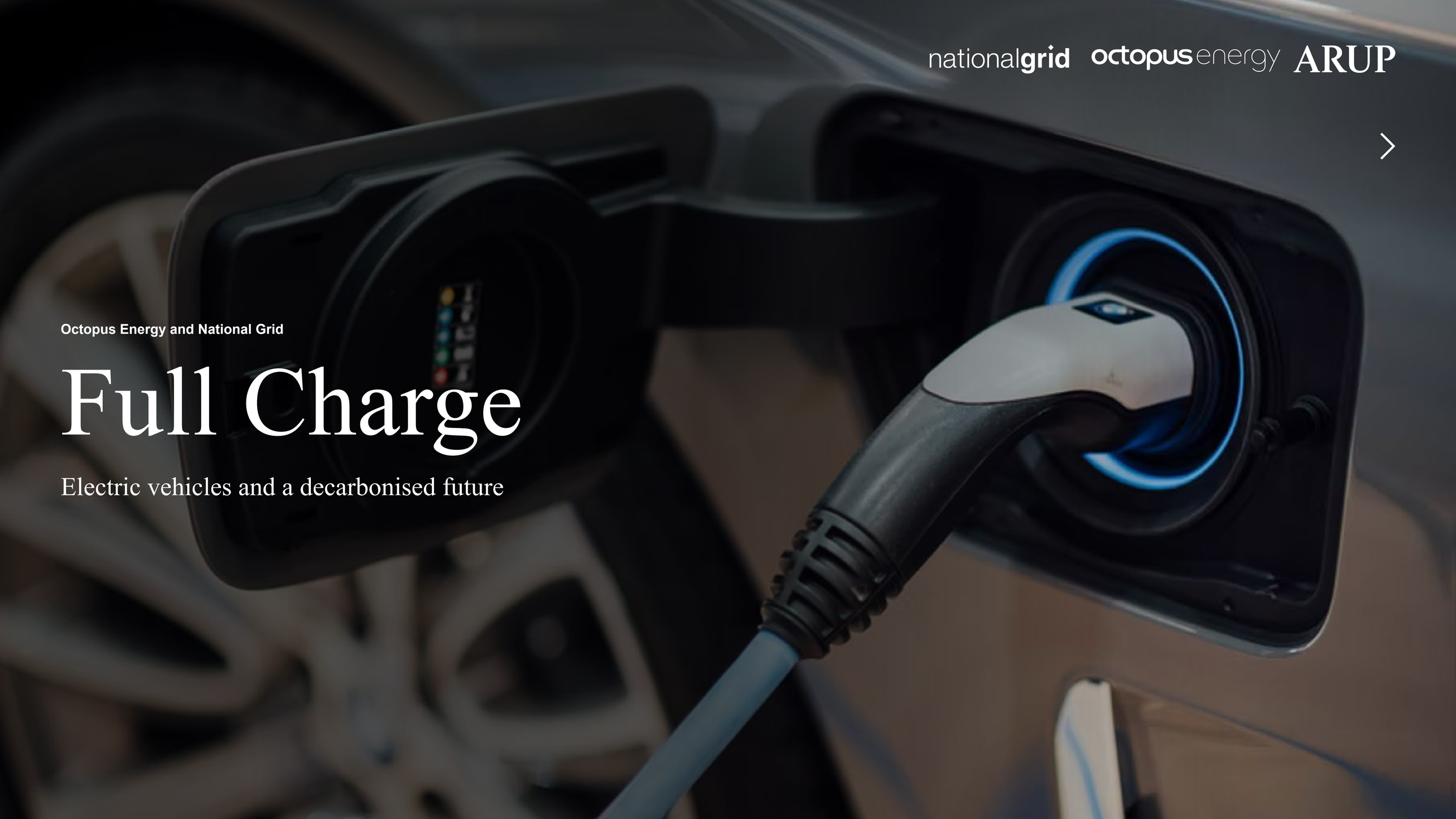


Octopus Energy and National Grid

Full Charge

Electric vehicles and a decarbonised future

Electric vehicles (EVs) – the facts

EVs are easy to use and fun to drive

Recent technological improvements have enabled EV cars to have extended driving ranges, rapid acceleration and extensive manufacturer warranties.

