energy saving trust

Charging electric vehicles

Getting the best out of electric vehicle batteries, home and public chargepoints, and maximising savings

Department for Transport

Office for Low Emission Vehicles

energysavingtrust.org.uk

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Introduction

Published in July 2018, the Road to Zero Strategy illustrates the government's aims to put the UK at the forefront of the design and manufacturing of ultra-low emission vehicles, and for all new car and vans to be effectively zero emission by 2040.[1] To support this, the strategy sets out plans to develop one of the best electric vehicle infrastructure networks in the world.

In addition, the government's long-term ambitions are:

- To see between 50% and 70% of new car sales ultra-low emission by 2030.
- For the majority of cars and vans to be zero emission by 2050.

Whether at home, at work or at public destinations, electric vehicles need to be plugged-in to recharge.

This best practice guide aims to help you understand the different aspects that should be considered when charging a plug-in vehicle. The guide explains the different types of charging infrastructure along with how, when and where best to charge your vehicle. It also covers the government grants available for plug-in vehicle users, advice on how to minimise plug-in vehicle running costs and what new and improved technologies are emerging for charging plug-in vehicles.

This guidance only discusses vehicles that have the ability to be plugged in and charged up using an electric vehicle chargepoint, not conventional hybrids which generate electricity solely through reclaiming energy through braking.

If you have any further questions, please contact the Energy Saving Trust at **transportadvice@est.org.uk**.

1 assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/739460/road-to-zero.pdf

1. Ultra-low emission vehicles

Ultra-low emission vehicles (ULEVs) are defined as vehicles that emit less than 75g of CO_2 per kilometer.

1.1 Types of ULEV

There is a range of different ULEVs, including battery electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs) and extended-range electric vehicles (E-REVs).

BEVs, PHEVs and E-REVs all have the ability to be plugged in and charged using an electric vehicle (EV) chargepoint. Knowing how to recharge these vehicles is key to getting the most out of them and making big savings on your fuel bill.

Below is a table summarising the key differences between the different vehicle technologies.

Table 1: Key differences between ULEVs

Types of ULEV	Information	Example
Battery electric vehicle (BEV or pure EV)	A vehicle powered only by electricity. The vehicle is charged by an external power source and incorporates regenerative braking which helps to extend the available range.	**Cars:** KIA Soul Mercedes B250e Nissan Leaf Renault Zoe Tesla Model S **Vans:** Citroen Berlingo Nissan E-NV200 Peugeot Partner Renault Kangoo 
Plug-in hybrid electric vehicle (PHEV)	A vehicle which has a battery, electric drive motor and an internal combustion engine (ICE). The vehicle has the ability to charge the battery from an external power source. The vehicle can be driven using the ICE or the electric drive motor, or both simultaneously.	Audi A3 e-tron Mercedes C 350e PHEV Mitsubishi Outlander Toyota Prius PHEV 
Extended range electric vehicle (E-REV)	A vehicle which combines a battery, electric drive motor and a small petrol or diesel generator. The electric motor always drives the wheels with the ICE acting as a generator when the battery is depleted.	BMW i3 REX 

1.2 Types of chargepoint and connector

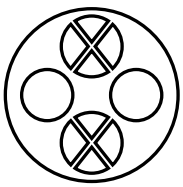
There are several different types of chargepoint, which vary in how fast they charge an electric vehicle and the type of connector they use. It is important to understand the differences between chargepoint types and when is best to use each type of chargepoint.

The fastest way to charge an electric vehicle is by using a rapid chargepoint. The UK has a public network of over 1,700 rapid chargepoints – one of the largest in Europe. The rapid chargepoints can provide an 80% charge in approximately half an hour and are designed for a 'top-up' during long journeys. Rapid chargepoints are typically more expensive to use than slower forms of charging and so, if you have time to spare, you can save money by using slower chargepoints.

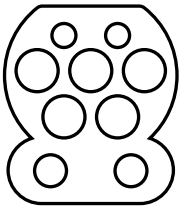
Slow chargepoints are more suited to recharging a vehicle that is parked for a longer period of time, such as when you are out shopping, or visiting friends and family. Slow chargepoints can also be installed at home, if you have a driveway or garage, making it easy to charge overnight. Public slow chargepoints are typically cheaper to use and so, if you are leaving your vehicle parked for a long time, they are often the best option. However, they are best avoided if you need to recharge quickly, as a full charge can take 8 hours or longer.

In between slow and rapid chargepoints, you can find fast chargepoints. These are a happy medium, ideal for when you are making a one or two hour stop. Fast 7kW chargepoints can also be installed at home. However, the rate at which your vehicle can be charged is determined by the vehicle's onboard charger which converts Alternating Current (AC) to Direct Current (DC). Details on your vehicle's onboard charger can be found in the vehicle handbook or vehicle brochure.

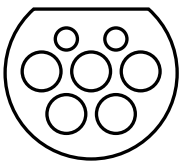
CHAdeMO
up to 100kW



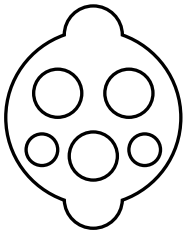
CCS
up to 350kW



Type-2
3-43kW AC



Type-1
3-7kW AC



Images courtesy of Zap-Map

Each chargepoint type also has an accompanying set of connectors that vary depending on whether they are for low or high power use, or Alternative Current (AC) or Direct Current (DC) charging. The main connectors you will see are CHAdeMO, CCS, Type-2 (7-pin) and Type-1 (5-pin). The CHAdeMO and CCS connectors are both DC, and the Type-2 and Type-1 chargepoints are AC.

On the chargepoint-side, rapid chargepoints use CHAdeMO, CCS or Type-2. Fast and slow units use Type-2 or Type-1. On the vehicle side, European models (VW, Volvo, Audi etc) usually have Type-2 inlets and the associated CCS connection, whereas Asian models (Nissan and Mitsubishi) have a Type-1 and a CHAdeMO connection. This usually varies between vehicles so it is best to check this and confirm.

Ultra-Rapid Chargepoints

The emergence of 120-350 kW ultra-rapid chargepoints will build upon the extensive network supporting future EV's with longer ranges when they are available on the market.

