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Electric vehicles and infrastructure

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Summary

Past and current governments have supported measures to encourage uptake of Electric Vehicles (EVs, sometimes referred to as Ultra Low Emission Vehicles or ULEVs) as they can contribute to a wide range of transport policy goals. These include improving air quality and reducing noise pollution. They may also have an important role in the 'least cost pathway' to the 2050 net zero greenhouse gas emission target. However, 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. There are also concerns over 'peak lithium' and future shortages constraining growth in the EV market.

Government policy and grants

The Government's 2018 Road to Zero Strategy outlines how it will support the transition to zero emission road transport and reduce emissions from conventional vehicles during the transition. Since the Strategy was published the Government has increased its ambitions, by announcing plans to end the sale of petrol and diesel cars by 2030, and hybrids by 2035. This is in line with the Committee on Climate Change's (CCC) recommendation that the market for EVs be 100% by 2035 at the latest to meet the 2050 net zero target.

To meet the aims of the Strategy, Government is (amongst other things) providing grants to make electric vehicle ownership more affordable and to offset the costs of installing chargepoints in the home, workplace and on-street. Eligibility and guidance for these grants is available on for vehicle purchases here and for chargepoint infrastructure here.

So, how many EVs are on UK roads?

Despite the rise in the number of licensed ULEV cars on UK roads, ULEVs still only represent a small proportion of the total number of cars licensed. In 2019 around 58.5% of licensed cars were petrol, 39.1% diesel and 0.8% were either a plug-in-hybrid, battery electric, range-extended electric, or fuel cell electric car.

According to the International Energy Agency's 2017 EV outlook, these figures place the UK fourth worldwide by market share, and seventh by volume. Going forward, 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.

Where are the EV chargepoints?

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. The Committee on Climate Change (CCC) says this figure will need to increase further to match the rising number of EVs on the road. The Government however envisages most charging to take place at home describing it as a "key attraction" of EV ownership. Through the Road to Zero Strategy, the Government has committed £400m (increased to £500m at Budget 2020) to the public-private Charging Infrastructure Investment Fund and says it plans to consult on proposals that would require chargepoint infrastructure for new dwellings in England.

How will increasing numbers of EVs impact the electric grid?

Concerns have been raised that increasing the number of electric vehicles will add to electricity demand and place pressure on the UK's grid network, operated by National Grid. While National Grid do expect electricity demand to increase, they have said that

policies and incentives should be able to address the increase in demand to reduce the impact on the UK's electricity system.

1. Introduction

1.1 What are Electric Vehicles?

Electric vehicles (EVs, sometimes referred to as Ultra Low Emission Vehicles or ULEVs) run on electricity some or all the time. There are several different types, as described by the Parliamentary Office of Science and Technology (POST) in its POSTnote on Electric Vehicles (see box 1).[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:

- **All-electric EVs**, where the battery is the only power source. Most current (non-luxury) models have a quoted range of 80-120 miles (130-190 km). In practice, range varies according to driving style, terrain and the use of auxiliary equipment such as heating/air conditioning.
- **Plug-in Hybrids (PHEVs)** can switch between running on electricity or fossil fuels. They typically have a smaller battery, and therefore a lower battery powered range of between 10-40 miles (15-60 km). However their maximum range is equivalent to a petrol car. Both plug-in hybrid and all-electric EVs are recharged by lugging them in to the electricity grid (see image).
- **Hybrids (HEVs)** which do not plug in, such as the Toyota Prius, have a much smaller battery which is recharged while driving. HEVs can drive in electric mode for a few miles.
- **Fuel Cell Vehicles** 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.

1.2 Why do we need Electric Vehicles?

Past and current governments have supported measures to encourage uptake of EVs as they can contribute to a wide range of transport policy goals.[2] EVs can help to improve air quality, reduce noise pollution and support efforts to reduce carbon emissions.

For instance, a 2018 report of the European Environment Agency found that electric vehicles offer "clear benefits" for local air quality largely due to zero exhaust emissions at street level. However, the report noted that even electric vehicles emit particulate matter from road, tyre and break wear.

Moreover, updated advice on meeting the net zero 2050 target was 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).[3] Under the older

1 POST, *Electric vehicles* (POSTnote 365), 1 October 2010, p1
2 IEA, *Global EV Outlook 2018*,
3 CCC, Net Zero: The UK's contribution to stopping global warming, May 2019, p.34

80% reduction target by 2050, the CCC advised a 'least cost' pathway would need 60% of all new cars and vans sold should be electric by 2030 (see box 2 for further information on transport emissions).[4]

Box 2: Transport emissions

As of 2017, transport was the largest-emitting sector of the UK economy at 126 MtCO2e, accounting for 28% of UK greenhouse gas (GHG) emissions. The CCC has recommended that if the UK is to meet the 2050 net zero target the market for electric cars and vans should scale up to 100% of new sales by 2035 at the latest (and ideally by 2030).[5]

Progress in reducing emissions in the transport sector have been slow. Average vehicle emissions from the UK fleet have fallen.[6] 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 in September 2018 caused a marked increase in average CO2 emissions. However, changes from September 2018 are not directly comparable with previous periods.*"[7]

The CCC says that most action to reduce emissions from the transport sector had been driven by EU regulations, rather than domestic policy.[8] Since 2015, the EU has set mandatory emission reduction targets for new cars.[9] Further, the CCC says renewed efforts are needed to encourage consumers to buy more efficient vehicles.[10]

EU vehicle emission targets

Since 2009, EU legislation has set mandatory emission reduction targets for new cars.

- Since 2015, a target of 130 g CO2/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 will be 95 g CO2/km.

There are penalties for manufacturer's if the average CO_2 emissions of a manufacturer's fleet exceed its target in a given year. This **excess emissions premium** for each car registered is set by the Commission as follows:

- €5 for the first g/km of exceedance
- €15 for the second g/km
- €25 for the third g/km
- €95 for each subsequent g/km.

