, including the policies and investments the Government is using to support the transition and some of the key challenges ahead.

What are EVs?

EVs run, either partially or wholly, on electricity stored on board the vehicle in batteries or produced from hydrogen. Some types of EV qualify as zero emission vehicles (ZEVs) or ultra-low emission vehicles (ULEVs), whereas others do not because their emissions are too high. ZEVs, for example, emit no CO2 emissions at the tailpipe, whereas ULEVs must have reported tailpipe emissions of less 75 g/km of CO2.

The market for EVs is immature yet growing. In Q2 2021, 14.9% of all newly registered cars were for ULEVs. However, most cars on the road in Great Britain are fuelled by petrol and diesel. ULEVs, for example, only accounted for 3.3% of the cars registered in Great Britain in 2020.

Government measures to support EVs

There have been a variety of strategies employed over the past decade to encourage the uptake of EVs.

In July 2021, alongside the transport decarbonisation plan, the Government published a 2035 delivery plan, which outlines the policies and investments the Government is taking to support the transition to zero emission cars and vans.

To help achieve its 2030 and 2035 targets, the Government, as part of its Net Zero Strategy, confirmed its plan to introduce a ZEV mandate from 2024. The mandate will set annual targets for the percentage of manufacturers' new car and van sales that need to be zero emission from 2024 onwards.

One of the main reasons why people do not choose to buy an EV is that they have fears, known as range anxiety, about the distance EVs can travel been charges. The Government has a variety of schemes to support the provision of charging infrastructure, including in people's homes and workplaces.

The Government's forthcoming Electric Vehicle Infrastructure Strategy is intended to set out the Government's vision for the rollout of charging points across the country. The provision of charging infrastructure will also be supported through amendments to the Building Regulations, which will require new homes and buildings, including properties undergoing major renovations, to have electric vehicle charging points installed from 2022.

Electricity Demand

The transition to electric vehicles will increase demand for electricity. In September 2021, Ofgem, the energy regulator, highlighted that electric cars and vans will need between 60-100TWh of electricity annually by 2050 – an increase of 20-30% compared to 2021 levels. While EVs pose significant demands for the National Grid, the use of smart charging or vehicle to grid technologies could significantly lower peak demands in the electricity required to fuel EVs.

Environmental Impact – why EVs are not the silver bullet

EVs improve local air quality and reduce point-of-use emissions; however they are not net-zero when considering the whole life cycle of a vehicle and its sub-components, as well as the particulate matter emitted on-street.

The shift to EVs will require more batteries to be manufactured. This opens up opportunities, such as the potential for the UK to develop battery production facilities, but also poses challenges. Batteries for EVs can require rare elements such as lithium and cobalt, which has raised environmental and ethical issues in countries where these elements are mined.

1 Introduction

1.1 What are Electric Vehicles?

Electric vehicles run on electricity some or all the time. There are several different types, as described in Box 1.

Box 1: What is an Electric Vehicle?

Electric vehicles use electric motors to drive their wheels. They derive some or all of their power from large, rechargeable batteries. The distance an EV can drive between recharges is known as its range.

Different categories of EV include:

- **Battery Electric Vehicles (BEVs)**, where the battery is the only power source. Most current (non-luxury) models have a quoted range of 100-250 miles (160-400 km). In practice, range varies according to driving style, terrain and the use of auxiliary equipment such as heating/air conditioning.
- **Fuel Cell Electric Vehicles (FCEV).** These generate their own electricity on-board from a fuel such as hydrogen, and do not need to plug in to the electricity grid to recharge. Re-fuelling is similar to a petrol car.
- **Plug-in Hybrids (PHEVs)**, which switch between running on electricity or fossil fuels. They typically have a smaller battery, and therefore a lower battery powered range of between 25-55 miles (40-90 km). However, their maximum range is equivalent to a petrol or diesel car. Both plug-in hybrid and all-electric EVs are recharged by plugging them in to the electricity grid.
- **Hybrid Electric Vehicles (HEVs)**. HEVs do not plug in and have a much smaller battery which is recharged while driving. HEVs can drive in electric mode for a few miles.

All electric vehicles require batteries. These are important to ensure suitable range whilst concurrently providing power commensurate with the vehicle. However, there is not one

chemistry that can be applied universally to all vehicles due to the varying properties they exhibit, for example, in their cost, energy storage capacity, safety, life, and charge rates.[1] Therefore, vehicle manufacturers (OEMs) must choose which they believe offers the best performance based on the application. As such, individual OEMs even use different chemistries for HEVs compared to EVs or PHEVs.[2]

Some of these types of EV qualify as zero emission or ultra-low emission vehicles, whereas others do not because their emissions are too high. Zero emission vehicles (ZEV) emit no CO2 emissions at the tailpipe. BEVs and FCEVs fall within this category. Vehicles with reported tailpipe emissions of less 75 g/km of CO2 are classified as ultra-low emission vehicles (ULEV). Some HEVs and PHEVs models meet this criteria, but others do not.[3]

1.2 Why do we need Electric Vehicles?

As of 2019, transport was the largest-emitting sector of the UK economy at 122 mega tonnes carbon dioxide equivalent ($MtCO_2e$), accounting for 27% of total UK greenhouse gas (GHG) emissions.[4] The chart below shows the contributions to transport GHG emissions by vehicle type, demonstrating how cars represented the greatest proportion of emissions within the transport sector in 2019, accounting for 55% of transport emissions.[5]

Past and current governments have supported measures to encourage the uptake of EVs, as they can contribute to a wide range of transport policy goals.[6] For example, EVs can help to improve air quality, reduce noise pollution and support efforts to reduce carbon emissions.

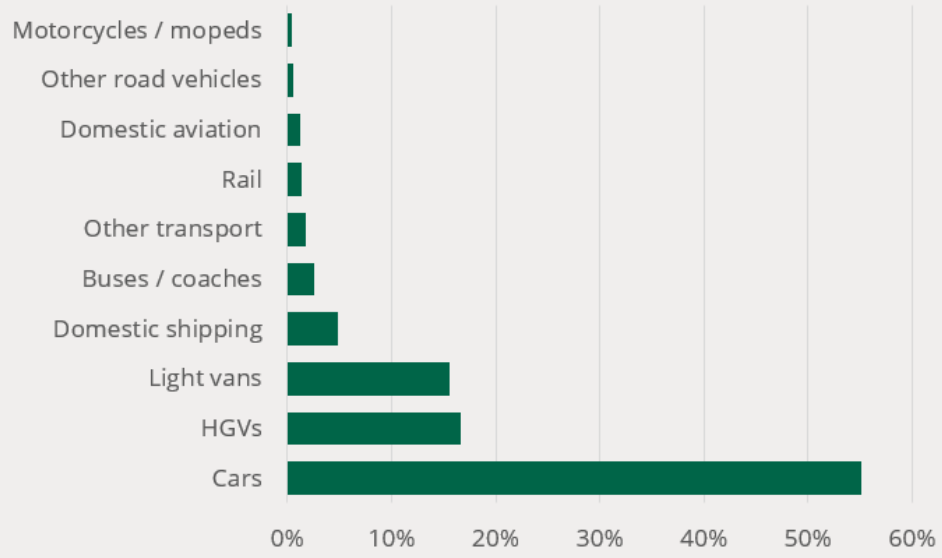
The importance of EVs was outlined in updated advice on meeting the net zero 2050 target, published in May 2019 by the Committee on Climate Change (CCC) – the statutory advisors on emissions reductions for Government. This said that the market for electric cars and vans should scale up to 100% of new sales by 2035 at the latest (and ideally by 2030) to meet the net zero target.[7] Under the older 80% reduction target by 2050, the CCC advised a 'least cost' pathway would need 60% of all new cars and vans sold to be

1 Miller P. 'Automotive Lithium-Ion Batteries', *Johnson Matthey Technol. Rev.* **59** (1) 4. 2015.
2 Miao Y, Hynan P., von Jouanne A., Yokochi A. 'Current Li-Ion Battery Technologies in Electric Vehicles and Opportunities for Advancements'. *Energies.* **12** (1074). 2019.
3 Department for Transport, Vehicle Licensing Statistics: 2021 Quarter 2 (Apr - Jun), 29 September 2021
4 DfBEIS, Final UK greenhouse gas emissions national statistics: 1990 to 2019, Table 1.2, 25 March 2021.
5 DfT, Table ENV0201 Greenhouse gas emissions by transport mode: United Kingdom, 1990-2018, *Energy and environment: data tables*, 17 December 2020.
6 IEA, *Global EV Outlook 2018*, May 2018.
7 CCC, Net Zero: The UK's contribution to stopping global warming, May 2019, p.34.

electric by 2030 (see Box 2 for further information on transport emissions).[8] In September 2020, the UK Climate Assembly[9] report, which looked at the pathway to achieving net zero, favoured policies that would encourage the uptake of electric vehicles over measures to reduce car use[10]

UK transport greenhouse gas emissions

Greenhouse gas emissions by transport mode, percent



Notes:
a. Rail does not include emissions caused by the production of electricity for electric trains. Rail emissions rise to 2.3% of total transport emissions when it is included.
b. Other transport mainly consists of military aircraft / shipping and aircraft support vehicles.
Source: DfT, Greenhouse gas emissions by transport mode, table ENV0201

Although electric vehicles offer "clear benefits" for local air quality due to zero exhaust emissions at street level, they still emit particulate matter from road, tyre and brake wear. This means EVs cannot entirely eliminate issues of air pollution in cities.[11] Further, they do not address wider issues, such as urban sprawl, inactive lifestyles or congestion, which may increase due to reduced operational costs of motoring.[12]

8 CCC, Reducing UK emissions 2018: Progress Report to Parliament, June 2018, p. 161.
9 The Climate Change Assembly was commissioned by six Commons select committees. The assembly was made up of 108 members representative of the UK population.
10 Climate Assembly UK, The path to net zero, September 2020
11 EEA, Electric vehicles from life cycle and circular economy perspectives, 13/2018, TERM 2018: Transport and Environment Reporting Mechanism (TERM) report.
12 Eyre, N and Killip, G. (eds). Shifting the focus: energy demand in a net-zero carbon UK. Centre for Research into Energy Demand Solutions. July 2019.

Box 2: Transport emissions

The CCC has recommended that if the UK is to meet the 2050 net zero target, 100% of new vehicle sales should be electrically propelled by 2035 at the latest (and ideally by 2030).

Progress in reducing emissions in the transport sector has been slow, although average vehicle emissions from the UK fleet have fallen.[13] In 2018 the average CO_2 emissions of newly registered vehicles was 124.9 grams per kilometre (g/km). This is down from 178.8 g/km in 2001 and represents a decrease of around 30%. Between 2001 and 2018 the average CO_2 emissions of newly registered vehicles were falling year on year although began to rise from mid-2016. According to the DFT this increase was:

> "broadly due to a shift towards registering larger cars (which have higher emissions) and increases in emissions for popular petrol car models. The introduction of WLTP [14] in September 2018 caused a marked increase in average CO_2 emissions. However, changes from September 2018 are not directly comparable with previous periods." [15]

The CCC says that most action to reduce emissions from the transport sector had been driven by EU regulations, rather than domestic policy.[16] Since 2015, the EU has set mandatory emission reduction targets for new cars.[17] Further, the CCC says renewed efforts are needed to encourage consumers to buy more efficient vehicles.[18]

EU vehicle emission targets

Since 2009, EU legislation has set mandatory emission reduction targets for new cars. Since 2015, a target of 130 g CO_2/km applies for the EU fleet-wide average emission of new passenger cars. From 2021, phased in from 2020, the EU fleet-wide average emission target for new cars is 95 g CO_2/km. There are penalties for manufacturers if the average CO_2 emissions of their fleet exceed its target in a given year.

Impact of Brexit on emission targets

On 31 January 2020, the UK left the EU, before then much existing EU legislation had been converted into UK law. For example,

13 Society of Motor Manufacturers and Traders (SMMT), Facts & Figures, accessed: [17 June 2019].
14 The Worldwide Harmonised Light Vehicle Test, used to measure fuel consumption and pollutant emissions from passenger cars.
15 Department for Transport, Vehicle licensing statistics 2018, p. 6.
16 Ewa Kmietowicz, Road to Zero: A missed opportunity?, CCC, 10 July 2018.
17 European Commission, Reducing CO2 emissions from passenger cars, accessed: [5 June 2019].
18 CCC, Reducing UK emissions 2018 Progress Report to Parliament, June 2018, p.161.

Regulation 2019/631, which outlines CO_2 emission requirements for new passenger cars and light commercial vehicles in the EU, has become The Road Vehicle Emission Performance Standards (Cars and Vans) (Amendment) (EU Exit) Regulations 2019) in the UK.

EU regulation 2019/631 defines that by 2025 the average emissions from cars and vans across the EU must have been reduced 15% from the 2021 baseline; further, this reduction should be 37.5% for cars and 31% for vans by 2030 against the same baseline. It also specifies that 15% of new cars and vans should be zero or low emission by 2025 which is further increased to 35% of cars and 30% of vans by 2030. [19]

The approach outlined by the Department for Transport is to retain policies within EU regulation 2019/631 that:

- support CO_2 reductions in the transport sector to achieve the goal of net-zero emissions by 2050;
- ensure that the UK emissions targets are in line with, if not more ambitions than, those of the EU; and
- provide the UK government the same level of control as is currently performed by the European Commission. [20]

1.3 How many Electric Vehicles are on UK roads?

ULEVs represent a small percentage of the overall vehicle fleet. The Government is keen to highlight the growth rate, rather than the absolute numbers on the roads.

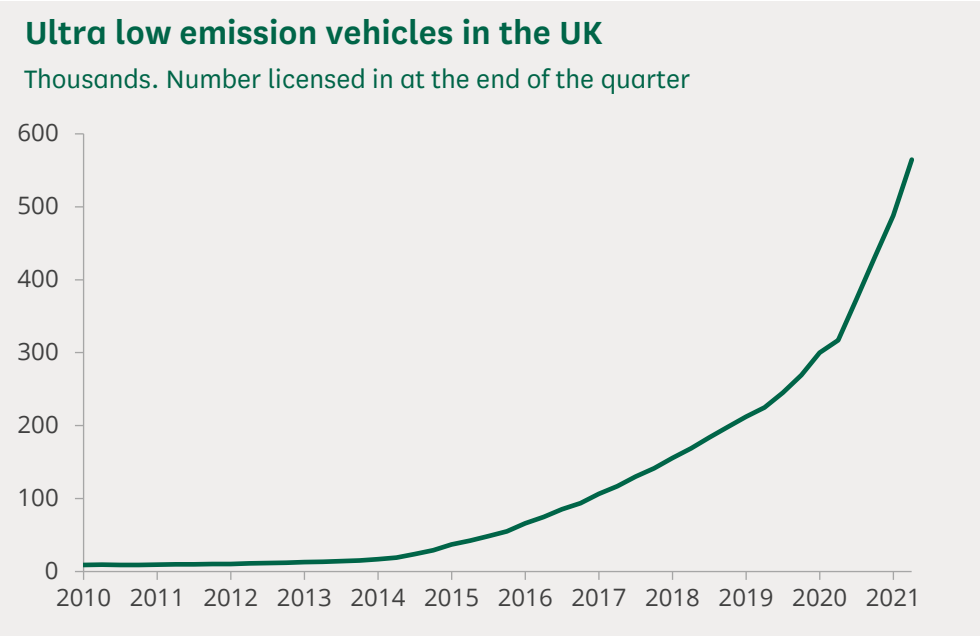
Data on the number of licensed ultra-low emission vehicles (ULEVs) [21] is available from the Department for Transport's Vehicle licensing statistics dataset. Data on the number of licensed vehicles is available by quarter since 2010. The chart below shows how the number of ULEV vehicles in the UK has increased from just under 9,000 at the end of Q1 2010 to 565,000 at the end of Q2 2021. At the end of Q3 2013 the number of licensed ULEV cars overtook

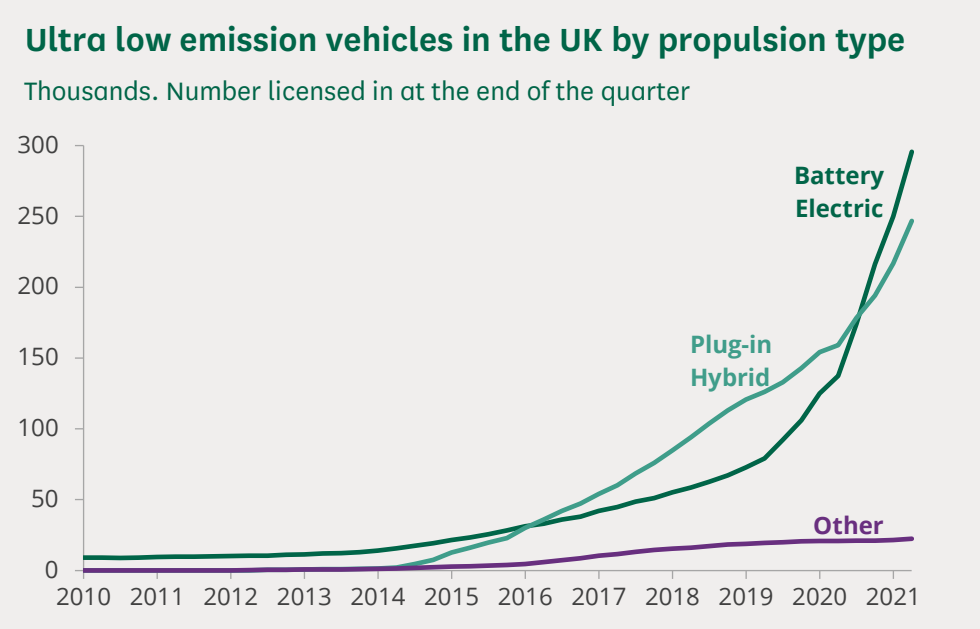
[19] European Commission, Regulation (EU) 2019/631 of the European Parliament and of the Council of 17 April 2019 setting CO2 emission performance standards for new passenger cars and for new light commercial vehicles, and repealing Regulations (EC) No 443/2009 and (EU) No 510/2011.

[20] DfT, CO_2 emission performance standards for new passenger cars and light commercial vehicles, 13 October 2020.

[21] Ultra low emission vehicles (ULEVs) are vehicles that emit less than 75g of carbon dioxide (CO2) from the tailpipe for every kilometre travelled. In practice, the term typically refers to battery electric, plug-in hybrid electric and fuel cell electric vehicles.

the number of vehicles of other types, such as vans, scooters, HGVs and buses etc, and now account for around 94% of all licensed ULEV vehicles. The growth in ULEVs was initially in plug-in hybrid electric vehicles from 2014 onwards. Growth in battery electric vehicles took off from early 2019 and they outnumbered plug-in electric vehicles from Q4 2020 onwards.





Source: Vehicle licensing statistics, DfT (Tables VEH0130 & VEH0133b)

Despite the rise in the number of licensed ULEV cars on UK roads, as a proportion of the total number of cars licensed ULEVs still represent a very small share. In 2020, 58.9% of licensed cars were petrol, 37.6% diesel and

3.3% were either a plug-in-hybrid, battery electric, range-extended electric, or fuel cell electric car. [22]

In Q2 2021 plug-in-hybrid, battery electric, range-extended electric or fuel cell electric cars accounted for 14.9% of all newly registered cars. Two years earlier this was just 2.3%. This was against a general reduction in new car registrations as a result of Covid-19. [23]

Box 3: Batteries or Hydrogen?

The power for EVs is stored in large, rechargeable batteries. These can be the only power source or they can be supplemented by a petrol or diesel engine. Hydrogen fuel cell vehicles meanwhile convert hydrogen gas to electricity, with a battery used to store surplus energy or supplement the power during periods of high demand.

