Northern Ireland Assembly

Research and Information Service Research Paper

8 September 2021

Des McKibbin

A comparison of electric vehicle (EV) markets and policies to promote adoption in Europe

NIAR 203-2021

This paper considers the current state of the Electric Vehicle (EV) market in Europe. The main focus of the paper is on the key drivers of EV adoption in Europe's top EV markets with a particular focus on financial incentives, infrastructure development and supply side factors.

.

Paper 84/21 **8 September 2021**

Executive Summary

The transport sector was responsible for around 27% of greenhouse gas (GHG) emissions in the UK in 2020 and the main source of emissions from this sector is the use of petrol and diesel in road transport.

The UK is one of a growing number of governments to announce phase out targets for the sale of petrol and diesel cars and vans, with a view towards all cars and vans sold from 2035 being fully zero emission (at the tailpipe).

The EV market

There were 10 million electric cars on the world's roads at the end of 2020 with around 3 million new electric cars sold globally in 2020. This represents around 4.6% of all cars sold.

In 2020 Europe overtook China as the world's largest EV market for the first time, with one in every ten cars sold an EV. The majority of electric passenger cars on European roads were concentrated in Germany, Norway, the United Kingdom, France, and the Netherlands with a combined share of 70% of Europe's electric passenger car fleet.

While the electric car market is growing, they still make up only a small proportion of the total car fleet. Norway has the most advanced EV market with a 16% fleet share, the next best is Iceland with 5% while the UK is 1%. Northern Ireland has the smallest EV fleet of any of the UK regions with a 0.5% share. Norway's electric car sales are also increasing at the highest rate with EVs accounting for 72% of new car registrations in 2020.

While the advancement of EV markets in often measured in terms of new sales, it is important to note that used car sales generally account for around three quarters of the total car sales market in the UK. Used EV sales are increasing, but at a slower rate than new EV sales. Used BEV sales increased by 29.7% in 2020, this represents a 0.3% market share. Used diesel and petrol car transactions fell by -15.5% and -15.2% respectively, yet combined this totalled 6.6 million transactions.

Phase out targets for EV

Many Governments, including the UK, have announced plans to phase out vehicles with internal combustion engines (ICE). These plans have appeared in national policy documents/announcements and have yet to be set in regulation.

The European Commission (EC) first introduced mandatory emission standards for passenger cars across the EU/Iceland/Norway/UK in 2009. These have resulted in the CO2 emissions from petrol and diesel cars falling gradually. However, it is now likely that the EC will lower its current emission standards to effect a ban on new petrol and diesel cars and vans from 2035 across the EU.

Regulating for EV post Brexit

The existing EU regulations were retained in UK law following Brexit. However, the UK has committed to phasing out new petrol and diesel cars and vans by 2030, something which it could not achieve under the current framework. It is now consulting on regulations that will see the UK move away from the retained EU framework.

The UK Government's preferred option for regulation is to update the regulations with more ambitious targets for zero emissions to run alongside a zero emission vehicle (ZEV) mandate. This would require car manufacturers to sell an increasing proportion of ZEVs over the next decade, reaching 100% by 2030. The main advantages with ZEV mandate are that it would:

- be revenue neutral;
- provide certainty to allow manufacturers to invest in the UK and supply a sufficient volume of ZEVs to meet the UK's decarbonisation commitments;
- reduce costs for consumers by increasing the supply of electric vehicles; and
- free taxpayers from the annual £135 million cost of the plug-in car grant.

Incentives for EV

Countries such as the Netherlands, Norway and Denmark have high taxation on cars, which makes it possible to incentivise EVs through taxation benefits. France and Germany have, on the other hand, much lower overall taxation on cars and focus on providing attractive subsidies to bring the purchase cost of EVs in line with ICE alternatives.

The UK Government, via the Office for Zero Emission Vehicles (OZEV), offers a plug-in car grant (PiCG). This is a £2,500 grant intended to off-set the higher purchase price of EV in the UK. The grant has reduced over the last decade in line with market adjustments and the UK Government expects to phase out the grant as the EV market develops even further. At present, the OZEV is committing to providing the grant to 2022-23.

The UK Government does not provide any incentives for the purchase of used EV. It has stated that current incentives are sufficient to support the development of the second-hand EV market by increasing supply thereby driving down prices. The House of Commons Transport Select Committee has pointed out that *"…a healthy used electric vehicle market is critical to ensuring that electric vehicles are not the sole preserve of people who can afford new models."* [1]

It cited the example of grants for used cars that have recently been introduced in the Netherlands, France and Germany. These are three of the top EV markets in Europe. It

[1] House of Commons, Zero Emission Vehicles, Transport Committee, July 2021

also cited the Low Carbon Transport Loan (LCTL) in Scotland which provides £20,000, to be repaid over 5 years, to support the purchase of used EV.

Infrastructure

The transition from ICE cars and vans to ZEVs will depend on the timely roll-out of accessible and reliable charging infrastructure. Along with purchase price, a perceived inability to charge en route, due to poor infrastructure provision is a leading barrier to EV uptake according to numerous surveys.

There is uneven geographical distribution of charging devices within the UK. Some UK local authorities have bid for UK Government funding for charging devices, and others have not. Most of the provision of this infrastructure has been market-led, with individual charging networks and other businesses (such as hotels) choosing where to install devices.

A Committee for Climate Change (CCC) progress report to Parliament recommended that the Government should ensure the provision of 150,000 public charge points by 2025 with another report suggesting 400,000 would be needed by 2030. This will require private sector investment of between £5-10 billion alongside the Government's £1.3 billion.

As of January 2021 NI had 320 public charging points, the lowest number of both standard (300) and rapid charging points (20) of any UK region, and represents a ratio of 17 and 1.1 per 100,000 people respectively. The ratio of charging points per 100,000 is also the lowest of the UK regions. Analysis by the CCC on the need for charging points in NI suggests between 30 to 35 public rapid chargers will be required on major roads, and 800 to 950 public top-up chargers will be required by 2030. As an indication of the possible technology cost in Northern Ireland, National Grid has estimated that to upgrade 50 motorway sites with sufficient power to accommodate 350 kW rapid chargers could cost between £500 million and £1 billion in the UK (£10-20 million per site).

Among European countries in 2020, the most public recharging points were available in the Netherlands, followed by Germany and the UK. The EC recommends one public recharging point per ten electric vehicles. However, there is a wide variation among the European countries assessed in this paper. Iceland has the ratio that is the lowest, with 39 electric vehicles per public recharging point, Norway is next with 24: 1 charging points. Ireland and NI are some way off the 10 charging points per BEV with 19 and 18 respectively while the UK is closer to the recommended coverage with 13.

Wales has around the same level of EV ownership as Northern Ireland, with both regions lagging behind Scotland and England. In order to increase public confidence in EVs, the Welsh Government published the Electric Vehicle Charging Strategy for Wales in March 2020. The strategy sets out a vision for electric vehicle charging in

Wales, that "…by 2025, all users of electric cars and vans in Wales are confident that they can access electric vehicle charging infrastructure when and where they need it".

The strategy includes a modelled prediction of the number of chargers that could be needed, and the types of chargers needed for each local authority across Wales, based on a number of variables including forthcoming bans, traffic levels and travel demand in Wales it predicts the need for a substantial increase in the number of slow, fast and rapid/ultra-rapid chargers available in Wales.

Supply-side factors

For BEVs, the increase in registrations strongly correlates with the introduction of new models, improved range and more affordable options. Worldwide about 370 electric car models were available in 2020, a 40% increase from 2019.

The average driving range of new BEVs has been steadily increasing. In 2020, the weighted average range for a new battery electric car was about 350 kilometres (km), up from 200 km in 2015. The average electric range of plug-in hybrid electric vehicle (PHEV) has remained relatively constant at about 50 km over the past few years. The widest variety of models and the biggest expansion in 2020 was in the sports utility vehicle (SUV) segment. More than 55% of announced models worldwide are SUVs and pick-ups.

In addition to increased choice and range perhaps the key factor in the mass transition to EV will be the point at which EV prices reach parity with petrol and diesel alternatives. Industry analysis suggest cost parity could be reached between 2025-27 due to falling battery prices and the development of optimized platforms that result in the rapid decline in BEV costs. An optimal vehicle design, produced in high volumes, can be more than a third cheaper by 2025 compared to now.

The analysis suggests that a menu of policy interventions, including tighter emissions rules, carbon taxes, and extensive geographic coverage of charging networks remain critical for consumer buy-in while policies that stimulate early adoption can generate consumer buy-ins and bring down costs.

Glossary

The paper refers to Electric Vehicles (EV); this is a collective term for one or a combination of:

- Battery Electric Vehicles (BEVs), or 'pure electric' vehicles, which use the battery as the only power source; and
- Plug-in hybrid electric vehicles (PHEVs), which switch between a battery and an internal combustion engine (ICE). These typically have a smaller battery and a lower zero emission range.
- 'Zero emission vehicle' (ZEV) are vehicles that produces zero CO2 or nitrogen oxides (NOX) from the exhaust when driving.
- Ultra Low Emission Vehicles (ULEV) are vehicles that are reported to 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.

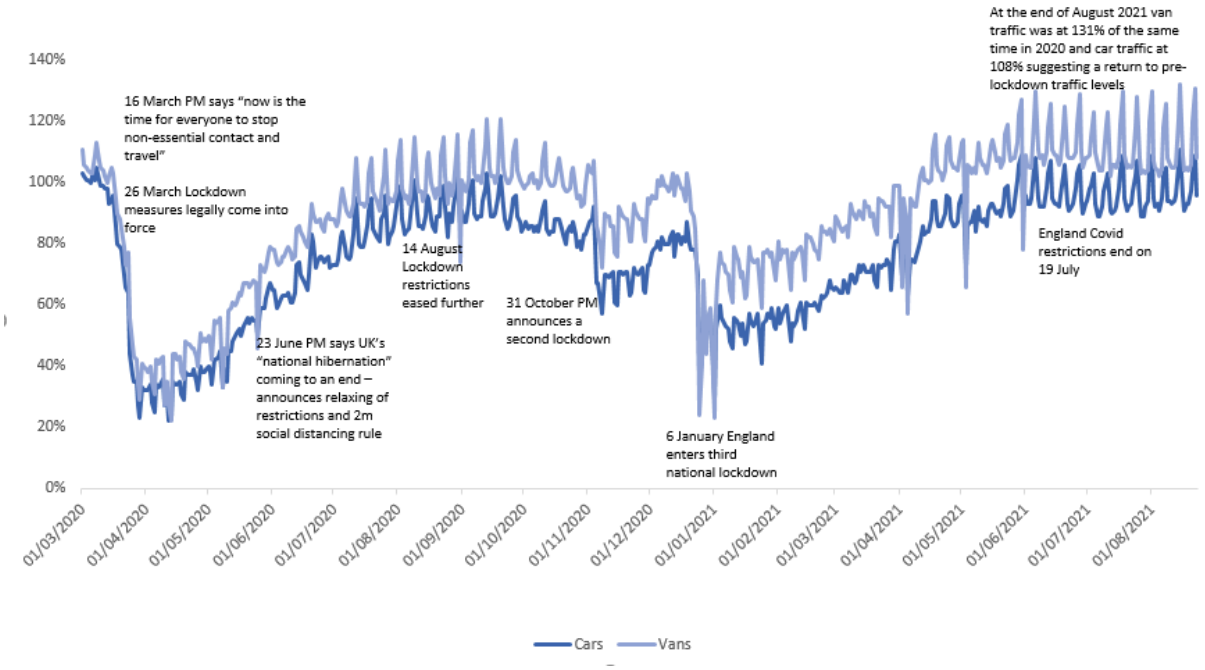
Contents

1 Introduction and context

The transport sector was responsible for around 27% of greenhouse gas (GHG) emissions in the UK in 2019 and the main source of emissions from this sector is the use of petrol and diesel in road transport.[2]

The extent to which road transport contributes to emissions was clearly demonstrated in 2020, when the coronavirus (COVID-19) pandemic (the pandemic) and the resulting restrictions brought in across the UK, greatly reduced the demand for travel, resulting in a 10.7% drop in carbon dioxide (CO2) emissions.[3] Overall, across 2020, carbon dioxide emissions in the transport sector fell by an estimated 19.6%, but it remained the largest emitting sector in the UK, accounting for 29.8% of carbon dioxide emissions in 2020.

Figure 1 Use of cars and vans: Great Britain, since 1 March 2020



Source: DfT and Institute for Government

Vehicle usage figures from the Department for Transport (DfT) show that since the lifting of lockdown restrictions in England, both car and van traffic has returned to post lockdown levels (figure one). There had been a suggestion that behaviours such as working from home and increased levels of walking and cycling may contribute to a reduced demand for road transport.[4] However, this does not appear to be the case at this point.[5]

[2] DfBEI, 2019 UK Greenhouse Gas Emissions, Final Figures, February 2021
[3] DfBEI, 2020 UK greenhouse gas emissions, provisional figures, March 2021
[4] IEA, Changes in transport behaviour during the Covid-19 crisis. May 2020
[5] DfT, Transport use during the coronavirus (COVID-19) pandemic, August 2021

Policies that encourage behavioural change are at the centre of the UK Government's plans to decarbonise road transport. For example, in the *Transport Decarbonisation Plan*, the UK Government has committed to investing £2 billion over five years with the aim that half of all journeys in towns and cities will be cycled or walked by 2030.[6]

Another key component of this policy is the phasing out of the Internal Combustion Engine (ICE). The UK is one of a growing number of countries to announce phase out targets for the sale of ICE vehicles; the sale of new petrol and diesel cars and vans will be prohibited from 2030, with the sale of new plug-in hybrid (PHEV) vehicles banned from 2035. This means all new cars and vans sold from 2035 will be fully zero emission (at the tailpipe).[7] The *Transport Decarbonisation Plan* indicates this ban will widen to cover motorbikes and HGV vehicles by 2040.[8]

The electric car market has been slowly developing around the world since 2010. The number of battery-electric vehicles (BEV) and PHEV on the road is still small but steadily increasing as vehicle manufactures launch an increasing range of models, public charging infrastructures expand and governments worldwide fund multiple demonstrations and pilots, and create framework conditions and incentives for the purchase and use of electric vehicles.[9]

In addition to Government interventions such as subsidies and infrastructure provision, the growth in the global EV market may also be a result of supply side factors, particularly an increase in the range of new models available, as well as improved range and relative purchase cost reductions.