The following table provides a simple summary of charging technology, connectors and their associated charging times:

Table 2: Guide to chargepoint infrastructure

	Slow	Fast	Rapid
Power rating	3-7kW	7-22kW	Up to 50kW
Electrical supply type	AC	Usually AC, DC available at higher rates	Usually DC, AC also available
Charge time	4 to 8 hours	2 to 4 hours	25-40 minutes (80% charge)
Vehicle range added in 15 minutes	3-6 miles	6-20 miles	35-40 miles
Connector	Type-1 Type-2	Type-1 (max 7kW) Type-2	CHAdeMO CCS Type-2
Best use	Work/home	Home/work/on-the-go	On-the-go/long journeys
EV compatibility	All	All, some vehicles may charge slower than others	Dependent on connector type. Not all BEVs and very few PHEVs are capable of accepting a rapid charge

1.3 How to charge a BEV vs a PHEV

There is a wide range of vehicles available with different sized batteries and different charging capabilities.

A key factor to consider when charging your vehicle is size, as the bigger the battery is the longer it will take. PHEVs typically have a considerably smaller battery than BEVs, and can be almost four times quicker to charge using a slow chargepoint. It can take as little as two hours to fully charge a PHEV using a slow chargepoint, compared to around eight hours for a BEV. For this reason, slow charging is often the most cost-effective and convenient way to charge a PHEV in public.

It is worth noting that some E-REV vehicles, like the BMW i3, are able to use electricity supplied from chargepoints, as well as from the range extender, and therefore are also a type of PHEV.

Most PHEVs cannot use rapid chargepoints. For those that can, it is typically more expensive, per mile, to charge a PHEV on a rapid chargepoint compared to a BEV. This is because rapid chargepoints often require payment of a fixed connection fee every time they are used, and because a higher rate is charged per kWh supplied. As PHEVs have smaller batteries, this flat rate connection fee will make them more expensive per mile than a BEV.

If you own a PHEV, it is important to recharge it regularly. This is the most cost-effective and environmentally friendly way to use your vehicle. The electric driving range will be sufficient for most of your shorter journeys – 10 miles is the average length of a commuter trip across England and Wales, dropping to about 8.6 miles in London.[2] The petrol engine can be used as back-up for when you need to travel further.

Regardless of whether you own a PHEV or BEV, if you recharge them sensibly, you can achieve significant savings compared to pure petrol or diesel vehicles.

2 National Travel Survey: England 2017, 26.07.2018, assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/729521/national-travel-survey-2017.pdf

Nissan Leaf, Battery electric vehicle

Mitsubishi Outlander, Plug-in hybrid vehicle

2. Home charging

The majority of electric vehicle charging will take place at home. The charging method will be dictated by where you are able to park, and your access to an electricity supply.

Section 2.1 will discuss charging an electric vehicle if you have off-street parking, such as a driveway or garage. Section 2.2 covers what options are available to those that park their vehicles on-street.

2.1 If you have a driveway or garage

Charging cars overnight at home is usually cheaper and more convenient for consumers than charging in public. By using this cheaper home charging, both PHEVs and BEVs can also maximise their potential contribution to the UK's future smart, flexible energy system, via smart charging (2.1.6) and vehicle-to-grid (2.1.8).

2.1.1 Installing a home chargepoint

There are two options for charging your electric vehicle at home: using a regular UK three-pin socket or having a dedicated EV chargepoint installed.

As an estimated 80% of electric car charging takes place at home, it is recommend that EV drivers install a dedicated EV chargepoint, which is a much faster and convenient method of charging.[3] If you own a PHEV, the faster charging time between journeys will also enable you to make the most of the electric driving range which is cheaper to run.

3 Take charge: An analysis of the domestic electric vehicle tariff market, January 2019, www.citizensadvice.org.uk/Global/CitizensAdvice/Energy/Take%20Charge%20-%20EV%20tariff%20report.pdf

Although using a three-pin socket requires no additional installation, it is much slower than using a dedicated charging point. Furthermore, unless you have a dedicated waterproof three-pin plug socket near where you park your car, you will need to run cables from inside the house or garage, outside to your car to charge. New electric vehicles will be supplied with a standard Electric Vehicle Supply Equipment charging cable, allowing you to charge from any mains socket. Extension cables should not be used for charging electric vehicles. When charging from a three-pin socket only use the cable supplied by the vehicle manufacturer.

There are government incentives available to reduce the cost of home chargepoints – EV users with off-street parking can receive funding from the Office for Low Emission Vehicles (OLEV) to install a chargepoint for their plug-in vehicle through the Electric Vehicle Homecharge Scheme (EVHS). This provides a grant of up to 75% of the eligible costs of a chargepoint and its installation (capped at £500, including VAT) for the registered keeper, lessee or nominated primary user of a new or second-hand eligible electric vehicle.

It is recommended that you consider more than one chargepoint installer, as a number of different suppliers have subscribed to the scheme. Each offers slightly different speeds of chargepoint for different costs, as well as different mounting options (e.g. on a wall or a standalone charge post).

The chargepoint installation should not take any longer than a few hours; your chosen installer will be able to talk you through their installation process in more detail. Before the installer arrives, consider where you would like the chargepoint, taking into account your power supply and how you park your car – the installer will be able to help you with this if you are unsure. The installer will also provide a full demonstration of how to use your chargepoint and how to get in touch if you have any further questions.

2.1.2 Safety

Charging your electric vehicle is safe and easy when done with proper, independently safety certified equipment.

Make sure you use an approved vehicle, chargepoint model and installer for the homecharge scheme.[4]

4 www.gov.uk/government/publications/customer-guidance-electric-vehicle-homecharge-scheme

Charging your vehicle safely, using a dedicated chargepoint.

Table 3: Benefits and drawbacks of tethered vs non-tethered chargepoint cables

	Non-tethered cable	Tethered cable
Benefits	The flexibility of being able to charge vehicles with different connectors from the same chargepoint – as long as each vehicle has its corresponding cable. More 'future-proof'; if you change cars and therefore change cables you can still use your chargepoint. The cable can be used at public chargepoints. No tangled or trailing cables when not in use.	More convenient and quicker when plugging/ unplugging as it is already attached to the chargepoint. More secure than untethered as they cannot be stolen or unplugged (not all units lock during charging). Cheaper if a cable is not supplied with your car.
Drawbacks	You have to connect/disconnect the cable every time you use it. There is a chance that the cable can be stolen or unplugged while the car is charging.	The cable is either Type-1 or Type-2 and therefore not compatible with all vehicles. This prevents you from charging some types of vehicles, so if you change car or have visitors with a non-compatible cable, they will be unable to charge using this connector. Adaptors are becoming more widely available to combat this.