Emissions comparison

Both offer a significant reduction in emissions compared to petrol or diesel vehicles. Whilst the most notable difference is in the tailpipe emissions, which are completely removed in both BEVs and FCEVs, it is also important to consider the emissions generated over the life of the vehicle. Once the production costs are also accounted for, a standard mid-sized gasoline powered vehicle emits approximately 190 g of CO_2 per km over a 150,000 km lifetime. [24] Meanwhile, it is estimated that this is reduced to 124 g of CO_2 for each BEV km travelled, and 120 g of CO_2 for each km an FCEV travels. The difference compared to petrol or diesel vehicles will be enhanced with a reduction in emissions during the production of electricity.

Refuelling/recharging times

Refuelling of a FCEV takes a similar time as to refuelling a typical mid-sized petrol or diesel vehicle. On the other hand, recharging the battery of BEV and PHEVs takes significantly longer, with the exact time dependant on factors such as battery size and charge power. Rapid chargers provide EVs with approximately 80% of their charge in 30-40 minutes. However, home charging systems are not typically rated to provide such power, with a full charge normally achieved in 6-12 hours.

22 Department for Transport, Vehicle Licensing Statistics: table VEH0203.

23 Department for Transport, Vehicle Licensing Statistics: table VEH0253.

24 Low Carbon Vehicle Partnership, Life Cycle CO_2e Assessment of Low Carbon Cars 2020-2030, August 2018.

Infrastructure to recharge EVs is more available than FCEV refuelling stations. Zap-Map report there were 14,006 charging points, 22,029 devices and 38,219 connectors in April 2021. Of these, 4,198 devices and 9,885 connectors in 2,782 locations are rapid chargers. Conversely, the public-private UK H2Mobility Consortium detail the 11 refuelling stations available for FCEVs, with one additional station specifically for buses. This is offset to an extent by the increased range of FCEVs, with commercially available FCEVs capable of 400 miles between charging, however this is not dissimilar to petrol or diesel powered vehicles which can be refuelled at any one of the 8330 petrol stations in the UK.

Costs

EVs are more advanced commercially with 216,379 BEVs and 194,194 PHEVs licenced at the end of Q4 2020 compared with 263 FCEVS.[25] This is reflected in the purchase price of new vehicles, with FCEVs approximately twice the price of a similarly sized BEV.

The operational cost of FCEVs is also currently greater than BEVs. Typical hydrogen consumption is approximately 1 kg per 100 km, with each kilo of hydrogen currently £10-15. Conversely, a BEV would typically require approximately £3 of charge to cover the same distance.

Availability

Electricity is widely available, with 307 TWh produced in the UK in 2019.[26] A variety of sources are currently used with, in 2020, 43.3% from fossil fuels (mainly gas), 23.6% renewably produced and 24.1% from other sources, such as nuclear, with the remainder imported.[27]

The UK currently produces around 0.7 Mt, equivalent to 26.9 TWh, of hydrogen per year, via high temperature processing of methane (steam methane reforming (SMR)), gasification of organic material, such as coal, oil and biomass, and electrolysis.[28] The National Grid Future Energy Scenario (FES) 2020 suggests that 7.4 million tonnes (284 MWh) of Net Zero hydrogen could be produced by 2050, achieved primarily through significant increases in production between 2030 and 2045.[29]

25 Department for Transport, Ultra-low emissions vehicles statistics, Table VEH0133b.
26 National Grid, *Future Energy Scenarios*, July 2020.
27 National Grid, Historic Generation Mix & Carbon Intensity, accessed: [9th June 2021].
28 CDP 2020-0172, UK Hydrogen Economy, 16 December 2020.
29 National Grid, *Future Energy Scenarios*, July 2020.

Further details regarding the UK hydrogen economy can be found in the Debate Pack.

Government car fleet

The Government is committed to electrifying the fleet of central government cars. In the 2017 Autumn Budget, it was pledged that 25% of this fleet would be electrified by 2022.[30] The Road to Zero Strategy outlined further commitments, with it stating 100% of central government car fleet would be electric by 2030.[31]

As of October 2020, 1,848 ultra-low emission vehicles had been incorporated into the Government car fleet, representing 8%.[32] However, at the same time it was also reported that the DfT had 22 EVs in their fleet of 1860 vehicles (approximately 1.2%).

1.4 Used Cars

Used cars transactions make up a significant proportion of vehicle sales, as shown in Table 1 below. For example, in 2019 there were 2.3 million (22%) new cars registered [33] compared with 7.9 million (78%) used car transactions. The impact of the Covid-19 pandemic on the used car market in the UK is detailed in Box 4.

However, the second-hand market for EVs is less developed. In 2019, ultra-low emission vehicles made up 3.4% of new vehicle registrations, whilst only 1.8% of used car transactions involved alternatively fuelled vehicles.

Table 1 New vs Used Car Transactions for United Kingdom

Year	New Car Sales (million)	Used Car Sales (million)
2014	2.44	7.43
2015	2.60	7.64
2016	2.67	8.20
2017	2.51	8.11

30 HM Treasury, Autumn Budget 2017, 22 November, 2017.
31 DfT, Reducing emissions from road transport: Road to Zero Strategy, July 2018.
32 PQ 180941, [Electric Vehicles] 14 April 2021.
33 Department for Transport, Vehicle Licensing Statistics: Annual 2019, April 2020.

2018	2.34	7.95
2019	2.30	7.94
2020	1.62	6.75

Source: DfT, VE0253; SMMT, Used car sales: Q4 2020

Over half of new vehicles each year are bought by fleet operator businesses, [34] these feed through to the used car market and hence incentives to such companies to choose EVs when purchasing new vehicles will increase the number of EVs coming through to the second hand EV market.

An additional factor potentially affecting the number of vehicle sales is that the average age of vehicles at scrappage has been gradually increasing since 2009. For example, in 2018 the life of a car was approximately 14.1 years, whilst those of light commercial vehicles and heavy goods vehicles was approximately 12.9 and 11.4 years respectively. [35] Meanwhile, most EV manufacturers offer five to eight-year warranties on the battery, [36] although those based in California have a mandated warranty of 10-years. [37] This would require the battery to be changed at least once in the life of the vehicle. However, although the performance in laboratory-based tests is typically better than that achieved operationally, research has shown EV batteries could last up to 3 times as long as currently warrantied, thus outlasting the typical life of the vehicle. [38]

34 SMMT, Car Registrations, accessed: [27 April 2021].

35 SMMT, 2019 UK Automotive Sustainability Report, 20th Edition – 2018 Data, 2019.

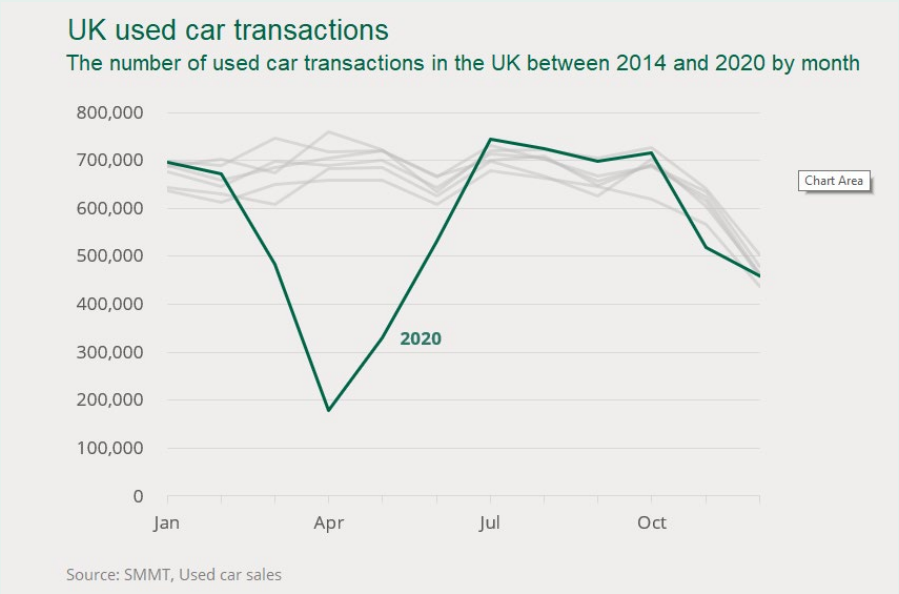
36 EDF, All about electric car batteries, [accessed: 27th April 2021].

37 Office of Energy Efficiency & Renewable Energy, Fact #913: The Most Common Warranty for Plug-In Vehicle Batteries is 8 Years/100,000 Miles, 22 February 2016.

38 Battery University, BU-1003a: Battery Aging in an Electric Vehicle, 22 August 2020.

Box 4: Used car sales during the Covid-19 pandemic

The Covid-19 pandemic impacted the number of used car transactions due to lockdown measures coupled with a turbulent market. There were 6.8 million transactions of used cars in 2020, which was a reduction of 14.9% on the 7.9 million transactions of 2019. The majority of these were petrol or diesel cars. However, 144,245 were 'alternatively fuelled vehicles' which was an increase of 5.2% on 2019. HEVs and BEVs saw increases of 4.7% and 29.7% respectively, whilst PHEVs experienced a slight decline of 5.0%. Conversely, used diesel and petrol car transactions decreased by 15.5% and 15.2% respectively. [39]



As restrictions due to the pandemic have eased, the interest in used cars has increased. This is in in part due to a wariness about the risks of catching Covid-19 on trains or buses, [40] exacerbated by early advice from the Prime Minster to "avoid public transport if at all possible". [41] Additionally, many used car buyers are those adding second or third cars, whilst there were an increasing number of new learner drivers in mid-2020. [42]

39 SMMT, Used car sales report: Q4 2020, 11th Feb 2021.

40 Campbell P, Miller J, Bushey C, Inagaki K, Time to buy a car? Industry hopes for coronavirus silver lining, *Financial Times*, 20 May 2020.

41 UK Government, Prime Minister's statement on coronavirus (COVID-19): 10 May 2020.

42 Campbell P, UK lockdown measures drive used car prices to record growth, *Financial Times*, 2 October 2020.

1.5 Other EVs

This paper primarily focuses on the policies and considerations for electric vehicles for personal use, i.e. electric cars. However, there are other forms of transport designed to operate on the highway that are also being electrified.

Taxis

Taxis and private hire vehicles offer many similarities in terms of vehicle design to personal cars. However, the nature of the operational characteristics is different, with cars typically used less frequently whilst taxis aim for extended periods of use.

A hackney carriage is a taxi that can be hailed in the street or can operate from taxi ranks. A private hire vehicle can only be hired by prior arrangement. Hackney carriage vehicles have defined vehicle characteristics, whilst private hire vehicles can be any 4-door saloon/hatchback or multi-person vehicle. [43]

There were 4,202 electric taxis registered at Q4 2020. It is worth noting that the number of electric taxis varies greatly by location. Most electric taxis (4,047) within the UK had been registered in England. London represents the region with the greatest number of electric taxi registrations, at 2,715. A significant number have also been registered in the East (647) and the South East (442). Scotland is the only other nation that had electric taxis registered with the DfT; most of their 140 vehicles are in Dundee. [44]

Buses

Buses and coaches are responsible for 2.5% of transport greenhouse gas emissions in the UK. [45] However, each fully loaded bus enables up to 75 cars to be removed from the road; [46] decarbonisation of buses therefore offers the potential to significantly reduce emissions from the transport sector.

Despite currently only representing a relatively low proportion of transport emissions, decarbonisation of buses is a key ambition of both UK Government and bus operators alike. Representing bus and coach operators in the UK, the Confederation of Passenger Transport (CPT) aims for all buses to be ultra-low or zero emission by 2025. However, they also note that the range of EVs is not suitable for longer or more rural applications and that other options, such as FCEVs, may offer potential, subject to infrastructure and pricing considerations. [47]

43 Low Carbon Vehicle Partnership, The Low Emission Taxi Guide, 2018.
44 Department for Transport, Ultra-low emissions vehicles statistics, Table VEH0130.
45 Department for Transport, Decarbonising Transport: Setting the Challenge, March 2020.
46 Department for Transport, Bus Back Better, March 2021, p. 72.
47 CPT, Moving Forward Together, September 2019.

Freight

Heavy goods vehicles accounted for approximately 16% of UK domestic transport emissions in 2019.[48] The Road to Zero strategy for decarbonisation of highway vehicles outlines a long-term goal of the current government to develop and deploy zero-emission HGVs, whilst also acknowledging the sector specific difficulties in achieving this. As such, the short-term aim, supported by both the Freight Transport Association and Road Haulage Association, is to reduce HGV greenhouse gas emissions by 15% from 2015 levels by 2025.[49]

Zero-emissions technologies exist across the freight sector. Whilst the technologies are more advanced for smaller vehicles, electrification has also been proven for larger HGVs, with hydrogen also seen as a viable alternative. Further development has been supported by funding the Low Emissions Freight and Logistics Trial (£20 million) [50] and Integrated Delivery Programme (IDP) 14 (£18.1 million specifically for HGVs).[51]

There is also support for shifting to modes of transporting freight other than road. The Mode Shift Revenue Support scheme (MSRS) that provides grant funding for transport of goods using rail or inland waterways has been extended to 2025.[52] Between December 2014 and September 2020, 435 grants were awarded by the MSRS, totalling £115 million.[53] The Government says this removed approximately 900,000 HGV journeys annually.[54]

48 Department for Transport, Decarbonising Transport: Setting the Challenge, March 2020, p 39.
49 Department for Transport, Road to Zero, July 2018, p62.
50 Department for Transport, Decarbonising Transport: Setting the Challenge, March 2020, p 39.
51 Department for Transport, Road to Zero, July 2018, p61.
52 DfT, Mode Shift Revenue Support (MSRS) grant scheme 2020 to 2025, 3 March 2021.
53 DfT, Mode shift revenue support and waterborne freight grant awards since December 2014, 19 November 2020.
54 PQ 174254, [Railways: Waste] 23 March 2021.

2 Government measures to encourage uptake of EVs

Past and current governments have supported measures to encourage uptake of EVs through a mixture of different policies, targets and grants and incentives (see Box 5 for historical overview of pre-2015 policies and select committee reports).

Box 5: Past Government policies and select committee reports

Labour Government

The **Labour Government published its ULEV strategy** in April 2009.[55] It said it would provide £20 million "seed money" to support the development of lead cities and regions in building the necessary charging infrastructure to help increase consumer confidence that would make ultra-low carbon vehicles viable. The Strategy also expected the private sector ultimately to take the lead in infrastructure provision.

The Labour manifesto for the 2010 General Election promised to "ensure there are 100,000 electric vehicle charging points by the end of the next Parliament".[56]

Coalition Government

The 2010 **Coalition Agreement** contained a commitment to "mandate a national recharging network for electric and plug-in hybrid vehicles".[57] In delivering on this mandate, the Government's June 2011 **EV infrastructure strategy** said that its approach was "not to mandate 'a chargepoint on every corner' – this is not necessary to help the market grow and would be uneconomic".[58] Rather, it said the majority of recharging is likely to take place at home and at work, so an extensive public recharging infrastructure would be underutilised and uneconomic. Labour said at the time that this represented a renege on the Coalition's commitment to a 'national charging

55 DfT, *Ultra Low Carbon Vehicles in the UK*, April 2009, p8.
56 Labour Party, *A Future fair for All: the Labour Party Manifesto 2010*, April 2010, p1.8.
57 HMG, *The Coalition: our programme for government*, May 2010, p31.
58 HMG *Making the Connection: The Plug-In Vehicle Infrastructure Strategy*, executive summary.

network'.[59] However, others, including manufacturers of electric vehicles, supported the Government's claim that most charging would be done at home or in the workplace and that the need for public recharging points was therefore limited.[60]

The Government's April **2014 strategy paper on ULEVs** pledged that by the end of 2014 there would be a rapid chargepoint at every motorway service station and that there would be a network of over 500 rapid chargers across the country by March 2015. It also pledged £32m for charging infrastructure in 2015-20.[61]

In 2014, the Office for Zero Emission Vehicles announced that funding of £40 million would be made available for the **Go Ultra Low Cities scheme**. Eight 'cities' were funded to create exemplars for reducing carbon emissions, improving air quality and promoting electric vehicles: Bristol (£7 million), London (£13 million), Milton Keynes (£9 million), Nottinghamshire and Derby (£6 million), with the remaining £5 million split across Dundee, the North East, Oxford, and York.[62]

Conservative Government: Road to Zero strategy

The Conservative Government published its Road to Zero Strategy in 2018. This strategy outlined how it would support the transition to zero emission road transport and reduce emissions from conventional vehicles during the transition. The strategy was "long term in scope and ambition, considering the drivers of change, opportunities and risks out to 2050 and beyond".[63] It set out several measures, including plans to phase out the sale of petrol and diesel vehicles and the rollout charging infrastructure.[64]

Select Committee reports on EV policy, 2010-16

59 Labour Party press notice, "Ministers must come clean over attempt to bury bad news on strike day – Woodcock", 1 July 2011; also reported in: "Coalition scraps national network of charging points for electric cars", *The Independent*, 2 July 2011.

60 See, e.g. comments by Nissan in "Hammond criticised over car charging points", *Financial Times*, 1 July 2011.

61 OZEV, *Investing in ultra low emission vehicles in the UK, 2015 to 2020*, April 2014, p16.

62 DfT & OZEV, £40 million to drive green car revolution across UK cities, 25 Jan 2016.

63 DfT, Reducing emissions from road transport: Road to Zero Strategy, July 2018.

64 DfT, Reducing emissions from road transport: Road to Zero Strategy, July 2018.

The Transport Select Committee published a report on ULEV in September 2012: **Low Carbon Vehicles** [65] with the **Government's response** published in January 2013. [66]

The Environmental Audit Select Committee assessed policies for ULEVs in its September 2016 report: **Sustainability at the DfT**. [67] The **Government response** was published on 11 November 2016. [68]

.

2.1 Transport Decarbonisation Plan

On 14 July 2021, the Government published its transport decarbonisation plan, Decarbonising transport: a Greener, Better Britain, which set out the commitments and actions the UK Government has made, or is taking, to decarbonise the UK's transport sector.[69] The Secretary of State for Transport, Rt Hon. Grant Shapps, emphasised the plan is:

> not about stopping people doing things: it's about doing the same things differently. We will still fly on holiday, but in more efficient aircraft, using sustainable fuel. We will still drive on improved roads, but increasingly in zero emission cars. We will still have new development, but it won't force us into high-carbon lifestyles.[70]

The Government's approach to reducing emissions from road transport is focused encouraging the introduction and uptake of cleaner vehicles, rather than restricting demand. The transport decarbonisation plan, however, outlines that the Government may need to introduce further measures in future to help achieve its carbon reduction targets, which could, depending on its progress, include targeted actions to cut the use of the most polluting cars and/or tackle congestion in towns and cities.[71]

---

65 Transport Committee, *Low Carbon Vehicles*, fourth report of session 2012-13, **HC 239**, 20 September 2012, p3 and para 31.

66 *Government Response to the Committee's Fourth Report of Session 2012–13*, eighth special report of 2012-13, **HC 884**, 21 January 2013.

67 EAC, *Sustainability in the Department for Transport* (Third Report of Session 2016–17), HC 184, 1 September 2016, para 25, p14; the response is available at: *Fourth Special Report of Session 2016–17*, HC 819, 11 November 2016.

68 *Government Response Fourth Special Report of Session 2016–17*, **HC 819**, 11 November 2016.