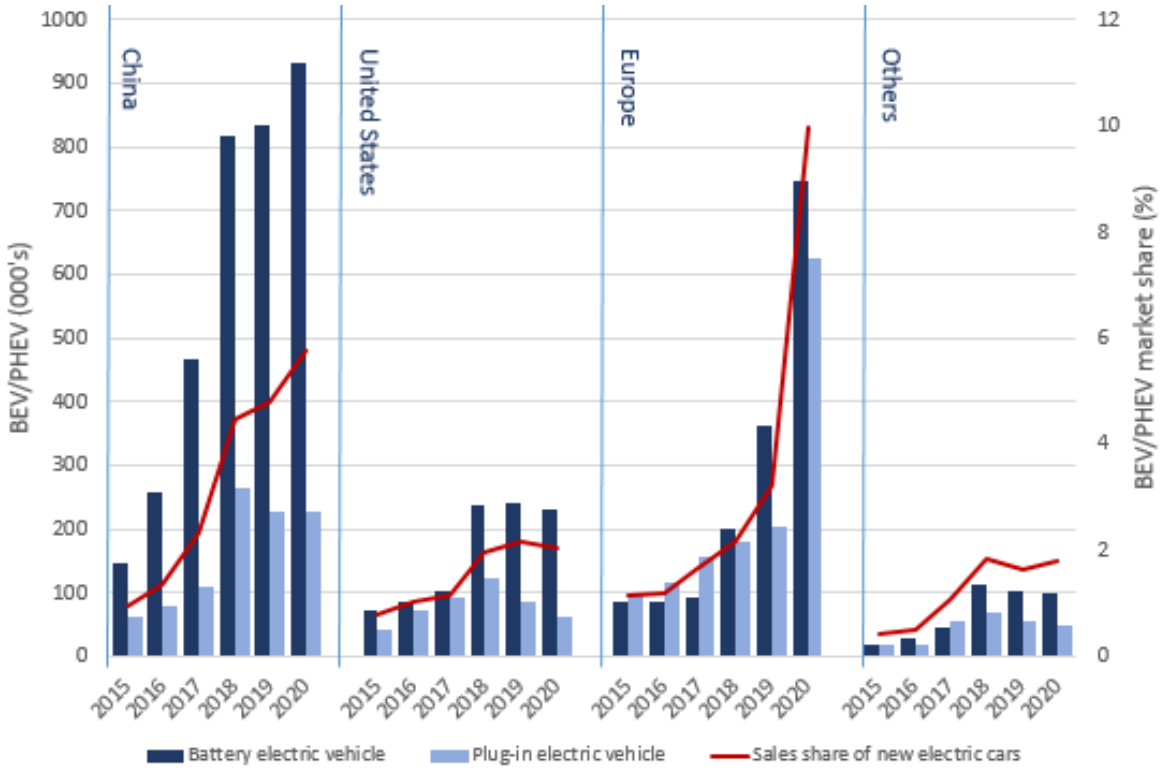
This paper considers the current state of the global EV market. It particularly focuses on the European BEV and PHEV market and explores the key drivers of EV adoption in Europe's top EV markets with a particular focus on financial incentives, infrastructure development and supply side factors.

2.0 Electric car market – a global comparison

The International Energy Agency's (IEA) Global EV Outlook (2021) reported there were 10 million electric cars on the world's roads at the end of 2020.[10] In total around 3 million electric cars were sold globally in 2020, representing around 4.6% of all cars sold. In a year where restrictions brought about by the pandemic saw car sales fall by 16%, electric car registrations increased by 41%. In 2020 Europe overtook the China as the world's largest electric vehicle (EV) market for the first time, with one in every ten cars sold a BEV/PHEV.

[6] DfT, Decarbonising Transport Plan, July 2021
[7] UK Government, Government takes historic step towards net-zero with end of sale of new petrol and diesel cars by 2030, November 2020
[8] DfT, Decarbonising Transport Plan, July 2021
[9] European Commission, Electrification of the Transport System, June 2017
[10] IEA, Global EV Outlook 2021, April 2021

Figure 2 Global electric car registrations and market share, 2015-2020



Source: International Energy Agency 2021

The number of new Battery Electric Vehicles (BEV) registered in Europe in 2020 was more than double the number registered in 2019. The sales of hybrids (PHEV) also soared in this period (by 206%). The IEA (2021) suggest that while car sales in other regions were hurt by the economic conditions brought on by the pandemic, increased purchase incentives and (temporary) pandemic related stimulus packages (for the auto industry), notably in Germany, France and Italy drove electric car sales in Europe.[11]

For example, the German Government temporarily increased the subsidy available by €3,000,[12] [13] the subsidy available in France increased from €6,000 to €7,000 while it also introduced a scrappage bonus for low-to middle-income households.[14] [15] Italy introduced a suite of temporary stimulus packages that were successful in driving EV sales including increased subsidies for BEV and PHEV as well as a scrappage bonus.[16]

[11] IEA, Global EV Outlook 2021, Policies to promote electric vehicle deployment, April 2021
[12] Fred Lambert, Germany boosts EV incentives to ~$10,000, helping Tesla Model 3 and VW ID.3, electrek, 4 June 2020 [online] accessed 25/07/2021
[13] IEA, Promoting vehicle efficiency and electrification through stimulus packages, November 2020
[14] economie.gouv.fr, The ecological transition at the heart of the automotive support plan
[15] IEA, Promoting vehicle efficiency and electrification through stimulus packages, November 2020
[16] ibid

2.1 Electric Cars in Europe

By the end of 2020, 1% of passenger cars driving on European roads were electric, (for the purposes if this paper Europe refers to the 27 EU European Member States, the United Kingdom and the EFTA Member States: Iceland, Liechtenstein, Norway and Switzerland.)

The majority of electric passenger cars on European roads were concentrated in Germany, Norway, the United Kingdom, France, and the Netherlands with a combined share of 70% of Europe's electric passenger car fleet. The German electric car fleet was the largest, consisting of almost 600,000 vehicles, followed by Norway with over 450,000 electric cars, the United Kingdom with just under 450,000, France (almost 410,000) and the Netherlands (almost 280,000 electric cars).[17]

As a share of the total fleet, Norway has the most advanced EV market with 16% of the total passenger car fleet being either a BEV or PHEV by the end of 2020. Norway's electric car sales are also increasing at the highest rate with BEV accounting for 52% of new car registrations in 2020, while a further 20% were PHEV.

Table one shows Norway is the only country in Europe where BEV/PHEV make up more than 10% of the total fleet (16.3% collectively). There is a notable drop to the second and third largest EV markets in Europe, Iceland and the Netherlands, where although BEV/PHEV sales are relatively high, compared to other countries, fleet share is low with EV making up a 6% and 3% share of the total fleet respectively.

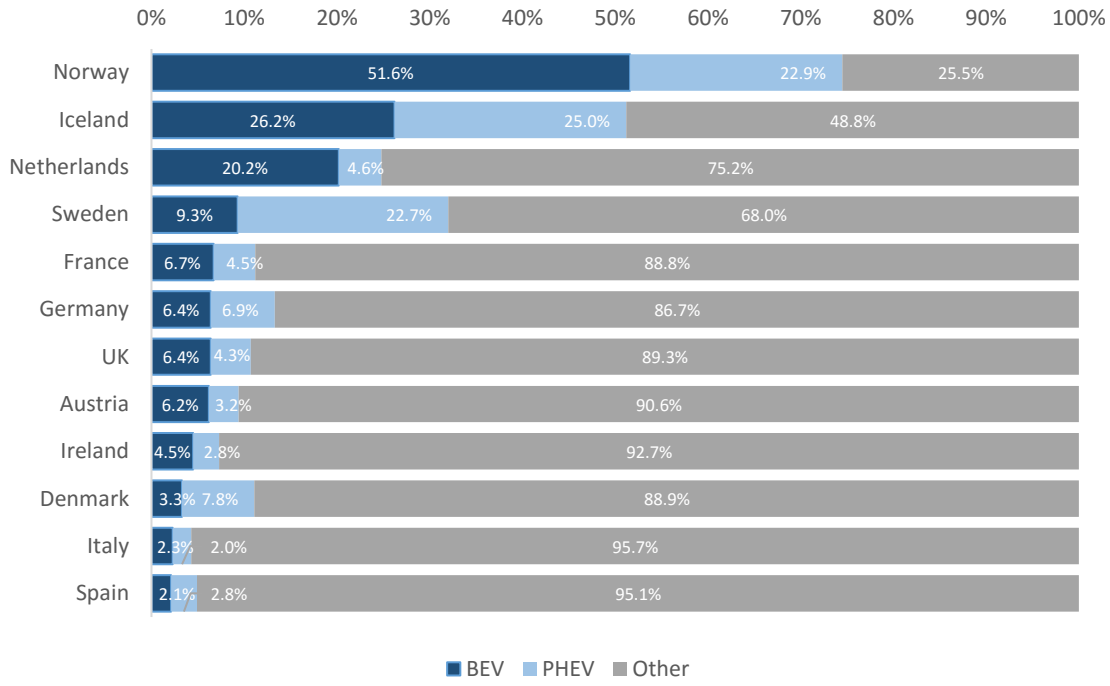
Table 1: Market share of new BEV/PHEV and share of total vehicle fleet

Country	market share new registrations 2020		% total Fleet 2020	
	BEV	PHEV	BEV	PHEV
Norway	51.6%	22.9%	11.4%	4.69%
Iceland	26.2%	25.0%	1.99%	3.51%
Netherlands	20.2%	4.6%	2.01%	1.17%
Sweden	9.3%	22.7%	1.14%	2.6%
France	6.7%	4.5%	0.87%	0.42%
Germany	6.4%	6.9%	0.64%	0.59%
UK	6.4%	4.3%	0.64%	0.74%
Austria	6.2%	3.2%	0.82%	0.29%
Ireland	4.5%	2.8%	0.5%	0.43%
Denmark	3.3%	7.8%	0.56%	1.25%
Italy	2.3%	2.0%	0.14%	0.11%
Spain	2.1%	2.8%	0.18%	0.18%

Source: European Alternative Fuel Observatory

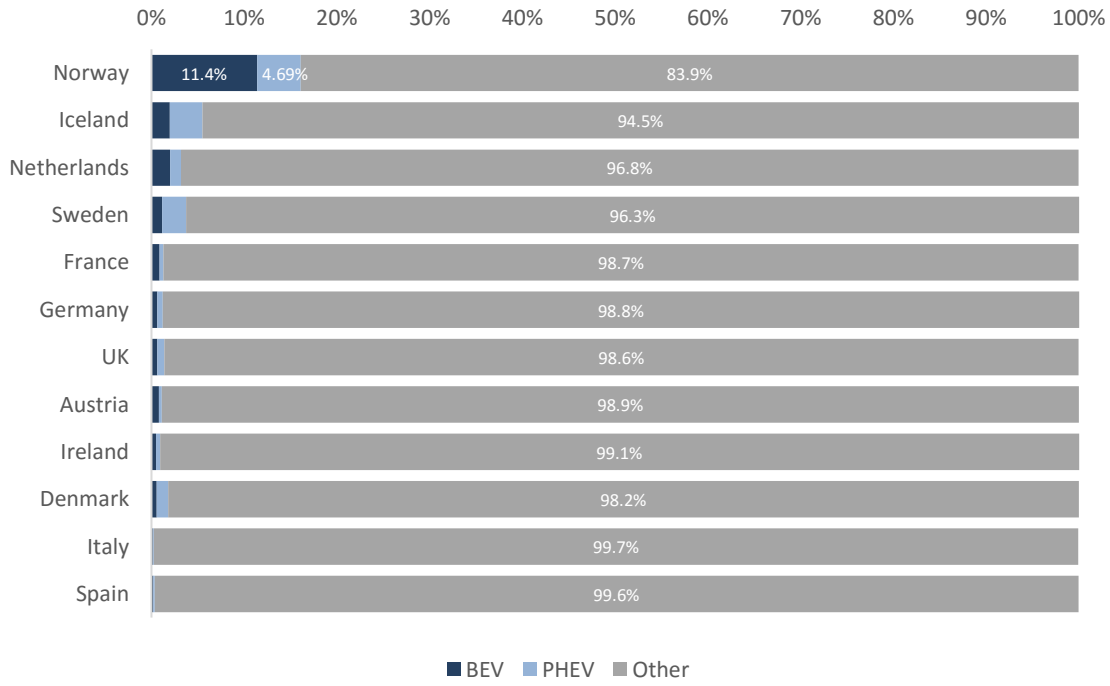
[17] European Alternative Fuels Observatory, On the electrification path: Europe's progress towards clean transportation, March 2021

Figure 3: Market share of new BEV/PHEV versus other fuel types, selected countries 2020



Source: European Alternative Fuel Observatory

Figure 4. BEV/PHEV Share of total vehicle fleet versus other fuel types, selected countries 2020



Source: European Alternative Fuel Observatory

Table 2: Top five countries e-car fleet total, share of total fleet (%), total new registrations and share of all registrations 2020.