Driving Range

Battery technology is improving rapidly. With an average battery capacity of 62kWh, EV cars currently have an average range of 215 miles. Many new models have ranges of well over 300 miles, similar to cars with a traditional internal combustion engine. EV ranges have more than doubled in the past 10 years.

In the UK, the average daily journey taken by car is 20 miles. As such, a home charger can be used for day-to-day charging, with the public network being used on longer journeys.

The driving range of an EV can be impacted by factors such as driving style or the cold. However, technological developments including regenerative braking and pre-warming of the battery can already minimise the impact of these factors, and are expected to increasingly do so over time.

Driving Experience

Unlike in a conventional car with gears, an EV's motor delivers instant torque and extremely fast and quiet acceleration. This means that some EVs such as the Tesla Model 3 can go from zero to 60mph in about three seconds.

If fast acceleration doesn't do it for you, the ease of operation and smooth ride are also big attractions. With no clutch, many EVs are similar to traditional automatic cars, except for the regenerative braking that provides smooth deceleration when the foot is taken off the accelerator. This contributes to the overall ride quality and extends the driving range.

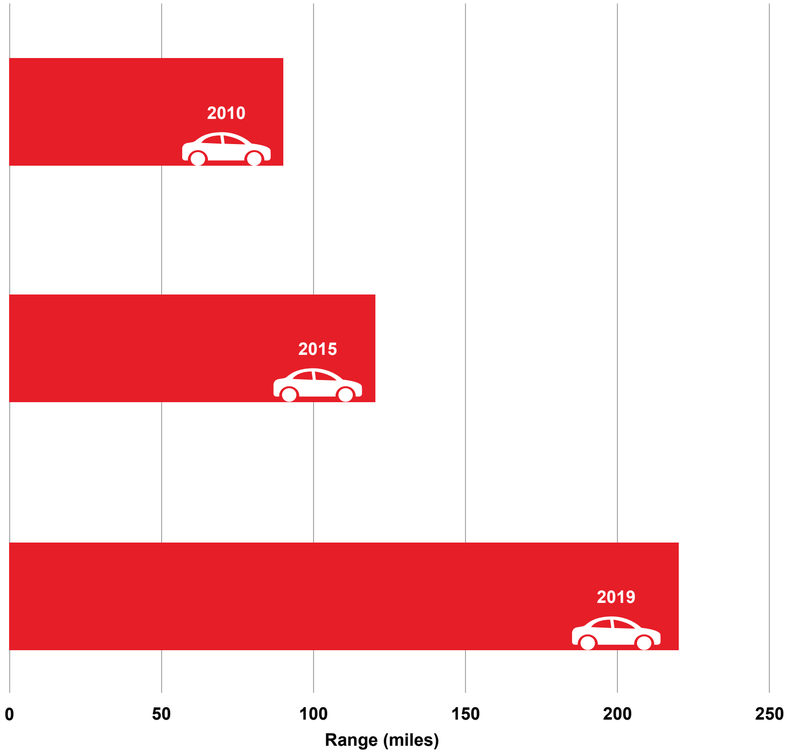
The Battery

Many manufacturers provide a full battery warranty of 5-8 years, or 100,000 miles. However both the vehicle and the battery typically operate for a period much longer than this. Depending on battery health and mileage, batteries may need replacing after 10 or more years to maintain the range.

The price of batteries has fallen considerably over the last decade, from about £50,000 for a 62kWh battery in 2010, to under £6,000 for the same battery in 2020. The cost of battery replacement is expected to fall further in the future, and used batteries can be repurposed and eventually recycled (see page 7).

20 miles
the average daily journey by car

215 miles
the average range of an EV



The driving range of a Nissan leaf over time.
Sources: EV-Database UK

EVs are easy to use and fun to drive

In England you are never more than 25 miles from a rapid charge point on the motorways and major A roads, and nearly £2 billion has been committed to increase the number of ultra-rapid chargers.

Where can I charge my EV?

EVs can be charged at home, on the go, or at your final destination.

Charging infrastructure networks are being designed around the needs of different EV users. Home charging is generally the cheapest charging option, while public charge points tend to provide faster charging. The urban density and population distribution in each country will shape EV users' charging behaviours.

Home charging access

Two-thirds of English and Scottish households have access to on-site parking. In Wales this rises to over 75% of households. EV users with low daily average mileage are very likely to favour home charging due to its convenience and lower cost of electricity (as low as 5p/kWh).