69 Department for Transport, Decarbonising transport: Greener, Better Britain, July 2021

70 Department for Transport, Decarbonising transport: Greener, Better Britain, July 2021, p4

71 Department for Transport, Decarbonising transport: Greener, Better Britain, July 2021

Alongside the plan, the Government published a delivery plan for the transition to zero emission cars and vans by 2035[72] and a Green Paper on a New Road Vehicle CO2 Emissions Regulatory Framework for the United Kingdom (see section 2.3 below).[73]

Transitioning to zero emission cars and vans: the Government's 2035 Delivery Plan

The delivery plan sets out the Government's policies and investments for achieving the transition to zero emission cars and vans, along with the key milestones entailed in this transition and how it will monitor progress.[74] While the Government has a role to play, especially in the early stages, it expects most of the delivery to be carried out by the private sector. The plan states:

> Government will not deliver this transition alone. We will set direction, remove barriers and support the early market, but it is the private sector that will lead the charge towards mass zero emission vehicle ownership.[75]

The Government's focus on providing early support for the market is reflected in the dates when the current grants and tax incentives may expire (see Box 6). For example, the Government has said grants for home, workplace and on-street charging points will run until at least 2024/25.[76] The plug-in car grant, which helps consumers to purchase zero emission cars, will last until at least 2022/23.[77] Tax incentives, such as the exemption from Vehicle Excise Duty and favourable company car tax rates, will continue until at least March 2025.[78] The balance of measures used to support the transition to zero emission cars and vans shifts towards greater regulation from the mid-2020s.

72 HM Government, Transitioning to zero emission cars and vans: 2035 delivery plan, July 2021
73 DfT, Green Paper on a New Road Vehicle CO2 Emissions Regulatory Framework for the United Kingdom, July 2021
74 HM Government, Transitioning to zero emission cars and vans: 2035 delivery plan, July 2021
75 HM Government, Transitioning to zero emission cars and vans: 2035 delivery plan, July 2021
76 HM Government, Transitioning to zero emission cars and vans: 2035 delivery plan, July 2021
77 HM Government, Transitioning to zero emission cars and vans: 2035 delivery plan, July 2021
78 HM Government, Transitioning to zero emission cars and vans: 2035 delivery plan, July 2021

Box 6: Milestones in the Government's 2035 Delivery Plan

2022

- EV charging infrastructure strategy.
- Further consultation on the CO2 regulatory regime, including the design of a ZEV mandate on manufacturers.
- Launch of the Local EV infrastructure Fund.

2024

- New regulatory regime introduced, including a ZEV mandate on manufacturers.

2025

- Grants for chargepoints in homes, workplaces and on-street parking will continue until at least 2024/25.
- Favourable company car tax rates and exemptions from Vehicle Excise Duty will continue to apply to ZEVs until at least March 2025.

2027

- The Government has a target for its car and van fleet to be 100% zero emission by 2027.

2030

- The Government has a target for at least 2,500 high powered chargepoints to be in place across the Strategic Road Network by 2030.
- Sale of new petrol and diesel cars and vans to end by 2030.
- All new cars and vans to deliver significant zero emission capability from 2030 to 2035.

2035

- All new cars and vans to be 100% zero emission at the tailpipe.

Source: HM Government, Transitioning to zero emission cars and vans: 2035 delivery plan, July 2021

2.2 Ending the sale of new petrol and diesel vehicles by 2030

In February 2020, the Government consulted on proposals to bring forward to the deadline for ending the sale of petrol and diesel cars from 2040 to 2035.[79] The response to this consultation was published on 18 November 2020, alongside a 10 point plan for a green industrial revolution.[80] This confirmed that the Government would pursue a two-phased approach:

- Step 1: will see the phase-out date for the sale of new petrol and diesel cars and vans brought forward to 2030; and
- Step 2: will see all new cars and vans be fully zero emission at the tailpipe from 2035.[81]

The announcement said that hybrids could continue to be sold between 2030 and 2035 "if they have the capability to drive a significant distance with zero emissions [...] and this will be defined through consultation."[82]

The ban does not extend to motorbikes, buses and HGVs. In November 2021, the Government announced that all new heavy goods vehicles would be zero emission by 2040.[83] The Government has also consulted on plans to phase-out the sale of new diesel buses.[84]

The Society of Motor Manufacturers and Traders (SMMT) responded to this announcement by stressing vehicle manufacturer's willingness to "work with government on the detail of this plan, which must be delivered at pace to achieve a rapid transition that benefits all of society, and safeguards UK automotive manufacturing and jobs."[85] In a post on the Green Alliance blog, Inside Track, Caterina Brandmayr, Head of Climate Policy at the Green Alliance, said:

> were very pleased to see that the government has shown genuine ambition by bringing forward the phase out of new conventional petrol and diesel cars and

79 Department for Transport, Consulting on ending the sale of new petrol, diesel and hybrid cars and vans, 20 Feb 2020.
80 HM Government, The Ten-point plan for a Green Industrial Revolution, November 2021
81 DfT, Government takes historic step towards net-zero with end of sale of new petrol and diesel cars by 2030, 18 Nov 2020.
82 DfT, Government takes historic step towards net-zero with end of sale of new petrol and diesel cars by 2030, 18 Nov 2020.
83 Department for Transport, UK confirms pledge for zero-emission HGVs by 2040 and unveils new chargepoint design, 10 November 2021
84 Department for Transport and Office for Zero Emission Vehicles, Ending the sale of new diesel buses, 15 March 2021
85 SMMT, SMMT response to 2030 ICE end of sale date announcement , 17 Nov 2020.

vans to 2030. This shows clear commitment to addressing climate change and puts the UK at the forefront of the global electric vehicle revolution. [86]

EV market forecasts

As charging infrastructure improves and the costs of EVs decrease, market analysts have forecast that more people will purchase EVs over petrol and diesel vehicles.

- Research published by Accenture Strategy in April 2019 forecast EV sales to grow exponentially, and for over half of all UK vehicles sales to be EVs by 2040.[87]
- Research published by Emu Analytics (a UK-based technology) in May 2018 forecast 1 million EVs on the road by the early 2020s.[88]
- Bloomberg's New Energy Finance Electric Vehicle Outlook 2019 has forecasts for global EV markets. This report forecasts global EV sales to rise to 10 million in 2025, 28 million in 2030 and 56million in 2040.[89]

These forecasts were all made prior to the Government's announcement in November 2020 to ban the sale of new petrol and diesel cars and vans by 2030 (see Section 2.4).[90]

Changing dates and targets

When the Road to Zero Strategy was first published its targets were criticised for being unclear and unambitious. Responding to the publication, the CCC said the targets lacked clarity leaving open the possibility of sales of conventional hybrids and very short range plug-in hybrids in 2040 and following years, which is inconsistent with the UK's climate change commitments.[91]

The Commons Library brief, Net Zero in the UK provides an explanation of the introduction of the UK's net zero by 2050 legislative target.

Since the Road to Zero strategy was published, the Government legislated for a net zero by 2050 target. Under this target, the CCC has said the EV market should scale up to 100% of new sales by 2035 at the latest (and ideally by 2030).[92] The older 80% reduction target would have only necessitated for 60% of all new cars and vans sold should be electric by 2030, according to CCC analysis.[93]

Green paper: CO_2 emissions regulatory regime

In July 2021, the DfT published its Green Paper on a New Road Vehicle CO2 Emissions Regulatory Framework for the United Kingdom, which sets out the

86 Caterina Brandmayr, Will the PM's plan put the environment at the heart of the UK's economic recovery?, 19 Nov 2020.
87 Accenture Strategy, Utilities: lead the charge in eMobility, April 2019.
88 Emu Analytics, A Sustainable Future Preparing for Electric Vehicles, May 2018.
89 Bloomberg New Energy Finance, Electric Vehicle Outlook 2019, accessed: [10 Jan 2020].
90 HM Government, The Ten-point plan for a Green Industrial Revolution, November 2021
91 CCC, Government's Road to Zero Strategy falls short, CCC says, 10 July 2018.
92 CCC, Net Zero: The UK's contribution to stopping global warming, May 2019, p.34.
93 CCC, Reducing UK emissions 2018: Progress Report to Parliament, June 2018, p. 161.

regulatory options the Government is considering to help deliver its commitments to phase out the sale of petrol and diesel cars by 2030 and ensure all new cars and vans are zero emission at the tailpipe by 2035.[94] Following UK's exit from the European Union, and the end of the transition period, vehicle emissions for new cars and vans have been covered by a Great Britain-only regime introduced under *The Road Vehicle Emission Performance Standards (Cars and Vans) (Amendment) (EU Exit) Regulations 2019.*[95] These regulations require reductions in CO_2 emissions from new cars (37.5%) and vans (31%) by 2030, which apply across the entire fleet of new cars and vans in Great Britain.[96] The Government acknowledged in the Green Paper that changes to the law are needed to support and enforce the Government's 2030 and 2035 targets.[97] The Green Paper:

- discusses ways to define and measure zero emission capability;
- proposes regulatory options which could be used to achieve the Government's phase out dates; and
- considers how regulations could support other forms of road transport to transition to zero emission vehicles.[98]

In the Green Paper, the Government signalled its preferred option was to introduce a ZEV mandate, alongside separate CO2 emission targets.[99]

Definition of Zero emission capability

The range of EVs on the market includes hybrid models, which emit CO2 from the tailpipe (see Section 1.1). Depending on the extent of their emissions some of these models qualify as ultra-low emission vehicles, but others do not. By 2030, all new cars and vans sold in the UK will need be "required to have a significant zero emissions capability."[100] However, the Government had not defined what it meant by "significant zero emission capability" when the Prime Minister announced the 2030 and 2035 targets in November 2020.[101] The definition of what constitutes "significant zero emission capability" will determine which hybrid models can be sold between 2030 and 2035.

94 DfT, Green Paper on a New Road Vehicle CO2 Emissions Regulatory Framework for the United Kingdom, July 2021

95 The Road Vehicle Emission Performance Standards (Cars and Vans) (Amendment) (EU Exit) Regulations 2019, SI 550

96 DfT, Green Paper on a New Road Vehicle CO2 Emissions Regulatory Framework for the United Kingdom, July 2021

97 DfT, Green Paper on a New Road Vehicle CO2 Emissions Regulatory Framework for the United Kingdom, July 2021

98 DfT, Green Paper on a New Road Vehicle CO2 Emissions Regulatory Framework for the United Kingdom, July 2021

99 DfT, Green Paper on a New Road Vehicle CO2 Emissions Regulatory Framework for the United Kingdom, July 2021

100 HM Government, *The Ten Point Plan for a Green Industrial Revolution: Building back better, supporting green jobs, and accelerating our path to net zero*, November 2020 p.14

101 HM Government, *The Ten Point Plan for a Green Industrial Revolution: Building back better, supporting green jobs, and accelerating our path to net zero*, November 2020 p.14

According to analysis by the International Council on Clean Transportation (ICCT), CO2 emissions from plug-in hybrid models (PHEV) can be 2-4 times higher than their officially certified levels.[102] This means that CO2 emissions from driving a PHEV can be similar to those from petrol or diesel car.[103]The Transport Select Committee, in July, recommended that only the "cleanest possible hybrid technology" should be available until 2035, when all new cars and vans are expected to be zero emission.[104] The Climate Change Committee (CCC) suggested a shift to "genuine zero emission vehicles" is needed to achieve net zero in the most cost effective way.[105] The CCC suggested:

> large increases in the share of PHEVs in the on-road fleet would still result in tail-pipe emissions through to mid-century. To achieve Net Zero, these cars would either need to be scrapped or their emissions offset with expensive GHG removals, resulting in increased costs.[106]

The Government proposes to measure zero emission capability using grammes of CO2 per kilometre (gCO2/km), an established metric in the UK for calculating greenhouse gas emissions from vehicles, potentially in combination with other metrics such as the zero-emission range of a vehicle or the percentage of journey time spent in zero emission.[107]

ZEV Mandate

A Zero Emission Vehicle (ZEV) mandate is a form of regulation that requires vehicle manufacturers to sell a minimum number of zero emission vehicles as a proportion of their overall UK sales. This proportion is progressively increased over time, reaching 100% by the time of the ban on all non-zero tailpipe emission vehicles. [108]

In October 2021, the Government announced its plan to introduce a ZEV mandate from 2024. The mandate will set targets for the "percentage of manufacturers' new car and van sales" that need to be "zero emission each year from 2024."[109] The Government plans to consult on the design of the mandate in 2022.[110]

---

[102] Patrick Plötz et al., Real-World Usage of Plug-in Hybrid Electric Vehicles: Fuel Consumption, Electric Driving, and CO2 Emissions, , September 2020

[103] Climate Change Committee, Briefing: The role of Zero Emissions Vehicles in global road transport pathways, July 2021

[104] House of Commons Transport Committee, Zero emission vehicles, HC 27, July 2021

[105] Climate Change Committee, Briefing: The role of Zero Emissions Vehicles in global road transport pathways, July 2021

[106] Climate Change Committee, Briefing: The role of Zero Emissions Vehicles in global road transport pathways, July 2021

[107]DfT, Green Paper on a New Road Vehicle CO2 Emissions Regulatory Framework for the United Kingdom, July 2021

[108] Melton N, Axsen J, Moawad B,. Which plug-in electric vehicle policies are best? A multi-criteria evaluation framework applied to Canada, Energy Research & Social Science, 64, 2020 https://doi.org/10.1016/j.erss.2019.101411.

[109] HM Government, Net Zero Strategy: Build Back Greener, October 2021, page 152

[110] HM Government, Net Zero Strategy: Build Back Greener, October 2021, page 160

Prior to the Government's announcement, the Climate Change Committee, Transport & Environment (T&E) – a campaign group for clean transport -, Policy Exchange and the Green Alliance all suggested a ZEV mandate was necessary.[111, 112, 113114]

Welcoming the announcement, T&E suggested that a ZEV mandate "provides the certainty industry needs about how many electric vehicles will be on the UK's roads in coming years" by enabling it to plan much better for the shift to zero emission vehicles. T&E has also estimated the mandate will "save around 25% more CO2 by 2035 than using the regulation preferred in the EU, which also encourages sales of hybrid cars." [115]

The British Vehicle Rental and Leasing Association (BVRLA) has called for a series of safeguards to be incorporated into the design of the mandate, including exemptions for specialist vehicles with onboard power requirements and a review mechanism to assess the scheme's impact.[116] In response to the Government's announcement, The Society of Motor Manufacturers and Traders (SMMT) said:

> If constructed appropriately, and proportionately, a ZEV mandate and CO2 backstop can deliver a flexible pathway for manufacturers to deliver the UK's shared decarbonisation ambition by providing affordable choice for consumers. If constructed carelessly, it could amount to double regulation, restricting the already impressive roll-out of zero emission vehicles that we are currently seeing and leaving behind significant parts of society in the journey to net zero..
>
> each type of transport needs to be evaluated individually to find the best regulatory approach to deliver decarbonisation, taking into account the different consumer profiles and available technologies as well as the different usage and market conditions. Where the approach can be harmonised, then of course this should be done, but it cannot be simply assumed that one size will fit all.[117]

[111] The Climate Change Committee, The UK's transition to electric vehicles, December 2020.

[112] Policy Exchange, Route '35 How a California-style ZEV Mandate can deliver the phase out of petrol and diesel cars, July 2020.

[113] Transport & Environment, Phasing out sales of new cars with engines, July 2020.

[114] Green Alliance, Accelerating the electric vehicle revolution: Why the UK needs a ZEV mandate, May 2021.

[115] Transport & Environment, Mandates confirmed in Net Zero Strategy signal the route to zero emission transport and opportunities for green jobs, 19 October 2021

[116] BRVLA, Summary Response on New Road Vehicle CO2 Emissions Regulatory Framework, September 2021

[117] SMMT, A strategy for a greener future, 21 October 2021

Box 7: Industry electrification plans

A number of vehicle manufacturers have announced changes to the types of vehicles that they will be producing.

- Bentley aims to only offer electric vehicles by 2030, even though their first electric vehicle is not expected until 2025;
- Ford plan for every car sold in Europe to be PHEV by 2026 and pure-electric by 2030;
- General Motors plan to sell only electric vehicles by 2035 and be carbon neutral by 2040;
- Groupe PSA, which includes Peugeot, Citroen, DS Automobiles, Opel and Vauxhall, have committed to offering electrified versions of all their vehicles by 2025;
- Honda aims for all European models to be electric by 2022;
- Jaguar plan to be an 'all-electric luxury brand' by 2025, whilst Land Rover are phasing out all-diesel vehicles by 2026, with the Jaguar Land Rover brand aiming for net-zero carbon emissions by 2039;
- Lotus is due to release its final petrol-powered vehicle in 2021, with only electric models to be sold from 2028;
- Peugeot aims to electrify all its vehicles by 2023, using a combination of BEVs (for smaller models) and PHEVs (for larger vehicles);
- Vauxhall plan to have a hybrid or electric variant of all models by 2024;
- Volvo anticipating to sell BEVs and PHEVs only from 2025, en-route to electric only sales from 2030.

However, shortly before his retirement in December 2020, the CEO of Ferrari, Louis Camilleri, claimed that he did not expect Ferrari to ever be 100% electric.

Box 8: Previous EV targets

The Government has announced that it will ban the sale of petrol and diesel vehicles by 2030. Prior to these targets, the Government had made several other related announcements:

- In 2018, the Government set an "ambition" for almost every car and van to be zero emission by 2050 through its Road to Zero Strategy.[118]
- In 2015, the Government set a target to "ensure almost every car and van is a zero-emission vehicle by 2050".[119]
- In July 2017, the Government announced that "it will end the sale of all new conventional petrol and diesel cars and vans by 2040".[120]
- In May 2018, the Prime Minister announced a further target for 2040, that all new cars and vans should be "effectively zero emission."[121]

Alongside the sales targets, the Government has set a goal for the UK to be "a world leader in the development, manufacture and use of zero emission vehicles... [and] in the design, development and manufacture of batteries" in the Automotive Sector Deal.[122]

118 DfT, Reducing emissions from road transport: Road to Zero Strategy, July 2018.
119 DfT, UK government pledges bold ambition for electric cars, 3 December 2015.
120 Department for Environment, Food & Rural Affairs and Department for Transport, Air quality plan for nitrogen dioxide (NO2) in UK (2017), July 2017.
121 The Rt Hon Teresa May MP, PM speech on science and modern Industrial Strategy, 21 May 2018.
122 HM Government, Industrial Strategy Automotive Sector Deal, 2018.

2.3 Development and Manufacture of EV Batteries

To meet UK and global EV targets, the number of automotive batteries produced annually will need to increase. The UK government has pledged to invest £318 million between 2017-2022 on the Faraday Battery Challenge, a key part of the Industrial Strategy Challenge Fund supported by the Department for Business, Energy & Industrial Strategy. [123]

One of the Faraday battery challenge projects, the Faraday Institution was established in September 2017 as the UK's flagship battery research and development programme. With funding of £108 million, it supports research with the potential to deliver commercial solutions for the future battery market within the UK. [124] A consortium of 21 UK universities and over 50 businesses, it designs and manages a portfolio of research projects that are defined by industry.

Another key project within the Faraday Battery Challenge is the UK Battery Industrialisation Centre based in Coventry. This £129 million facility will support companies through the battery manufacture process, so that they can scale up capacity to expand globally. [125]

The Advanced Propulsion Centre outline that the UK is in a "strong position to capitalise on the rapidly growing market for Lithium-ion (Li-ion) batteries in the U.K. However, it also states that there is "not a fully integrated supply chain," with the development of 'giga-factories' suggested as a potential route to integrate large scale battery, electrode and cell manufacturing. [126] The government anticipate gigafactories to have a key role in decarbonising the transport sector, committing a £1 billion investment in a UK-based gigafactory at the 2019 election. [127] However, the Faraday Institution suggests that over the next 20 years, seven such plants are required, [128] with plans for such facilities on the site of the Blyth Power Station in Northumberland, and at Coventry Airport in the West Midlands, with suggestions of a third on a smart campus under development in Somerset.