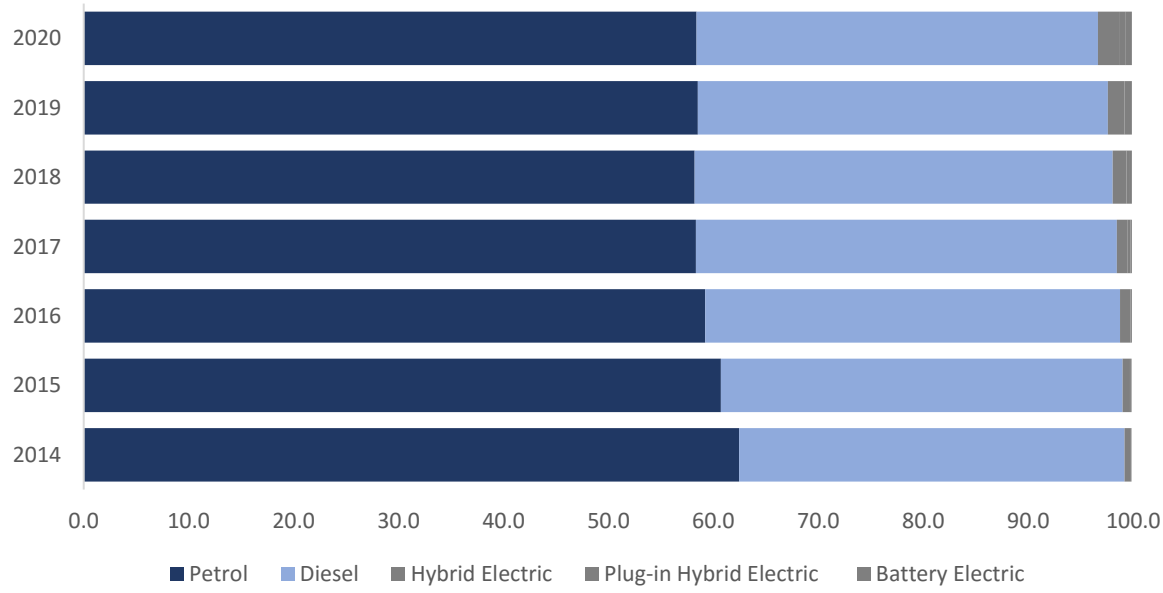
Geographical Area	Electric passenger car fleet total 2020	Electric passenger car fleet share 2020	Electric passenger car registrations share 2020	Electric passenger car registration share 2020
EU-27 Member States, United Kingdom, Norway, Iceland, Liechtenstein, Switzerland	1. Germany 2. Norway 3. United Kingdom 4. France 5. Netherlands *Covering 70% of the electric car fleet*	1. Norway 16% 2. Iceland 6% 3. Sweden 4% 4. Netherlands 3% 5. Denmark 2%	1. Germany 2. France 3. United Kingdom 4. Norway 5. Sweden *Covering 70% of electric car registrations*	1. Norway 75% 2. Iceland 51% 3. Sweden 32% 4. Netherlands 25% 5. Finland 18%

Source: European Alternative Fuel Observatory

2.2 Electric cars in the UK

Table two shows that in terms of numbers the UK has the third largest EV fleet in Europe. However, proportionally it sits in sixth place with just over 1% of the total fleet made up of either BEV or PHEV vehicles.

Figure 5: Licensed vehicles by propulsion or fuel type: UK 2014-2020 (Percentage)



Source: DfT, VEH0203: Licensed cars by propulsion or fuel type: Great Britain and United Kingdom

At the end of 2020 NI had the smallest ULEV fleet of the UK's main devolved regions (0.49%), slightly less than Wales (0.52%) and less than half the size of Scotland (1.04%) and England (1.43%) (table three).

Table 3: Total cars and ULEV licensed in England and ULEV share of all cars at the end of 2020

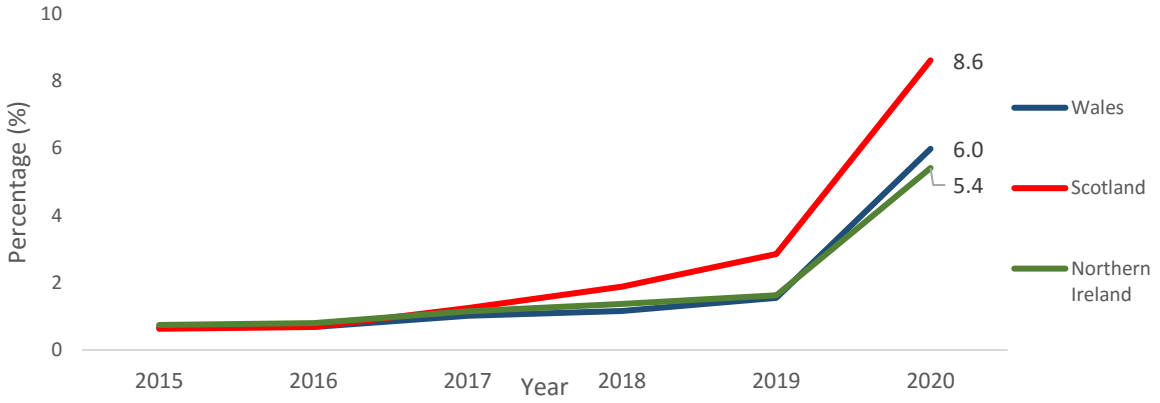
	Total Cars	Total ULEV	ULEV share of total (%)
England	27,036,100	385,980	1.43
Scotland	2,519,800	26,189	1.04
Wales	1,579,200	8,163	0.52
NI	990,300	4,818	0.49

Source: DfT, Tables VEH0132a and VEH0105

Department for Transport (DfT) statistics show that the market share for EV in the UK is increasing year-on-year. In 2020,

- 181,090 ULEVs were registered for the first time in the United Kingdom, an increase of 125% on 2019 and 183% on 2018.
- Battery Electric Vehicles (BEVs) accounted for 64% of new ULEV registrations in 2020, which has increased from 54% in 2019 and 28% in 2018.
- Plug-in Hybrid Electric Vehicles (PHEVs) accounted for 35% of new ULEV registrations in 2020, which has decreased from 43% in 2019 and 65% in 2018.
- Among the three devolved regions, Scotland has the fastest growing market. In 2020 ULEVs were at 8.6% market share, compared to Wales 6% and NI 5.4%.[18]
- It should be noted that pandemic conditions contributed to significant reductions in new car registration in each of the devolved regions: Wales -25%, Scotland -28% and Northern Ireland -30%.[19] However, ULEV sales increased as a proportion of all sales (figure four).

Figure 6: Ultra low emission vehicles registered for the first time as a percentage all new vehicles in Wales, Scotland and NI, 2015-2020



Source: DfT, VEH0172: Ultra low emission vehicles registered for the first time by region: United Kingdom and VEH0204: Licensed cars, by region: Great Britain and United Kingdom

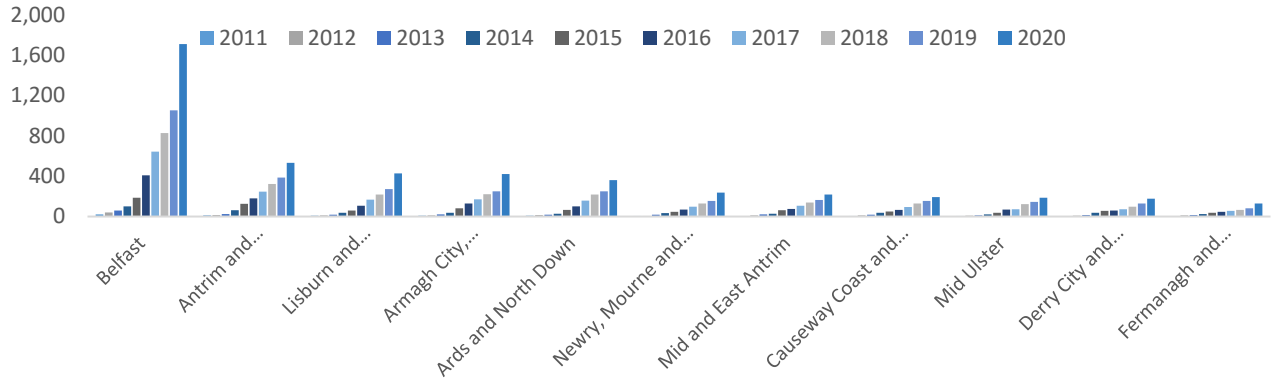
[18] DfT, Table VEH0172: Ultra low emission vehicles registered for the first time by region: United Kingdom, May 2021
[19] DfT, Table VEH0204: Licensed cars, by region: Great Britain and United Kingdom, May 2021

2.2.1 Electric cars in Northern Ireland

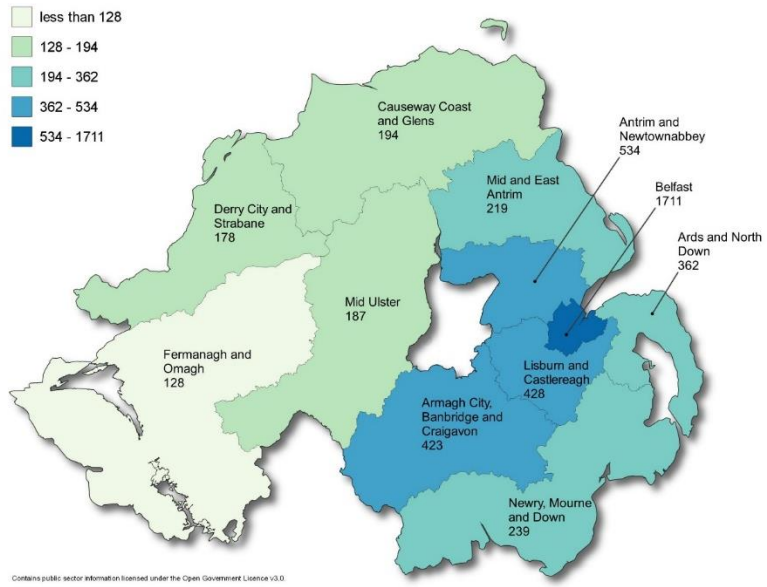
Despite the pandemic and an overall drop in new car registrations in 2020, Northern Ireland recorded its highest ever number (1,946) of newly licensed ULEV, a 134% increase on the number (831) licensed in 2019.[20] At the end of 2020 there were 4,818 ULEV in NI. This has risen significantly in the first quarter of 2021 to 5,602 (+16%). However, ULEV account for only 0.5% of the total fleet.

The ULEV market has grown in all LGDs over the last 10 years, albeit at different rates. Figure five and map one show Belfast has the highest number of ULEV in NI. Causeway Coast and Glens had only the 8th highest number of ULEV in 2020 but it has the highest share of ULEV among licensed vehicles, 2.5% compared to 1.2% in Belfast which has the second highest share.[21]

Figure 7: Ultra low emission vehicles (ULEVs) licensed at the end of 2011-20 by NI LGD



Map 1: Ultra low emission vehicles (ULEVs) licensed at the end of 2020 by NI LGD



NI LGD	ULEV share of fleet (%)
Causeway Coast and Glens	2.5
Belfast	1.2
Antrim and Newtownabbey	0.7
Lisburn and Castlereagh	0.5
Ards and North Down	0.4
Armagh City, Banbridge and Craigavon	0.4
Mid and East Antrim	0.3
Newry, Mourne and Down	0.2
Derry City and Strabane	0.2
Mid Ulster	0.2
Fermanagh and Omagh	0.2

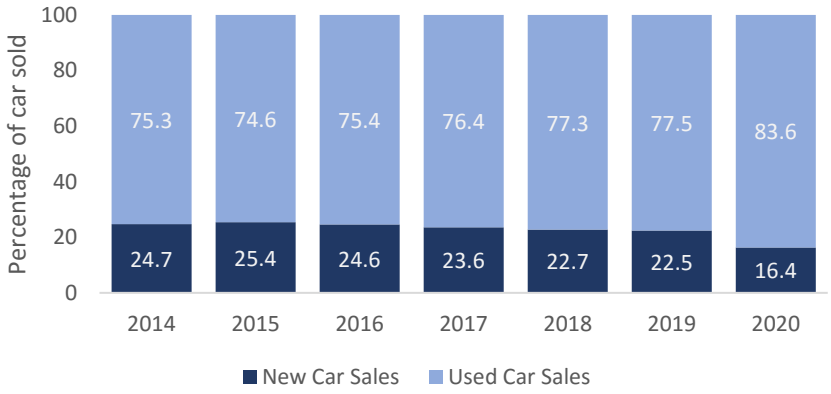
Source: DfT, Tables VEH0132a and VEH0105

[20] DfT, Table VEH0172
[21] DfT, Tables VEH0132a and VEH0105

2.3 Used Cars

While the advancement of EV markets is often measured in terms of new sales, it is important to note that used car sales generally account for around three quarters of the total car sales market in the UK. For example, in 2019 there were 2.3 million (22%) new cars registered compared with 7.9 million (78%) used car transactions.[22] Pandemic conditions brought about a drop in new car sales in 2020 with 1.32m units sold, a 43% decrease on 2019, while used car transactions also fell by 15%.[23]

Figure 8: New car vs used car sales, UK 2014 - 2020



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

According to The Society of Motor Manufacturers and Traders (SMMT), while used car sales fell in 2020, the market share for 'alternatively fuelled vehicles' (AFVs) increased. 144,225 used AFVs were sold during 2020, *"an increase of 5.2%, with their market share rising to 2.1%"*. Used BEV sales increased by 29.7% on 2019 to 19,184 units (0.3%). The market for hybrids (HEVs) also rose, by 4.7%, while demand for plug-in hybrids (PHEVs) fell by -5.0%. Used diesel and petrol car transactions fell by -15.5% and -15.2% respectively, yet combined they still accounted for 6.6 million cars.[24]

In terms of the number of units sold the used AFV market is growing albeit at a slower rate than the new car market. This could be a result of more cars becoming available as early EV adopters are now changing their vehicle while it may also represent a growing acceptance that AFV are a viable alternative to petrol and diesel vehicles.

An additional factor that could potentially affect EV sales in the coming years, even post-2030, is the lifespan of time ICE vehicles. 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 the average life of light commercial vehicles is 12.9 years.[25] This means the average ICE car sold in 2029 will still be on the road in 2044. Indeed, as technology develops between now and the ban, it is possible many of these vehicles could remain on the road up to 2050 and beyond.