2.1.3 Tethered or non-tethered cables

Electric vehicles are connected to the chargepoint via a cable, with the option of having a cable permanently attached to the chargepoint (tethered), or not (non-tethered).

A simple way of explaining the difference is thinking of non-tethered cables as being like a laptop charger – entirely removable with connectors at either end. More specifically, non-tethered units will have a Type-2 socket and the user must provide the cable. Charging cables can cost over £125 so factor this into your purchase costs.

On the other hand, tethered units have a cable permanently attached to the charging unit, like the hoses at fuel station pumps. The cable is usually around 5m, with a 5-pin connection (Type-1) or a 7-pin connection (Type-2).

See above for a summary of the benefits and drawbacks of both tethered and non-tethered chargepoints.

2.1.4 How to use a domestic chargepoint

Using a domestic chargepoint is a simple process. If you have a tethered chargepoint, simply plug the free end into the electricity socket on your car. If you have a non-tethered chargepoint, take the cable from where it is stored and plug the compatible end into the chargepoint and then the other end into your car. The charging should start automatically and will stop automatically when the car is fully charged so the car can be left connected until you are ready to use it again. The charging can be stopped at any time by instructing the charging equipment to do so. Depending on the vehicle type and chargepoint, it may also be controlled through the car or an app.

GB smart metering implementation programme

The government is committed to all homes and small businesses being offered smart meters by the end of 2020. You will not be charged separately for a smart meter or for the in-home display. Under current arrangements you pay for the cost of your traditional meter and its maintenance through your energy bills, and this will be the same for smart meters. See government guidance for further information on how smart meters can support new consumer technologies and services: **www.gov.uk/government/publications/smart-meters-unlocking-the-future**

2.1.5 EV-friendly tariffs

Charging at home is the most cost-effective and convenient way to charge your electric vehicle. The majority of EV users with their own chargepoint are able to fully charge their car overnight.

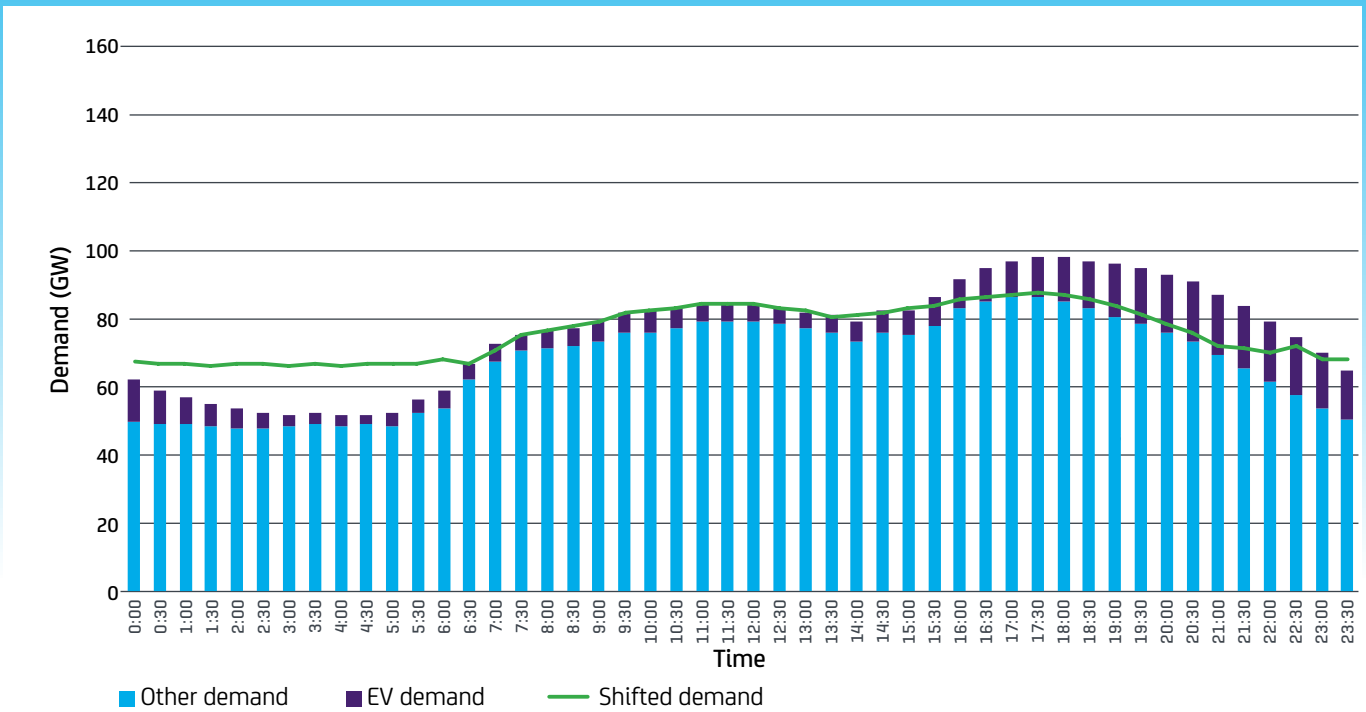
However, this does mean an increase of electricity usage at home, which could be as high as 80%. Although the cost of charging an EV at home will still be significantly less than your usual petrol or diesel fuel bill, having the right electricity tariff is important to maximise your savings and the environmental benefits of an electric vehicle.

Several energy companies offer energy tariffs specifically for electric vehicle owners. These tariffs tend to rely on smart metering and are generally cheaper to use during the night when demand is low. Having a smart meter will enable EV owners to access the full range of tariffs on offer, as well as providing real time information on electricity consumption. EV tariffs sometimes incorporate renewable energy promises and other added benefits targeted at EV drivers.