[123] UKRI, Faraday battery challenge, 28th January 2021, accessed: [27 April 2021].
[124] UKRI, Faraday battery challenge, 28th January 2021, accessed: [27 April 2021].
[125] Faraday Institution, UK electric vehicle and battery production potential to 2040, March 2020.
[126] APC, Automotive Batteries, April 2019, pp. 7.
[127] HoC Debate, 914921, Transport Decarbonisation Plan, Volume 693, 29 April 2021.
[128] The Faraday Institution, UK electric vehicle and battery production potential to 2040, March 2020, 5.

Box 9: Current battery manufacture

The battery constitutes approximately 40-50% of the value of an EV, with other components in the electric powertrain responsible for another 20%.[129] The Faraday Institution estimate the UK will be producing 1.6 million EVs by 2040; this leads to an estimated battery market within the UK alone of £9 billion per year. Further, it is estimated that by that time the UK EV market will require 140 GWh per year of batteries.[130]

Under the 'rules of origin' requirements in the UK-EU Trade and Cooperation Agreement (TCA), at least 40% of the finished EV must originate in the EU or UK by 31 December 2023, rising to 45% by 31 December 2026 and 55% from 1 January 2027.[131]

Most cells are currently produced in Asia, with companies based in China, Japan and South Korea, whilst pack manufacture is typically based close to vehicle production.[132] Indeed, there are currently no major battery producers in the EU or US, whilst over 70% of EV battery production is in China. This has been identified as a major weakness with the UK EV supply chain, whilst also providing an opportunity for the UK to become a global leader in EV battery manufacturing.[133]

There is some capacity to manufacture EV batteries within the UK. For example, a joint venture between Nissan Motor Company, NEC Corporation and NEC Tokin Corporation known as AESC (Automotive Energy Supply Corporation) led to the first battery production facility in Europe being opened in 2010 in Sunderland.[134] This site is currently used by Nissan to produce packs for the LEAF.[135] It has a current capacity for 2GWh annual battery production, with this anticipated to increase to 6 GWh by 2030.

[129] Zhang Y, et al. A SWOT Analysis of the UK EV Battery Supply Chain, *Sustainability*, **12** (23) https://doi.org/10.3390/su12239807.

[130] The Faraday Institution, UK Electric Vehicle and Battery Production Potential to 2040, March 2020.

[131] European Commission, Trade and Cooperation Agreement between the European Union and the European Atomic Energy Community, of the one part, and the United Kingdom of Great Britain and Northern Ireland, of the other part, *Official Journal of the European Union,* **444,** 14-1462 31 December 2012.

[132] Coffin D, Horowitz J, The Supply Chain for Electric Vehicle Batteries, JICE, 2018.

[133] Zhang Y, et al. A SWOT Analysis of the UK EV Battery Supply Chain, *Sustainability*, **12** (23) https://doi.org/10.3390/su12239807.

[134] The Faraday Institution, UK Electric Vehicle and Battery Production Potential to 2040, March 2020.

[135] Coffin D, Horowitz J, The Supply Chain for Electric Vehicle Batteries, JICE, 2018, pp. 21.

However, other European countries, notably Germany, Sweden, Poland and Hungary, are also developing battery manufacture capability. The German government, for example, is providing €1 billion,[136] whilst France is investing €700 million as part of a Franco-German project to establish European battery cell production.[137] Meanwhile, the Polish and Hungarian governments are providing tax relief to try to create new economic growth around battery manufacturing.[138] Plans for new manufacturing centres in continental Europe could see 450 GWh annual battery production capacity by 2030, including a 70 GWh per year LG Chem facility in Wroclaw, a 15 GWh per year Samsung plant in Göd, a 60 GWh per year CATL site in Erfurt, and a 40 GWh per year Northvolt factory in Skellefteå.[139]

[136] Wagner R. Germany has set aside 1 billion euros to support battery cell production: minister, Reuters, 13 November 2018.

[137] Rose M. France's Macron unveils plan to give electric battery industry a jolt, Reuters, 13th February 2019.

[138] The ICCT, European Electric Vehicle Factbook 2019/2020, 2020.

[139] The Faraday Institution, UK Electric Vehicle and Battery Production Potential to 2040, March 2020.

2.4 Charging Infrastructure

Without enough chargepoints EV ownership is not practical. There is currently some uncertainty as to how many EV chargepoints are needed, and where they should be located – at home, on the road network, in streetlamps etc. Government-commissioned research, published in August 2015, commented that public charging was seen to have two overlapping, but different, roles:

> meeting the needs of existing owners and addressing the concerns of potential future EV owners about buying an EV. Existing EV owners rely mostly on home and workplace charging but consistently report a desire for more extensive – and fast – public charging to enable them to undertake longer journeys. The evidence also suggests that additional public charging infrastructure can help to address the range concerns of potential future EV owners and increase EV uptake. Current public charging provision in the UK is comparable, even favourable in certain respects, to provision in countries with more developed EV markets. [140]

The Government has taken several measures to ensure there will be enough chargepoints installed in the coming years (detailed below). In 2019, the then Transport Minister, Michael Ellis, set out the Government's vision for a vehicle charging network as follows:

> Our vision is to have one of the best electric vehicle infrastructure networks in the world. This means current and prospective electric vehicle drivers are able to easily locate and access charging infrastructure that is affordable, reliable and secure. [141]

More recently, the Parliamentary Under-Secretary for the Department for Transport stated that the government "want to make charging as easy as refuelling a petrol or diesel car." [142]

Availability of charging points: "Range anxiety"

Developments in EVs and battery technology mean some vehicles already have the range necessary to meet the needs for most journeys without having to charge. [143] However, range anxiety – fears over the distance EVs can travel between charges – is often cited as one of the key barriers to people opting to buy EVs.

Linked to this is the availability of charging points. In a survey conducted for OVO energy – a small energy supplier – fears over a lack of charging points was cited as the number one reason for not buying an EV. [144] Indeed, public chargepoints are still unevenly distributed across Great Britain meaning

[140] OZEV, Uptake of Ultra Low Emission Vehicles in the UK: A Rapid Evidence Assessment for the Department for Transport, executive summary.
[141] PQ265457 [Electric Vehicles: Charging Points] 20 June 2019.
[142] PQ174019 [Electric Vehicles: Charging Points] 23 March 2021.
[143] "Plugging the gap: What next for Britain's EV public charging network?", *CCC blog*, 19 Jan 2018.
[144] OVO Energy, What's stopping the 'electric vehicle revolution'?, Sept 2017.

access to chargepoints is still something of a "postcode lottery," according to analysis by HSBC in 2016.[145]

Highways England has a commitment of £15m to ensure there are chargepoints (rapid where possible) every 20 miles on 95% of the Strategic Road Network by 2020.[146] This led to 97.4% of the SRN being within 20 miles of a rapid charge point due to the installation of 66 new charge points.[147] Moreover, the number of public chargepoint connectors and locations in the UK is increasing. Data available from the European Alternative Fuels Observatory shows that the number of EV charge points per 100km of road in the United Kingdom has increased from 42 in 2011 to 570 in 2019. Year-on-year, the number of chargepoint connectors is also increasing. Between 2018 and 2019, there was a 50% increase as a further 10,000 connections were added.[148] Most charge points remain to be those with a charge rate of less than or equal to 22 kW.

As of early December 2021, ZapMap reported [149] in Great Britain there were: 17,626 locations with public charging points, 27,967 devices at those locations and 47,358 connections within those devices (of which 11,457 were rapid[150]). Whilst the general number is increasing, there is still a wide variation in the number of charging devices between local authorities. Normalised for population, the greatest number of devices in October 2021 was in the Westminster, with 406 per 100,000 population, whilst Castle Point in Essex had only 3.3 per 100,000 population each and there were none on the Isles of Scilly.[151]

the number of chargepoints will need to increase further to match the rising number of EVs on the road

The number of chargepoints will need to increase further to match the rising number of EVs on the road. The CCC commissioned research, published in January 2018, to assess future demand for Britain's electric vehicle public charging network.[152] This analysis was based on the CCC's 'central scenario' which envisages EVs accounting for 60% of new car and van sales (approximately 30% of the total fleet) by 2030. The report's key findings were:

- The number of rapid chargers located near the major roads network needs to expand from 460 in 2016 to 1,170 by 2030.
- The number of public chargers needed for 'top-up charging' needs to rise from 2,700 in 2016 to over 27,000 by 2030.

[145] "Owners of electric cars are struggling to get plugged in", *The Times*, 24 September 2016.

[146] PQ 267734 [Electric Vehicles: Charging Points] 27 Jun 2019.

[147] Arup, Highways England Rapid Electric Vehicle Charge Points Programme, Creating a sustainable future for the Strategic Road Network in England, accessed: [11th May 2021].

[148] Zap-Map.com, accessed: [25 March 2020].

[149] Zap-Map.com/statistics, accessed: [25 March 2020].

[150] EV chargepoint sites can have multiple charging devices. Additionally, EV charging devices can have multiple connectors. This means one chargepoint can have multiple available charging connections allowing more than one EV to charge at any one time.

[151] DfT, Electric vehicle charging device statistics: October 2021, Table EVCD_01a.

[152] Systra, Cenex and Next Green Car, Plugging the gap: An assessment of future demand for Britain's electric vehicle public charging network, Jan 2018.

- Overall nearly 29,000 charging points are needed across Great Britain by 2030, of which around 85% of these are fast (22 kW) or rapid (43+ kW) chargers. [153]

This analysis does not include the number of private chargepoints on EV owners' homes. The Government envisages the majority of charging to take place at home. [154] Indeed, the Government identifies homecharging as a "key attraction" of owning an EV. [155]

In 2020, further analysis by the SMMT into achieving a fully zero-emission capable UK car market detailed that 1.7 million public chargepoints were required by 2030, rising to 2.8 million by 2035. Achieving this is expected to cost £16.7 billion. [156]

There is no duty on local authorities to provide electric charging points, it is up to them to decide, based on local priorities, whether to do so. In November 2017 the Mayor of London, Sadiq Khan, said that there had been opposition to the installation of EV charge points in some areas after complaints by residents. [157] In January 2018, Government ministers announced that they had written to local councils calling on them to "do more to help reduce carbon emissions and tackle air quality after it emerged just 5 councils in the whole of the UK" had have taken advantage of the On-Street Residential Chargepoint Scheme (see below). [158]

In November 2019, DfT published a "league table" of electric car charging availability in local authorities across the UK. This showed that (as of October 2019):

- There are more charging locations than petrol stations.
- There are over 100 local authorities with fewer than 10 public charging devices per 100,000 population.
- There are 15,000 charging devices across the country, equating to 22,500 places to charge.
- There is at least one rapid charge point at over 95% of all motorway services areas. [159]

Wireless, or inductive, charging could offer an alternative to plugs and chargepoints. Thus, by the implementation in suitable locations, vehicles could be charged during their usual use (i.e. stationary at traffic lights, etc.), minimising downtime whilst concurrently enabling the use of smaller

[153] Systra, Cenex and Next Green Car, Plugging the gap: An assessment of future demand for Britain's electric vehicle public charging network, Jan 2018.
[154] DfT, Reducing emissions from road transport: Road to Zero Strategy, July 2018, p. 15-16.
[155] DfT, Reducing emissions from road transport: Road to Zero Strategy, July 2018, p. 83.
[156] SMMT, Billions invested in electric vehicle range but nearly half of UK buyers still think 2035 too soon to switch, 4 September 2020.
[157] "Electric cars hampered by fear of charge-point clutter", *The Times*, 27 November 2017.
[158] DfT press notice, "Funding for thousands of electric car charge points unused by councils", 12 Jan 2018.
[159] DfT, New 'league table' reveals electric car charging availability across UK as Transport Secretary calls on local authorities to do more, 2 Nov 2019.

batteries and overcoming range anxiety. However, this technology is still relatively commercially immature.

EV charging market study

The Competition and Markets Authority (CMA) launched a market study into the EV charging market in December 2020. This followed on from the Government's announcement that it would be banning the sale of petrol and diesel cars from 2030, and hybrids from 2035 (See section 2.2)

Launching the study, the CMA said:

> If people can see that the service will work for them, they are more likely to make the switch to electric vehicles, which is crucial to achieving the government's long-term ambition for a net zero economy by 2050. [160]

The CMA's market study work will focus on two broad themes:

- how to develop a competitive sector while also attracting private investment to help the sector grow; and
- how to ensure people using electric vehicle chargepoints have confidence that they can get the best out of the service. [161]

Government policy and grants

The Government's current approach to delivering chargepoint infrastructure was set out by Baroness Vere of Norbiton, Parliamentary Under Secretary of State for Transport, in response to a PQ as follows:

> The Government's vision is to have one of the best electric vehicle infrastructure networks in the world but has not set targets for the number of chargepoints. We want to encourage and leverage private sector investment to build and operate a self-sustaining public network supported by the right policy framework. In many cases, the market is better-placed than the Government to identify the right locations for chargepoints and it is essential that viable commercial models are in place to ensure continued maintenance and improvements to the network. [162]

This has been subsequently expanded, with Baroness Vere of Norbiton responding to another PQ, stating:

> We are seeing a natural progression towards the adoption of the Combined Charging System (CCS) standard; we do not believe there is the need for government intervention at this point. [163]

[160] CMA, CMA to examine electric vehicle charging sector, 2 Dec 2020.
[161] CMA, CMA to examine electric vehicle charging sector, 2 Dec 2020.
[162] PQ HL15730 [Electric Vehicles] 29 May 2019.
[163] PQ HL14030 [Electric Vehicles: Charging Points] 9 March 2021.

Electric Vehicle Infrastructure Strategy

The Government's forthcoming Electric Vehicle Infrastructure Strategy is due to set out the Government's vision for the rollout of charging infrastructure. According to the Government's 2035 Delivery Plan, the strategy will outline the Government's:

> approach to addressing the remaining market failures, enabling sufficient infrastructure provision at the pace required, and ensuring that consumers needs are met.[164]

The strategy will also set out the roles and responsibilities of key stakeholders, including the private sector and local authorities. The Transport Select Committee, in July 2021, recommended the strategy should explain how the Government will:

- support all regions and local authorities to deliver sufficient and well-maintained charging infrastructure solutions tailored to local needs, so that no area is left behind; and
- ensure that the roll-out of charging infrastructure keeps pace with the increase in EVs and that the right types of chargers are in the right locations.[165]

The strategy was due to be published in 2021. Trudy Harrison MP, Parliamentary Under Secretary of State at the DfT, referred to the strategy as "forthcoming" on 13 December 2021, in response to a parliamentary question on electric vehicle charging points.[166]

Funding

To achieve the ambitions set out in the Road to Zero strategy, the Government committed to "investing nearly £1.5 billion between April 2015 and March 2021, with grants available for plug-in vehicles and schemes to support chargepoint infrastructure."[167]

To ensure EV owners can enjoy one of the "key attractions" of owning an EV [168] – home charging – the Government has created funding mechanisms to help support the installation of chargepoints at home, as well as in the workplace and on local streets.[169]

- The Electric Vehicle Homecharge Scheme (EVHS) provides grant funding of up to 75% towards the cost of installing electric vehicle chargepoints at domestic properties across the UK.

---

[164] HM Government, Transitioning to zero emission cars and vans: 2035 delivery plan, July 2021

[165] House of Commons Transport Committee, Zero emission vehicles, HC 27, July 2021

[166] PQ 87650 [Electric vehicle charging points] answered on 13 December 2021

[167] DfT, Government launches Road to Zero Strategy to lead the world in zero emission vehicle technology, Jul 2018.

[168] DfT, Reducing emissions from road transport: Road to Zero Strategy, July 2018, p. 83.

[169] For more information on eligibility and guidance on how to apply for these grants, please see the Office for Zero Emission Vehicles (OZEV) website.

- EV chargepoints cannot be installed in all properties. For instance, terraced or apartments properties may not have allocated off-street parking. The On-street Residential Chargepoint Scheme (ORCS) provides grant funding for local authorities towards the cost of installing on-street residential chargepoints for plug-in electric vehicles.
- The Workplace Charging Scheme (WCS) is a voucher-based scheme that provides support towards the up-front costs of the purchase and installation of electric vehicle charge-points, for eligible businesses, charities and public sector organisations.

At Budget 2017, the Government announced its intention to establish the **Charging Infrastructure Investment Fund**.[170] When it was announced the Government said it would be worth £400m, comprising a £200m "cornerstone investment" by government to be matched by the private sector.[171] In September 2019, part of the first £35 million of government-funds was invested in a private company aiming to generate 5,000 rapid charge-points.[172]

In July 2019, the Government announced it would be investing £37 million into twelve innovative projects related to charging infrastructure that aim to improve the experience of owning electric vehicles. Innovations include charging hubs for drivers without access to off-street parking, renovation of car parks, solar powered forecourts, information sharing using high speed internet connections, and the deployment of wireless charging in residential areas.[173] Further, the OZEV and Innovate UK announced a £3.4 million investment for trials for wireless charging of electric taxis in Nottingham.[174]

Furthermore, from July to October 2019 the Government consulted on proposals that would require chargepoint infrastructure for new dwellings in England. This was a commitment outlined in the Road to Zero Strategy.[175] However, as of May 2021, the outcome of this consultation had not been published.

At Budget 2020, the Government increased the size of this fund to a total of £500m.[176] This included a **Rapid Charging Fund** to "help businesses with the cost of connecting fast charge points to the electricity grid". Budget 2020 also committed the Office for Zero Emission Vehicles (OZEV) to carrying out a "comprehensive electric vehicle charging infrastructure review" to ensure that money spent from this fund is well targeted.[177]

---

[170] HM Treasury, Budget 2017, Nov 2017, **HC587**, para 4.15.

[171] DfT, Details of the operation of the Charging Infrastructure Investment Fund, Sept 2019.

[172] NAO, Reducing emissions from cars, 26 February 2021.

[173] DfT, Solar, high speed and wifi charging set to revolutionise electric transport, 9 July 2019.

[174] DfT & BEIS, Electric taxis to go wireless thanks to new charging tech trial, 17 Jan 2020.

[175] DfT, Reducing emissions from road transport: Road to Zero Strategy, July 2018, p. 83.

[176] HM Treasury, Budget 2020v, Mar 2020, **HC121**, para 1.246.

[177] In December 2020, the Office for Low Emission Vehicles (OLEV) rebranded as the Office for Zero Emission Vehicles (OZEV) to align more closely with the government's ambitions to ban the sale of new petrol and diesel vehicles by 2030 and for all new vehicles to be fully zero emission by 2035.

The latest data on uptake of the different grant schemes for charging infrastructure is at 1 October 2021 when:[178]

- Just under 190,000 chargers had been installed under the EVHS at a total cost of £88.1 million
- Around 19,000 sockets had been installed under the WCS with a grant value of £7.9 million
- 1,603 charging devices had been installed as part of the ORCS

The National Audit Office (NAO) reported the funding invested by OZEV in different schemes to encourage the uptake of zero-emission vehicles up to March 2020, including:

- £97.2 million on grants to support the installation of more than 133,000 home charge points;
- £8.5 million on 690 on-street residential charge points;
- £3.7 million on 8,500 workplace charge points; and
- £9.5 million on the Go Ultra Low consumer awareness campaign. [179]

It is worth noting that the uptake from local authorities for on-street residential charge-points has been lower than anticipated, with only 68% of the total budget used.