Home chargers are typically regarded as 'slow' (3-7.4kW) and often used overnight.

What if I cannot charge at home? What are my options?

A driver is never further than 25 miles away from a rapid charge point anywhere along England's motorways and major A roads. Across the UK this number will continue to decrease as more charge points are installed. As of 2021, there were 26,682 public charge points in the UK, about 5,000 of which were rapid or ultra-rapid chargers. This is more than double the number of public charge points in 2018, demonstrating the rapid growth in infrastructure.

By 2035, the UK government is planning for there being around 6,000 ultra-rapid charge points across England's motorways and major A roads. In September 2020, it announced the Rapid Charging Fund as part of a £950 million commitment to EV charging infrastructure. A further £620 million is being invested in EV grants and street charging points as part of the government's Net Zero Strategy.

Wales and Scotland have equally ambitious plans. For example, by 2030 Wales wants to have 4,000 rapid or ultra-rapid public chargers, and between 30-55,000 fast chargers.

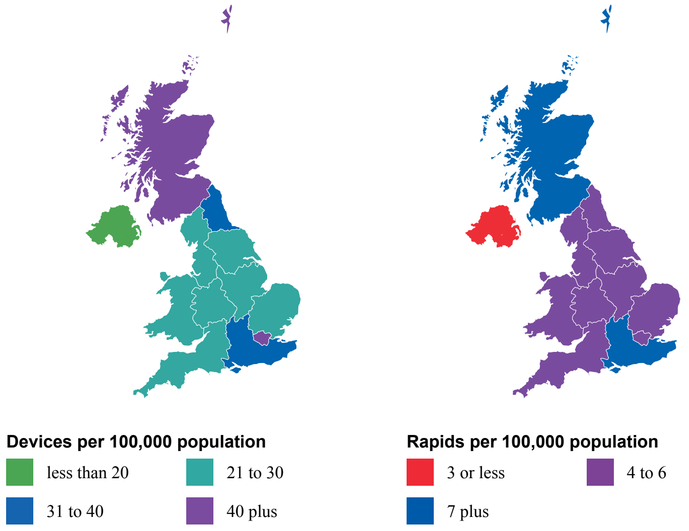
EV users without home charging facilities — or those needing a top-up — have access to several options:

- Slow: rated 3-7.4kW and often used to charge overnight, or during the day at the workplace.
- Fast: rated at either 7kW or 22kW, typically installed in car parks, supermarkets and leisure centres.
- Rapid: rated 43-50kW, usually found in charging hubs or on motorways, and able to provide quicker charging times.
- Ultra-rapid: rated 100kW-400kW and increasingly compatible with more EV models, they can be found in dedicated mobility hubs or service stations for fastest service.

25 miles
the furthest distance you are from a public charge point in England

26,682
public charge points in the UK

6,000
ultra-rapid charge points in England by 2035



All charging devices (left) and rapid charging devices (right), both by 100,000 population.
Sources: Zap Map

EVs are cost effective and increasingly affordable

The lifetime cost of an EV is now generally lower than that of an internal combustion engine equivalent, with significantly lower running costs and financial support to enable ownership.

Total Cost of Ownership

The sum of the initial purchase price of a car and its operational expense — for example purchasing a car in 2021 and running it for 15 years in the UK — reveals a favourable outlook for EVs. Our example opposite demonstrates a saving of over £8,000 if using overnight home charging.

Price and speed comparison

Home charging is the cheapest charging option, at as little as 5p/kWh. Non-home charging will generally be more expensive but significantly faster – as little as 15 minutes - reflecting the value of time. The cost ranges opposite reflect differences in operators, charger speed and membership status.

Free or low cost charging is also available at some destinations, as part of some vehicle lease offers or with monthly subscription. Whilst this might not be offered forever, it does provide an incentive for EV owners.

Average charging cost	Charger type	Cost	Charge time
£		5-18p/kWh	5 hours
££		25p/kWh	2 hours
£££		30-41p/kWh	45 mins
££££		30-64p/kWh	5-20 mins

Maintenance costs

EVs generally have a simplified and infrequent maintenance routine due to:

1. fewer moving parts demanding less maintenance;
2. regenerative braking reducing the load on braking systems and tyres;
3. simpler transmission from battery to motor.