Specifically designed EV tariffs may not always be the cheapest option, especially for tariffs where the price is the same throughout the day (a single rate tariff). Citizens Advice have published an analysis of the domestic EV tariff market[5], explaining what EV tariffs are, the benefits of different tariffs and the cheapest tariffs available for EV users. They found on average, it was cheaper for EV owners to have an Economy (E7) tariff, which lets you pay less for your electricity overnight. However, new EV tariffs have since been launched and you need to think about your individual use as a consumer to select the right tariff for you. Remember not all EV specific tariffs are available on price comparison sites at the moment.

5 www.citizensadvice.org.uk/Global/CitizensAdvice/Energy/Take%20Charge%20-%20EV%20tariff%20report.pdf

Figure 1: How EV charging load could be shifted to the off-peak[6]



2.1.6 Smart charging

By charging EVs at the most advantageous times to the energy system, users will get lower costs, while maximising the use of lower carbon ways of generating electricity such as renewables. It will also help reduce the need for expensive electricity infrastructure upgrades. This will ensure all the environmental and energy security benefits anticipated from moving to electric vehicles can be realised. As more EVs are regularly plugged in, this will only become more important.

As you can see in Figure 1, the current electricity system has been designed to meet peak demand between roughly 16.30 - 20.30, which is typically when people arrive home from work and begin to use electrical appliances in the home, including electric vehicle chargepoints. Outside of these hours, there is less demand for electricity, so the cost of generating and distributing is cheaper.

Developments are in place so that when permitted by the user, smart chargepoints can pause, increase or decrease the rate of charge going into an electric vehicle. This is in response to signals sent by the chargepoint operator, energy supplier or industry parties such as electricity network operators, suppliers or aggregators. The user is in control of how this occurs, choosing the parameters on the smart chargepoint to suit their driving and charging needs, while allowing some level of relinquished control in return for lower electricity costs.

6 The Road to Zero, July 2018, assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/739460/road-to-zero.pdf, p88.

Figure 2: Vehicle-to-grid technology

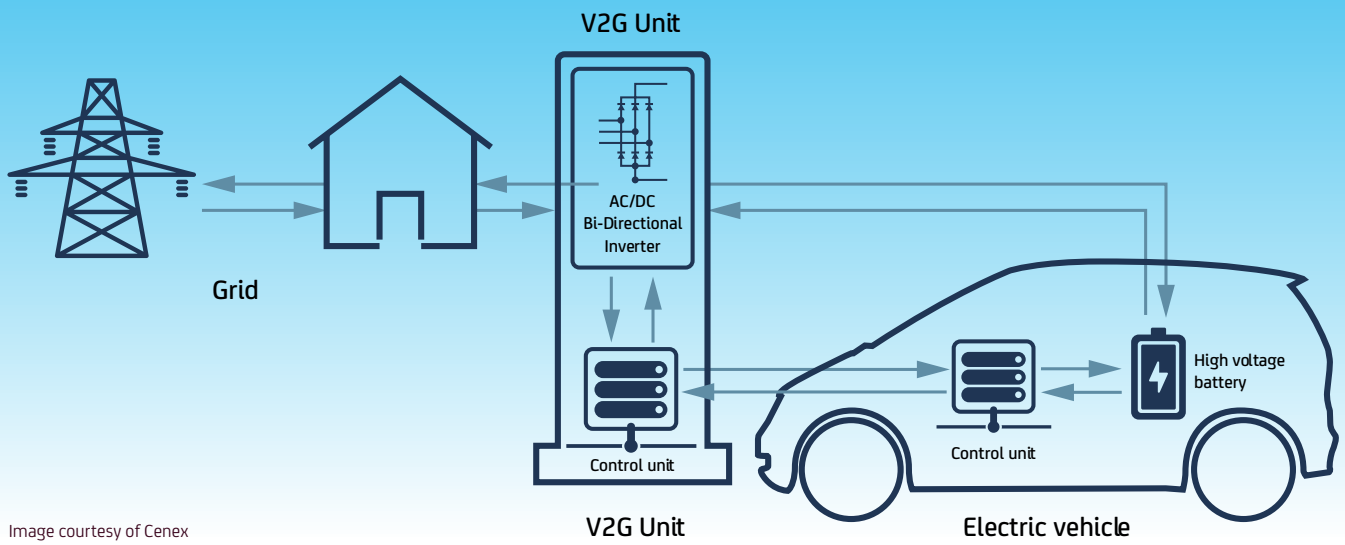


Image courtesy of Cenex

2.1.7 Renewable energy integration

Using an EV is an important step towards a low carbon lifestyle, and can be supported through the use of renewable energy in your home. There are two ways to approach renewable integration:

- Buying your electricity from a renewable energy supplier. The website Zap-Map has a list of EV tariffs currently offered in the UK, a number of which include renewable energy promises. You can even make a change to a renewable tariff before buying an electric car.
- Generating your own electricity. The most common form of domestic energy generation in the UK is via a Solar PV System.[7] This will give you sustainable electric power, that you can use to power your home as well as your EV, free of ongoing costs.

Grid balancing: Redistributing the demand on the grid by moving usage from peak times to off-peak times

2.1.8 Vehicle-to-home and vehicle-to-grid (V2G)

Electric vehicle adoption has soared, with about 206,000 registered plug-in cars in the UK.[8] The grid needs to be prepared for this increase in demand, and this is where vehicle-to-grid and vehicle-to-home can help.

The growth of EVs is an opportunity for change. Batteries lying dormant in garages and driveways present enormous potential for grid balancing, by storing and releasing electricity at the right times for the energy system.

Vehicle-to-home and V2G refer to technologies that utilise specialised bi-directional chargepoints, alongside electric vehicles with batteries, that can both receive and provide electricity. This means the battery is able to withdraw electricity from the grid (as any electric vehicle battery is), but also discharge the battery and return power to the home or to the grid. Figure 2 illustrates how this works.

7 https://www.energysavingtrust.org.uk/renewable-energy/electricity/solar-panels
8 Electric car market statistics, www.nextgreencar.com/electric-cars/statistics/

By using this technology, users can take electricity from their EV and sell it back to the grid – or potentially use it to power their home. Vehicles can discharge to the grid and support the peak demand (during the 16.30-20.30 time period discussed earlier), or discharge to a home, decreasing reliance on the grid during this time period. This could potentially reduce the need for major investment in network upgrades or new power plants: ultimately saving you money on your energy bill.

This technology also has the capacity to reduce domestic electricity costs. Some energy companies offer a reduced lease price on an electric vehicle as part of a bundle with a V2G unit and a tariff if the customer is able to complete a certain number of V2G sessions per month.