From 2019 on the penalty will be €95 for each g/km of target exceedance.[11]

4 CCC, Reducing UK emissions 2018: Progress Report to Parliament, June 2018, p. 161
5 CCC, Net Zero: The UK's contribution to stopping global warming, May 2019, p.34
6 Society of Motor Manufacturers and Traders (SMMT), Facts & Figures, [accessed: 17 June 2019]
7 Department for Transport, Vehicle licensing statistics 2018, p. 6
8 Ewa Kmietowicz, Road to Zero: A missed opportunity?, CCC, 10 July 2018
9 European Commission, Reducing CO2 emissions from passenger cars, [accessed: 5 June 2019]
10 CCC, Reducing UK emissions 2018 Progress Report to Parliament, June 2018, p.161,
11 European Commission, Reducing CO2 emissions from passenger cars, [accessed: 5 June 2019]

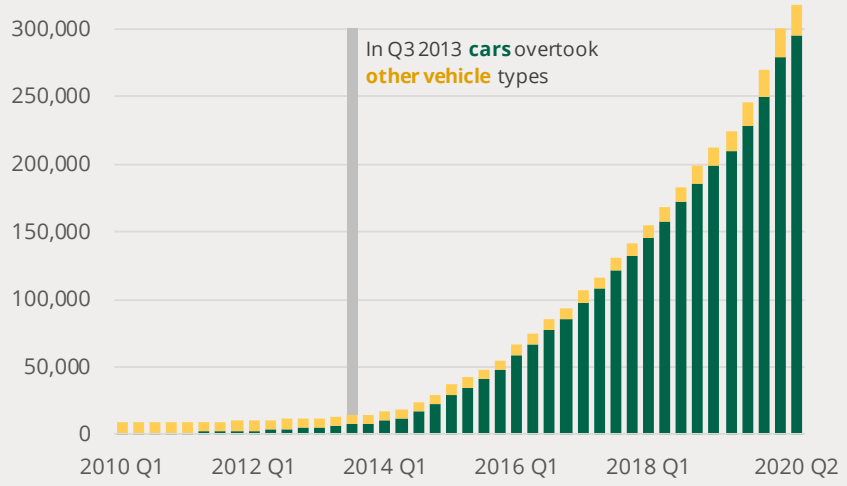
1.3 How many Electric Vehicles are on UK roads?

ULEVs represent a tiny 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)[12] 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 United Kingdom has increased from just under 9,000 at the end of Q1 2010 to 317,000 at the end of Q2 2020. This is an increase of 3,427%. At the end of Q3 2013 the number of licensed ULEV cars overtook the number of vehicles of other types. Currently cars account for around 93% of all licensed ULEV vehicles. Other ULEVs include vans, scooters, HGVs and buses etc.

Licensed ultra low emission vehicles

The numbe of licensed ultra low emission vehicles (ULEVs) at end of quarter, United Kingdom



Source: Department for Transport, Vehicle Licensing Statistics: table VEH0130

Despite the rise in the number of licensed ULEV cars on UK roads, as a proportion of the total number of cars licensed ULEVs represent a tiny share. In 2019 around 58.5% of licensed cars were petrol, 39.1% diesel and 0.8% were either a plug-in-hybrid, battery electric, range-extended electric, or fuel cell electric car.[13]

At the end of Q2 2020 plug-in-hybrid, battery electric, range-extended electric of fuel cell electric cars accounted for 10.9% all newly registered cars. A year earlier this was just 2.2%. As a result of COVID-19 new car registrations in Q2 2020 fell by around 65% compared to the previous quarter. Low emission car registrations also declined, but to a lesser

[12] 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.

[13] Department for Transport, Vehicle Licensing Statistics: table VEH0203

extent (42%). Because new low emission car registrations declined less than petrol or diesel cars, their share of registrations increased 4.2 points on Q1 2020.[14]

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 to individuals buying new vehicles (see box 3 for historical overview of pre-2015 policies and select committee reports).

Box 3: Past Government policies and select committee reports

Labour Government:

The Labour Government published its ULEV strategy in April 2009.[15] 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".[16]

Coalition Government:

The 2010 Coalition Agreement contained a commitment to "mandate a national recharging network for electric and plug-in hybrid vehicles".[17] 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".[18] 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 network'.[19] 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.[20]

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

14 Department for Transport, Vehicle Licensing Statistics: table VEH0253
15 DfT, *Ultra Low Carbon Vehicles in the UK*, April 2009, p8
16 Labour Party, *A Future fair for All: the Labour Party Manifesto 2010*, April 2010, p1.8
17 HMG, *The Coalition: our programme for government*, May 2010, p31
18 HMG *Making the Connection: The Plug-In Vehicle Infrastructure Strategy*, executive summary
19 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
20 See, e.g. comments by Nissan in "Hammond criticised over car charging points", *Financial Times*, 1 July 2011

across the country by March 2015. It also pledged £32m for charging infrastructure in 2015-20.[21]

Select Committee reports on EV policy, 2010-16

The Transport Select Committee published a report on ULEV in September 2012: *Low Carbon Vehicles*. [22]

The Government's response was published in January 2013.[23]

the Environmental Audit Select Committee assessed policies for ULEVs in its September 2016 report: Sustainability at the DfT.[24] The Government response was published on 11 November 2016.[25]

2.1 Road to Zero strategy

The Government published its Road to Zero Strategy in 2018. This strategy outlines how it will support the transition to zero emission road transport and reduce emissions from conventional vehicles during the transition. The strategy is "long term in scope and ambition, considering the drivers of change, opportunities and risks out to 2050 and beyond".[26] It sets out several new measures, including:

- an "ambition" for at least 50% — and as many as 70% — of new car sales to be ultra-low emission by 2030, alongside up to 40% of new vans. (see section 2.2 on revised ambitions for sales of EVs and petrol/diesel cars)
- a push for chargepoints to be installed in new build homes, where appropriate, and new lampposts to include charging points
- the launch of a £400 million charging infrastructure investment fund to help accelerate the roll-out of charging infrastructure by providing funding to new and existing companies that produce and install charge points.
- providing up to £500 for electric vehicle owners to put in a charge point in their home through the electric vehicle homecharge scheme.
- the extension of the plug-in car and van grants to at least October 2018 at current rates, and in some form until at least 2020
- the launch of an electric vehicle energy taskforce to bring together the energy and automotive industries to plan for the increase in demand on energy infrastructure that will result from a rise in the use of electric vehicles.[27]