In the November 2020 Spending Review, the Government announced that it would "invest £1.9 billion in charging infrastructure and consumer incentives", including:

- £950 million to support the rollout of rapid electric vehicle (EV) charging hubs at every service station on England's motorways and major A-roads;
- £582 million for the Plug-in Car, Van, Taxi, and Motorcycle Grant until 2022-23;
- £275 million to extend support for charge point installation at homes, workplaces and on-street locations; and
- £90 million to fund local EV charging infrastructure to support the roll out of larger on-street charging schemes and rapid hubs in England. [180]

Accessibility and convenience for charging: Legislation

Accessibility and convenience of vehicle charging and refuelling has frequently been raised by consumers as a key concern in choosing to purchase and use an EV.

Following consultation, the Government plans to amend the Building Regulations to require new homes and buildings, including properties undergoing major renovations, to have electric vehicle charging points installed from 2022. The Government consulted on these proposals between

[178] DfT, Electric vehicle charging device grant scheme statistics: October 2021

[179] NAO, Reducing emissions from cars, 26 February 2021.

[180] HM Treasury, Spending Review 2020, **CP330,** Nov 2020.

July and October 2019, [181] but only published its official response on 22 November 2021,[182] alongside the Prime Minister's announcement of an electric vehicle revolution.[183] Under the new measures:

- Every new home, including those created from a change of use, with associated parking space, will have an electric vehicle charge point;
- Residential buildings undergoing major renovation, with over 10 parking spaces within the site boundary after the renovation is complete, will be required to have at least one electric vehicle charge point for each dwelling with associated parking within the site boundary and cable routes in all spaces without charge points;
- All new non-residential buildings, with more than 10 parking spaces within the site boundary of the building, will be required to have a minimum of one charge point and in addition to this, cable routes for one in five of the total number of spaces; and
- All non-residential buildings, undergoing a major renovation, which will have more than 10 parking spaces within the site boundary after the renovation is complete, will be required to have a minimum of one charge point and in addition to this, cable routes for one in five spaces.[184]

The Government said it plans to lay regulations to implement these proposals in Parliament by the end of 2021.[185]

The Alternative Fuel Infrastructure Regulations 2017 ensure the way in which alternative fuels (including electricity) are supplied to vehicles is consistent across the UK. These define that:

- All publicly accessible standard or rapid chargepoints deployed or renewed since 17 November 2017 must at least offer a 'Type 2' recharging connector. This means the majority of charging stations across the UK and Europe have connectors to fit most cars;
- Geographic location data of publicly accessible recharging points must be made freely available to anyone who wishes to access it;
- Charge points must be available to anyone for 'ad-hoc access', i.e. without contract or ongoing financial commitments to the electricity supplier; and
- Charge points incorporate intelligent metering systems, that enables customers to record real-time information regarding their energy use.

See the accompanying guidelines to the regulations for further details.

[181] DfT, Electric Vehicle Charging in Residential and Non-Residential Buildings, July 2019.

[182] The Department for Transport, Consultation Response: EV Charge points in Residential and Non-residential Buildings, November 2021

[183] Prime Minister's Office, 10 Downing Street, PM to announce electric vehicle revolution, 22 November 2021

[184] The Department for Transport, Consultation Response: EV Charge points in Residential and Non-residential Buildings, November 2021

[185] The Department for Transport, Consultation Response: EV Charge points in Residential and Non-residential Buildings, November 2021

In 2018, the Government legislated to help deliver the aim in the Conservative Manifesto for almost every car and van to be a zero emission vehicle by 2050.[186] Taken together, the powers in the Automated and Electric Vehicles Act 2018 allow Government to regulate, if necessary, in the coming years to:

- improve the consumer experience of electric vehicle charging infrastructure;
- ensure provision at key strategic locations like Motorway Service Areas; and
- require that charge points have 'smart' capability.

The measures were broadly welcomed. However, some groups noted that this was all contingent on the details to be included in the Secondary Legislation. Until then, they argued, the Act resembles no more than a wish list.[187]

One of the main groups affected by the measures in the Act will be petrol retailers. Responding to the main provisions, the Petrol Retailers Association (PRA) said they considered the powers granted to be unnecessary. The PRA felt the best course of action would be to allow the market to dictate the uptake of EV charging infrastructure. Brian Madderson, Chairman of the PRA commented:

> The best course of action the government can take to ensure the UK has a well-developed EV charge point infrastructure, especially away from urban centres and major roads, would be to create a grant scheme for forecourt retailers - similar to the Homecharge and Workplace schemes which are already in place.[188]

Whilst the technical requirements of charging infrastructure are considered in the Alternative Fuels Infrastructure Regulations 2017,[189] one of the key concerns frequently raised by consumers considering purchasing and using EVs is the accessibility and convenience of vehicle charging. Whilst the Government have not made any regulations to date, a public consultation was launched in February 2021 that seeks views on plans to introduce legislation improving consumer experience.

[186] HL Deb c18, Automated and Electric Vehicles Bill, 20 Feb 2018.

[187] New Legislation To Revolutionize EV Charging In The UK, *Clean Technica*, 1 Aug 2018.

[188] "PRA continues to lobby for investment into charging infrastructure", 1 Feb 2018.

[189] UK Government, The Alternative Fuels Infrastructure Regulations 2017, No. 897.

2.5 Vehicle grants

EVs are currently more expensive than equivalent petrol or diesel engine vehicles and are not projected to reach price parity until the mid-2020s.[190] The CCC assessment of the Road to Zero Strategy said that "Financial support for the higher upfront costs of electric vehicles (EVs) will be required beyond 2020." The CCC suggest "minor amendments to vehicle excise duty (VED) and company car tax (CCT) can support continued improvement in fleet efficiency."[191] See Box 10 for more on VED.

Box 10: Fiscal incentives and Vehicle Excise Duty

Fiscal incentives have been shown to drive behaviour changes. Car registration taxes in the UK since 2001 increased the number of diesel vehicles on the road. In 2001, just 13.8 per cent of new car registrations were diesel but this had risen to 39.3 per cent by 2018.

Vehicle Excise Duty (VED) is an annual tax levied for most types of vehicles to be used (or parked) on public roads. Certain vehicles are exempt from paying VED.

Since 2003, VED rates have been linked to emissions, meaning lower emission cars pay lower rates. From 2003 to 2017 cars that emitted less than 100 g/km of carbon dioxide were exempt from VED. Rates for other vehicles were on a sliding scale, with the most polluting paying the highest levels of tax.

Major reforms to VED were introduced in the 2015 budget (taking effect from 1 April 2017). Cars that emit less than 50 g/km of carbon dioxide continue to be exempt, but all other vehicles now pay the same standard rate (the rate after the first year of registration). Cars with a list price greater than £40,000 also pay a supplement of £310 for the first five years in which a standard rate is paid. At Budget 2020, zero emission vehicles were exempted from paying the "expensive car supplement".[192]

In practice the strict 50 g/km limit means that only fully-electric vehicles qualify for the exemption, and the flat rate for other

[190] Bloomberg New Energy Finance, Electric Vehicle Outlook: 2018, May 2018.
[191] Letter to Chris Grayling and Greg Clark – assessment of the Road to Zero Strategy, 11 October 2018.
[192] HM Treasury, Budget 2020, Mar 2020, para 1.245.

vehicles has removed the incentive to purchase alternative ultra-low emissions vehicles, such as plug-in hybrid EVs or hydrogen fuel cell cars. Further, as electric vehicles are more expensive than equivalent conventional models, they are disproportionately affected by the VED supplement.

The Library brief, Vehicle Excise Duty (VED) provides an extensive background and overview of the evolution of VED.

To make electric vehicle ownership more affordable, the Government offers plug-in grants. The amount of grant available depends on which category the vehicle is in. Details of the different categories of vehicle eligible for the grant and the amount they are eligible for are set out in Table 2. You can find more information on the vehicles eligible for the grant on the OZEV plug-in car grants page. From 2010 to the end of 2021, the Government had invested £1.5billion through the scheme, which has been used to support the purchase of almost half a million vehicles.[193]

The Government expects to deliver a "managed exit from the grant in due course" and provide support through other measures

In the Road to Zero Strategy, the Government said it expected to deliver a "managed exit from the grant in due course" to provide support through other measures.[194] The grant was due to expire in April 2020. At Budget 2020, the Government said it would extend the grant until 2022-23 and announced a further £0.5 billion to continue the grant scheme (£403 million for electric cars and £129.5 million for vans, taxis and motorcycles). An extra £620million was also announced in the Spending Review in October 2021 to support the transition to electric vehicles, which included additional funding for the plug-in grant as well as for charging infrastructure.[195]

[193] HC Deb 15 December 2021 cWS483

[194] DfT, Reducing emissions from road transport: Road to Zero Strategy, July 2018, p. 52.

[195] HMT, Autumn Budget and Spending Review: A stronger economy for the British people, HC822, October 2021, para 4.66

Table 2 Low-emission vehicles eligible for a plug-in grant

Category	CO2 emissions	Zero emission range	Grant	Maximum amount
Car (up to £32,000)	No CO_2	112 km (70 miles)	35%	Up to £1,500
Motorcycles (up to £10,00)	No CO_2	50 km (31 miles)	35%	Up to £500
Mopeds (up to £10,00)	No CO_2	30 km (19 miles)	35%	Up to £150
Vans (up to 2,500 kg)	Less than 50 g/km	96 km (60 miles)	35%	Up to £2,500
Vans (2,500 kg - 3,500 kg)	Less than 50 g/km	96 km (60 miles)	35%	Up to £5,000
Trucks (up to 12,000 kg)	Less than 50% of equivalent Euro VI	96 km (60 miles)	20%	Up to £16,000 (first 250, 10 per customer) Up to £5,000
Taxis	Less than 50 g/km	112 km (70 miles)	20%	Up to £7,500

Source: DfT, Low-emission vehicles eligible for a plug-in grant

Changes to plug-in grants scheme since 2018

Previously, there were three categories of cars eligible for a grant. In October 2018, the DfT announced changes to grant levels, removing the grants for hybrid EVs (formerly category 2 and 3 EVs).[196] At the same time, the maximum grant available for EV cars (formerly a category 1 EV) was lowered from £4,500 to £3,500 to reflect a shift "to focus on zero tail pipe emission vehicles."[197]

The automotive industry called for the Government to rethink these changes. Further, the Commons Business, Energy and industrial Strategy (BEIS) Committee criticised the Government's decision in its inquiry into EVs, stating the decision had been "made too soon and too suddenly" and "risked undermining the UK's burgeoning EV market."[198] However, the Government is confident that the changes to the grants available are working.[199]

At Budget 2020, the grants for EVs were lowered further to £3,000. At the same time the Government exempted zero-emission vehicles from the

[196] OZEV, Changes to the Plug-in Car Grant, 2 Nov 2018.
[197] PQ 252016 [Electric Vehicles: Grants] 17 May 2019.
[198] Business, Energy and Industrial Strategy Committee, Electric vehicles: driving the transition, Fourteenth Report of Session 2017–19, **HC 383,** para 33-36.
[199] PQ 252016 [Electric Vehicles: Grants] 17 May 2019.

"expensive car supplement" and set a cap on the maximum list price of vehicles eligible for the grant at £50,000.[200]

The maximum grant was again lowered in March 2021 to £2,500 with the maximum list price of vehicles eligible also lowered, to £35,000. Transport Minister Rachel Maclean explained that this was due to "refocusing our vehicle grants on the more affordable zero emission vehicles – where most consumers will be looking and where taxpayers' money will make more of a difference".[201] This has subsequently led to a number of manufacturers reducing their EV pricing to ensure they maintain eligibility for the grant, including Hyundai, Nissan, BMW, Peugeot, Kia, Vauxhall, MG, Tesla and Citroen.[202] The grant for zero emission cars was lowered again in December 2021 to £1,500, with a maximum list price of £32,000.[203]

Scottish Government Initiatives

Transport Scotland, part of the Scottish Government, are funding the Electric Vehicle Loan. This is an interest free loan of up to £28,000, with a repayment term of up to six years, to cover the cost of purchasing new electric vehicles. It also provides up to £10,0000 towards a new electric motorcycle or scooter.[204]

Transport Scotland also funds the Used Electric Vehicle Loan, which provides up to £20,000 or £5,000 for used electric cars or electric motorcycles or mopeds respectively with a 5-year repayment term.[205]

Additionally, the Energy Saving Trust is providing grants of up to £250 to assist the installation of home charge points, with a further £100 available for those in the most remote locations.[206]

Who benefits from vehicle grants and how accessible is EV ownership?

There are questions over who benefits from plug-in grants. Research commissioned by the Government and published in August 2015 found that the sorts of people who tend to buy ULEVs are "middle-aged, male, well-educated, affluent, and live in urban areas with households containing two or more cars and with the ability to charge at home" and that this socio-

[200] HM Treasury, Budget 2020, Mar 2020, para 1.245.

[201] DfT & OZEV, Plug-in car, van and truck grant to be targeted at more affordable models to allow more people to make the switch, 18 March 2021.

[202] Hyde E, Hyundai confirms price reductions after UK government cuts plug-in grant, *Driving Electric*, 8 April 2021.

[203] Government funding targeted at more affordable zero-emission vehicles, DfT, 15 December 2021

[204] Energy Saving Trust, Electric Vehicle Loan, accessed: [28 April 2021].

[205] Energy Saving Trust, Used Electric Vehicle Loan, accessed: [28 April 2021].

[206] Energy Saving Trust, Domestic charge point funding, accessed: [28 April 2021].

demographic profile of ULEV owners in the UK was "not likely to change significantly". [207]

Furthermore, the influence on the decision to purchase an electric vehicle due to government support is unclear. In 2016, the DfT found that the plug-in grant influenced the decision of 93% of those who had purchased an EV. [208] However in a separate survey also undertaken in 2016, only 67% of driving licence holders were aware of the grant whilst only 31% thought it influenced opinions regarding the purchase of EVs. [209] These questions have not been repeated in surveys since 2016.

The BEIS Committee concluded that "EVs should not be the sole preserve of the relatively affluent." The Committee recommend that the Government introduce more creative support mechanisms to ensure that all motorists are able to benefit from EVs. [210]

Developing the second-hand market for EVs will be important to increase accessibility. There are no specific grants for purchasing second hand EVs; the grants for charging infrastructure however are available regardless of whether the chargepoint is for a new or used vehicle. Combined with reductions to vehicle taxes and fuel costs, these would make EVs more affordable to consumers who typically do not purchase new vehicles. Additionally, a buoyant second-hand market for EVs could support the growth of the wider national EV fleet by bolstering the economic case for new EVs. [211] ENGIE – an energy company – told the BEIS Committee the Government should

> ...review the secondary market for electric vehicles and puts pressure on manufacturers and retailers to rethink how this market might be stimulated. Government should also consider how this market could be stimulated from the consumer (buyer and seller) viewpoint, highlighting the value for money used electric vehicles represent against alternatives in the market. Introducing arrangements for warranty guarantees and support for battery refit costs could be considered as part of this. [212]

Further, Bright Blue, an independent think tank, recommended that the government should 'establish a used vehicle plug-in grant of at least £2,000 to support low income people into BEV ownership'. This would only apply to vehicles currently meeting the criteria for the existing Plug-in car grant for

---

[207] Brook Lyndhurst for DfT, *Uptake of Ultra Low Emission Vehicles in the UK: A Rapid Evidence Assessment for the Department for Transport*, August 2015, executive summary.

[208] Bacon J, Scott A, Growing the UK ULEV market: Understanding people's motivations and barriers, *IEA Workshop on Transport, Energy Efficiency & Behaviour*, Paris, 10-11 May 2016.

[209] DfT, Public attitudes towards electric vehicles: 2016 (revised), 8 September 2016.

[210] Business, Energy and Industrial Strategy Committee, Electric vehicles: driving the transition, Fourteenth Report of Session 2017–19, **HC 383,** para 40-42.

[211] Business, Energy and Industrial Strategy Committee, Electric vehicles: driving the transition, Fourteenth Report of Session 2017–19, **HC 383,** para 42.

[212] ENGIE [ELV0053] written evidence to BEIS Committee Inquiry: Electric vehicles: driving the transition, April 2017.

new EVs, and it is suggested that it is only applied to vehicles costing less than £30,000. [213]

2.6 Brexit and EVs

The UK left the EU on 31 December 2020. [214] On the 24 December 2020, the UK-EU Trade and Cooperation Agreement (TCA) was announced. As part of the TCA, the UK must ensure that domestic laws are aligned with the obligations agreed to within the TCA.

To meet zero tariff requirements, goods must meet 'rules of origin' requirements. This relates to the amount of content within the good that originates from outside the EU or UK. As defined above, the amount of the finished EV that must originate in the UK or EU is defined in the TCA and increases with time, starting with 40% by 31 December 2023. [215]

Potential barriers to trade created as a result of leaving the EU may have subsequent impact on the cost of materials and/or components and/or EVs as market access is lower than that that the single market offered. [216] However, within the TCA, Annex TBT-1 outlines requirements related to motor vehicles, which aim to prevent the arising of any barriers to bilateral trade and thus maintain a competitive market, whilst also maintaining compatible approval routes and regulatory application between the UK and EU. [217]

2.7 Electric public transport

Whilst electrification of personal transport offers one method of reducing emissions from transport, increasing public transport usage offers another opportunity. Detailed above, the average emissions from public transport, are lower than those from cars. However, the rise of EVs could lead to public transport emitting more CO_2 than cars. As such, electrification of other transport sectors is also important to meet national decarbonisation targets.

---

[213] Hall P, Shorthouse R, Driving uptake: Maturing the market for battery electric vehicles, *Bright Blue*, 2021.

[214] House of Commons Library, End of Brexit transition: Transport, 18 December 2020.

[215] European Commission, Trade and Cooperation Agreement between the European Union and the European Atomic Energy Community, of the one part, and the United Kingdom of Great Britain and Northern Ireland, of the other part, *Official Journal of the European Union,* **444,** 14-1462 31 December 2012.

[216] European Commission, EU-UK Trade and Cooperation Agreement: protecting European interests, ensuring fair competition, and continued cooperation in areas of mutual interest, 24 December 2020.

[217] European Commission, EU-UK Trade and Cooperation Agreement: protecting European interests, ensuring fair competition, and continued cooperation in areas of mutual interest, 24 December 2020.

Taxis

The low-emission vehicle plug-in grant also applies to taxis. There are two models included, the LEVC TX and the Dynamo Taxi, both of which are produced in Coventry. The scheme offers up to £7,500 towards the purchase of a new zero-emission capable taxi. Meanwhile, private hire vehicles are eligible for a plug-in grant provided they meet the scheme requirements.[218]

One method for towns and cities to reduce local emissions is by introducing clean air zones (CAZs), with ultra-low emission vehicles exempt from any charges. In a similar vein, Transport for London stipulated that, from January 2018, all newly licenced taxis must be zero-emission capable.

The Ultra Low Emission Taxi Infrastructure Scheme has provided funding for local authorities to install chargepoints. Detailed further in Table 3 below, the first round of funding, awarded in February 2017 was worth £14 million, whilst the second, awarded in January 2019, provided £6.9 million.

Buses

The Government-funded Low Emission Bus Scheme and Ultra-Low Emission Bus Schemes have delivered 742 low emission vehicles, of which 263 are zero emission.[219] Additionally, launched in 2020, the All-Electric Bus Town or City competition will provide up to £50 million each to Coventry and Oxford to run all-electric bus services, subject to successful business cases.[220] Further, on 30 March 2021, the Zero Emission Bus Regional Areas scheme was launched by the DfT.[221] This will provide up to £120 million for local transport authorities to support the introduction of up to 500 zero-emission buses and associated infrastructure.