[22] David Hirst, et al. Electric Vehicles and Infrastructure, House of Commons Library, June 2021
[23] SMMT, Used car Sales: Q4 2020, February 2021
[24] Ibid.
[25] David Hirst, et al. Electric Vehicles and Infrastructure, House of Commons Library, June 2021

3 Phase out targets

Many governments view vehicle electrification as a critical factor in reducing CO2 emissions from the transportation sector. This has prompted a number of them to announce plans to phase out vehicles with internal combustion engines (ICE)[26]. These phase-out targets relate to both conventional petrol and diesel cars as well as PHEV vehicles. These phase-out commitments apply to the sale of new vehicles and not vehicles already on the road, but given the average lifespan of most cars and vans is around 15 years, it can be expected most cars and vans will be fully zero emission by 2050:

- Norway's 2017 Transport Plan states that sales of passenger cars and light vans shall be zero-emissions from 2025 onwards.
- Denmark's 2018 Climate and Air Plan, set a 2030 target to stop sales of new petrol and diesel cars and a 2035 goal to ban new PHEVs.
- Ireland's 2019 Climate Action Plan proposes banning the sale of new fossil-fuelled cars and vans from 2030.
- The Netherland's 2019 Climate Agreement set 2030 as the latest point for requiring 100% emission-free new passenger cars.
- Scotland's Climate Change Plan indicates the Government's intention to 'phase out the need' to buy petrol or diesel cars by 2032.
- In November 2020 the UK Prime Minister announced that the sale of new petrol and diesel cars and vans will be prohibited from 2030, with new PHEV sales banned from 2035.[27]

These goals are mostly set out in official national policy documents rather than legislation. To date, France is the only European country to write its phase-out target for ICE cars into law. The Mobility Guidance Law adopted in December 2019 establishes the objective of carbon neutrality for land transport by 2050 into law. It includes provisions for a ban on new fossil-fuelled cars (petrol or diesel) by 2040, and targets for increasing public charging stations (by five times) by 2022.

For EU Member States there has been a question around the proposed prohibitions compatibility with EC law. For example, the Irish Government had indicated its intention to set its phase out targets into law through the Climate Action Amendment Bill 2021[28] However, when the Bill was published it did not include reference to the ban for this reason.[29] The Climate Action and Low Carbon Development (Amendment) Act 2021 was signed into law in July 2021. The act does include a binding commitment to a 51% reduction in emissions by 2030 and to have a carbon neutral economy (essentially

[26] The International Council on Clean Transportation, The end of the road? An overview of combustion engine car phase-out announcements across Europe, May 2020
[27] UK Government, Government takes historic step towards net-zero with end of sale of new petrol and diesel cars by 2030, November 2020
[28] Lee, G., Ban on new fossil fuel cars in Ireland by 2030 under proposed Bill, RTE News, Jan 6 2020
[29] Lee, G., Ban on sale of petrol, diesel cars from 2030 not in new Climate Action Bil, RTE News, Oct 7 2020

have net zero emissions) no later than 2050.[30] The Government has also reiterated its commitment to its phase-out target.[31]

3.1 Emission standards in law

The EU introduced mandatory CO2 standards for passenger cars in 2009, after a voluntary commitment by the auto industry to reduce emissions had failed to produce adequate results.[32] These fleet-wide average CO2 emissions targets were mandatory for the entirety of the EU + Norway + Iceland new car fleet. Similar regulations were adopted for vans in 2011.[33]

CO2 emissions of new cars and vans in the UK were regulated by EU law (Regulation 2019/631) until the end of 2020. In 2020, a fleet-wide average emissions target of 95g CO2/km applied to the entirety of the EU/Iceland/Norway/UK new car fleet, down from 130g CO_2/km in 2019. These targets are set be reduced further:

- By 2025, the new car and new van fleet will be required to reduce CO2 emissions by an additional 15% compared to the 2021 baseline.
- By 2030, new cars will be required to reduce CO2 emissions by 37.5%, and new vans by 31%, against the 2021 baseline.
- No additional targets or vehicle requirements currently apply beyond the 2030 targets.

It is likely now that the European Commission will further amend its emission targets in view of a growing consensus among member states that a 2030-35 cut off for new petrol and diesel cars/vans should be implemented.[34] The EC tabled proposals to prohibit the sales of ICE vehicles from 2035 (on Wednesday July 14, 2021).[35] These proposals indicate that achieving these targets *"would mean that by 2050, almost 100% of cars on the roads in 2050 could be emissions free".*[36]

3.1.1 Current UK Regulations

Following the end of the EU transition period, vehicles registered for use in Great Britain (GB) became subject to domestic fleet-wide CO2 emissions targets that must be met by the entirety of the GB new car and new van fleet.[37] The existing EU regulations were retained in UK law and came into force on 1 January 2021.Vehicles in Northern Ireland were due to continue to be subject to EU targets as a result of the Northern Ireland Protocol. However, following the removal of relevant provisions from the

[30] Department of the Environment, Climate and Communications, Ireland's ambitious Climate Act signed into law, July 2021
[31] Lee, G., Ban on new fossil fuel cars in Ireland by 2030 under proposed Bill, RTE News, Jan 6 2020
[32] ICCT, CO2 emissions standards for passenger cars and light commercial vehicles in the European Union, January 2019
[33] Ibid,
[34] Euractiv, Denmark calls for EU plan to phase out diesel and petrol cars, October 7, 2019 [online] accessed 1 August 2021
[35] European Commission, European Green Deal: Commission proposes transformation of EU economy and society to meet climate ambitions, Press release, 14 July 2021
[36] Carroll, S. EU signals end of internal combustion engine by 2035, EURACTIV.com, accessed 14 July 2021
[37] DfT, The Green Paper on a New Road Vehicle CO2 Emissions Regulatory Framework for the United Kingdom, July 2021

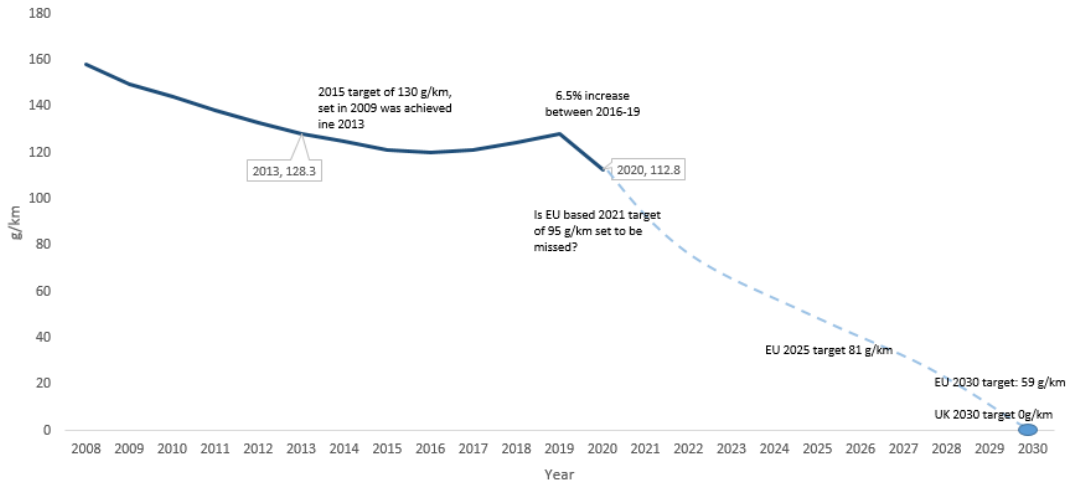
Northern Ireland Protocol last December, EU targets do not apply in Northern Ireland. New legislation (forthcoming) will apply the GB regime to vehicles in Northern Ireland.[38]

3.1.2 Proposed UK regulation

As mentioned above, the UK has committed to phasing out new petrol and diesel cars and vans by 2030, with all new cars and vans being zero emission by 2035. The retained version of the EU regulations alone will not deliver this as they currently only require a 37.5% CO2 reduction for cars by 2030, and a 31% CO2 reduction for vans. Using the current 2021 CO2 target of 95 g/km as the baseline, these reductions would translate into a target value for new vehicles of 59 g/km by 2030.[39]

Figure seven shows the average emissions of CO2 from new cars in the UK from 2008-2020. The average fell steadily between 2008 and 2016, exceeding EU targets (130 g/km by 2015) earlier than planned. However, average emissions increased steadily between 2016-19, reaching 127.9 g/km, just below the EU target of 130 g/km from a low of 120 g/km. By 2021, this figure needs to decrease to 95 grams per kilometer to be in accord with the EU target.[40]

Figure 9: Average CO2 emissions from new cars, UK 2008-2020 (incl. past and future targets)



Source: DfT: VEH0156

The UK Government is currently consulting on the proposed regulatory framework for the UK with regard to all newly sold road vehicles that will enable it to deliver on its ICE phase-out commitments. The Green Paper on a New Road Vehicle CO2 Emissions Regulatory Framework for the United Kingdom was published for consultation in July 2021, this closes on 22 September 2021. The consultation puts forward two approaches to regulating for the ICE ban: either continue with the current framework with more ambitious efficiency targets or introduce a UK zero emission vehicle (ZEV)

[38] DfT, The Green Paper on a New Road Vehicle CO2 Emissions Regulatory Framework for the United Kingdom, July 2021
[39] ICCT, CO2 emissions standards for passenger cars and light commercial vehicles in the European Union, January 2019
[40] DfT, Provisional average reported CO2 emissions figure of vehicles registered for the first time by body type and data source, monthly: Great Britain and United Kingdom, July 2021

mandate alongside CO2 regulations. The UK Government stated that a ZEV mandate combined with a CO2 emissions target is its preferred option.[41]

3.1.3 ZEV mandate

A ZEV mandate would require car manufacturers to sell an increasing proportion of ZEVs over the next decade, reaching 100% by 2030.[42] The House of Commons (HOC) Transport Select Committee (TSC) recently published the findings of its inquiry into zero emission vehicles. It heard evidence that a ZEV mandate *"would be a cost-effective way in which to support the uptake of ZEVs compared with taxpayer-funded incentives."* It was suggested that *"a ZEV mandate would encourage global vehicle manufacturers to invest in electric vehicle production for the UK market, increasing vehicle supply, which in turn would reduce the cost of those vehicles for the consumer."*

The Government has until now used taxpayers' money to stimulate the ZEV market. However, incentives such as the plug-in car grant are going to be phased out in the coming years.[43] The main advantages with ZEV mandate are that it would:

- be revenue neutral;
- provide certainty to allow manufacturers to invest in the UK and supply a sufficient volume of ZEVs to meet the UK's decarbonisation commitments;
- reduce costs for consumers by increasing the supply of electric vehicles; and
- free taxpayers from the annual £135 million cost of the plug-in car grant.

The TSC has stated that *"in order to achieve its 2030 and 2035 targets, the Government must introduce a ZEV mandate to incentivise manufacturers to sell an increasing proportion of ZEVs, reaching some 100% ZEV sales by 2030."*[44]

4 Measures to encourage uptake of EVs

A key question for governments regarding the transition to EV is what government supports are needed, how long should they be offered, and how long can they be offered when weighed against other spending priorities. There is no doubt that early adopters of EV, particularly the Nordic countries such as Norway, successfully incentivised the transition to EV with a combination of fiscal mechanisms to off-set high purchase prices whilst also alleviating common anxieties such as range with sustained investment in infrastructure.[45] However, as shown above it is likely that this approach will be phased out in the coming years as the purchase price of EV reach parity with

[41] DfT, The Green Paper on a New Road Vehicle CO2 Emissions Regulatory Framework for the United Kingdom, July 2021 p.28
[42] House of Commons, Zero Emission Vehicles, Transport Committee, July 2021
[43] Ibid (reference: 85 Q107 (Rachel Maclean MP))
[44] Ibid (Conclusions and recommendations: 4)
[45] ICCT, Funding the transition to all zero-emission vehicles, October 2019

ICE models. This section explores some of the different approaches taken to increase EV uptake in Europe.

4.1 Financial incentives

Financial incentives have been a widely used measure to encourage the uptake of EVs. There are clear differences in incentives, often led by the existing tax structure in a country. Countries such as the Netherlands, Norway and Denmark, have high taxation on cars, which makes it possible to incentivise EVs through taxation benefits. France and Germany have, on the other hand, much lower overall taxation on cars and focus on providing attractive subsidies to bring the purchase cost of EVs in line with ICE alternatives.

4.1.1 United Kingdom

Powers to provide financial incentives to encourage EV uptake fall, largely, outside the scope of devolved powers. The Office for Zero Emission Vehicles (OZEV), part of the Department for Transport (DfT) and the Department for Business, Energy & Industrial Strategy (DBEIS), is the body charged with developing EV uptake across the UK providing support for the take-up of plug in vehicles, as well as funding to support chargepoint infrastructure across the UK.

The OZEV administers the plug-in car grant (PiCG). Since its launch in 2011, close to £1.3 billion in PiCG funding has supported the purchase of more than 285,000 vehicles.[46] The amount of grant available depends on which category the vehicle is in. Prior to October 2018, there were three categories of car eligible for the grant; these categories were:

- category 1 – CO_2 emissions of less than 50g/km and a zero emission range of at least 70 miles
- category 2 – CO_2 emissions of less than 50g/km and a zero emission range between 10 and 69 miles
- category 3 – CO_2 emissions of 50 to 75g/km and a zero emission range of at least 20 miles

Since October 2018, Category 2 and 3 vehicles (Hybrid vehicles) have not been eligible for the PiCG, while the rate available for category 1 vehicles has been reduced. Initial changes to the scheme in October 2018 saw the grant rate drop from £4,500 to £3,500.[47] The UK Government updated the grant levels again at Budget 2020

[46] OLEV, Plug-in car, van and truck grant to be targeted at more affordable models to allow more people to make the switch, March 2021
[47] OLEV, Changes to the Plug-in Car Grant, November 2018

(reducing it to £3,000)[48] and in March 2021 (to £2,500).[49] The updated grant levels are reflected in table four below.

Table 4: Low-emission vehicles eligible for a plug-in grant

Category	CO2 emissions	Zero emission range	Grant	Maximum amount
Car (up to £35,000)	Less than 50 g/km	112 km (70 miles)	35%	£2,500
Motorcycles	No CO2	50km (31 miles)	20%	£1,500
Mopeds	No CO2	30 km (19 miles)	20%	£1,500
Van up to 2,500 kg	Less than 50 g/km	96 km (60 miles)	35%	£3,000
Van 2,500-3,500 kg	Less than 50 g/km	96 km (60 miles)	35%	£6,000
Trucks up to 12,000 kg	Less than 50% equivalent Euro VI	96 km (60 miles)	20%	Up to £16,000 (first 250, 10 per customer) Up to £6,000
Taxis	Less than 50 g/km	112 km (70 miles)	20%	Up to £7,500

Source: House of Commons Library

Since March 2021, the PiCG has been capped at £2,500, for electric cars priced under £35,000. According to the UK Government this reduction reflects the greater range of affordable EV available and will enable *"…the scheme's funding to go further and help more people make the switch to an electric vehicle"*.[50] "*Grants will no longer be available for higher-priced vehicles, typically bought by drivers who can afford to switch without a subsidy from taxpayers."*[51] The UK Government expects further price reductions in electric vehicles as the market develops even further.[52] Consumers do not need to apply for the PiCG, dealers include the value of the grant in the vehicle's price.