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21 OLEV, *Investing in ultra low emission vehicles in the UK, 2015 to 2020*, April 2014, p16

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

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

24 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

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

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

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

Spending review 2020

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;
- £90 million to fund local EV charging infrastructure to support the roll out of larger on-street charging schemes and rapid hubs in England.[28]

Road to Zero funding

To achieve the ambitions set out in the Road to Zero strategy, "the Government is investing nearly £1.5 billion between April 2015 and March 2021, with grants available for plug-in vehicles and schemes to support chargepoint infrastructure."[29]

2.2 Ending the sale of petrol and diesel vehicles by 2030

The Government's Road to Zero strategy set the "ambition" that by 2050 almost every car and van will be zero emission. The Government has since moved its planned date for ending the sale of petrol and diesel vehicles from 2040 to 2030 and for hybrid vehicles to 2035.[30]

In February 2020, the Government published proposals bringing forward the deadline for ending the sale of petrol and diesel cars to 2035. From February to May 2020, the Government consulted on this measure, and in particular has asked for views on:

- the phase out date
- the definition of what should be phased out
- barriers to achieving the above proposals
- the impact of these ambitions on different sectors of industry and society
- what measures are required by government and others to achieve the earlier phase out date.[31]

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28 HM Treasury, Spending Review 2020, **CP330,** Nov 2020
29 DfT, Government launches Road to Zero Strategy to lead the world in zero emission vehicle technology, Jul 2018
30 Department for Transport, Consulting on ending the sale of new petrol, diesel and hybrid cars and vans, 20 Feb 2020
31 Department for Transport, Consulting on ending the sale of new petrol, diesel and hybrid cars and vans, 20 Feb 2020

The Government published the consultation response on 18 November, alongside it's 10 point plan for a green industrial revolution. 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.
- Step 2 will see all new cars and vans be fully zero emission at the tailpipe from 2035.[32]

The announcement said that hybrids would continue to be able 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."[33]

The Government also stated it would publish a green paper "in the coming months" on post-EU regulation for CO_2 emissions from new road vehicles, considering both:

- overall fleet efficiency; and
- how to best deliver the transition to 100% zero emission sales for cars and vans.

In addition, the Government said it would consult on the phase-out of new diesel heavy goods vehicles (HGVs).[34]

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."[35]

In a post on the Green Alliance blog, *Inside Track*, Caterina Brandmayr said the Green Alliance:

> …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 vans to 2030. This shows clear commitment to addressing climate change and puts the UK at the forefront of the global electric vehicle revolution.[36]

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.[37]

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32 DfT, Government takes historic step towards net-zero with end of sale of new petrol and diesel cars by 2030, 18 Nov 2020
33 DfT, Government takes historic step towards net-zero with end of sale of new petrol and diesel cars by 2030, 18 Nov 2020
34 DfT, Government takes historic step towards net-zero with end of sale of new petrol and diesel cars by 2030, 18 Nov 2020
35 SMMT, SMMT response to 2030 ICE end of sale date announcement , 17 Nov 2020
36 Caterina Brandmayr, Will the PM's plan put the environment at the heart of the UK's economic recovery?, 19 Nov 2020
37 CCC, Government's Road to Zero Strategy falls short, CCC says, 10 July 2018

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).[38] 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.[39]

Box 3: 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.[40]
- In 2015, the Government set a target to "ensure almost every car and van is a zero emission vehicle by 2050".[41]
- In July 2017, the Government announced that "it will end the sale of all new conventional petrol and diesel cars and vans by 2040"[42]
- In May 2018, the Prime Minister announced a further target for 2040, that all new cars and vans should be "effectively zero emission."[43]

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.[44]

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..

EV market forecasts

There is some evidence that sales of diesel vehicles are already on the wane. A study by UBS in 2016 predicted that diesel would "almost disappear" from the global car market within 10 years if competition from cheaper electric cars and tougher stances by regulators come to pass.[45] Further, the number of EVs on UK roads has been increasing year-on-year. In addition, more models of EVs are becoming available.[46] As charging infrastructure improves and the costs of EVs decreases, market analysts are forecasting 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.[47]

38 CCC, Net Zero: The UK's contribution to stopping global warming, May 2019, p.34
39 CCC, Reducing UK emissions 2018: Progress Report to Parliament, June 2018, p. 161
40 DfT, Reducing emissions from road transport: Road to Zero Strategy, July 2018
41 DfT, UK government pledges bold ambition for electric cars, 3 December 2015
42 Department for Environment, Food & Rural Affairs and Department for Transport, Air quality plan for nitrogen dioxide (NO2) in UK (2017), July 2017
43 The Rt Hon Teresa May MP, PM speech on science and modern Industrial Strategy, 21 May 2018
44 HM Government, Industrial Strategy Automotive Sector Deal, 2018
45 "Diesel faces global crash as electric cars shine", *Financial Times*, 11 December 2016
46 Jasper Jolly, 2020 set to be year of the electric car, say industry analysts, *Guardian*, 25 Dec 2019
47 Accenture Strategy, Utilities: lead the charge in eMobility, April 2019

- Research published by Emu Analytics (a UK-based technology) in May 2018 forecast 1million EVs on the road by the early 2020s.[48]
- Bloomberg's New Energy Finance Electric Vehicle Outlook 2019 has forecasts for global EV markets. This report forecasts global EV sales to rise to 10million in 2025, 28 million in 2030 and 56million in 2040.[49]

2.3 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.[50]

The Government has taken several measures to ensure there will be enough chargepoints installed in the coming years (detailed below). 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.[51]

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.[52] 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.[53] Indeed, public chargepoints are still unevenly distributed across Great

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48 Emu Analytics, A Sustainable Future Preparing for Electric Vehicles, May 2018
49 Bloomberg New Energy Finance, Electric Vehicle Outlook 2019, [accessed: 10 Jan 2020]
50 OLEV, *Uptake of Ultra Low Emission Vehicles in the UK: A Rapid Evidence Assessment for the Department for Transport*, executive summary
51 PQ265457 [Electric Vehicles: Charging Points] 20 June 2019
52 "Plugging the gap: What next for Britain's EV public charging network?", *CCC blog*, 19 Jan 2018
53 OVO Energy, What's stopping the 'electric vehicle revolution'?, Sept 2017