At the moment, only the 'CHAdeMO' DC connector is compatible with V2G, and so only car models that support this connector are V2G compatible. The current models that accept a 'ChAdeMO' connection are; Nissan Leaf, Kia Soul, Mitsubishi Outlander and Nissan e-NV200 (van). Although V2G chargepoints are not readily available on the market, they are already being trialled in homes across the country by companies including Octopus Energy and OVO Energy. It is anticipated that V2G will be commercially mainstream in the next five years.

2.2 If you park on-street

For those who live in properties that do not have dedicated off-street parking, charging an EV at home can be more challenging. However, action is being taken to make sure that residents of households without off-street parking still have convenient access to cost-effective charging infrastructure near to their homes.[9]

2.2.1 On-street Residential Chargepoint Scheme (ORCS)

The On-street Residential Chargepoint Scheme gives local authorities access to grant funding to support the installation of on-street chargepoints, to meet the charging needs of residents without off-street parking. The Office for Low Emission Vehicles (OLEV) has allocated £4.5 million of funding for this scheme between 2018 and 2020.

It is possible for a member of the public to ask their local council to install a roadside chargepoint near their home. If the area meets the criteria of the scheme, it is likely the local authority will be able to take this request into account when planning chargepoint locations.

Although this funding cannot be used to support the installation of chargepoints for the primary use of taxi fleets, installations near individual taxi drivers' homes are eligible, providing that no off-street parking is available.

2.2.2 Local authority engagement

If you would like to make a request and do not know who to contact in your local authority, please email **onstreetchargepoints@est.org.uk.**

It is up to local authorities to apply to ORCS, but through resident requests, your local council can forecast where there is demand for EVs and therefore decide where charging infrastructure may be best located.

9 The Road to Zero, July 2018, assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/739460/road-to-zero.pdf

2.2.3 Lamppost charging

One popular method of installing public charging infrastructure is through the modification of lampposts to provide sockets to charge EVs.

In comparison to other EV chargepoints, lamppost charging is quicker and cheaper to install and does not add additional furniture to the pavements. Companies such as Char.gy, Ubitricity and Swarco are already making this option a reality.

Chargepoints can be retrofitted onto existing lampposts in as little as 30 minutes and chargepoints are typically for 'slow' charging, which is perfect for residential overnight charging.

Some lamppost chargepoints are installed in a discreet manner. They can be the same colour as the rest of the lamppost and may have no screen. These may require a specific cable for charging use. Your local authority should be able to provide you with information on whether these cables are required and where you can purchase one. These cables typically cost less than installing a chargepoint at home. As councils own and maintain the lampposts in their locality, it is up to them if they decide to install a lamppost chargepoint. It is not possible for an individual to buy or fit lamppost chargepoints.

Lamppost charging in use in London

2.3 Shared car parks

If you have private parking but not a designated parking space, you will need to seek the relevant permissions from the site owner and may need to pay for the installation yourself. The site owner may wish to organise and pay for the installation themselves, and then charge the residents a fee to cover the electricity that they use from the chargepoint.

You could consider speaking to the other residents in the area who share the parking and evaluating interest levels for chargepoints. If you have the support from many residents, a site owner may be more prepared to install chargepoints.

2.4 Advice for rental properties

The property arrangements for the installation and operation of electric vehicle charging infrastructure will depend on who will own and operate the equipment (e.g. the site owner or someone else) and the ownership structure for the relevant land.

2.4.1 Advice to landlords

It is likely that in the future, just as it is expected that rental properties have Wi-Fi, electric vehicle charging infrastructure will become a standard.

Currently, having electric charging infrastructure can give landlords a competitive edge in the market. It can boost their environmental credentials, make a property more attractive to a wider audience, and provide revenue if they decide to install the chargepoint at their own cost and charge an increased rental fee.

Things to consider for landlords are:

- Which elements are going to be charged to the tenants – installation, repair, maintenance?
- If the car park is shared, can you control access to it? If not, access controls to the chargepoint may be required.
- The type and specification of the equipment to be installed, as new technology can become outdated quickly and if the tenants change they may have different access requirements.

2.4.2 Advice to tenants

If you don't own your own home, you need to seek permission from your local authority, landlord or relevant organisation to install a chargepoint.

Please note that there are permitted development rights that apply to EV chargepoints units meaning that they do not necessarily require planning permission in public places. More information on this can be found by searching online for SI 2056 2011.

As above in 2.3, if you live in a property managed by an organisation it may be worth engaging your tenants' association. If you can get the backing of the tenant's association with a majority vote for requesting charging infrastructure, property managers may be more likely to agree.

3. Public charging

Nationwide, there are now over 17,000 public chargepoints, and this network is expanding rapidly. The vast majority of chargepoints are found in towns, cities and dense urban areas.

Below is a table showing examples of when it might be most suitable to use different kinds of chargepoint.

Table 4: Guide to chargepoint uses

Chargepoint Type	Typical Charging Time	Example
Slow	2-8 hours	'Destination charging' e.g. a shopping centre, supermarket or cinema
Fast	1-4 hours	'Destination charging' e.g. a shopping centre, supermarket or cinema
Rapid	30 minutes or less	Motorway service station stop and 'destination charging'

3.1 Workplace charging

Workplace charging is a great alternative for those people who do not have off-street parking at home, or those who have plug-in hybrids or range-extended vehicles to fully take to take advantage of the electric range provided by their vehicles.

The Workplace Charging Scheme is a voucher-based, government funded scheme for private businesses and public bodies that provides support towards the up-front costs of the purchase and installation of electric vehicle chargepoints in the workplace for staff and fleet use.

The contribution is limited to 75% of purchase and installation costs, and a maximum of £500 for each socket, up to 20 sockets per company. Further information and eligibility criteria is available on the OLEV website.[10]

Charegepoints at a motorway service station

10 assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/722541/workplace-charging-scheme-guidance.pdf

3.2 Finding a chargepoint

Public chargepoint operators and chargepoint map providers give details of the types of public chargepoints available and their location. This includes rapid chargepoints available at service stations on the strategic road network, which includes motorways and major A roads.