As a result, the average lifetime maintenance/repair costs in 2020 were as follows:

– EV: 2.3p/mile

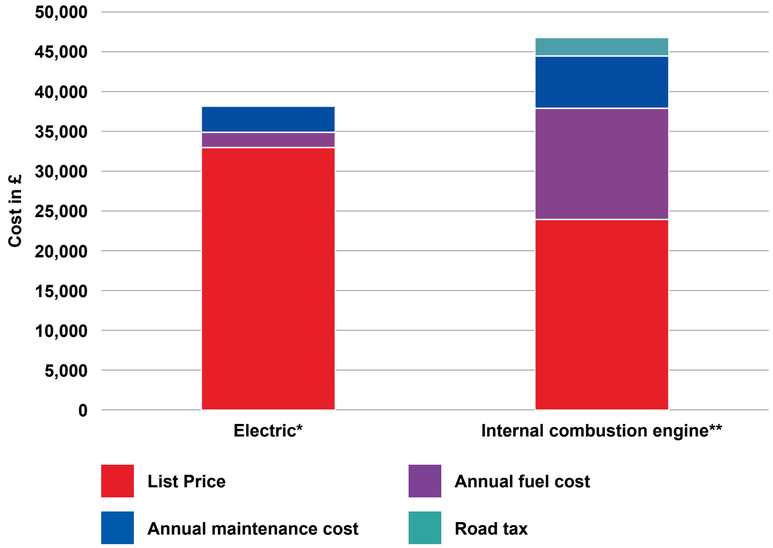
– Plug-in hybrid EV: 2.2p/mile

– Internal combustion engine: 4.5p/mile

£575/year
saving on lifetime cost vs internal combustion engine equivalent

£8,600
total saving over saving over 15 years

2.3p/mile
average lifetime maintenance cost for a EV



Cost comparison over 15 years, excluding grants assuming 5p/kWh.
Sources: Arup analysis, Ford UK, Nissan UK, Automobile press, BEIS

*Nissan Leaf e+ N-Connecta 62kWh and **1.0L Ford EcoBoost 125PS ST-Line Edition

EVs are cost effective and increasingly affordable

Support for EVs

A number of subsidies are available for EV users in 2021. They include:

Plug-in Grant

up to £2,500 discount on eligible EVs and low-emission vehicles.

EV home charging scheme

a 75% contribution to the cost of purchase and installation (capped at £350 per installation) for one charge point.

Urban charges exemption

with zero tailpipe emissions, EVs are currently exempt from London's congestion charge and ultra low emission zone (ULEZ) charge.

Reduced parking charges

EVs pay reduced or zero parking charges in many places across the UK.

Vehicle Company Car tax and Excise Duty

zero-emissions vehicles receive favourable company car tax rates and are exempt from vehicle excise duty until March 2025.

Green licence plate initiative

since December 2020, EVs can use bus lanes and enter zero-emission zones in some cities/towns.

EV leasing and the second-hand market

Leasing is the most cost-effective way to access a new EV without facing the up-front cost, as well as incorporating the servicing and maintenance expenses. Many leasing deals last 2-4 years, after which the EVs are sold on the second-hand market at a significantly lower cost than new EVs.

An Autotrader search in September 2021 found ~3800 used EVs available for sale. All main dealerships and manufacturers provide 'approved' used cars and alternative finance packages.

Typical prices for second-hand EVs in 2021 were:

Nissan Leaf - £5,000

VW e-Up! - £11,000

Renault Zoe - £7,500

BMW i3 - £20,000

If a new EV is preferable, some companies offer salary sacrifices to subsidise the purchase of (company) EVs, with the cost of the vehicle, maintenance and insurance being withheld from an employee's gross monthly salary. The cost is further reduced due to EVs having a very low Benefit in Kind tax (BiK) thanks to their zero tailpipe CO2 emissions; BiK is expected to be 1% in the 2021/22 tax year and 2% in 2022/23 compared with ~27% BiK for internal combustion engine cars.

£2,500
discount on low-emission vehicles

1%
Benefit in Kind tax for EVs in 2021/22

£278/month
saving on lifetime cost vs combustion engine car equivilant

Lease cost example: Leasing a 4-seater EV Mini Cooper could save you £278 a month compared with its fuel-run equivalent. That's £10,380 over a three-year period.