Britain meaning access to chargepoints is still something of a "postcode lottery", according to analysis by HSBC in 2016.[54]

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.[55] 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. Most charge points remain to be those with a charge rate of less than or equal to 22kW. As of March 2020, ZapMap reported[56] in Great Britain there were: 11,293 public charging points, 18,178 devices and 31,504 connections (of which 7,630 were rapid[57]). Year-on-year, the number of chargepoint connectors is increasing. Between 2018 and 2019, there was a 50% increase as a further 10,000 connections were added.[58]

Even so, 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.[59] 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 chargepoints will need to increase further to match the rising number of EVs on the road

- 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.
- Overall nearly 29,000 charging points are needed across Great Britain by 2030, of which around 85% of these are fast (22kW) or rapid (43+kW) chargers.[60]

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.[61] Indeed, the Government identifies homecharging as a "key attraction" of owning an EV.[62]

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54 "Owners of electric cars are struggling to get plugged in", *The Times*, 24 September 2016
55 PQ 267734 [Electric Vehicles: Charging Points] 27 Jun 2019
56 ZapMap.com [accessed: 25 March 2020]
57 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.
58 ZapMap.com [accessed: 25 March 2020]
59 Systra, Cenex and Next Green Car, Plugging the gap: An assessment of future demand for Britain's electric vehicle public charging network, Jan 2018
60 Systra, Cenex and Next Green Car, Plugging the gap: An assessment of future demand for Britain's electric vehicle public charging network, Jan 2018
61 DfT, Reducing emissions from road transport: Road to Zero Strategy, July 2018, p. 15-16
62 DfT, Reducing emissions from road transport: Road to Zero Strategy, July 2018, p. 83

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.[63] 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).[64]

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.[65]

EV charging market study

The Competition and Markets Authority (CMA) launched a market study into the EV charging market in December. 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.[66]

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
- how to ensure people using electric vehicle chargepoints have confidence that they can get the best out of the service[67]

63 "Electric cars hampered by fear of charge-point clutter", *The Times*, 27 November 2017
64 DfT press notice, "Funding for thousands of electric car charge points unused by councils", 12 Jan 2018
65 DfT, New 'league table' reveals electric car charging availability across UK as Transport Secretary calls on local authorities to do more, 2 Nov 2019
66 CMA, CMA to examine electric vehicle charging sector, 2 Dec 2020
67 CMA, CMA to examine electric vehicle charging sector, 2 Dec 2020

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.[68]

To ensure EV owners can enjoy one of the "key attractions" of owning an EV[69] – home charging – the Government has created a grant scheme to help support the installation of chargepoints at home, as well as in the workplace and on local streets.[70]

- 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.
- 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.

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.[71]

At Budget 2017, the Government announced its intention to establish the **Charging Infrastructure Investment Fund**.[72] 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.[73] At Budget 2020, the Government increased the size of this fund to a total of £500m.[74] 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 OLEV to

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68 PQ HL15730 [Electric Vehicles] 29 May 2019
69 DfT, Reducing emissions from road transport: Road to Zero Strategy, July 2018, p. 83
70 For more information on eligibility and guidance on how to apply for these grants, please see the Office for Low Emission Vehicles (OLEV) website.
71 DfT, Reducing emissions from road transport: Road to Zero Strategy, July 2018, p. 83
72 HM Treasury, Budget 2017, Nov 2017, **HC587**, para 4.15
73 DfT, Details of the operation of the Charging Infrastructure Investment Fund, Sept 2019
74 HM Treasury, Budget 2020v, Mar 2020, **HC121**, para 1.246

carrying out a "comprehensive electric vehicle charging infrastructure review" so that money spent from this fund is well targeted.

Improving consumer experiences: Automated and Electric Vehicles Act 2018

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.[75] 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.

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.

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.[76]

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."[77]

2.4 Vehicle grants

EVs are currently more expensive than equivalent internal combustion engine vehicles and are not projected to reach price parity until the mid-2020s.[78] 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."[79] (see box 4 for more on VED).

To make electric vehicle ownership more affordable, the Government offers plug-in grants (launched in 2011). The amount of grant depends

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75 HL Deb 20 Feb 2018 c18
76 New Legislation To Revolutionize EV Charging In The UK, *Clean Technica*, 1 Aug 2018
77 "PRA continues to lobby for investment into charging infrastructure", 1 Feb 2018
78 Bloomberg New Energy Finance, Electric Vehicle Outlook: 2018, May 2018
79 Letter to Chris Grayling and Greg Clark – assessment of the Road to Zero Strategy, 11 October 2018

on which category the vehicle is in. The five categories and their eligible grants are detailed in the table below. Prior to October 2018, there were three categories of car eligible for a grant when the DfT announced changes to grant levels. The Government updated the grant levels again at Budget 2020.[80] The updated grant levels are reflected in the table below. You can also find more information on eligible vehicles on the OLEV plug-in car grants page.

Category	CO2 emissions	Zero emission range	Grant	Maximum amount
Car (up to £50,000)	Less than 50g/km	112km (70 miles)	35%	Up to £3,000
Motorcycles	No CO2	50km (31 miles)	20%	Up to £1,500
Mopeds	No CO2	30km (19 miles)	20%	Up to £1,500
Vans	Less than 75g/km	16km (10 miles)	20%	Up to £8,000
Taxis	Less than 50g/km	112km (70 miles)	20%	Up to £7,500

Low-emission vehicles eligible for a plug-in grant

In the Road to Zero Strategy, the Government said it expected to deliver a "managed exist from the grant in due course" to provide support through other measures.[81] The grant was due to expire in April 2020. At Budget 2020, the Government said it would extend the grant until 2022-23 with a further £0.5bn available (£403m for electric cars and £129.5m for vans, taxis and motorcycles).

Eligibility and guidance for these grants is available on Gov.uk.