The UK Government's 2018 Road to Zero strategy set out its intention for a managed exit from the plug-in car grant and stated that the growth of ultra-low emission cars would be supported through other measures. As has been shown, support through the plug-in car grant has been incrementally scaled back since 2018, with OZEV committing to providing the grant to 2022-23.

[48] OLEV, Update on plug-in vehicle grants following today's budget, March 2020
[49] OLEV, Plug-in car, van and truck grant to be targeted at more affordable models to allow more people to make the switch, March 2021
[50] ibid
[51] OLEV, Plug-in car, van and truck grant to be targeted at more affordable models to allow more people to make the switch, March 2021
[52] Ibid.

Used cars

The size of the used car market was discussed in section 1.3 above. In 2020, overall used vehicle sales in the UK declined by 14.9%. However, used BEV sales increased by 29.7% with some 19,000 units sold.[53] The House of Commons (HOC) Transport Select Committee (TSC) has stated that *"…a healthy used electric vehicle market is critical to ensuring that electric vehicles are not the sole preserve of people who can afford new models."* [54]

The TSC has noted that the Government's position is that current incentives to stimulate the sale of new EVs are sufficient to support the development of the second-hand EV market by increasing supply thereby driving down prices. However, it notes that electric vehicles that will be traded on the second-hand market in three to five years' time are likely to be more expensive to buy upfront than comparable ICE models. [55]

The TSC has recommended to the UK Government that in order to drive mass consumer uptake of ZEVs, it *"…must ensure that the market facilitates the supply of affordable new and used electric vehicles"*[56] noting that in order to ensure that the Government achieves the targets set out in the Transport Decarbonisation Plan, it *"may need to intervene to support the second-hand market in electric vehicles until price parity with comparable ICE vehicles is reached".*[57]

There are examples of incentives designed to stimulate the used EV market in other jurisdictions. For example:

- The Netherland's offers a grant of €2,000 for used BEVs (introduced 2020);[58]
- France offers a €1,000 subsidy for the purchase of used BEVs (introduced 2021).[59]
- Germany offers a €5,000 for BEV and €3,750 for PHEV.[60]

Scotland has had the Low Carbon Transport Loan (LCTL), an interest free loan for the purchase of BEV, in place since 2011/12. The loan is funded by Transport Scotland, an executive agent of the Scottish Government, and delivered by Energy Saving Trust (EST). In September 2020, the Low Carbon Transport Loan was extended to cover used BEV up to the value of £20,000, to be repaid over 5 years.[61]

[53] SMMT, UK used car market declines -14.9% as coronavirus lockdowns curb 2020 sales, accessed 19 July 2021
[54] House of Commons, Zero Emission Vehicles, Transport Committee, July 2021
[55] ibid
[56] ibid
[57] ibid
[58] EAFO, Netherlands Incentives, accessed 23 July 2021
[59] EAFO, France, incentives, accessed 23 July 2021
[60] EAFO, Germany, incentives, accessed 23 July 2021
[61] Energy Saving Trust, Used Electric Vehicle Loan, accessed 24/06/21

According to the EST The loan has steadily increased in popularity since 2011, with 2019/20 recording the highest uptake to date. The loan fund provides support to both domestic consumers and businesses.[62]

At a meeting of the Scottish Parliament's Rural Economy and Connectivity Committee (19 February 2020) Peter Chapman MSP, suggested there had been some concern that *"…those on lower incomes might not be able to afford an ultra-low-emission vehicle, even by securing a loan* [and that] *in effect,* [the LCTL] *subsidises those who are already well off to buy relatively expensive electric vehicles."* In response the Cabinet Secretary for Net Zero, Energy and Transport (Michael Matheson), indicated his belief that providing a loan for used EV (the only resource supporting the purchase of used EV in the UK) would help people on lower incomes who may want to secure a loan to buy such a vehicle.[63]

4.1.2 Norway

As noted previously, Norway has the most advanced EV market in Europe with BEV accounting for 52% of all new vehicles registered in 2020. Financial incentives have been the key driver in this market, dating back to 1990.[64] Particularly strong incentives apply to the purchase of zero-emission BEVs.

BEVs have been exempted from registration tax (and import tax which is the same in Norway) and VAT since 1990.[65] This is a key determinant for the lower purchase price of BEV models versus a conventional ICE (Internal Combustion Engine) vehicle. For example, in 2020 a conventional ICE Volkswagen Golf costs ~€34,000 while a VW e-Golf costs ~€33,000.[66]

Table 5: Comparison of cost breakdown for ICE VW Golf and BEV VW Golf 2020

	Volkswagen Golf (€)	Volkswagen e-Golf (€)
Import price	22,046	33,037
CO2 tax (113 g/km)	4,348	-
NOx tax	206	-
Weight tax	1,715	-
Scrapping fee	249	249
25% VAT	5,512	-
Retail price	34,076	33,286

Norway's car tax policy is based on the polluter pays principle. It levies taxes on the acquisition of a new car, including 25% VAT plus registration tax; ownership in the form of motor vehicle tax; consumption, as taxes on fuel and electricity; private use of a

[62] Energy Saving Trust, The Low Carbon Transport Loan, June 2019
[63] Scottish Parliament, Official Report: Rural Economy and Connectivity Committee , 19 February 2020
[64] Erik Lorentzen, et al. Charging infrastructure experiences in Norway - the worlds most advanced EV market, proceedings: International Battery, Hybrid and Fuel Cell Electric Vehicle Symposium, October 2017
[65] European Alternative Fuels Observatory. Norway: Incentives and Legislation, [online] accessed 24 July 2021
[66] (Norsk elbilforening) Norwegian Electric Car Association, Norwegian EV policy, [online] accessed 21, June 2021

company car; and infrastructure use in the form of road tolls. BEV on the other hand are either exempt or benefit from significant discounts of these taxes**:**

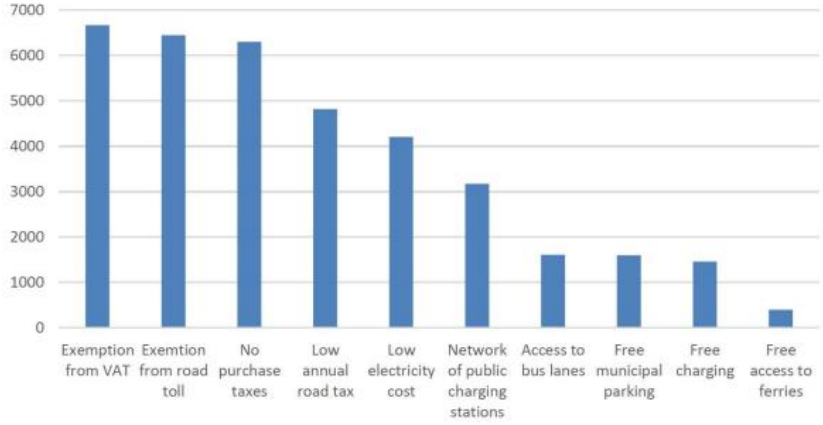
- No purchase/import taxes
- Exemption from 25% VAT on purchase
- No annual road tax (1996-2021). Reduced tax from 2021.
- No charges on toll roads or ferries (1997- 2017). Maximum 50% of the total amount on ferry fares for BEV since 2018.
- Maximum 50% of the total amount on toll roads (2019)
- Free municipal parking (1999- 2017). Parking fee for BEVs was introduced locally with an upper limit of a maximum 50% of the full price (2018)
- Access to bus lanes. New rules allow local authorities to limit the access to only include BEV that carry one or more passengers (2016)
- 50% reduced company car tax (2000-2018). Company car tax reduction reduced to 40% (2018)
- Exemption from 25% VAT on leasing (2015)
- Compensation for the scrapping of ICE vans when converting to a zero-emission van (2018)[67]

While tax incentives are determined nationally, since 2015 local authorities have had the power to decide on local incentives such as free parking and access to bus lanes. This has allowed local authorities to weigh up the need for revenue generation against the need to increase EV uptake. It also allows them to address local issues as they arise. For example, permitting EVs access to bus lanes has been a controversial policy in Norway and has contributed to congestion in bus lanes during peak hours.[68] The municipality of Oslo tackled this issue in 2017 by restricting access to the bus lane on two specific corridors to electric cars with two or more persons on board.

Consumer research carried out in Norway confirms the importance of these financial incentives. The VAT exemption along with exemptions from tolls on roads are perceived as the most important factors in EV purchases (see figure eight). There are other non-financial factors that contribute to Norway's high EV uptake including a well-developed public charging network (section 3). However, Lorentzen, et al. noted that while *"a well-developed charging infrastructure is appreciated by EV users, it is not on its own enough to convince consumers to buy BEVs"*.[69]

[67] Ibid.
[68] Benjamin Myklebust, EVs in bus lanes – controversial incentive, Proceedings: International Battery, Hybrid and Fuel Cell Electric Vehicle Symposium, November 17-20, 2013
[69] Erik Lorentzen, et al. Charging infrastructure experiences in Norway - the worlds most advanced EV market, proceedings: International Battery, Hybrid and Fuel Cell Electric Vehicle Symposium, October 2017

Figure 10: Perceived importance of Norway's electric car support policies based on survey results (Haugneland, Lorentzen, Bu, & Hauge, 2017)



Source: Lorentzen, Haugneland, Bu, & Hauge, 2017

Research from the Norwegian Institute of Transport Economics (NITE) found that *"Policies that address the purchase price of a BEV are found to be most effective in the way that they contribute significantly to BEV market shares."*[70] The NITE research found again that VAT and purchase tax exemptions have the largest effect in terms of increasing EV uptake. However, they are also the costliest to implement. The NITE report suggests that in order to make these incentives 'revenue-neutral', adjustments should be made to the car taxation regime for ICE vehicles. *"An annual real increase in the annual tax of 2.5 percent; about one percent higher fuel tax increases per year; and a gradual steepening of the car registration tax […] secure a stable stream of government revenues despite the presence of strong and costly BEV incentives"*.[71]

4.1.4 France

The French Government follow this approach with high emitting vehicles facing a higher tax (malus) while less emitting vehicles are incentivised (bonus). The Bonus-Malus System is one of the main climate policy instruments in the French transport sector and has successfully contributed to reducing average passenger car emissions since its implementation in 2008.[72]

The scheme uses revenues from fees for emission-intensive vehicles to finance bonus payments to incentivise EV purchases. For example, the Peugeot 3008 is the most popular SUV in France.[73] Depending on the model/spec emissions range from 146g/km - 165g/km.[74] This would see the purchaser pay a one-time malus of between €335-€2,205.[75]

[70] Nils Fearnley, et al., E-vehicle policies and incentives - assessment and recommendations, August 2015
[71] Ibid.
[72] Yannick Monschauer, Sonja Kotin-Förster, Bonus-Malus Vehicle Incentive System in France, Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) (Germany), September 2018
[73] Focus2move, France 2021. Best selling cars ranking, July 2021
[74] Autoexpress, Peugeot 3008 review - MPG, CO2 and running costs, July 2021
[75] French Government, Malus tax on the most polluting vehicles, January 2021

France's BEV bonus has been reducing in recent years:

- For new BEV the bonus has gone from €7,000 in 2020 (up to 27% of the acquisition cost), to €6,000 in 2021 and €5,000 in 2022.
- For new PHEV the bonus has gone from €2,000 in 2020 to €1,000 in 2021.

France also offers a scrappage bonus of up to €2,000 for used diesel vehicles while it has introduced a bonus for used BEV in 2021 (as discussed).[76]

4.1.5 Germany

In Germany, the government has funded a broad range of measures for the promotion of EV. A key financial incentive is the one-time bonus for the purchase of BEV, introduced in 2016. From 2019-20 the bonus was €6,000 and is funded on a 50/50 basis between the Federal Government and motor industry.[77] In June 2020, as part of a package of stimulus measures for the motor industry, Germany increased the subsidy to €9,000.[78] All of the additional fund is provided by the Federal Government.

The increased bonus was due to expire at the end of 2021. However, it has been extended and will now be lowered in two steps before 2025.[79] There is currently a €6,750 bonus available for PHEV, but this will be removed in 2022.[80] As discussed above used BEV are also eligible to receive a bonus of €5,000. For used PHEV, the bonus is €3,750.[81]

While Germany has traditionally focused on incentivising EV uptake through generous subsidies the German Parliament (Bundestag) has recently (September 2020) passed an amendment of the Motor Vehicle Tax Act that means the amount of tax payable by vehicle owners will be determined by the vehicle's emissions. Owners of a vehicle with high CO_2 emissions will be taxed more heavily while owners of a low emission vehicle will benefit from more favourable tax breaks.[82]

The electric mobility law which came into force in June 2015 provides municipalities with the legal framework to implement local privileges for drivers of an electric vehicle, such as preferential parking, exemptions on parking fees, or driving in restricted areas. To further promote electric vehicles.[83]

[76] EAFO, Incentives and legislation, France
[77] Bloomberg, Germany increases EV incentives to stimulate demand, November 5, 2019
[78] EAFO, Germany, incentives, accessed 23 July 2021
[79] Economic Times, Germany to extend electric car subsidies to 2025, November 2020
[80] Ibid.
[81] EAFO, Germany, incentives, accessed 23 July 2021
[82] Bundesamt, Motor Vehicle Tax Act, September 2020
[83] CMS, Electric vehicle regulation and law in Germany, accessed 10 August 2021

4.2 Infrastructure

The transition from ICE cars and vans to ZEVs will depend on the timely roll-out of accessible and reliable charging infrastructure. In a September 2020 poll of 17,628 drivers, 69% cited a lack of public charge points as a reason not to purchase an electric vehicle.[84] In August 2021, the All Party Parliamentary Group (APPG) for fair fuels for UK motorists and hauliers published a report entitled: "What does the 2030 fossil fuelled new vehicle sales ban really mean to the economy, environment, and UK's 37m drivers?". The report includes a survey of over 50,000 road users. This survey found that for 77% of non EV drivers (n=34,119), a lack of 'charging point availability on route', was a main reason for their 'reluctance to buy electric'.