Most chargepoint map providers have search functions where you can put in your postcode and a selection of chargepoints that are closest to you will be flagged. Some of the most popular websites are:

- Zap-Map[11]
- ChargePlace Scotland[12]
- Plugshare[13]
- Open Charge map[14]

Often chargepoint operators will also have their own maps – but these are restricted to specific chargepoints, and may not be accessible unless you have a membership. Some examples are:

- Pod Point[15]
- Chargemaster[16]
- Ecotricity[17]
- Charge Your Car[18]

New electric cars often come with a built-in satellite navigation system to direct you to the nearest chargepoint should you need it.

It is always better to plan ahead for long distance travel, specifically looking at chargepoint locations and when you are likely to need them. This can help long journeys become a stress-free experience. With EVs now available that can travel over 200 miles on a single charge, planning where you will charge on long journeys may be no different to planning to take a break.

3.2.1 Charging Networks

Access to charging is usually provided by a radio-frequency identification (RFID) card or via a smart phone application, although an increasing number of chargepoints will accept payment from a regular contactless credit or debit card. New regulations mean that every public chargepoint has to have ad-hoc access, however, some charging networks will offer a reduced rate for their members.

As with home charging, the charging will start automatically when the vehicle is properly plugged in and stop automatically when the car is fully charged. The charging can be stopped or paused at any time by tapping the RFID card on the reader on the chargepoint or using your smartphone app to instruct the equipment to stop.

Zap-Map lists the major charging networks across the UK, as well as the smaller local and regional networks that exist in some parts of the country. It is worth knowing which chargepoint operators manage the charging infrastructure in your area and the best way of accessing these chargepoints, as you may save money by becoming a member of the network you are likely to use most often. All of this information should be found online on the operator's websites.

Should you have a complaint about a chargepoint you can register it with the Office for Product Safety and Standards.[19]

11 zap-map.com
12 chargeplacescotland.org
13 plugshare.com
14 openchargemap.org/site
15 pod-point.com
16 bpchargemaster.com
17 ecotricity.co.uk/for-the-road/our-electric-highway
18 chargeyourcar.org.uk
19 rohs.bis.gov.uk/enquiry

Using an app to pay for charging

3.3 Paying for a charge

3.3.1 Payment cards and apps

An example of an RFID card which you may already be familiar with is an Oyster Card. Similarly, a chargepoint card is linked to an account which is topped up separately, so when you come to use the chargepoint all you need to do is tap the card on the chargepoint, and the charging session will begin. Each chargepoint operator has a different RFID card. Some cards are compatible with more than one network (for example, 'Polar Plus' customers can use their RFID card on 'Charge Your Car' chargepoints).

An alternative way of accessing the chargepoint is via smartphone apps provided by the network operators. The app on your smart-phone is linked to your credit or debit card so it will automatically deduct payment based on the charging network cost and the electricity you have used. From the app you will be able to start and stop the charge.

New regulations that came into force in November 2018 have made it mandatory that every chargepoint can be accessed by any driver without having to subscribe to a charging network. This aims to increase driver confidence in the chargepoint network across the UK, as more chargepoints become accessible.

3.4 Getting the most out of public infrastructure

3.4.1 Top-up charging

Charging your electric vehicle is not a like-for-like swap for adding fuel to a petrol or diesel vehicle. Topping up your vehicle charge throughout your journey can help ease range and chargepoint availability concerns, especially with older EVs that have a lower range. Check with the manufacturer of your vehicle the best way to charge to maintain battery efficiency.

When top-up charging, try to avoid chargepoints with high connection fees to save money.

3.4.2 Free charging

According to the National Chargepoint Register, 9% of Chargepoints in the UK are free to use.[20] For example, Lidl offer free charging at some of their supermarkets in partnership with Pod Point and Tesco have announced plans to offer free charging at some stores from 2019, in partnership with Volkswagen. IKEA follow a slightly different model where users of their chargepoints pay £6 for a charge but this can be off-set by a £6 discount off in-store spend.

This free charging at 'destinations,' like supermarkets and shopping centres can make a material difference to fuel costs and the business case for owning an electric vehicle. It should be noted that 'free' charging is an exception, not a rule.

20 www.national-charge-point-registry.uk

3.4.3 Destination Charging

Chargepoints can often be found at destinations where you are likely to park your vehicle for an hour or more. For example, Fullers pubs have signed a deal with Pod Point to install chargepoints at 10 of their sites, and similarly Marston's pubs have partnered with Engenie to install rapid chargepoints across its pubs nationwide.

You will often find information on whether EV charging is available on the website of the destination you are visiting. If the chargepoint is open to the public (i.e. not just for customers), it may also appear on online chargepoint maps, such as Zap-Map.

3.4.4 Transit charging

Modern electric vehicles often have a range of over 200 miles on a single charge. On longer journeys you will need to charge your vehicles along your route, often at a motorway service station. This is referred to as "transit charging". 96% of motorway service stations have rapid chargepoints, but are more expensive than domestic and on-street charging.

The largest provider of motorway charging facilities is Ecotricity, with approximately 145 public charging stations on motorways and A roads across the UK, providing around 300 individual chargepoints.

Charging station: While there is no concrete definition for a charging station, a chargepoint becomes a charging station when there is two or more individual chargepoints in close proximity, with dedicated EV bays

3.5 Charging etiquette

It is important to use public chargepoints in a way that is considerate to other EV users. This is often referred to as 'charging etiquette'. These are informal and often unwritten guidelines on how to use public chargepoints. Whilst you won't get a criminal record for ignoring charging etiquette, acting with consideration for others has benefits for all.

Good principles to follow are:

Parking.

Only park at a parking bay dedicated for EV charging if you are going to charge your electric vehicle.

Knowing the state of charge of your car.

Once your battery has reached the level that suits your journey, unplug your car and move it from the charging bay so that other people can use the chargepoint. If you do not need a full charge, it is cheaper to top up as much as you need publicly before fully charging at home (if possible). This allows other electric vehicles to use the chargepoint more quickly after you.

If you are rapid charging, aim to stay for up to one hour on the chargepoint.

Only plug into a rapid chargepoint if your vehicle is rapid charge capable (except in an emergency or when there are no other options available). Even if your PHEV can take a rapid charge, it should be avoided where possible as they can use their combustion engine as back-up. Once your charging session ends, move to a standard parking space so someone else is able to use the rapid chargepoint.