As of March 2020, the Government said the plug-in car grant had provided over £800m to support the purchase of low emissions vehicles (£450m of which had supported the purchase of zero emission vehicles).[82]

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

Changes to plug-in grants scheme in 2018 and 2020

Previously, there were three categories of car 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).[83] At the same time, the maximum grant available for EV cars (formerly a category 1 EV) was lowered from £4,500 to £3,500. Transport Minister, Jesse Norman, explained that these changes reflected a shift "to focus on

80 DfT, Update on plug-in vehicle grants following today's budget, 11 Mar 2020
81 DfT, Reducing emissions from road transport: Road to Zero Strategy, July 2018, p. 52
82 DfT, Update on plug-in vehicle grants following today's budget, 11 Mar 2020
83 OLEV, Changes to the Plug-in Car Grant, 2 Nov 2018

zero tail pipe emission vehicles."[84] 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 "expensive car supplement" and set a cap on the maximum list price of vehicles eligible for the grant at £50,000.[85]

The automotive industry called for the Government to rethink the 2018 changes. Reacting to the announcement, Mike Hawes, Chief Executive of the Society of Motor Manufacturers and Traders (SMMT), said:

> We understand the pressure on the public purse but, given the importance of environmental goals, it's astounding that just three months after publishing its ambitious vision for a zero emissions future, government has slashed the very incentive that offers our best chance of getting there.
>
> Industry is working hard to address the challenges of CO2 and air quality but, while it can produce the technology, it cannot determine the pace of uptake.
>
> We have consistently said that if the UK is to be fit for an electrified future, we need a world-class package of incentives and infrastructure. Government needs to rethink its policy, else its ambitions will never be realised.[86]

Further, the Commons Business, Energy and industrial Strategy (BEIS) Committee criticised the Government's decision in its inquiry into EVs. The Committee felt that the decision had been "made too soon and too suddenly" and "risked undermining the UK's burgeoning EV market."[87] Instead, the Committee called for the grants to be maintained until the cost of EVs nears price parity with conventional Internal Combustion engine vehicles.

The Government is confident that the changes to the grants available are working. In response to a PQ, Transport Minister, Jesse Norman, said that since the 2018 changes were introduced

> …overall sales of alternatively fueled vehicles have increased compared to the same period last year. While the sales of zero emission capable plug-in hybrids have decreased since the grant was reviewed, the sales of the cleanest zero emission vehicles have increased by over 50 per cent over the same period.[88]

Box 4: 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.

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84 PQ 252016 [Electric Vehicles: Grants] 17 May 2019
85 HM Treasury, Budget 2020, Mar 2020, para 1.245
86 SMMT, Automotive industry calls for plug-in grant rethink as cuts put Government ambition at risk, 12 Oct 2018
87 Business, Energy and Industrial Strategy Committee, Electric vehicles: driving the transition, Fourteenth Report of Session 2017–19, **HC 383,** para 33-36
88 PQ 252016 [Electric Vehicles: Grants] 17 May 2019

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 100g/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 50g/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".[89]

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

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-demographic profile of ULEV owners in the UK was "not likely to change significantly".[90]

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.[91]

Developing the second-hand market for EVs will be important to increase accessibility. This 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.[92] 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

89 HM Treasury, Budget 2020, Mar 2020, para 1.245

90 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

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

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

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.[93]

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

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.[94]

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.[95]

3.1 Targets and bans around the world

The BEIS Committee has described the UK's targets to: (i) phase out diesel and petrol vehicles and (ii) increase EV ownership as unambitious.[96] 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."[97] 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 shows the even within the UK separate countries had more ambitious targets:

Table 1: Government commitments to the end of sales of conventional vehicles

Country	Timing
Norway	2025
India, China, Slovenia, Austria, Israel, the Netherlands, Ireland	2030
Scotland	2032
UK, France, Sri Lanka, Taiwan	2040

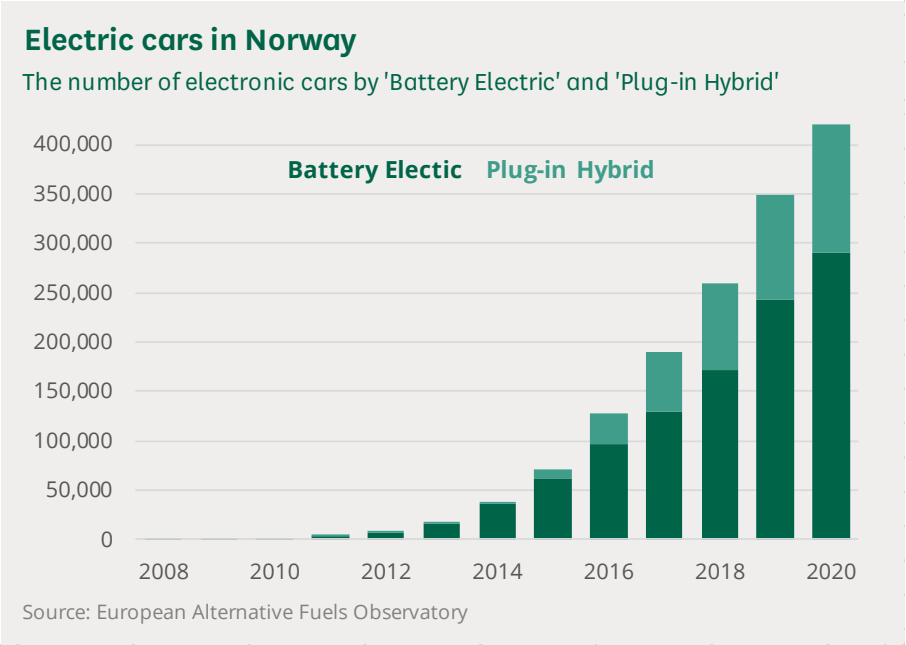
Source: Reproduced from CCC, Reducing UK emissions: 2018 Progress Report to Parliament, June 2018, Table 5.3

94 "Electric vehicle sales fall far short of Obama goal", *Reuters*, 20 Jan 2016
95 IEA, *Global EV Outlook 2017: Two million and counting*, Oct 2017, p5
96 Business, Energy and Industrial Strategy Committee, Electric vehicles: driving the transition, Fourteenth Report of Session 2017–19, **HC 383,** para 22
97 Business, Energy and Industrial Strategy Committee, Electric vehicles: driving the transition, Fourteenth Report of Session 2017–19, **HC 383,** para 24

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 countries: the US, China and France) and the largest market share.[98] The UK by comparison is ranked fourth worldwide by market share, and seventh by volume. 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.[99]

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. If we include 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.