4.2.1 UK

As of 1 April 2021, there were 22,790 public electric vehicle charging devices available in the UK, of which 4,259 are rapid chargers[85].

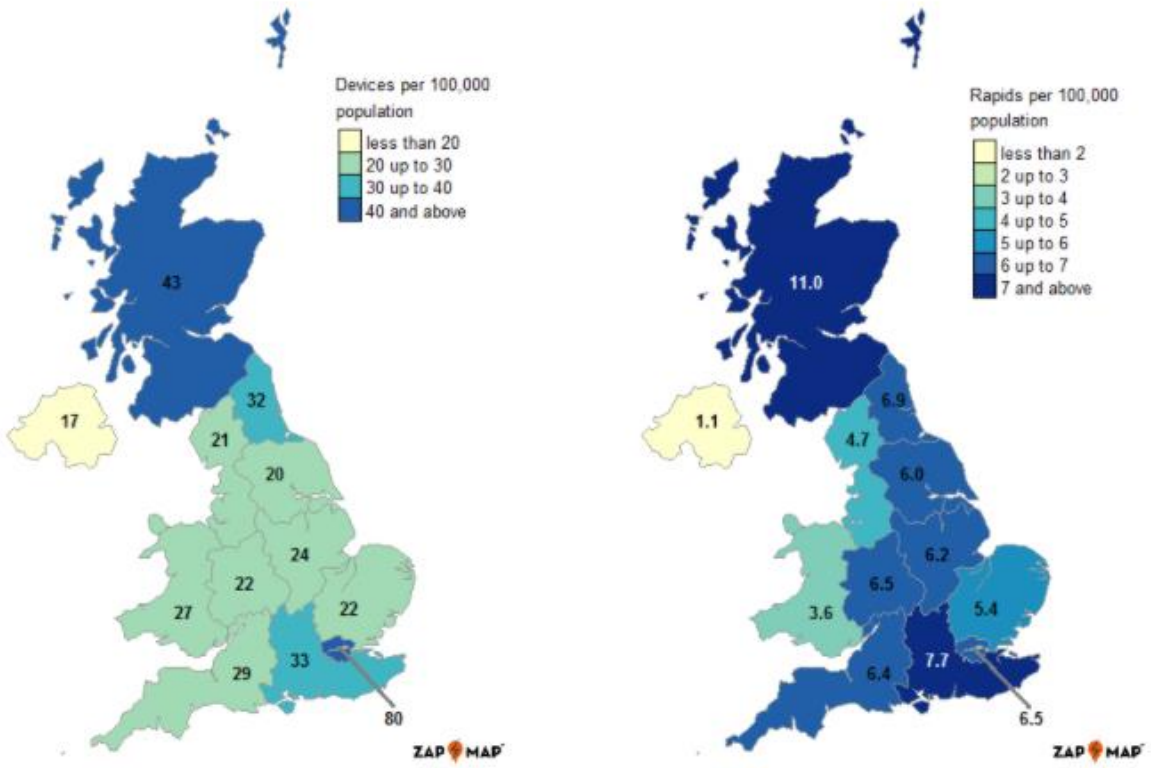
There is uneven geographical distribution of charging devices within the UK. Some UK local authorities have bid for UK Government funding for charging devices, and others have not. Most of the provision of this infrastructure has been market-led, with individual charging networks and other businesses (such as hotels) choosing where to install devices.[86]

London and Scotland have the highest level of charging provision per 100,000 of population, with 80 and 43 devices per 100,000 respectively. Almost twice as many public rapid charge points per head of population are available in Scotland compared with London, with 11 and 6.5 chargers per 100,000 of population respectively.[87]

A Committee for Climate Change (CCC) progress report to Parliament recommended that the Government should ensure the provision of 150,000 public charge points by 2025.[88] A recent Policy Exchange report stated that by 2030 the UK will need approximately 400,000 public charge points, requiring charge point operators to invest between £5 billion and £10 billion alongside the Government's £1.3 billion. The report noted that the increase in EVs in the UK outpaced the growth in public charging infrastructure.[89]

[84] The AA, Almost half of drivers thinking of buying an electric vehicle, accessed 15 July 2021
[85] OZEV, Electric vehicle charging device statistics: April 2021, May 2021
[86] ibid
[87] ibid
[88] CCC, Progress in reducing emissions: 2021 report to Parliament, 24 June 2021
[89] Policy Exchange, Charging Up, 2 February 2021

Map 2: Total and rapid public charging points per 100,000 population by UK region 2021



Source: DfT and ffice for Zero Emission Vehicles

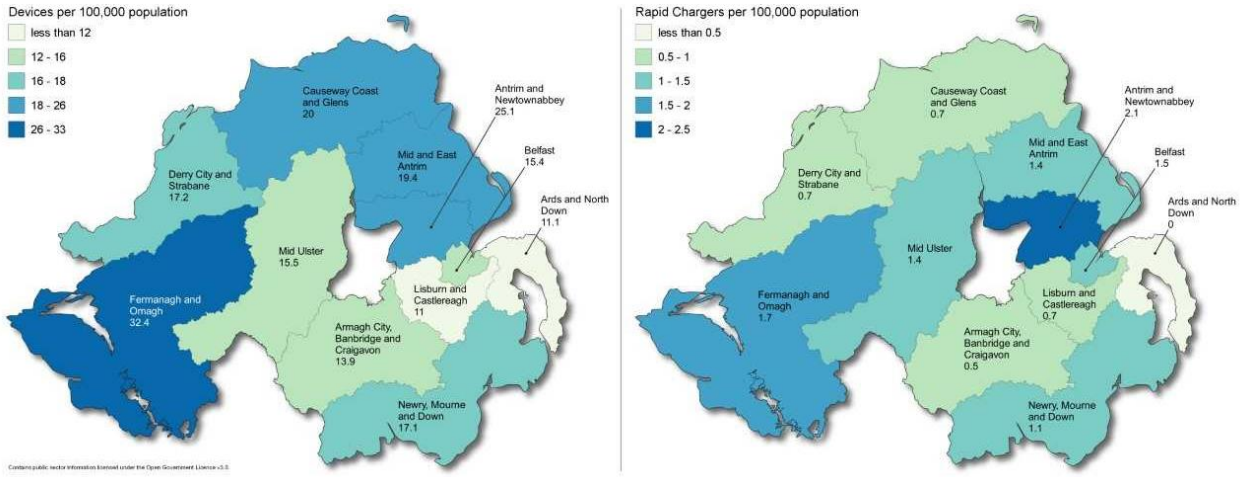
4.2.2 Northern Ireland

As of January 2021 NI had 320 public charging points, the lowest number of both standard (300) and rapid charging points (20) of any UK region, and represents a ratio of 17 and 1.1 per 100,000 respectively. The ratio of charging points per 100,000 is also the lowest of the UK regions. Map one shows the distribution of all charging points and rapid charging points across the eleven LGDs per 100,000.[90]

Analysis by the CCC on the need for charging points in NI suggests between 30 to 35 public rapid chargers on major roads, and 800 to 950 public top-up chargers will be required by 2030.[91] As an indication of the possible technology cost in Northern Ireland, National Grid has estimated that to upgrade 50 motorway sites with sufficient power to accommodate 350 kW rapid chargers could cost between £500 million and £1 billion in the UK (£10-20 million per site).[92]

[90] Department for Transport and Office for Zero Emission Vehicles, Electric vehicle charging device statistics: July 2021 tables, August 2021
[91] CCC, Reducing emissions in Northern Ireland, February 2019
[92] Ibid

Map 3 Total and rapid public charging points per 100,000 population by NI LGD 2021



Source: DfT and Office for Zero Emission Vehicles

Note: The statistics used have been taken from DfT which is using experimental statistics on the number of publicly available electric vehicle charging devices in the UK, broken down by Local Authority. Data is provided by the electric vehicle and charging point platform Zap-Map An interactive map of this data is available.

Table 6: Total and rapid public charging points per 100,000 population by NI LGD 2021

	Total Devices	Per 100,000	Rapid Devices	Per 100,000
NORTHERN IRELAND	**320**	**16.9**	**20**	**1.1**
Antrim and Newtownabbey	36	25.1	3	2.1
Ards and North Down	18	11.1	0	0.0
Armagh City, Banbridge and Craigavon	30	13.9	1	0.5
Belfast	51	14.8	5	1.5
Causeway Coast and Glens	29	20.0	1	0.7
Derry City and Strabane	27	17.8	1	0.7
Fermanagh and Omagh	38	32.4	2	1.7
Lisburn and Castlereagh	11	7.5	1	0.7
Mid and East Antrim	27	19.4	2	1.4
Mid Ulster	22	14.8	2	1.3
Newry, Mourne and Down	31	17.1	2	1.1

The report noted that as well as focusing on the total number of charging points, it is important that reliability issues are addressed to ensure that public charge points are providing an effective service. Public concerns about charging infrastructure reliability are a barrier to uptake for consumers.[93]

[93] CCC, Reducing emissions in Northern Ireland, February 2019

The CCC report recommended that in order to facilitate ULEVs NI should adopt the Automated and Electric Vehicles Act 2018 to ensure all chargers are 'smart'. The Act aims to increase the access and availability of charge points for electric cars, making it compulsory for charge points to be installed across the country. The key provisions for charging infrastructure are:

- A requirement for motorway services and large fuel retailers to install charging points and to ensure that all chargers are 'smart', providing grid flexibility by adjusting the rate of charge when necessary and practical for the consumer;
- Mandate the method of payment for electric vehicle charging points, ensure charging points are compatible with all vehicles and also to set standards for reliability; and
- Ensure that all UK-funded domestic chargers are 'smart', including those installed in Northern Ireland.[94]

This Act was extended to Northern Ireland via the Automated and Electric Vehicles Act 2018 (Commencement No. 1) Regulations 2021 in April 2021.

4.2.3 Charging infrastructure regulations

According to the current EU Directive on the deployment of alternative fuels infrastructure (2019/94/EU), *"the number of recharging points should be established taking into account the number of electric vehicles estimated to be registered by the end of 2020 in each Member State. As an indication,* ***the appropriate average number of recharging points should be equivalent to at least one recharging point per 10 cars,*** *also taking into consideration the type of cars, charging technology and available private recharging points".*[95]

4.2.4 Provision of charging infrastructure in Europe

Among European countries in 2020, the most public recharging points were available in the Netherlands. EV drivers have access to over 64,000 normal and over 2,400 high power recharging points. France has 42,000 normal and over 4,000 high power recharging points, Germany (over 37,000 and almost 7,500, respectively), the United Kingdom (over 27,000 and almost 6,300, respectively) and Norway where drivers of an electric car had access to over 13,500 normal and over 5,000 high power recharging points.

The top seven European countries with more than 100,000 BEVs and PHEVs in their respective car fleet by the end of 2020 accounted for 80% of electric passenger cars on the road across the EU-27 Member States, the United Kingdom, and EFTA countries.

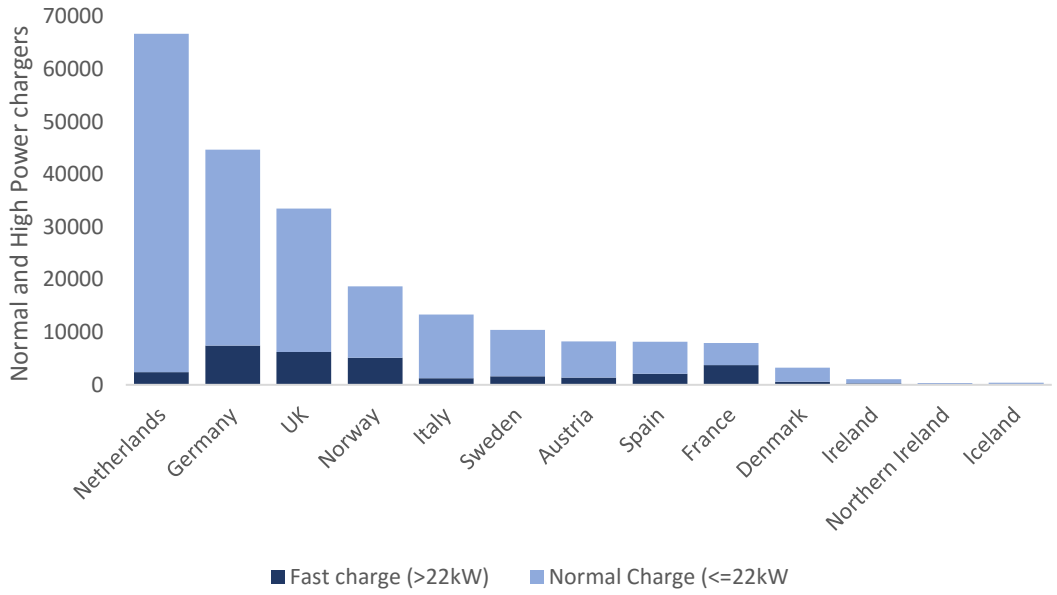
[94] CCC, Reducing emissions in Northern Ireland, February 2019
[95] EU, Directive 2014/94/EU of the European Parliament and of the Council of 22 October 2014 on the deployment of alternative fuels infrastructure, October 2014

At the same time, these seven countries also had 80% of Europe's public recharging points in place by the end of 2020.