The Government published its strategy for bus travel in the UK in March 2021.[222] This includes consideration of both electric batteries or hydrogen fuel cells as propulsion sources, with measures announced therein to further the implementation of zero emission buses. The Government, for example, has also consulted on plans to phase-out the sale of new diesel buses.[223]

Table 3 Funding Awards for Ultra Low Emission Taxi Infrastructure Scheme

Bidder	Funding (£'000)	Chargepoints		Funding Round
		Rapid	Fast	
Bath and North East Somerset Council	412.5	10	0	2

[218] DfT, Low-emission vehicles eligible for a plug in grant.
[219] DfT, Decarbonising Transport: Setting the Challenge, March 2020, p 24.
[220] DfT, Coventry and Oxford set to be UK's first all-electric bus cities, 6 January 2021.
[221] DfT, Multi-million pound scheme for zero-emission buses across England launched, 30 March 2021.
[222] DfT, Bus Back Better, March 2021.
[223] Department for Transport and Office for Zero Emission Vehicles, Ending the sale of new diesel buses, 15 March 2021

Brighton and Hove City Council	468	12	0	2
Bristol City Council	336.3	8	0	2
Bromsgrove District Council	300	10	0	2
Cornwall Council	94	1	4	2
Kent County Council	180	8	0	2
Lancaster City Council	630	24	0	2
Leicester City Council	390	10	18	2
Luton Borough Council	90	4	0	2
Newcastle Borough Council and Stafford Borough Council	787.5	30	0	2
North East and North of Tyne Combined Authorities	504.8	10	0	2
Northampton Borough Council	45	2	0	2
Peterborough City Council	90	0	4	2
Rochford Council and Basildon Council	187.5	5	0	2
Sheffield City Council	487.5	0	20	2
Southend Borough Council	9	4	0	2
Transport for Greater Manchester	1,800	30	0	2
Birmingham City Council	2,929	100	97	1
Coventry City Council	1,201	39	39	1
Nottingham City Council	702	20	12	1
Dundee City Council	515.5	11	2	1
West Yorkshire Combined Authority (WYCA)	1,980	66	22	1
Oxford City Council	373	16	3	1
Cambridge City Council	426	18	3	1
City of Wolverhampton Council	478	20	4	1
Transport for London (TfL)	5,244	92	0	1
Slough Borough Council	157.5	7	0	1

Source: OZEV, Ultra Low Emission Taxi Infrastructure Scheme: winners with funding amounts. 12 August 2020.

Rail

Electric propulsion has been used for public transport in the UK for over 100 years. Rail based transport currently uses a mixture of electric and diesel traction, however the government have targeted the removal of all diesel-only powered rolling stock by 2040. Currently, power for electric trains is

provided by fixed infrastructure; whilst this is suitable for the directionally constrained operation, it is expensive to implement, and is not suited even to all rail alignments. As such, the Rail Industry Decarbonisation Taskforce outlined how batteries, hydrogen, and electrification will all be required to achieve net zero targets.[224] Ongoing academic and industrial research aims to bring these technologies to fruition.

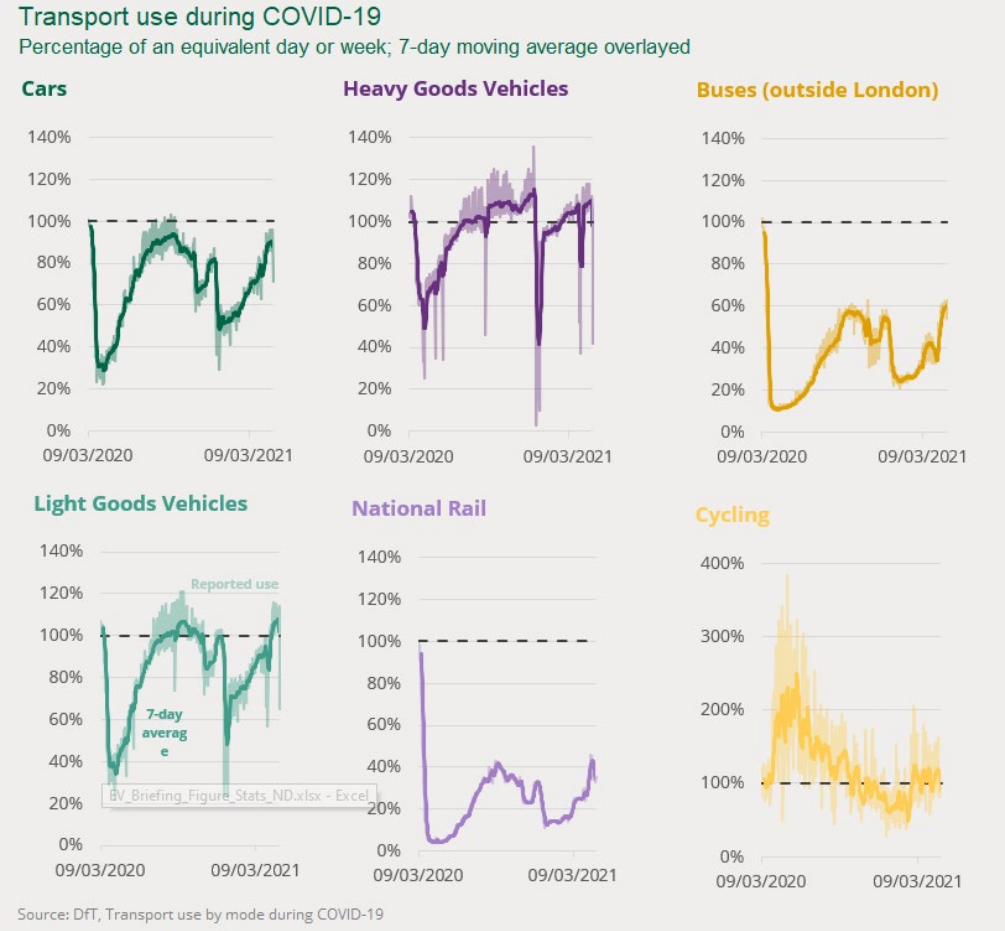
2.8 The impact of Covid-19 on transport usage

Transport use during the pandemic

On 23rd March 2020, the UK began a full nationwide lockdown to reduce the spread of SARS-CoV-2 coronavirus (Covid-19). This entailed the public being instructed to stay at home as much as possible, with limited exceptions such as for exercise or a limited number of occupations. Thus, transport use across all sectors was reduced, with public transport being particularly affected. National rail use for example fell to as low as 4 % of February levels in April/May 2020, whilst bus use was as low as 10% of January levels.[225]

As the initial restrictions were eased, road transport use increased to levels similar to those seen in the first week of February 2020. National restrictions in Wales, from 23 October to 9 November, and in England, from 5 November to 2 December led to further dips in transport use. Transport use recovered slightly following the easing of the second lockdowns, although this was also aligned with the introduction of tougher tiered restrictions. On the 19 December, Tier 4 restrictions were announced, instructing the public to stay at home; these came into force for London and South East England on the 21 December, before additional areas were added on the 26 December. England entered a third nationwide lockdown on the 6 January, with restrictions being eased from the 8 March.[226] The impact of the changes to the measures used to curb the spread of Covid-19 against transport can be seen in the figure below, with peaks and troughs aligned with easing and tightening of restrictions respectively.

[224] Rail Industry Decarbonisation Taskforce, Final report to the Minster for Rail, July 2019.
[225] DfT, Transport use by mode: Great Britain, since 1 March 2020, accessed: [18 April 2021].
[226] Institute for Government, Timeline of UK coronavirus lockdowns, March 2020 to March 2021, accessed: [18 April 2021].



The restrictions brought in as a result of the Covid-19 pandemic in 2020 had a significant impact on total greenhouse gas emissions. For example, provisional estimates of the UK carbon dioxide emissions are 10.7% lower in 2020 than in 2019, at 326.1 million tonnes, whilst total greenhouse gas emissions decreased by 8.9%, to 414.1 million tonnes carbon dioxide equivalent.[227]

A significant portion of this reduction in emissions was due to the transport sector, with carbon dioxide emissions due to transport falling by 19.6%. It is also worth noting that emissions in the energy supply sector, which includes electric trains, decreased by 11.9% whilst those in the residential sector rose slightly, by 1.8% due to people staying at home.[228] It is perhaps worth noting that the majority of private EV charging is undertaken at home, with this representing 87% of charging in 2018, with 8% at work, 4% in destinations such as public car parks, and 1% in en-route environments equivalent to 'petrol stations.'[229]

[227] BEIS, 2020 UK greenhouse gas emissions, provisional figures, 25 March 2021.
[228] BEIS, 2020 UK greenhouse gas emissions, provisional figures, 25 March 2021.
[229] Ofgem, Implications of the transition to Electric Vehicles, 23 July 2018.

Post Pandemic

The nature of future travel is currently unclear. This is not just a case of how people will travel, but also a question of, for example, whether a daily commute to the office will be required at all. Whilst it is not possible to predict what the long-term level of transport use will be, some of the considerations are discussed here.

With people advised to stay at home, many businesses transitioned to remote working. As such, many people now have home working arrangements that can be used moving forward. This is impacted by personal opinion, not only in whether travelling to a workplace is desired, but also what mode of transport is used. For example, bus and rail travel did not recover to pre-pandemic levels during the summer of 2020, when most restrictions had been lifted, whilst car use peaked at 103% of that seen before restrictions came into place. Additionally, active travel significantly increased, with the number of cyclists increasing two – three-fold during spring/summer, with a return to pre-pandemic levels in late September.[230]

In part, this is due to a perception of increased safety when using personal vehicles. Public transport increases the number of contacts with other people, not just in terms of face-to-face contacts but also considering the surfaces touched. However, there was no trace of Covid-19 particles in surface or air samples at three TfL stations, on a Northern line train, or on a TfL no. 21 bus.[231] Further, ongoing research (Transport Risk Assessment for COVID Knowledge) aims to quantify the risks to passengers and transport staff, to inform policy decisions regarding control strategies, whilst others are investigating mitigation methods, such as antimicrobial surfaces.

[230] DfT, Transport use by mode: Great Britain, since 1 March 2020, accessed: [18 April 2021].

[231] Green D, Zhou J, Desouza, C, Transport for London SARS-CoV-2 RNA Sampling Study, 12th February 2021.

3 International comparisons

For some years sales of ULEVs were lower than expected in other parts of the world, with the falling price of gas cited as the main disincentive for switching from petrol and diesel vehicles to electric.

For example, in the US only about 400,000 electric cars were sold by the final year of President Obama's term: less than half of his goal of getting one million plug-in electric vehicles on the roads by 2015.[232]

In October 2017 the International Energy Agency (IEA) reported that the number of electric vehicles on the road increased to 2 million in 2016. China was by far the largest electric car market, accounting for more than 40% of the electric cars sold in the world and more than double the amount sold in the US. Norway achieved the most successful deployment of EVs in terms of market share, followed by the Netherlands and Sweden.[233]

3.1 Targets and bans around the world

The BEIS Committee described the UK's earlier targets to: (i) phase out diesel and petrol vehicles and (ii) increase EV ownership as unambitious.[234] The Committee compared these targets to those in other countries around the world and found the UK risked falling behind which may result in the UK having "to accept vehicle emission standards set by more ambitious international regulations."[235] Since these comments, the Government has increased its ambition to end the sale of petrol and diesel vehicles to 2030. The BEIS Committee referred to the CCC's analysis of bans on petrol and diesel vehicles in other countries that showed the even within the UK separate countries had more ambitious targets. However, bringing the target for banning petrol and diesel vehicle sales forward is more in line with other nations targets, as detailed in Table 4.

[232] "Electric vehicle sales fall far short of Obama goal", *Reuters*, 20 Jan 2016.

[233] IEA, *Global EV Outlook 2017: Two million and counting*, Oct 2017, p5.

[234] Business, Energy and Industrial Strategy Committee, Electric vehicles: driving the transition, Fourteenth Report of Session 2017–19, **HC 383,** para 22.

[235] Business, Energy and Industrial Strategy Committee, Electric vehicles: driving the transition, Fourteenth Report of Session 2017–19, **HC 383,** para 24.

Table 4 Government commitments to the end of sales of conventional vehicles	
Country	**Timing**
Norway,	2025
Slovenia, Austria, Israel, Ireland, Iceland, Denmark, Sweden, UK, Germany, the Netherlands, Hainan Province*	2030
Scotland	2032
California, Cape Verde, Colombia****	2035
France, Canada, Sri Lanka, Taiwan, Singapore, Spain, Portugal	2040
Costa Rica	2050
* **China has not specified a national timescale to ban the sales of petrol and diesel cars.** ** The US has not imposed a nationwide ban on the sales of petrol or diesel cars. *** For vehicles in public transport fleets	

Source: Reproduced from CCC, Update on the global transition to electric vehicles through 2019, June 2020, Table 1

COP 26 declaration on accelerating the transition to 100% zero emission cars and vans

At the COP 26 conference in Glasgow, a host of governments (from advanced and emerging markets, city states and regions) manufacturers, fleet owners and other institutions committed to rapidly accelerate "the transition to zero emission vehicles to achieve the goals of the Paris Agreement."[236] In particular, the signatories committed to work towards ensuring "all sales of new cars and vans being zero emission globally by 2040, and by no later than 2035 in leading markets," is in line with the UK's current plans to transition to zero emission cars and vans (see Section 2.2). Three of the top four car markets in the world – China, United States and Japan – did not sign the declaration, although several US states and cities are among the signatories.[237]

3.2 Norway

Norway has been by far the most successful country in achieving EV market penetration. The IEAs 2017 EV outlook highlighted that Norway had the fourth largest volume of sales of EVs in the world in 2017 (behind only much larger

[236] BEIS and DfT, COP26 declaration on accelerating the transition to 100% zero emission cars and vans, 10 November 2021

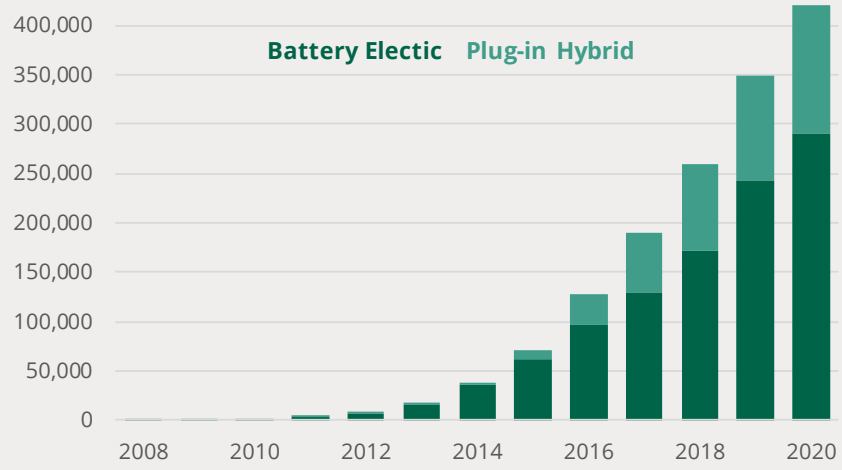
[237] BEIS and DfT, COP26 declaration on accelerating the transition to 100% zero emission cars and vans, 10 November 2021

countries: the US, China and France) and the largest market share.[238] The UK by comparison was ranked fourth worldwide by market share, and seventh by volume in 2017. Projections by National Grid suggest that the UK stock of EVs could reach between 2.7 and 10.6 million by 2030, and could rise as high as 36 million by 2040.[239]

In Norway, the number of electric passenger cars has increased substantially over the last decade: in 2008 the number of cars which were Battery Electric Vehicles (BEV) was around 1,200. In 2019 there were just under 290,000. This is around a 23,200% increase. Including Plug-in Hybrid Vehicles (PHEV), the number of cars which were powered (at least in part) by electricity numbered 420,000 in 2020. According to the Norwegian equivalent of the ONS, there were 2.8 million registered cars in 2019 with electrics cars accounting for around 9% of the total stock.

Electric cars in Norway

The number of electronic cars by 'Battery Electric' and 'Plug-in Hybrid'



Source: European Alternative Fuels Observatory

The most important incentives driving Norway's success have been long-term and financial. In addition, the Norwegian Government has committed to the end of sales of conventional vehicles in 2025.

Incentives for EV car ownership in Norway have been in place for many years. They have been designed to make EV ownership less expensive than conventional petrol or diesel vehicles. The support Norway provides includes:

- **Exemptions from the vehicle registration tax for Battery EVs (1990-).** Norway levies a registration or import tax on cars, which can reach EUR 10,000 or more depending on the car model's CO_2 emissions. BEVs are exempted from the tax. Plug-in hybrid electric cars also pay a lower tax.

[238] As quoted in Business, Energy and Industrial Strategy Committee, Electric vehicles: driving the transition, *Fourteenth Report of Session 2017–19*, **HC 383,** p.7.

[239] National Grid, Future Energy Scenarios, Jul 2018.

The exemption is expected to run out at the end of 2020, but due to the low-emissions, BEVs will still pay a lower amount.

- **Low annual road tax (1996-).** Battery EVs pay a lower annual road tax. Instead of NOK 3,060 or (~EUR 367), owners of BEVs pay NOK 435 (~ EUR 52). The annual tax increased to half the rate of fossil fuelled cars in 2018 and will increase to the full rate in 2020.
- **Free municipal parking (1999-).** Local governments can decide on incentives such as access to bus lanes and free municipal parking.
- **Reduced company car tax (2000-).** Norway provides a 40% reduction on the company car tax.
- **Exemption from 25% VAT on purchase (2001-).** Battery EVs are exempted from paying the value added tax of 25% on the purchase or leasing rate. The VAT exemption for electric cars is prolonged until the end of 2022. [240]
- **No charges on ferries or toll roads (2009-).** Battery EVs enjoy exemptions from road tolls and ferries. This can be a substantial saving amounting to several thousand Euros a year on certain roads. Complete exemption for toll roads will likely be phased out over the coming years. [241]

Altogether, this approach makes the total cost of ownership less expensive for Plug-In Electric Vehicles than for a comparative petrol or diesel vehicle. [242]

3.3 Iceland

EVs made up a similar market share of new passenger vehicle registrations in Iceland and the UK in 2012. In September 2020, this was over 20% in Iceland, [243] whilst this was 7.8% in the UK in Q3 2020. [244]

As in the UK, the Icelandic government is to ban the sale of new petrol and diesel vehicles from 2030. [245] Furthermore, the City of Reykjavik intends to halve the number of fossil fuel pumps by 2030, with a view to almost removing them completely by 2040. [246]

There are also financial incentives to lower the cost of EVs, including:

[240] Det Kongelige Finansdepartement (Norwegian Ministry of Finance), Notification of zero rate VAT for electric vehicles, 10 November 2020.

[241] Dr. Karoline Steinbacher, Minke Goes, Korinna Jörling, Incentives for Electric Vehicles in Norway: Fact Sheet, September 2018

[242] Dr. Karoline Steinbacher, Minke Goes, Korinna Jörling, Incentives for Electric Vehicles in Norway: Fact Sheet, September 2018

[243] Wappelhorst S, Tietge U, Iceland is one of the world's most interesting electric vehicle markets, *icct*, 9 July 2018.

[244] DfT, Vehicle Licensing Statistics: July to September 2020, 9 December 2020.

[245] Ministry for the Environment and Natural Resources, Iceland's Climate Action Plan for 2018-2030 – Summary, September 2018

[246] City of Reykjavik, Reykjavik and Climate, [accessed: 28 April 2021].

- Exemption from import excise duty for vehicles that produce less than 80 grams CO_2 per kilometre;
- VAT exemption (24% in Iceland) for EVs; and
- Local initiatives, such as free charging coupled with 90 minutes free parking at certain chargepoints across Reykjavik. [247]

It is also worth noting that Iceland has amongst the lowest electricity [248] and highest fossil fuel prices [249] in Europe, enhancing the financial benefits of EVs compared to conventionally fuelled vehicles. Finally, approximately 80% of the 103,000 km^2 land area of Iceland is uninhabited, [250] with nearly two thirds of the 350,700 residents living in the capital region of Reykjavik. [251] This limits the requirement for charging infrastructure to the population centres as well as main roads.