The most important incentives driving Norway's success have been long-term and financial. In addition, the Norway 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:

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

99 National Grid, Future Energy Scenarios, Jul 2018

- **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 CO2 emissions. BEVs are exempted from the tax. Plug-in hybrid electric cars also pay a lower tax. 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 2020
- **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.[100]

Altogether, this approach makes the total cost of ownership less expensive for Plug-In Electric Vehicles than for a comparative internal combustion engine vehicle.[101]

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

4. Additional Electricity Demand

Increasing the number of electric vehicles will add to electricity demand and place pressure on the UK's grid network, operated by National Grid (see concerns raised in Box 5).

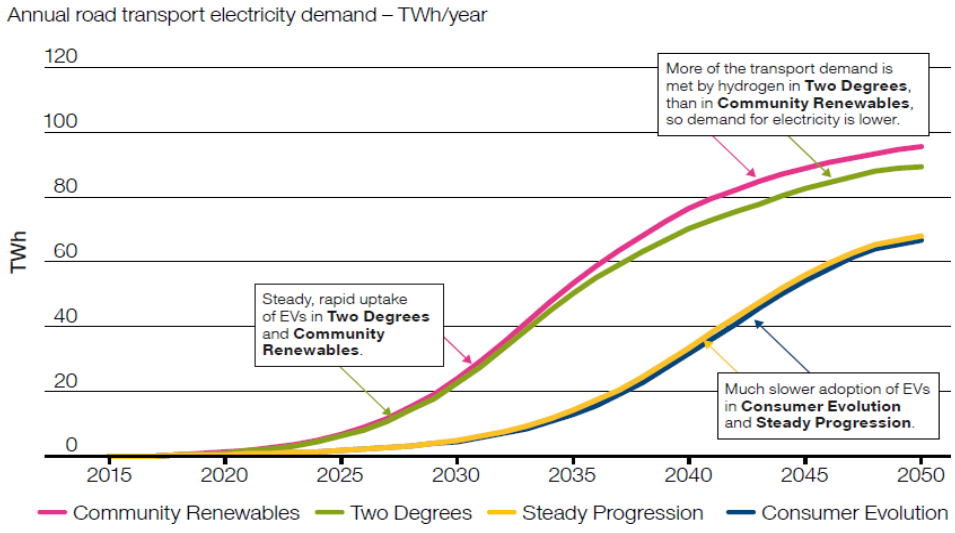
National Grid (NG) publish an annual Future Energy Scenarios (FES) report. These reports provide what NG describe as "a range of credible futures" in the energy sector but are not intended to be a forecast of future electricity demand. The reports cover demand from different sectors, such as electric vehicles (as part of transport) but also industrial, commercial, and residential demand for both electricity and gas.

The 2019 FES had four scenarios; Community Renewables and Two Degrees (which both meet the Government's 2050 net zero decarbonisation target[102]) and Steady Progression and Consumer Evolution (which do not meet the 2050 target).[103] The scenarios differ in the speed of decarbonisation and level of decentralisation.

On electric vehicles adding to electricity demand, the 2019 FES found that total energy demand for road transport fell across all scenarios:

> Total energy demand is similar across scenarios, but the speed at which vehicles shift from petrol and diesel to electricity, natural gas or hydrogen varies across scenarios. Total annual energy demand for road transport is currently around 500 TWh. By 2050 it has reduced, in all scenarios, to below 200 TWh. This is due to the shift from petrol/diesel vehicles to electric vehicles, which use less energy per mile; causing a significant drop in total energy used for transport.[104]

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 2019 FES:



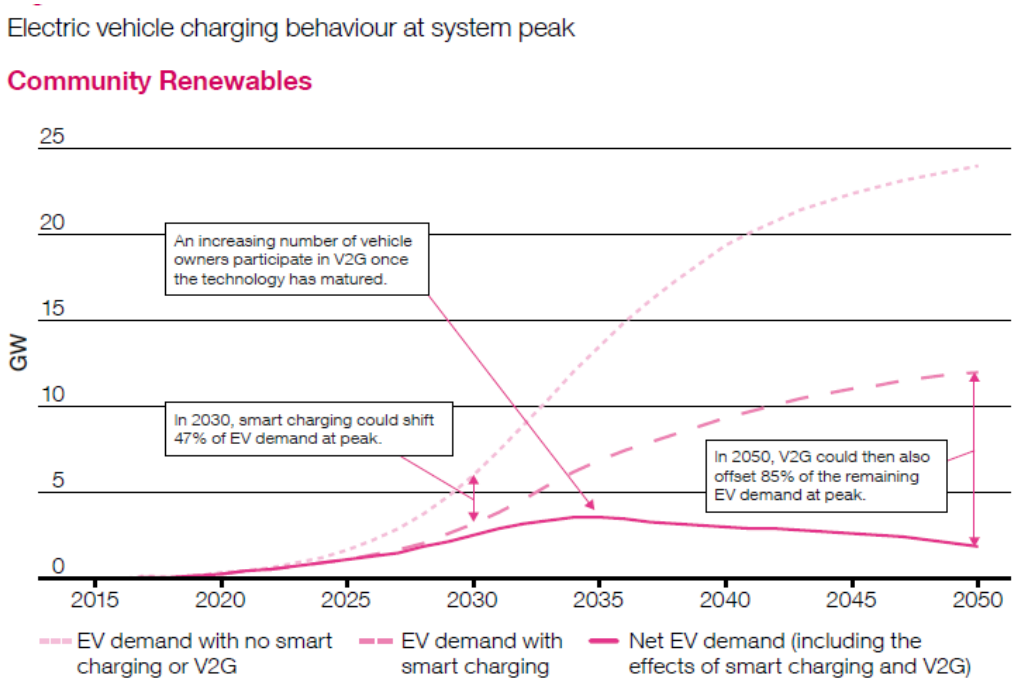
National Grid: System operator

National Grid owns the transmission network (the high voltage power infrastructure in England and Wales) and separately manages the transmission network to ensure the grid remains balanced and supply meets demand at all times. More information can be found on these roles on the NG website.