Don't unplug someone else's car.

If you encounter a vehicle that has reached its charging capacity, it is not advisable to unplug the car. If you are at a service station, you could ask a member of staff to make a public announcement. Only as a last resort should you unplug the car as the vehicle owner may not appreciate it. If you do, it is polite to leave a note on their car as to why you have unplugged it. Some charging cables and connectors do not allow you to unplug them if the car is locked.

If a vehicle with an internal combustion engine (ICE) is parked in an electric vehicle charging spot, there are a few options to choose from.

If it is at a destination chargepoint (e.g. supermarket, shopping centre etc.) you can ask reception to make an announcement to alert the driver to move their car. If it is in an on-street or unmanned car park location, you can register that the chargepoint is 'ICE'd' on Zap-Map, which prevents other EV users from travelling to the space to find that they cannot use it. Local authorities have the power to implement and enforce traffic regulation orders to provide dedicated charging bays for electric vehicles and penalise their misuse. As electric vehicle uptake increases it is hoped that more people become aware of electric vehicle charging and understand the importance of these spaces being accessible to electric vehicle owners.

Make sure the charging cable is neatly stowed.

If you are using a chargepoint with a tethered cable, make sure you stow it properly when you have finished your charge. It could easily get damaged if it is left trailing which could prevent people from using the chargepoint.

Report any damage to charging stations to the network operator.

The supplier's phone number will be on the chargepoint. In some cases, you can report a fault directly through the app provided by that particular network operator.

4. Maximising savings for money – reducing fuel costs

4.1 Home charging vs public charging

Home charging can be cheaper than public charging because there is no connection fee or membership fee, and you are charged at a domestic rate. Exact costs are dependent on what sort of electric vehicle you have, your mileage and how much your electricity tariff costs at home.

PHEV's smaller batteries may cost less to charge but the cost of the petrol or diesel required to fuel the vehicle's internal combustion engine needs to be factored in. These models may also need charging more frequently.

There will be occasions where you are unable to reach your destination using only electricity from home charging, and this is when you should use the quickly expanding network of public chargepoints, to 'top-up' your battery.

4.2 Cost comparisons for different modes of use

The table below shows cost comparisons for different vehicle types, charging speeds and charge amounts. Rapid charging on the public network also comes at a higher cost, but has the benefit of enabling the majority of EVs to charge to 80% in approximately 30 minutes.

Table 5: Cost comparisons

Vehicle Type	Charging speed	Charge level (+%)	Miles added	Charging time (hours)	Public charge cost	Home charge cost	Cost per mile (public)	Cost per mile (home)	Public price premium
Nissan Leaf (BEV)	7kW	+40%	75	2.3	£6	£2.24	8p	3p	+£3.76
		+80%	150	4.6	£10.80	£4.48	7.2p	3p	+£6.32
	50kW (rapid)	+50%	94	~0.3	£7.20	N/A	7.7p	N/A	N/A
VW e-golf (BEV)	7kW	+40%	60	2	£5.50	£2.00	9.2p	3.4p	+£3.50
		+80%	119	4.1	£9.79	£4.01	8.2p	3.4p	+£5.78
	50kW (rapid)	+50%	75	~0.3	£6.57	N/A	8.8p	N/A	N/A
Mitsubishi Outlander (PHEV)	3kW	+40%	9	1.8	£2.86	£0.77	31.7p	8.5p	+£2.09
		+80%	18	3.7	£4.51	£1.55	25.1p	8.5p	+£2.96
Toyota Prius (PHEV)	3kW	+40%	12	1.2	£2.26	£0.49	18.8p	4.2p	+£1.77
		+80%	24	2.3	£3.31	£0.99	13.8p	4.2p	+£2.32
Audi A3 e-tron (PHEV)	3kW	+40%	10	1.2	£2.26	£0.49	22.6p	5.3p	+£1.77
		+80%	19	2.3	£3.31	£0.99	17.4p	5.3p	+£2.32

Calculations assume that the vehicle was new, a connection fee of £1.20 to use public chargepoints, and a public charge cost of 30p/kWh. The average home electricity cost has been taken to be 14p/kWh, not including the one-off cost of chargepoint installation.

Using the same assumptions as the table on the previous page:

If you drive a **Nissan Leaf** 10,000 miles a year and:

If you charge 100% of the time at home, **your annual fuel cost will be**

£300

If you charge 100% of the time on the public network, getting above 80% charge each time, **your annual fuel cost will be**

£720

If you charge 70% of the time at home, and 30% of the time on the public network, getting above 80% charge each time, **your annual fuel cost will be**

£426

In comparison, if you drove a Nissan Micra (diesel, 1.5 litre engine) 10,000 miles a year, taking an average diesel cost to be 129.9p/litre, **your total annual fuel cost would be £858**.

If you drive a **VW E-golf** 8,000 miles a year and:

If you charge 100% of the time at home, **your annual fuel cost will be**

£272

If you charge 100% of the time on the public network, getting above 80% charge each time, **your annual fuel cost will be**

£656

If you charge 70% of the time at home, and 30% of the time on the public network, getting above 80% charge each time, **your annual fuel cost will be**

£387

In comparison, if you drove a VW Golf (petrol, 1.5 litre engine) 8,000 miles a year, taking an average petrol cost to be 120.7p/litre, **your total annual fuel cost would be £796**.

4.3 Driving efficiently

Driving efficiently can help you maximise the range of your vehicle and is especially important on long journeys. By employing efficient driving techniques, EVs have been driven over 600 miles on a single charge.[21]

Knowing how to efficiently drive electric vehicles can help overcome range anxiety, as well as reducing fuel costs and maximising the batteries' power.

There are five top tips for efficient driving in your ULEV:

1. Conserve momentum (avoid harsh acceleration)
2. Avoid harsh braking
3. Watch your speed
4. Reconsider use of heating and air conditioning
5. Know your vehicle's eco features, e.g. use regenerative braking where available.

For further information on efficient driving, please see Energy Saving Trust's best practice guide on 'Efficient driving in electric and low-emission vehicles.'[22]

21 Electrek, May 2018, Tesla Model 3 travels 606 miles on a single charge in new hypermiling record, electrek.co/2018/05/27/tesla-model-3-range-new-hypermiling-record/

22 www.energysavingtrust.org.uk/sites/default/files/reports/Efficient%20driving%20in%20electric%20and%20low%20emission%20vehicles.pdf

5. Case studies

Two EV owners were asked about their experiences in buying, charging and using their electric vehicles.