3.4 The Netherlands

The EV market in the Netherlands has grown rapidly since 2016. The Dutch government have implemented several policies with a target of all new passenger vehicles being zero-emission from 2030:

- Grants of EUR 4,000 and EUR 2,000 for leasing new and second hand BEVs respectively, providing the vehicle has a minimum range of 120 km and a list price of between EUR 12,000 and EUR 45,000; [252] and
- Targeted installation of chargepoints in areas of public demand. [253]

Further, the Netherlands currently has the greatest density of chargepoints in Europe at 2,940 chargers per million population, with over 66,000 public charging points including 350 stations capable of fast charging. [254] Combined, these policies led to it currently having the third highest percentage of new passenger BEV registrations in Europe. [255]

[247] City of Reykjavik, Charging stations for electric cars in parking garages, 17 May 2018.
[248] European Commission, Electricity prices for household consumers – biannual data (from 2007 onwards), NRG_PC_204, 12 April 2021.
[249] GlobalPetrolPrices, https://www.globalpetrolprices.com/gasoline_prices/, accessed: [28 April 2021].
[250] Visit Iceland, https://visiticeland.com/article/iceland-geography, accessed: [28 April 2021].
[251] Wappelhorst S, Tietge U, Iceland is one of the world's most interesting electric vehicle markets, *ICCT*, 9 July 2018.
[252] Rijksoverheid, Subsidy scheme for electric vehicles final; applications from 1 July, 4 June 2020.
[253] Interreg Europe, Amsterdam's demand-driven charging infrastructure, accessed: [28 April 2021].
[254] ANWB, https://www.anwb.nl/auto/elektrisch-rijden/waar-staan-de-oplaadpunten accessed: [27 April 2021].
[255] Hall D, Lutsey N, Charging infrastructure in cities: Metrics for evaluating future needs, *ICCT*, August 2020.

3.5 California

California has higher BEV uptake as a proportion than the United States as a whole, accounting for 6.1% of new vehicle registrations in 2020 [256] and estimated to rise to 8% by 2025. [257] This is primarily due to the Zero Emission Vehicle (ZEV) Mandate.

The flagship regulatory policy of California, the ZEV mandate was introduced in 1990. [258] It stipulates manufacturers to produce a certain number of ZEVs annually based on the total number of vehicles they produce. This is measured using credits equating to a percentage of total vehicle sales; whilst 4.5% in 2018, the credit requirement is estimated to rise to 22% by 2025. [259]

The requirements of the ZEV mandate are allocated depending on the total number of vehicles produced. Small-volume producers manufacturing less than 4,500 vehicles per year are exempt; mid-volume manufacturers, producing between 4,500 and 20,000 vehicles per year, can meet credit requirements with PHEVs as well as ZEVs; whilst large-volume manufacturers who fabricate more than 20,000 vehicles per year must meet their credit requirements using ZEVs alone. [260]

Longer range vehicles earn more credits, with up to four credits (equivalent to 350 mile zero-emission range) available per ZEV, whilst ZEVs with less than a 50 mile range are excluded. Manufacturers who do not meet their credit requirements are penalised USD 5,000 per credit deficit. Credits can be banked for use in future years or sold to other companies. [261]

Other policies include:

- **High Occupancy Vehicle (HOV) lane access**: typically for drivers with passengers, BEV drivers earning less than USD 150,000 per year are eligible to purchase permits to drive in the HOV lane for USD 22. HOV access permits are limited to the first four years of EV ownership, although second hand BEV owners with a maximum household income of USD 65,760 can also purchase one. [262]
- **California Clean Vehicle Rebate Program**: a policy providing rebates of up to USD 7,000 for purchasing or leasing BEVs, based on household and

[256] Hall P, Shorthouse R, Driving uptake: Maturing the market for battery electric vehicles, 2021.
[257] CARB, Zero-Emission Vehicle Program: About, accessed: [28 April 2021].
[258] Collantes G, Sperling D, The origin of California's zero emission vehicle mandate, *Transportation Research Part A: Policy and Practice*, **42** (10), 1302-1313, 2008.
[259] Hall P, Shorthouse R, Driving uptake: Maturing the market for battery electric vehicles, 2021.
[260] CARB, The California Low-Emission Vehicle Regulations for Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles, including all or portions of Sections 1900, 1956.8, 1960.1, 1960.5, 1961, 1961.1, 1961.2, 1961.3, 1962, 1962.1, 1962.2, 1962.3, 1965, 1976, 1978, 2062, and 2101, title 13, California Code of Regulations, as of October 1, 2019 (last amended October 1, 2019).
[261] CARB, Zero-Emission Vehicle Program: About, accessed: [28 April 2021].
[262] CARB, High-Occupancy Vehicle (HOV) Lane Access, accessed: [28 April 2021].

individual income, with limits of USD 150,000 for single individuals, USD 204,000 for heads-of-households, and USD 300,000 for joint filers. [263]

- **Federal tax credit:** the US Government also provides tax credit of up to USD 7,500 for the purchase of BEVs, based on the energy capacity of the vehicle and number of that vehicle sold in the US. [264]

[263] State of California DMV, Decals for Using Carpool and HOV Lanes, accessed: [28 April 2021].
[264] IRS, Plug-In Electric Drive Vehicle Credit (IRC 30D), accessed: [28 April 2021].

4 Additional electricity demand

Increasing the number of electric vehicles will reduce petrol and diesel demand but add to electricity demand. This could place pressure on the UK's electricity grid network, operated by National Grid (NG).

4.1 Concern over electricity demand and Government targets

National Grid has been legally separated into two companies: a transmission network owner (TO) which owns the transmission network (the high voltage power infrastructure in England and Wales) and the Electricity System Operator (ESO) which manages the transmission network to ensure supply and demand are balanced at all times. More information can be found on these roles on the NG website and in the Library briefing paper on Electricity Grids.

Following the Government's initial announcement in July 2017 of plans to ban sales of "all new conventional petrol and diesel cars and vans" from 2040 (since brought forward to 2030),[265] concerns were raised by the media that this policy would require significantly more capacity in the power sector and present challenges for balancing the electricity grid. For example, a Telegraph article suggested 10 new power stations would be required.[266]

Many of the estimates, and media reports, on future energy demand for electric vehicles were based on National Grid ESO's (NG) 2017 report on Future Energy Scenarios (FES).[267] The annual Future Energy Scenarios report provides what NG describes as "a range of credible futures" in the energy sector but are not intended to be a forecast of future electricity demand. The reports cover demand from different sectors, such as electric vehicles (as part of transport) but also industrial, commercial, and residential demand for both electricity and gas.

Due to the publicity around the issue, NG published a myth-buster explaining the range of scenarios and stating that they believed their figures had been misused. NG said that some media projections had used a more "extreme" scenario which they believed was unlikely to occur. Under the scenario reported in the media, NG's analysis estimated that by 2046 peak demand as a result of EVs charging would be 30 GW. By contrast, the most likely scenario in NG's analysis saw peak demand from electric vehicles alone being around 5 GW, about an 8% increase on today's peak demand value. This is because NG believe the switch to EVs will not be as extreme, and consumer behaviour

[265] Defra, *Plan for roadside NO2 concentrations published*, Jul 2017.

[266] *Diesel and petrol car ban: Plan for 2040 unravels as 10 new power stations needed to cope with electric revolution*, *The Daily Telegraph*, 27 July 2017.

[267] National Grid, *Future Energy Scenarios 2017*, July 2017.

will change to avoid charging at peak times, therefore resulting in a less significant increase to peak demand.[268]

The House of Commons Business, Energy and Industrial Strategy Committee's October 2018 report on Electric Vehicles said that media concern about additional electricity demand were "overblown" and concluded that the electric vehicle transition is "unlikely to present a risk to the security of national electricity supply" and that any increased electricity demand would "necessitate investment in new generation.[269] The Committee also made recommendations on managing higher demand including that charge points should have smart capacity, and that the Government should look further into the opportunity of vehicle to grid technology.

4.2 2020 Future energy scenarios

More recently, the 2020 FES report provided four scenarios; Steady Progression, System Transformation, Consumer Transformation, and Leading the Way. The scenarios differ in the speed of decarbonisation and level of decentralisation.[270]

On electric vehicles adding to electricity demand, the 2020 FES found that total energy demand for road transport fell across all scenarios:

> "Electrification is key to decarbonising transport, with at least 60% of all road transport being electrified in our net zero scenarios. Even in the slowest decarbonising scenario there will be no new cars sold with an internal combustion engine after 2040. This results in all cars on the road being ultra-low emission by 2050 at the latest, and up to 75% reduction in total energy demand for road transport, as EVs are more efficient than petrol and diesel vehicles."[271]

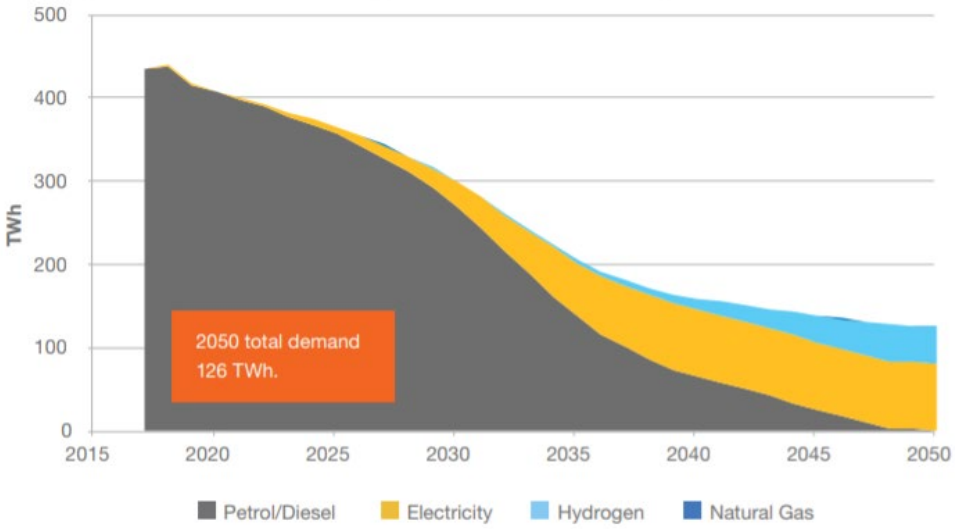
Despite a fall in overall energy demand, the shift to electric vehicles clearly results in increases in electricity demand in all scenarios. This is shown in the figure below from the 2020 FES which shows the change in energy demand in the Leading the Way Scenario:

[268] National Grid, *Our Energy Insights, Electric vehicle announcement and what the papers say*, August 2017.

[269] BEIS committee, *Electric vehicles: driving the transition*, Fourteenth report of session 2017-19, Oct 2018.

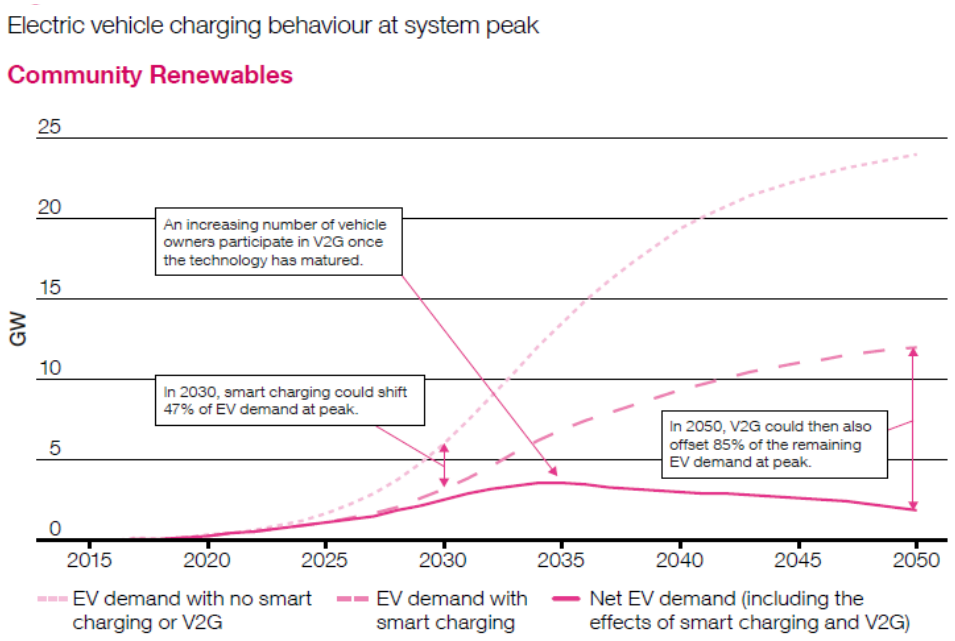
[270] National Grid, *Future Energy Scenarios*, July 2020.

[271] National Grid, *Future Energy Scenarios*, July 2020, page 42.



Source: National Grid, Future Energy Scenarios 2020

However, there are possible changes that could address this increase in demand. For example, if electric vehicle owners used "smart charging" or "vehicle to grid" (both discussed in more detail in section 4.4 below) the scale of the demand reduced significantly. This is shown in the graph below for one scenario from the 2019 FES report:



Source: National Grid, Future Energy Scenarios 2019

4.3 Balancing the Grid

For more information on grids and V2G, see the Library briefing paper on Electricity grids

NG ESO's role is to ensure that supply and demand always match on the electricity grid to prevent power cuts or increases in network frequency that could damage electrical equipment. This process is known as 'balancing'.

NG can use several tools to ensure the grid remains balanced, including storage such as batteries, reducing demand through demand side response, and calling on reserve generation through the capacity market (see Box 11 below).

Balancing is an increasing challenge for NG due to the changing electricity mix. Previously, generation was predominantly provided by large, centralised power stations. However, electricity in the UK is now supplied by a greater variety of generators, including fossil fuels, nuclear power, and large and small-scale renewables.

In July 2017, the Government and Ofgem, the energy regulator, published a report on upgrading the energy system: it outlined plans for transforming the grid with smart and flexible technologies.[272] In the December 2020 Energy White Paper, the Government announced "In partnership with Ofgem, we will publish a new Smart Systems Plan in spring 2021, which will include a new framework for monitoring flexibility across electricity markets."[273]

Box 11: The Capacity Market

The UK operates a Capacity Market to ensure there is sufficient power as the UK replaces older power stations with alternatives such as intermittent renewables. The Capacity Market is not just for EVs but covers all demands for electricity with the purpose of securing capacity to cover any potential shortfall in demand during peak periods.

The market works as an auction where capacity providers bid to offer a service to help balance the grid. The providers range between large power stations and smaller storage units that can supply power (which would not normally be generated due to high costs or inefficiencies), to industries that can reduce demand if there is a lack of supply in a process known as demand side response.[274] The market is paid for by consumers through their energy bills.

Ahead of the auction, the Secretary of State for Business, Energy and Industrial Strategy (BEIS) must decide the amount of capacity

[272] HMG/Ofgem, *Upgrading our energy system. Smart systems and flexibility plan*, July 2017.
[273] HMG, *Energy White Paper: Powering our Net Zero Future*, December 2020, page 73.
[274] Engie, *Understanding the Capacity Market*, 2016.

needed, following a recommendation from National Grid – which administers the capacity market auctions. This is a set amount of power that is required to keep the grid secure.

In September 2021, Ofgem, the independent regulator for Great Britain, published a report on enabling the transition to electric vehicles.[275] The report sets out Ofgem's role in facilitating the transition to EVs which includes ensuring that energy networks are prepared to meet future demands:

> Ofgem will make sure that energy sector regulation supports the rapid transition to EVs, and does so at least cost to consumers. We are already accelerating investment in the energy networks to ensure they are prepared for the increased demand for electricity, and recently set out our proposals to reduce the costs of installing new chargepoints.[276]

The report identifies some of the challenges in meeting the predicted increase in demand for electricity from EVs, highlighting the fact that a flexible grid and smart charging may be necessary to avoid excessive demand at peak times:

> The rapid uptake of electric vehicles (EVs) will be the most significant change in our energy sector over the next 10 years. We may well see 14 million EVs on UK roads by 2030. By 2050, electric cars and vans are expected to need 65–100TWh of electricity annually: an increase of 20–30% over today's levels. This will require significant investment in the energy system. But, with the right planning and regulatory measures, EVs can be an asset to the energy system, as well as to the environment. All consumers should be able to benefit from the transition, and our job is to help make this a reality.
>
> When and how EV users charge their vehicles will be critical to the impact on the overall system. If EVs smart charge and provide flexibility to the grid, they will be a huge asset to the energy system. Without smart charging, by 2050 EVs could introduce significant additional peak demand. Models suggest that EVs could see peak demand rise by more than ~20GW (which is 35% of current peak demand). With smart charging, the impact to peak demand would be minimised (models suggest smart charging alone could avoid 5-15GW of demand). Smart charging should benefit EV owners, who can charge their vehicles when electricity prices are low – for example overnight, or at times of high renewable electricity supply.[277]

4.4 Smart charging and Vehicle to Grid (V2G)

As shown above, wider proliferation of electric vehicles will add demand to the grid. However, smart charging can reduce charging at peak times, and

[275] Ofgem, Electric vehicles: Ofgem's priorities for a green fair future, 4 September 2021
[276] Ofgem, Electric vehicles: Ofgem's priorities for a green fair future, 4 September 2021
[277] Ofgem, Electric vehicles: Ofgem's priorities for a green fair future, 4 September 2021

the batteries in the vehicles could become an asset to NG, as they have the potential to be used for grid balancing.

'Smart' use of the electricity system involves using power at times when demand (and therefore prices) is low. Consumers can benefit from cheaper power, and operators benefit from an easier to balance system and avoiding all cars being charged simultaneously, such as at the end of rush hour. Smart meters, which are currently being rolled out, [278] have the potential to allow more detailed information on consumption to be sent to energy suppliers, and more reactive use of power for customers. For example, 'Time-of-use' tariffs are already available from some energy suppliers, [279] rewarding customers with smart meters who choose to sign up for using power at times of low demand. Integrating smart devices, such as smart charging electric cars, into this mechanism could mean that additional demand for electric cars is significantly reduced. [280]

An extension of smart charging, the concept of 'Vehicle to Grid' (V2G), is that when supply is low and demand high, EVs connected to the grid to charge can instead release power back into the grid. Owners of the vehicles can then be paid for this balancing service in a similar way to electricity storage unit operators. In theory, if a vehicle is needed to be charged for a certain time the owner could register that time and this would override the use of the car as a power source. Some suppliers have been developing V2G offers for their customers, though availability is currently limited. [281]

In July 2017, the Government launched a V2G competition with £20 million of funding to develop the technology. [282] In February 2018 the Government announced a further £30 million investment in V2G. [283]

Ofgem's enabling the transition to electric vehicles report also highlights the important role vehicle batteries might play in creating a more flexible energy grid:

> Vehicle batteries can play an active role in the energy system of the future. Vehicle-to-X (V2X) technologies allow to export electricity during periods of high demand and/or low electricity supply. V2X's potential goes beyond reducing peak demand, as it is capable of providing a temporary source of energy supply. By 2050, the capacity of V2X could significantly exceed 30GW. By providing power to the grid or buildings, they have the potential to provide further benefits to the energy system, and to EV owners providing that flexibility, as they earn money or reduce their own energy consumption from exporting power. If appropriately integrated, these technologies can lower the overall generation capacity required on the system and also avoid additional

[278] House of Commons Library, *Energy Smart Meters*, 7 October 2019.