[102] House of Commons Library, *Net Zero in the UK*, 16 December 2019
[103] National Grid, *Future Energy Scenarios*, July 2019
[104] National Grid, *Future Energy Scenarios*, July 2019, p77.

Source: National Grid, Future Energy Scenarios 2019

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 (see section 4.2) the scale of the demand reduced significantly as the graph below for one scenario from FES shows:



Source: National Grid, Future Energy Scenarios 2019

National Grid found that investment for EV infrastructure was needed, but that smart charging of electric vehicles, as a mechanism to help balance supply and demand on the grid (see section 4.2 below), would have benefits. For example, smart charging vehicles "could enable the storage of roughly one fifth of GB's solar generation for when this energy is needed". National Grid concluded:

> The investment in infrastructure to support increasing numbers of electric vehicles indirectly benefits all energy consumers through lower prices and lower carbon generation intensity, as smart charging of EVs can support increased renewable generation.[105]

Box 5: Concern over Government target and NG response

Following the Government's announcement in July 2017 of plans to ban sales of "all new conventional petrol and diesel cars and vans" from 2040[106], 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[107] suggested 10 new power stations would be required.

105 National Grid, *Future Energy Scenarios*, July 2019, p 4.
106 Defra, *Plan for roadside NO2 concentrations published*, Jul 2017
107 *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

Many of the estimates, and media reports, on future energy demand with electric vehicles are based on NG's Future Energy Scenarios 2017 (FES).[108] 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.[109] 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, by 2046 NG's analysis estimated that 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 will change to avoid charging at peak times, therefore resulting in a less significant increase to peak demand.[110]

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.[111] 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.

4.1 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.[112] 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 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.

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[108] National Grid, *Future Energy Scenarios 2017*, July 2017
[109] National Grid, *Our Energy Insights, Electric vehicle announcement and what the papers say*, August 2017
[110] National Grid, *Our Energy Insights, Electric vehicle announcement and what the papers say*, August 2017
[111] BEIS committee, *Electric vehicles: driving the transition*, Fourteenth report of session 2017-19, Oct 2018
[112] Engie, *Understanding the Capacity Market*, 2016

The capacity market began again in October 2019 following a suspension since November 2018. This suspension was due to a ruling from the General Court of the European Union which annulled the European Commission's 2014 approval of the UK's capacity market under state aid rules. The ruling effectively rendered the capacity market illegal as the Court decided that the Commission's original approval process was too short, and that the EU should have done further investigations into the scheme. In October 2019, the Commission approved the Capacity Marker under EU State aid rules and the Government gave notice of the market's reinstatement.

4.2 Balancing the Grid

National Grid are the Transmission System Operator. They 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'.

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

Balancing is an increasing challenge for National Grid 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.[113]

Smart charging and Vehicle to Grid (V2G) technology

As shown above, wider proliferation of electric vehicles will add demand to the grid. However, smart charging can reduce charging at peak times, and the batteries in the vehicles could become an asset to National Grid, 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 prices, are 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,[114] 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,[115] rewarding customers with smart meters for using power at times of low demand. Integrating smart devices, such as smart charging electric cars, into this mechanism could mean that additional

[113] HMG/Ofgem, *Upgrading our energy system, Smart systems and flexibility plan*, July 2017
[114] House of Commons Library, *Energy Smart Meters*, 7 October 2019
[115] Andrew Ward, *Households offered first time-of-use energy tariff*, Financial Times, 2 January 2017

demand for electric cars is significantly reduced (as section 4 above shows).[116]

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.

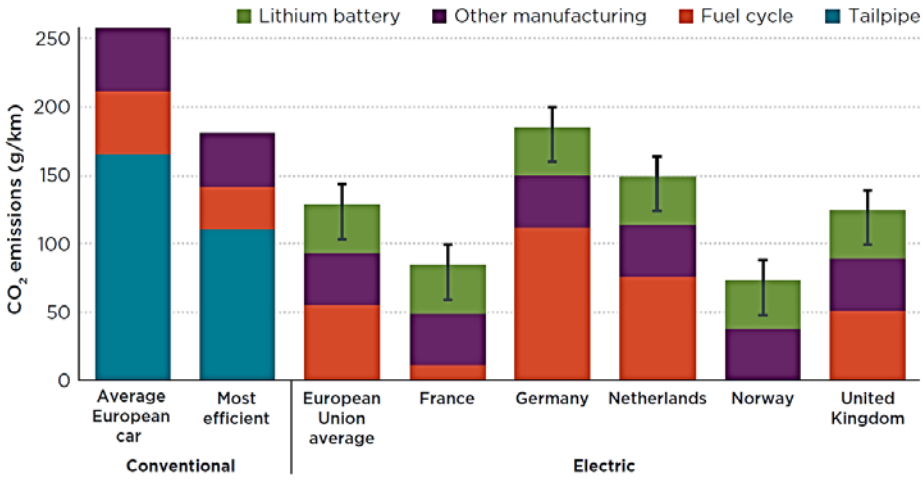
In July 2017, the Government launched a V2G competition with £20 million of funding to develop the technology.[117] As indicated in section 2.2. above, in February 2018 the Government announced a further £30 million investment in V2G.[118]

116 More information is available in the Library briefing paper on Electricity Grids (Section 5 – smart grids).
117 DfT press notice, *Innovative vehicle to grid technology to receive £20 million*, 8 July 2017
118 DfT, *£30 million investment in revolutionary V2G technologies*, Feb 2018

5. Emissions comparison: 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.[119]

The International Council on Clean Transportation (ICCT - an independent non-profit research and analysis organisation) published in 2018 a review of research on lifecycle emissions of EVs in Europe. This found that while EVs can have higher emissions at the manufacturing stage, these can be recovered over the lifetime of the car from reduced fuel emissions in relation to conventional vehicles, resulting in a lower overall lifecycle emission for EVs relative to average conventional cars.[120] However, as electric vehicle production and charging emissions are based on the energy mix where the EV is charged and used (e.g. the proportion of fossil fuel and low carbon sources), the lifecycle emissions of EVs vary between countries, and even locally. This national variation of the different lifecycle emissions is summarised below in a graph from the ICCT analysis:[121]



[119] 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

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

[121] The International Council on Clean Transportation, *Effects of battery manufacturing on electric vehicle life-cycle greenhouse gas emissions*, February 2019. Based on 2015 data and over 150,000km.