Table 7: Top five countries by 2020 electric car public recharging points

Geographical area	Normal power public recharging points 2020	High power public recharging points 2020	Total public recharging points 2020
EU-27 Member States, United Kingdom, Norway, Iceland, Switzerland	1. Netherlands 2. France 3. Germany 4. United Kingdom 5. Norway *Covering 74% of normal power public recharging points*	1. Germany 2. United Kingdom 3. Norway 4. France 5. Netherlands *Covering 66% of high power public recharging points*	1. Netherlands 2. France 3. Germany 4. United Kingdom 5. Norway *Covering 73% of total public recharging points*

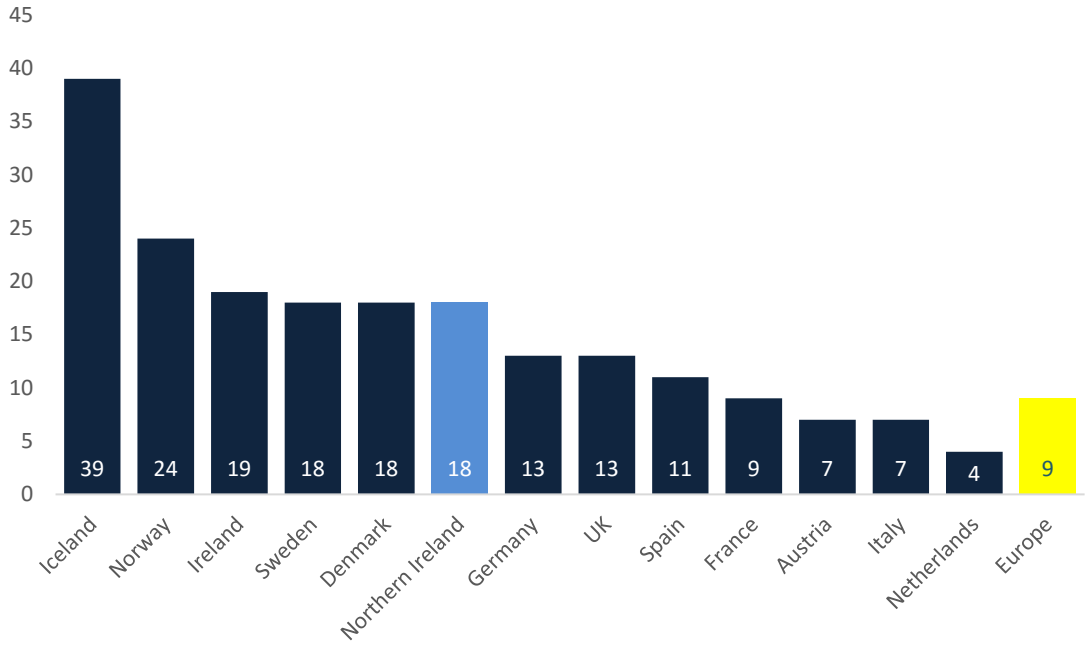
Figure 11: Total number of normal and high-power public recharging points, 2020



Source: EAFO and DfT/OZEV

As noted previously, the European Commission recommends one public recharging point per ten electric vehicles. Figure 10 shows there is a wide variation among the European countries assessed. In Iceland, the ratio is the lowest, with 39 electric vehicles per public recharging point, Norway in next with 24 charging points. However, Norway has the fifth highest number of charging points in Europe, therefore this is more of a reflection of its relatively high fleet share. Ireland and NI are some way off the 10 charging points per BEV with 19 and 18 respectively while the UK is closer to the recommended coverage with 13.

Figure 12: Plugin Electric Vehicles per public recharging point



Source: EAFO and DfT/OZEV

4.2.5 Infrastructure roll out

According to the European Alternative Fuel Observatory (EAFO) there is no 'one-size-fits-all' solution for the number of public recharging points needed at the country level. For example, the extent to which home charging and workplace charging is available has a direct effect on the number of public recharging points needed. In rural areas there may be a greater likelihood of homes having off street parking facilitating access to private home recharging facilities, whereas those in urban areas may be more likely to live in apartments or terraced housing with no private parking.

> *"In the Netherlands, residents living in city areas usually rely on kerbside public recharging. Therefore, a number of municipalities provide public recharging points on request of an electric vehicle owner in case he has no access to home or workplace recharging. This partially explains why high power recharging infrastructure plays a less important role in the Netherlands than it might be in other markets."*

Driving patterns also influence requirements for public recharging. For example, at an EU level there is a focus on cross border travel and community connectivity. This requires access to a network of 50KW rapid chargers along motorways to enable people to charge en route. The extent of the strategic road network will therefore be a key factor in determining the need for rapid chargers. Those charging at destinations

such as town centres or retail parks might use a 22KW fast charger for a couple of hours while those charging overnight will only require a 7KW fast charger, which could take four to six hours.

4.2.6 Electric Vehicle Charging Strategy for Wales

Wales has around the same level of EV ownership as Northern Ireland, with both regions lagging behind Scotland and England. In order to increase public confidence in EVs, the Welsh Government published the Electric Vehicle Charging Strategy for Wales in March 2020. The strategy sets out a vision for electric vehicle charging in Wales, that *"…by 2025, all users of electric cars and vans in Wales are confident that they can access electric vehicle charging infrastructure when and where they need it".*[96]

The strategy includes a modelled prediction of the number of chargers that could be needed, and the types of chargers needed for each local authority across Wales. This is based on a number of variables including forthcoming bans, traffic levels and travel demand in Wales. The model predicts the need for a substantial increase in the number of slow, fast and rapid/ultra-rapid chargers available in Wales, for example:

- The number of fast chargers needed across Wales increases from 30,000 to 55,000 by 2030. There is currently less than 1% of this total installed.
- The number of rapid chargers needed across Wales increases to up to 4,000 over the next ten years. There is currently less than 3% of this total installed.

The strategy outlines a number of actions that will be taken in order to facilitate at home charging as well as meet the fast and rapid/ultra-fast charging targets. These will be delivered through partnership, incentivising and regulation where necessary. With full delivery measures to be outlined in the forthcoming action plan.

Table 8: Proposed measures for increasing charging infrastructure in Wales

Slow Charging	Fast Charging	Rapid/ultra-rapid charging
• All new homes with an associated car parking space will be ready to have electric vehicle charging installed. • Homeowners and occupiers with off-street parking in Wales will be supported to charge at home. • Home charging will be 'smart enabled' for value and efficiency.	• New non-residential buildings with more than 10 parking spaces will have a charge point provided by 2025. • Business provides charging facilities at places of work for the use of staff and visitors. • Destinations provide charging facilities for the use of customers which may act as a means of improving customer experience. • On-street charging and in car parks will be encouraged in villages, towns and cities throughout Wales; with a view to installing on average one	• By 2025, a rapid charging network will be provided across the strategic trunk road network of Wales, providing charging at a distance of approximately 20 miles. • In urban centres taxis and private hire vehicles will have extensive access to charging facilities by 2025. • Transport for Wales will take the lead in delivering rapid charging on the strategic trunk road network. • The Welsh Government's Ultra Low Emission Vehicle

[96] Welsh Government, Electric Vehicle Charging Strategy for Wales, March 2021

	charge point for one in every three electric vehicles that cannot charge at home. • Charging hubs, including out of town park and ride, and supporting active travel will feature in enabling decarbonised multi-modal journeys across Wales.	Transformation Fund will be used to support the transition for taxis and private hire.

4.2.7 Funding charging infrastructure

According to the CCC, substantial roll-out of charging infrastructure across the UK is necessary to give consumers confidence that they will be able to reliably charge an EV whenever they need to. The CCC suggest investment will need to continue throughout the 2020s and beyond, whilst extra grid capacity will be needed to cope with increased demand.[97]

The UK Government has committed to the roll out of charging infrastructure that supports uptake and builds confidence in the transition to ZEVs with a package of measures that include:

- Publication of a new UK charging infrastructure strategy in 2021 setting out its long-term vision and building on the vision for a rapid charging network published in May 2020.
- A **£950m** Rapid Charging Investment Fund to support a network of rapid charge points along the strategic road network in England.
- Continuing with all three of OZEV's existing grant schemes to provide charging at home, on-street and in the workplace with **£275m** announced at Spending Review 2020.
- **£90** million to support the roll out of larger on-street charging schemes and rapid charging hubs in England.[98]
- Guidance for local authorities on how to facilitate, at a local level, the transition to ZEVs. This will include advice on infrastructure needs and parking allocation.
- The UK Government intends to bring forward the legislation mandating all private charge points must be smart and meet minimum device standards later in 2021.
- It plans to bring in regulations setting requirements for EV charge point infrastructure in all new residential and non-residential buildings later in 2021.
- It is consulting on using powers under the Automated Electric Vehicles Act to mandate minimum standards to improve the consumer experience at public charge points. The consultation will include ensuring open, accessible and available

[97] Committee for Climate Change, Written evidence submitted by the Climate Change Committee
[98] DfT, Written evidence submitted by the Department for Transport

chargepoint data, a reliable charging network, streamlined payment methods and clear pricing metrics.

To date, 9% of UK Government spending on supporting ULEV has been on the electric vehicle home-charging scheme, and its predecessor the domestic recharging scheme. This has resulted in the installation of 133,336 home chargers, which was equivalent to 48% of all ultra-low or zero-emission cars that had been registered as of March 2020.[99] However, some 30% of households do not have access to off-street parking.[100]

In 2017, the Government launched the on-street residential charging scheme (ORCS) to help local authorities install on-street charge points. Since its inception, more than 120 projects have benefitted from the scheme. The National Audit Office (NAO) stated, however, that 32% of the £8.5 million allocated up to 2020 was unused. The provision of on-street home charging is lagging behind off-street provision, with 690 chargers having been installed by March 2020 under the ORCS. In February 2021, the Government committed £20 million to extend ORCS into 2021–22 with efforts being made to improve uptake.[101]

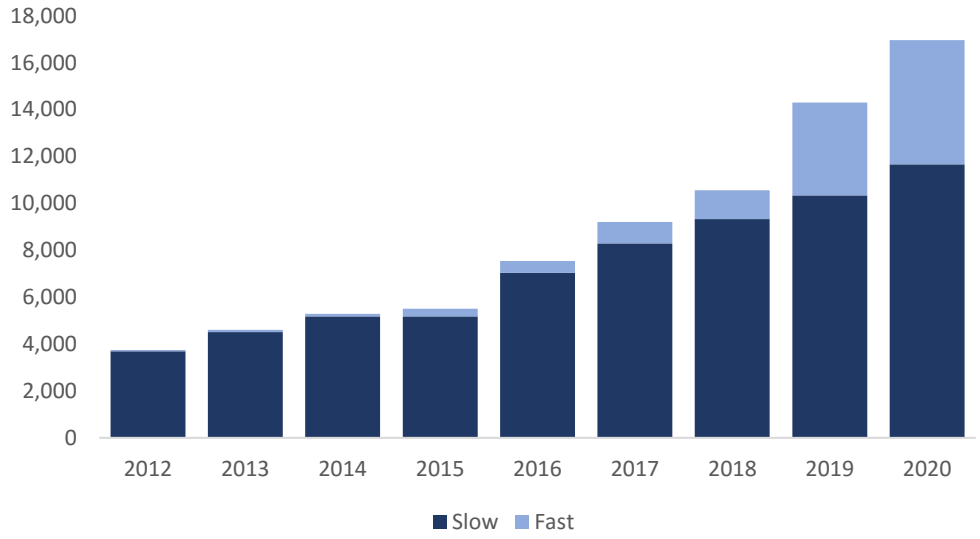
4.2.8 Norway

The Norwegian government ran its first public charging infrastructure support scheme in 2009-10, as part of a financial stimulus package. This funded 100% of installation costs for 1,800 public slow chargers, at a cost of NOK 50 million (~£4.2 million).[102] As slow chargers were being made redundant by the adoption of fast charging a second government support scheme ran from 2010-2014 to develop the public fast charging network. Again, 100% of installation costs were granted, usually to local utility companies. Around NOK 50 million was spent (~£4.2 million). By 2015 there were just over 300 fast chargers.

A third support scheme from 2015 aimed to install fast charging stations at 50 km intervals on main highways.[103] Stations are designed to have a minimum of two standard fast chargers, and two 22kW Type 2 chargers. By 2017 some operators were installing charging points without any state subsidies in densely populated areas, indicating that a commercial market was developing.[104] In 2020 Norway had a total of 16,976 publicly accessible fast and slow electric vehicle chargers, of which 5,299 (31%) were fast chargers.

[99] Committee for Climate Change, Written evidence submitted by the Climate Change Committee
[100] Ibid.
[101] House of Commons, Zero Emission Vehicles, Transport Committee, July 2021
[102] Erik Lorentzen, et al. Charging infrastructure experiences in Norway - the worlds most advanced EV market, proceedings: International Battery, Hybrid and Fuel Cell Electric Vehicle Symposium, October 2017
[103] Ibid.
[104] Ibid.

Figure 13: Number of publicly accessible fast and slow electric vehicle chargers in Norway from 2012 to 2020



Source: Statista

4.2.9 Germany

The German Government has a target for one million charging stations to be available by 2030. It is currently preparing a strategy/masterplan to set out how this will be achieved and has recently passed some important legislation to facilitate the roll out.