[279] Andrew Ward, *Households offered first time-of-use energy tariff*, Financial Times, 2 January 2017.

[280] More information is available in the Library briefing paper on Electricity Grids (Section 5 – smart grids).

[281] For example, Octopus energy's Powerloop product.

[282] DfT press notice, *Innovative vehicle to grid technology to receive £20 million*, 8 July 2017.

[283] DfT, *£30 million investment in revolutionary V2G technologies*, Feb 2018.

network costs. V2X technologies are at an early stage, but Ofgem is keen to support the development of this market.[284]

In July 2021, BEIS launched a call for evidence on the role of vehicle-to-X energy technologies in a net zero energy system which closed on 12 October 2021. The call for evidence highlighted that although "V2X technologies have been technically feasible for over a decade, the technology remains expensive and is not yet commercially viable for all use cases."[285] Views and evidence were sought on:

- the role of V2X technologies in the energy system;
- the barriers that might be preventing this; and
- the role of government.

The outcome of the public feedback has yet to be published, however the call for evidence document can be viewed here.[286]

[284] Ofgem, Electric vehicles: Ofgem's priorities for a green fair future, 4 September 2021

[285] BEIS, Role of vehicle-to-X energy technologies in a net zero energy system: call for evidence, 20 July 2021

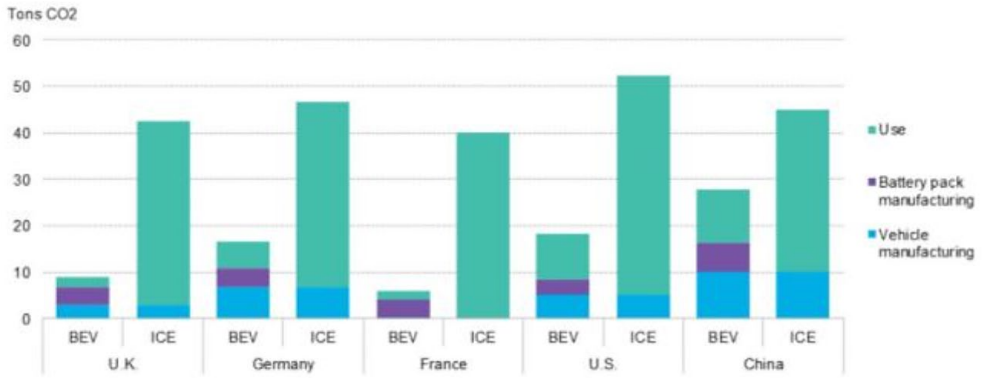
[286] BEIS, Role of vehicle-to-X energy technologies in a net zero energy system: call for evidence, 20 July 2021

5 Environmental Impact: EVs and conventional vehicles

The total emissions from an EV are known as the "lifecycle emissions" and combine the emissions from manufacturing the vehicle, powering it through its life, and decommissioning. Several studies have been conducted on EV lifecycle emissions with varying conclusions based on the methodology and assumptions used by the researchers. These include factors such as the size of the car, driving and efficiency assumptions, and where the car is manufactured and charged.[287]

Bloomberg New Energy Finance, a research provider, published in February 2021 research on the Lifecycle Emissions of Electric Vehicles. This presented estimates for usage and lifecycle emissions of battery electric vehicles (BEVs) and internal combustion (petrol or diesel) engines (ICEs) to 2040 for five countries (the U.S., China, the U.K., Germany and France). The results are summarised in the graph below:

Total CO2 emissions of medium segment ICE and BEV produced in 2020 and used for 250,000 km



Source: Bloomberg New Energy Finance, *The Lifecycle Emissions of Electric Vehicles*, February 2021

The research concluded:

> "The lifecycle CO2 emissions of medium segment battery electric cars produced in 2020 and used for 250,000 km would be between 18% and 87% lower than those of equivalent internal combustion engine vehicles in the five countries included in this report. The breakeven

[287] An overview of various studies is available from the environmental analysis website Carbon Brief, Factcheck: How electric vehicles help to tackle climate change, 13 May 2019.

> point is far sooner in France at 25,000 km, compared to 153,000 km in China. By 2030, all countries will see this emissions breakeven point occur far earlier." [288]

5.1 Vehicle manufacturing emissions

As the Bloomberg research shows, EVs often have higher manufacturing emissions than ICEs. The International Council on Clean Transportation (ICCT – an independent non-profit organisation providing analysis to regulators) published analysis in 2019 on EVs that echoed this; concluding that the energy intensive production of batteries meant that EVs have higher manufacturing emissions than conventional cars. The research went on to conclude there was potential for manufacturing emissions to either increase or decrease in future:

> Electric vehicle manufacturing requires more energy and produces more emissions than manufacturing a conventional car because of the electric vehicles' batteries. Lithium-ion battery production requires extracting and refining rare earth metals, and is energy intensive because of the high heat and sterile conditions involved. Most lithium-ion batteries in electric vehicles in Europe in 2016 were produced in Japan and South Korea, where approximately 25%–40% of electricity generation is from coal.
>
> [...]
>
> although the manufacturing of batteries does not outweigh the life-cycle environmental benefits of electric vehicles, these emissions are nonetheless substantial. These emissions could become more substantial as longer-range electric vehicles with larger batteries become more common. However, a number of trends point to reduced emissions from battery production in the future, further increasing the greenhouse gas savings offered by electric cars. [289]

Batteries for EVs can require rare elements such as lithium and cobalt, which has raised environmental and ethical issues in countries where these elements are mined [290] as well as questions over sustainable supply as demand for batteries grows. [291] For further information see POSTnote, Access to Critical Materials, September 2019.

[288] Bloomberg New Energy Finance, *The Lifecycle Emissions of Electric Vehicles*, February 2021.

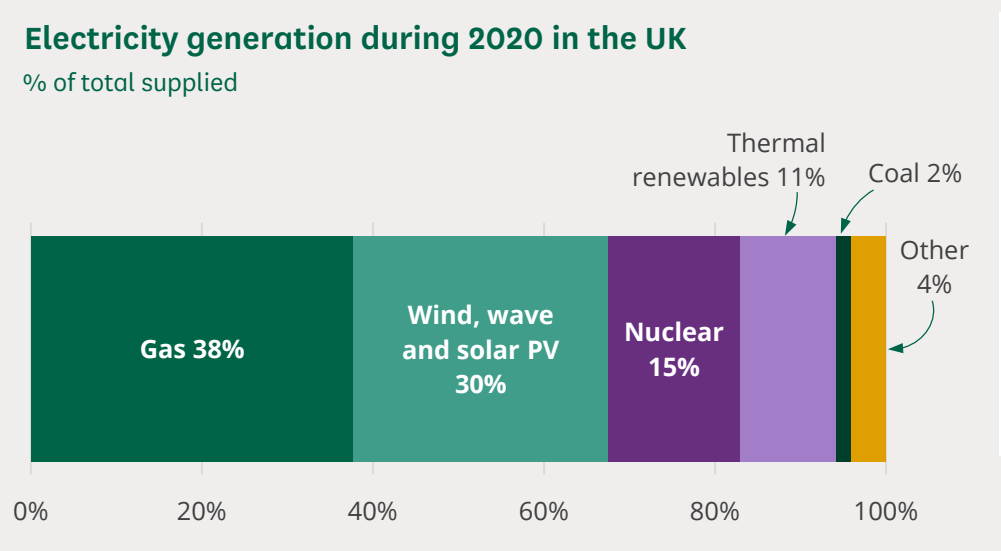
[289] The International Council on Clean Transportation, *Effects of battery manufacturing on electric vehicle life-cycle greenhouse gas emissions*, February 2019.

[290] E.g. "Children as young as seven mining cobalt used in smartphones, says Amnesty", *The Guardian,* 19 January 2016 and "Electric car growth sparks environmental concerns", *Financial Times,* 7 July 2017.

[291] Could a lithium shortage derail electric car boom?, *USA Today*, 26 Aug 2016.

5.2 Vehicle use emissions

As the Bloomberg research above shows, it is through use that over time means EVs can have lower emissions than ICEs. The emissions from the use of an EV can only be as clean as the charging power supply. In the UK, power is supplied from a variety of sources as shown in the graph below:



Source: Energy Trends, BEIS (Table 5.1)

In addition to greenhouse gases, EVs also produce fewer air pollutants than conventional vehicles when driven, as they have no exhaust emissions. More information on air pollution is available in HC Library briefing paper CBP 8179.

The power sector was previously (until 2016) the largest sector of UK emissions, accounting for just under a quarter of UK emissions. According to the Climate Change Committee's 2019 progress report to Parliament, "recent falls in UK emissions are dominated by policy-driven progress in the power sector" where emissions are now 72% below 1990 levels. [292]

The transport sector is now the largest source of UK emissions, though after increases in recent years, transport emissions fell for the first time in 2018. [293] Alongside increased car efficiency and other low carbon fuels, increases in EVs will help to decarbonise the transport sector provided that there is also enough low carbon power to ensure that emissions from electricity production are lower than those of conventional diesel or petrol. Energy demand for petrol and diesel are shown in Box 12.

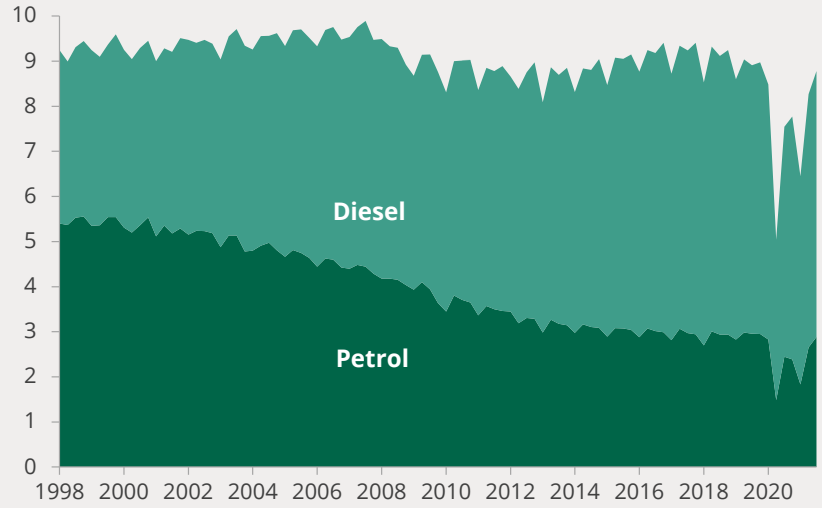
[292] Committee on Climate Change, *2020 Progress report to Parliament*, June 2020.
[293] Committee on Climate Change, *2020 Progress report to Parliament*, June 2020.

Box 12: Energy for petrol/diesel vehicles

Using fuel sales, it is possible to estimate the energy currently used by road transport. Over the past two decades petrol consumption has gradually fallen, while diesel use has increased. Immediately before the pandemic the diesel use had started to fall and petrol consumption was broadly stable. The sharp drop in fuel use at the start of the pandemic and the first quarter of 2021 is clear in the following chart.

UK petrol and diesel consumption

Inland deliveries, million tonnes



Source: Energy Trends, BEIS (Table 3.13)

By Q3 of 2021 fuel use was almost back up to pre-pandemic levels; petrol was 2% below Q3 2019 levels and diesel use 1% lower.

The longer-term change in transport use following the pandemic is currently unclear. Prior to this however, the total level of fuel consumed within the UK has remained relatively constant for many years, as shown in the figure above. Assuming transport usages returns to be similar as to before the pandemic, 10,500 litres of petrol and 7,400 litres of diesel will be used each day. Overall, petrol and diesel engines offer efficiencies of approximately 25%; thus the annual energy required would be approximately 501 TWh.

The Government has committed to decarbonising power through planning to phase out coal by 2024, and supporting the expansion of low-carbon power

sources.[294] These and other actions are expected to continue to drive down the carbon intensity of the UK electricity grid.[295]

A June 2017 study for the power company Drax conducted by researchers at Imperial College London and the Open University found that EVs are causing fewer emissions over time due to decarbonisation of the power sector:

> "Producing the electricity to charge a Tesla Model S back in 2012 would have created 124 g per km driven – the same as a 180 horsepower Range Rover. Nowadays that has halved to 74 g/km in winter and 41 g/km in summer. Smaller cars like the Nissan Leaf and BMW i3 can be charged for less than half the CO_2 of the cleanest non-electric car on the market – the Toyota Prius hybrid." [296]

As such, while EVs are not technically 'zero emission', evidence suggests that in the UK they are likely to have fewer emissions than the average conventional vehicle. EVs emissions have the potential to be reduced further in future as the power sector decarbonises and if manufacturing emissions are reduced.

5.3 EV battery end of life

Currently, EV batteries have a lifespan of 100,000 to 200,000 miles. Whilst this varies between manufacturers, warranties are typically offered for between five and ten years and although capacity will decline over time, the battery will likely continue working beyond the warranty.[297] For example, at this point the battery performance is still 70-80% of its initial capacity.

The average age of a vehicle on the road has increased, from 6.8 years in 2003 to 7.8 recorded in 2015.[298] This suggests that battery disposal rates are likely to be similar to normal vehicle disposal rates. At this point the battery can be disposed of, disassembled to enable the recycling of the precious metals, or reused.

The number of EVs currently approaching the end of their life is relatively small, however the EV market is growing which in turn will lead to more batteries reaching the end of their on-vehicle life. For example, it is estimated that by 2020, 14 GWh of batteries (102,000 tonnes) would be reaching the end of their first life.[299] However the recent increase in the sales of EVs coupled

---

[294] BEIS, *Implementing the end of unabated coal by 2025: Government response to unabated coal closure consultation*, 5 January 2018. For more information see the Library briefing paper on *Energy Policy: An Overview*, December 2020.

[295] Committee on Climate Change, *2020 Progress report to Parliament* , June 2020.

[296] Drax, *Electric Insights Quarterly*, April-June 2017.

[297] EECA Business, *Electric vehicle battery life*, 11 May 2017.

[298] SMMT, *Average Vehicle Age*, accessed: [19 February 2018].

[299] Nhede N, End-of-life Electric vehicle batteries: Recycling or second-life?, *Smart Energy International*, 13 June 2020.

with even greater anticipated market growth over the next decade could lead to 200 GWh of batteries globally reaching the end of their life on vehicles.[300]

European Directive 2006/66/EC mandates that at least 50% of the materials within used batteries or accumulators must be recycled, and that the producers are responsible for collecting batteries and disposing of them.[301] Whilst no longer part of the EU, the Government must ensure that UK legislation meets the requirements outlined in the UK-EU TCA. Further, the Government rules on waste batteries also delegates the responsibility for their disposal to the producer.[302] Some manufacturers have developed initiatives to utilise used EV batteries, as set out in Box 13.

Box 13: Initiatives to re-use batteries

Initiatives to reuse batteries include:

- The use of 148 Nissan LEAF batteries in a 3 MW storage system in the Johan Cruijff Arena;[303]
- Nissan collaborating with Green Charge Networks to develop and deploy commercial energy storage;[304]
- Toyota using more than 200 Camry hybrid batteries for an 85 kWh store for solar-generated electricity in Yellowstone National Park;[305]
- Banks of ten batteries from Prius cars to store locally produced solar electricity in Toyota dealerships in Japan, as well as hybrid batteries used as emergency power storage units after national disasters;[306]
- Renault working with Powervault to provide home energy storage for energy produced by solar panels of customers of M&S Energy, social housing tenants and schools in the South East;[307]
- Chevrolet Volt batteries used to store energy from a 74 kW solar array and two 2 kW wind turbines and in turn supply

[300] Engel H, Hertzke P, Siccardo G, Second-life EV batteries: The newest value pool in energy storage, *McKinsey & Co.*, 30 April 2019.

[301] European Commission, Directive 2006/66/EC of the European Parliament and of the Council of 6 September 2006 on batteries and accumulators and waste batteries and accumulators and repealing Directive 91/157/EEC.

[302] GOV.UK, *Waste Batteries: producer responsibility*, Last updated 25 September 2018.

[303] Nissan, Europe's largest energy storage system is now live at the Johan Cruijff Arena, 29 June 2018, accessed: [29 April 2021].

[304] Morris C, Nissan, GM and Toyota repurpose used EV batteries for stationary storage, *Charged*, 17 June 2015.

[305] Toyota, Reuse, accessed: [29 April 2021].

[306] Toyota, Reuse, accessed: [29 April 2021].

[307] Powervault, Powervault and Renault give EV batteries a "second-life" in smart energy deal, 5 June 2017, accessed: [29 April 2021].

power to the office building and lighting at the GM Milford Proving Ground; [308] and

- The use of BMW and MINI EV batteries to create mobile power units, with a prototype delivering 40 kWh capacity and 7.2 kW, although as more battery units reach the end of their life on vehicle, this is anticipated to enable units with up to 180 kWh capacity and 50 kW power capability. [309]

The Government announced £40 million as part of the Industrial Strategy Challenge fund for 27 projects to make EV batteries longer lasting and cleaner in November 2017. [310] Furthermore, in 2021 the Office for Zero Emission Vehicles funded a £17 million competition to support the transition to zero emission vehicles, which includes solutions that enable battery recycling. [311]

EV batteries can be difficult to recycle due to the multiple components. Further, the UK does not have a plant for disposing of EV batteries, whilst there is only one plant capable of processing lithium-ion batteries in continental Europe. In an October 2018 report, Electric vehicles: driving the transition, the Business, Energy and Industrial Strategy Committee said that further recycling facilities for lithium batteries will be required to accommodate an increase to the number of retired EVs and anticipated materials shortages, particularly with a rise in demand for EVs.

The report highlighted calls for waste disposal options to be addressed by policy:

> 92. …Witnesses agreed that disposal options for batteries needed to be addressed by policy, but had mixed views on whether the Government should seek to gain a lead in the development of second-life and battery recycling industries in the near-term. Nissan cautioned that timing would be important, to avoid scaling-up new industries before a steady supply of retired batteries is available
>
> 93. Second life battery applications, EV end of life disposal and battery recycling are nascent areas that could offer significant industrial opportunities. We recommend that the Government explores the potential value of these to the UK and take a lead in developing those that are promising, before other countries gain a competitive edge. [312]

[308] Morris C, Nissan, GM and Toyota repurpose used EV batteries for stationary storage, *Charged*, 17 June 2015.

[309] BMW, New second-life battery solution, 8 November 2020.

[310] Innovate UK press notice, "Future electric vehicle batteries: long-lasting, cleaner, better", 29 November 2017.

[311] Innovate UK, Transitioning towards Zero Emission Vehicles: feasibility studies, accessed: [29 April 2021].

[312] House of Commons Business, Energy and Industrial Strategy Committee, Electric vehicles: driving the transition, Fourteenth Report of Session 2017–19, HC 383, October 2018.

The Government's response to the Committee's report, published on 11 January 2019, concurred that there were "significant industrial opportunities for the UK" and set out work underway to improve battery recycling:

> One of the objectives of the Industrial Strategy Challenge Fund's Faraday Battery Challenge is: "A thriving UK industry in battery re-cycling / materials recovery/ reconditioning - enabling a circular economy and feeding a UK supply chain. [313]

[313] House of Commons Business, Energy and Industrial Strategy Committee, Electric vehicles: driving the transition: Government Response to the Committee's Fourteenth Report of Session 2017-19, HC 1881, 11 January 2019, p21.

The House of Commons Library is a research and information service based in the UK Parliament. Our impartial analysis, statistical research and resources help MPs and their staff scrutinise legislation, develop policy, and support constituents.

Our published material is available to everyone on commonslibrary.parliament.uk.

Get our latest research delivered straight to your inbox. Subscribe at commonslibrary.parliament.uk/subscribe or scan the code below:

commonslibrary.parliament.uk

@commonslibrary