5.1 Vehicle manufacturing greenhouse gas emissions

The ICCT analysis said that the energy intensive production of batteries meant that EVs have higher manufacturing emissions than conventional cars and went on to conclude there was potential for manufacturing emissions to either increase or decrease in future:

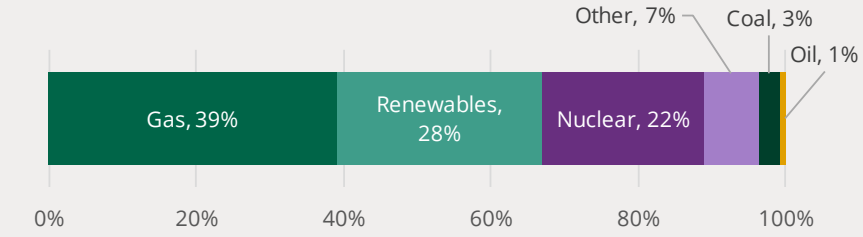
> Electric vehicle manufacturing requires more energy and produces more emissions than manufacturing a conventional car because of the electric vehicles' batteries. Lithium-ion battery production requires extracting and refining rare earth metals, and is energy intensive because of the high heat and 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.[122]

5.2 Fuel cycle greenhouse gas emissions

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:

Electricity generation during 2019 in the UK

% of UK total generated



Source: DBEIS, Digest of UK Energy Statistics, 2020

EVs 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 emissions, accounting for just under a quarter of UK emissions. According to the Committee on Climate Change's 2019 progress report to Parliament, power sector emissions reductions have seen "sustained progress" and are now 68% below 1990 levels. 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.[123] Increases in

[122] The International Council on Clean Transportation, *Effects of battery manufacturing on electric vehicle life-cycle greenhouse gas emissions*, February 2019
[123] Committee on Climate Change, *2019 Progress report to Parliament*, July 2019

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.

The Government has committed to decarbonising power through planning to phase out coal by 2025, and supporting the expansion of low-carbon power sources.[124] These and other actions are expected to continue to drive down the carbon intensity of the grid.[125]

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 CO2 of the cleanest non-electric car on the market – the Toyota Prius hybrid.[126]

As such, while EVs are not technically 'zero emission', research suggests that in the UK 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.

Other impacts of EV production

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[127] as well as questions over sustainable supply as demand for batteries grows.[128] For further information see POSTnote, Access to Critical Materials, September 2019.

In addition, EV batteries can be difficult to recycle due to the multiple components. Government rules on waste batteries mean producers of batteries are responsible for their disposal.[129] 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 as the number of retired electric vehicles increases and highlighted calls for waste disposal options to be addressed by policy:

> 92. Materials recycling may be important in the longer term, as the stockpile of batteries requiring disposal increases and particularly if anticipated materials shortages come to fruition. The risk of cobalt shortages has been identified as a major threat to global EV growth over the 2020s; according to the IEA, cobalt demand for EV batteries could

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124 BEIS, *Implementing the end of unabated coal by 2025: Government response to unabated coal closure consultation*, 5 January 2018
125 Committee on Climate Change, *2019 Progress report to Parliament*, July 2019
126 Drax, *Electric Insights Quarterly*, April-June 2017
127 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
128 Could a lithium shortage derail electric car boom?, *USA Today*, 26 Aug 2016
129 GOV.UK, *Waste Batteries: producer responsibility,* Last updated 25 September 2018

> increase by between 10 and 25 times by 2030. There are currently no UK treatment plants for disposal of batteries and only a single plant for processing lithium-ion batteries in continental Europe. The plant owners, Umicore, have invested £25 million in the plant and are piloting a process for the recycling of electric vehicle batteries in anticipation of a sizable market by 2025. Further facilities will be required as the number of EVs being retired increases. 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.[130]

The (then) Government's response to the Committee's report, published on 11 January 2019, set out work underway to improve battery recycling:

> The Government agrees with the Committee that these areas offer significant industrial opportunities for the UK. 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". In 2018 Birmingham University, as part of the Faraday programme, has led several collaborative Research & Development projects involving leading UK recovery and recycling companies and events to bring science and industry together to identify what is required in order to realise this potential.
>
> Among the collaborative R&D projects funded by InnovateUK includes a project that will look at reusing, remanufacturing or recycling end-of-life, automotive lithium-ion batteries. It will support the building of a complete supply chain network, and the development of legal and regulatory knowledge on end-of-life batteries in the UK. This will help to optimise battery design and increase use in second-life applications, improve recyclability and whole-life environmental impact, whilst building UK capabilities.
>
> A further project will aim to create a safe, economically sustainable battery recycling supply chain in the UK, which allows industrial batteries from vehicles to be recycled into base components and materials and then reused.[131]

EV battery longevity varies between manufacturers but warranties are offered for between five and ten years and although capacity will decline over time, the battery will likely continue working beyond the warranty.[132] The average age of a vehicle on the road has increased, from 6.8 years in 2003 to 7.8 recorded in 2015.[133] This suggests that battery disposal rates are likely to be similar to normal vehicle disposal

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

131 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

132 EECA Business, *Electric vehicle battery life*, 11 May 2017

133 SMMT, *Average Vehicle Age* [accessed 19 February 2018]

rates. Some car manufacturers have announced plans for reusing or recycling batteries,[134] and in November 2017 the Government announced £40 million as part of the Industrial Strategy Challenge fund for 27 projects to make EV batteries longer lasting and cleaner.[135]

[134] "Nissan launches British-made home battery to rival Tesla's Powewall", *The Guardian,* 4 May 2017

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

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