EVs are better for the environment

EVs are part of decarbonisation ‘jigsaw’. This is especially true as the share of renewables in our electricity generation mix continues to grow and we find innovative ways to repurpose the batteries.

Carbon reduction

Surface transport accounts for 22% of greenhouse gases in the UK. EVs, with zero tailpipe emissions, can play a major role in reducing carbon emissions from road transport.

In 2020, over 59% of the UK’s electricity was produced from renewable or low-carbon sources. This is only going to increase as the UK moves towards net zero. EVs charging from the grid will reduce carbon emissions compared with combustion engine vehicles.

The carbon emissions associated with the mining of battery components for EV cars are partly offset by the zero tailpipe emissions and the move to repurposing/recycling of batteries.

Air quality

EVs do not emit the toxic exhaust gases, including nitrogen oxides and hydrocarbons, that are associated with internal combustion engine vehicles. This can significantly reduce air pollution in local areas.

Both EVs and internal combustion engine vehicles produce particulates from tyre, brake and road surface wear. However, these particulates are generally larger in size than those produced by internal combustion engine emissions, making them less able to enter people’s lungs and bloodstream.

Second-life battery use

At the end of their useful life, EV batteries are increasingly being repurposed or recycled. Although the batteries’ reduced capacity may make them unsuitable for EV use, their remaining power storage capacity is still suitable for potential reinforcement and support of energy systems. In South Africa, for example, 200kWh of EV batteries have been successfully reused as part of a production facility’s microgrid. Similar planned projects in Germany, France, the Netherlands and Japan highlight the second-life potential of batteries.

Alternatively, batteries may also be recycled to extract valuable elements such as nickel, manganese, lithium and cobalt. Many vehicle manufacturers have committed to recycling the battery components.

Multi-modal transport

Looking ahead, a switch from internal combustion engine vehicles to EVs will support the decarbonisation of transport. This should be complemented by a wider shift from car trips to active travel - walking and cycling - alongside a multi-modal transport network including car sharing and autonomous vehicles.

A collective effort is required to create lasting improvements in air quality, noise reduction and decarbonisation as well as economic and social benefits for all users.

22%
greenhouse gases linked to surface transport

59%
percentage of electricity produced by renewable and low-carbon generation*

*Climate Change Committee and National Grid

EVs help support a decarbonising grid

Smart chargers and flexible electricity tariffs enable EV owners to use ‘green’ power, support decarbonisation and reduce EV running costs.

In the UK, electricity demand peaks between 4pm and 7pm. Charging your EV during this time would place additional pressure on the electricity grid and cost you more. To avoid this, a number of energy suppliers have started introducing flexible tariffs for homes. Flexible tariffs and smart charging together are the most cost-effective way to charge an EV and get the most out of the current grid.

Smart charging

Smart chargers in combination with a smart meter can communicate with the EV, the electricity grid and the market to increase, decrease or reschedule charging depending on the information received. This allows EV owners to select the ‘greenest’ or ‘cheapest’ time to charge. This supports decarbonisation by charging overnight and using renewable electricity when it is plentiful. All new EV chargers will be mandated to be smart from 2022.

Time-of-use tariffs

Flexible tariffs offer cheaper electricity during specific times of the day to shift usage to those times. One supplier charges 5p/kWh between 0:30am and 4:30am, compared with 15p/kWh during the rest of the day. A dynamic time-of-use tariff offers unit rates that vary every half hour, ranging from as high as 34p/kWh to negative — getting paid to charge your car.

Studies show that within a month of moving to these tariffs from a standard tariff, households reduced their demand in peak hours by 15% and increased usage during the cheap window. This is made even easier with the use of a smart charger.

This change in behaviour supports the power grid’s move towards zero emissions by using electricity when most of the UK’s renewable electricity — from wind energy — is being produced. This translates into a benefit for all electricity consumers, even those who do not use an EV.

Time-of-use EV charging tariffs are currently only available at home. However, it is possible that energy reforms will make it likely for public charging providers to offer these options too.

Vehicle to Grid (V2G)

Due to their ability to charge flexibly, EVs can use electricity when there is an abundance of it, for instance on very windy days, and feed that electricity back into the grid when it is needed, balancing electrical demand as required. This is known as Vehicle to Grid (V2G).

This technology is currently being tested, with some EV users receiving payments when they feed electricity into the grid. The use of this technology at scale would see EVs further contributing to efforts to decarbonise the grid.