Like the UK, Germany foresees most charging will take place at home. As such, it introduced a new grant of €900 to support the purchase and installation of home chargers for the first time in November 2020. Around 620,000 charging points had been applied for, resulting in expenditure of around €800 million to date.[105]

Through its infrastructure funding programme (2017-2020), the German Government has provided €300m for the construction of more than 30,000 publicly accessible charging points, in places such as car parks and petrol stations. Since March 2021 it has been mandatory for all petrol stations in Germany to provide charging stations on their customer parking areas.[106]

To further expand the public charging infrastructure at places such as supermarkets, hotels, restaurants, swimming pools or sports fields a €300m fund has been established. The Building Electric Mobility Infrastructure Act (2021) was approved by the Federal Council in February 2021. This Act forms the legal basis for the planned tender for the construction of a public fast-charging network with 1,000 locations. It is anticipated round €2 billion will be spent on the development of the fast-charging

[105] BMVI.de, Charging Infrastructure [online] accessed June 2021
[106] Ibid.

infrastructure. The Confederation will participate in this on a pro rata basis, insofar as this is necessary according to the results of the call for tenders.[107]

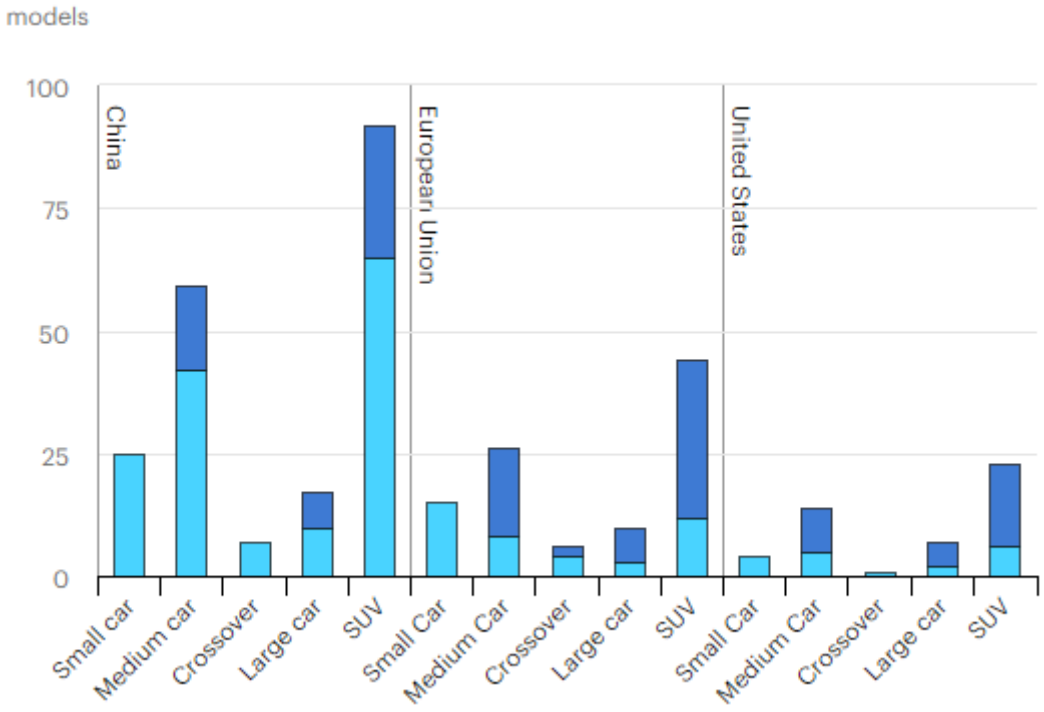
5 Supply-side factors

For BEVs, the increase in registrations strongly correlates with the introduction of new models, improved range and more affordable options. For example, at the end of 2018, the BMW i3 and the Renault Zoe were updated with increased battery capacity, Tesla introduced the Model 3, the company's most affordable car and various manufacturers introduced battery-electric SUV models, like the Hyundai Kona and Audi e-tron.[108]

5.1 BEV models

Worldwide, about 370 electric car models were available in 2020, a 40% increase from 2019. China has the widest offering, reflecting its less consolidated automotive sector and that it is the world's largest EV market. But in 2020 the biggest increase in number of models was in Europe where it more than doubled.[109]

Figure 14: Electric car models available by region 2020

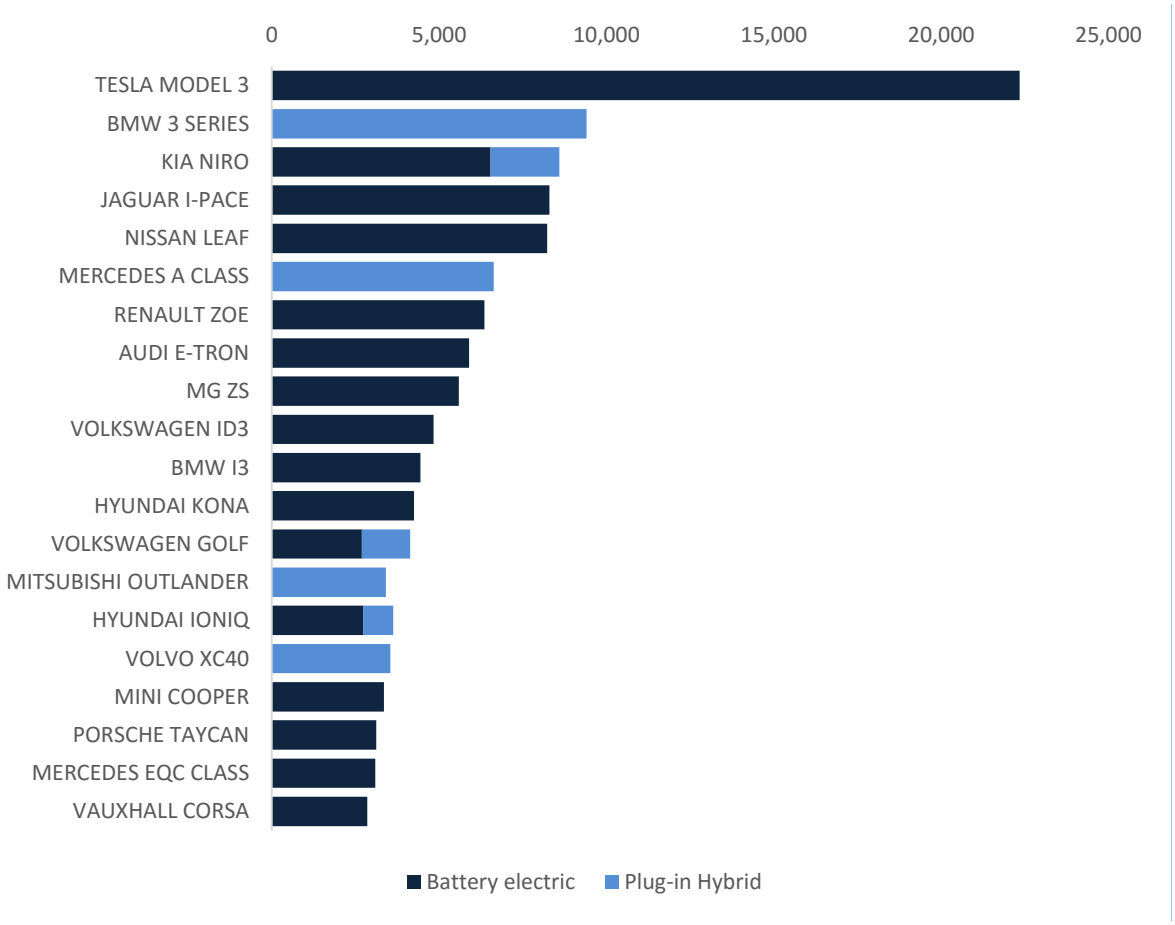


Source: IEA

[107] BMVI.de, Charging Infrastructure [online] accessed June 2021
[108] ICCT, Finally catching up: What powers the EV uptake in Germany?, December 2019
[109] IEA, Trends and developments in electric vehicle markets, Golbal EV Outlook 2001, accessed 28 July 2021

The bestselling BEV in the UK is the Tesla Model 3. The model 3 is a fully electric zero emission car with a range of 360 miles.[110] New cars are available to buy in the UK from £40,990-59,990 and used cars are available from £37,780.[111] Figure 15 shows the top 20 BEV and PHEV models sold in the UK in 2020.[112]

Figure 15: Top 20 generic models for ULEVs registered for the first time by fuel type, United Kingdom, January 2020 to December 2020



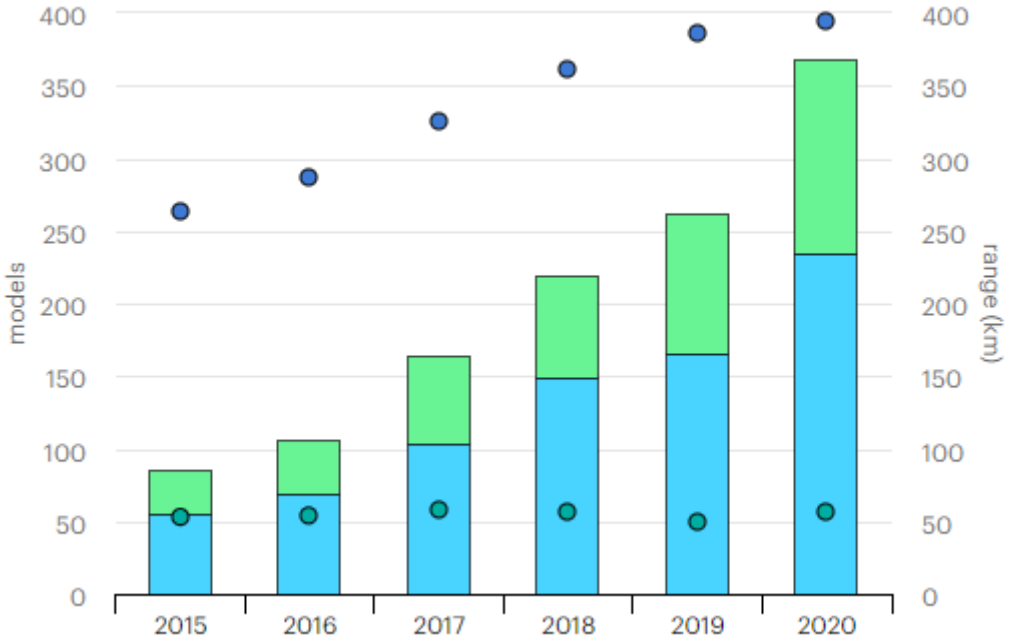
Source: VEH0171: Ultra low emission vehicles registered for the first time by body type and propulsion or fuel type: United Kingdom

The average driving range of new BEVs has been steadily increasing. In 2020, the weighted average range for a new battery electric car was about 350 kilometres (km), up from 200 km in 2015. The average electric range of PHEVs has remained relatively constant, at about 50 km, over the past few years.[113] The widest variety of models and

[110] TESLA, Model 3, accessed 18 August 2021
[111] What Car? Tesla Model 3 review, accessed 19 August 2021
[112] DfT, VEH0171: Ultra low emission vehicles registered for the first time by body type and propulsion or fuel type: United Kingdom, March 2021
[113] IEA, Trends and developments in electric vehicle markets, Golbal EV Outlook 2001, accessed 28 July 2021

the biggest expansion in 2020 was in the SUV segment. More than 55% of announced models worldwide are SUVs and pick-ups.[114]

Figure 16: Electric car models available globally and average range, 2015-2020



Source: IEA

5.2 Phase out targets of car manufacturers

National phase-out goals have prompted many of the top car manufacturers to announce their own plans to gradually phase out production of ICE vehicles. Volkswagen Group, PSA Group, Renault Group, Hyundai Motor Group, BMW Group, Daimler, Ford, Fiat Chrysler Automobiles Group, Toyota Group, and Volvo Car Group have announced plans to increase the sales share or the number of electric-vehicle models or to steer their strategy away from ICE vehicles over the next 10 years.[115]

Table 9: Selected phase out announcements by car manufacturers

Car manufacturer	Year	Announcement
Volkswagen Group (Volkswagen, Skoda, Audi, Seat, Porsche, others)	2020-24 2023 2025 2026 2029	• €33 billion investment in electric mobility from 2020 to 2024 • 1 million electric cars to be produced by the end of 2023 • 3 million electric cars to be produced in 2025 • Last launch based on a combustion-engine vehicle platform • Up to 75 BEV and 60 PHEV models to be launched
Ford	2022 2024	• More than 50% of passenger vehicle sales in Europe to be electrified (BEVs, PHEVs, MHEVs, HEVs)

[114] ibid
[115] ICCT, An overview of combustionengine car phase-out announcements across Europe, May 2020

		• 17 electrified vehicles to be launched in Europe including BEVs, PHEVs, MHEVs, HEVs
PSA Group (Peugeot, Opel/ Vauxhall, Citroën, DS Automobiles)	2021 2025 2025	• 14 new electric vehicle models by 2021 (7 fully electric models, 7 PHEVs) • More than 50% of group sales in the European market to be electric vehicles • 100% of models marketed by the group worldwide in an electric version
Renault Group (Renault, Dacia, Lada, Alpine)	2022 2022	• Range of 8 BEVs and 12 electrified models (PHEVs, HEVs) • 20% of group sales to be fully electric and 50% electrified
BMW Group (BMW, Mini)	2021 2025 2030	• 25% of all vehicles sold in Europe to be electrified • One-third of sales in the European market to be electrified • 50% of sales in the European market to be electrified
Daimler (Mercedes, Smart)	2025 2025 2030	• More than 40% of Mercedes-Benz vehicles delivered to customers in an electric version in the European market • 15% to 25% of total unit sales to be fully electric • More than 50% of Mercedes-Benz global car sales to be electric (BEVs, PHEVs)
Fiat Chrysler Automobile (FCA) Group (Fiat, Jeep, Lancia/ Chrysler, Alfa Romeo, others)	2022 2022 2022	• €700 million for construction of production line for Fiat 500 BEV • €9 billion group investment in electrification of vehicle portfolio until 2022 • Launch of new BEVs, PHEVs, and HEVs across all group brands
Toyota Group (Toyota, Lexus)	2025 2025	• 10% of new vehicles sold in Europe to be BEVs/FCEVs, 10% PHEVs, 70% HEVs) • 40 new or updated electrified models, including at least one PHEV a year
Hyundai Motor Group (Hyundai, Kia, Genesis)	2025 2025 2030	• Sale of 670,000 electric vehicles annually by 2025 (560,000 BEVs and 110,000 FCEVs) • 23 BEV models • Most models in key markets including Europe to be electrified (BEVs, FCEVs, PHEVs, HEVs)
Volvo	2020 2025	• 1 BEV model to be launched every year through 2025 • 50% of global sales to be fully electric cars

5.3 Price parity

In addition to increased choice and range perhaps the key factor in the mass transition to EV will be the point that which EV prices reach parity with ICE vehicles in Europe. According to research published in May 2021,

> *"…BEV in all segments in Europe are expected to reach upfront cost price parity with equivalent internal combustion engine vehicles within the next product cycle (between 2025-27). Falling battery prices and the development of optimized platforms lead the rapid decline in BEV costs. An optimal vehicle design, produced in high volumes, can be more than a third cheaper by 2025 compared to now."*[116]

[116] Bloomber NEF, Hitting the EV Inflection Point, May 2021

The report expects 4.3 million plug-in vehicles to be sold in Europe in 2025, representing around 28% of all sales in that year.[117] However, it expects sales to be unbalanced with the leading markets (as discussed) driving up sales. The report suggests that a menu of policy interventions, including tighter emissions rules, carbon taxes, and extensive geographic coverage of charging networks remain critical for consumer buy-in while policies that stimulate early adoption can generate consumer buy-ins and bring down costs.[118]

[117] ibid
[118] Bloomber NEF, Hitting the EV Inflection Point, May 2021