5.1 Graham – Using a Battery Electric Vehicle

Vehicle: Kia Soul

Cost of vehicle: Vehicle on lease, £220 per month, with servicing for 39 months and 30,000 miles.

Monthly cost of fuel: £25-30

NEDC Range: 155 miles

Actual range: It varies. The average range achieved was around 115 miles. On motorways it dropped to around 90-100 miles, whereas on smaller roads it was up at around 120. Graham's record is 7 miles/kWh for a 13-mile journey- which is equivalent to a 210-mile range.

Annual mileage: 10,000 miles

Use category: Crossover family car, has the ground-clearance for country roads and occasional rural site visits that are needed.

Average miles to kWh; 3 or 4

Average cost per mile: 4.19p

Tariff at home: Graham hasn't changed to an 'EV-friendly' tariff at home; he is currently just using a regular 'green' tariff. If he used the car for long journeys regularly, he would look at using Ecotricity.

Chargepoint at home: Graham used the government grant and looked for an approved installer online. The installation itself took about 2-3 hours, and it was installed on the outside of his garage, which was very easy.

Tethered or non-tethered? Graham went for a non-tethered chargepoint as the car came with a cable.

Charging usage patterns: Graham charges it overnight.

Favourite public charging network: Ecotricity (they're 100% renewable).

Top tips:

- Plan ahead for long trips
- Adjust behaviour and stop often to top up – this gives you a buffer in case of issues at a chargepoint or unavailability
- The range varies a lot depending on how you drive

Pros:

- The driving experience is amazing – there is no messing around with the clutch and the gears
- The Soul feels like it is encouraging you to drive responsibly as the dashboard is dominated by indicators of energy use/ driving style
- Regenerative braking – the dashboard tells you your car is charging itself as you coast down a hill which is very satisfying
- Easy charging – no dribbling nozzle, guilt, carcinogens or petrol smelling hands

Cons:

- The interfacing with public charging isn't all the same – so there can be some extra work involved

5.2 Colin – Using a Plug-in Hybrid Electric Vehicle

Vehicle: VW Passat GTE Estate

Cost of vehicle: The price at the dealer was £39,995. Colin had £6,000 deducted as part of the VW Scrappage deal for trading in his old diesel car, and then a further £2,500 deducted through the PHEV grant from the government (which no longer exists). The final price was £27,500.

Monthly cost of fuel: £29.78

NEDC range of electric engine: 31 miles

Actual range of electric engine: In the summer Colin gets about 25 miles, but in winter it goes down to about 15 miles because of heating. During shorter journeys, he spends more time raising the temperature so the battery is less efficient.

Annual mileage: 4,500 miles

Use category: Family car, social/domestic/pleasure – no commuting. Evenings and weekends.

Average miles to kWH: 2

Average cost per mile pure electric: 7p

Average mixed cost per mile: 8.6p

Chargepoint at home: Colin checked listings on OLEV for approved installers, and looked at three options in more detail, but decided to go with Pod Point as he'd come across them before. They had an online deal which was £275 (including £500 off from the OLEV Homecharge Scheme) involving an online application. The overall experience was good, Pod Point dealt with all the documentation that OLEV required. The actual installation took about half a day.

Tethered or non-tethered? Colin went for the tethered option as he felt it was going to be more convenient, even though the car came with two cables. He didn't want to be sorting out cables if it was raining. He ended up spending a bit more on a 7kW home chargepoint – Colin's hybrid only accepts a 3kW charge but he chose to future-proof the chargepoint so that if his next car is fully electric and can take a higher charge, he can charge more quickly.

Charging usage patterns: No strict pattern – when the battery is dead, he plugs it in.

Favourite public chargepoint: The only public chargepoint Colin has ever used is the Ecotricity one, at his local Ikea. The majority of charging is done at home or at his in-laws'.

EV Tariff at home: Octopus, 100% renewable tariff. 12-month fixed term contract.

Top tips:

- It is worth checking if you have any local chargepoints that are free to use
- To get the best of a PHEV, plug it in as much as possible
- Be considerate of fully electric cars – don't hog chargepoints when you have the option of using the petrol engine

Pros:

- The pence/per mile ratio
- The car is really smooth, quick, quiet and relaxing to drive in full electric mode
- No range anxiety – just range disappointment when the electric battery runs out
- Connectivity of the vehicle – VW Connect is an app that Colin can use to heat up the car or cool it down whilst it is plugged in so it doesn't hinder the range and is the right temperature when he's ready to go
- He can link family phones to the car and play their music through the speaker
- The regenerative braking means he rarely has to touch the brakes

Cons:

- The car still needs to be refueled at a petrol station, albeit more rarely
- There are lots of complaints about people not plugging in and utilising the electric battery on their PHEVs, but people also get annoyed when PHEVs are plugged in on the public network

6. Government policy

Alongside the Road to Zero, the government has published policy documents and recommendations, relating to improving air quality and increasing the uptake of ULEVs. By improving the standards and availability of public electric vehicle charging, both the Automated and Electric Vehicles Act (2018) and the Alternative Fuels Infrastructure Regulations (2017) aim to give everyone the confidence to use electric vehicles.

6.1 Clean Air Zones and Ultra-Low Emission Zones

Transport is the main source of local air pollution – on average road transport is responsible for around 25% of NOx emissions in the UK.[23] This is most acute in towns and cities.

One way that local authorities can combat this is to introduce a Clean Air Zone (CAZ). The zone defines an area where targeted action is taken to improve air quality.

The UK Plan for Tackling Roadside Nitrogen Dioxide Concentrations ('The NO_2 plan') published in July 2017 sets out government's approach to working with local authorities to enforce compliance with NO_2 limits.[24] This work is supported by the CAZ framework[25] which sets out principles for local government to define an area where targeted action is taken to improve air quality.

The NO_2 plan requires a number of local authorities to produce action plans to reduce NO_2 levels in the shortest time possible, which includes benchmarking proposals against the possible introduction of a charging CAZ, where this is appropriate. The UK government believes that if a local authority can identify measures as effective as charging zones at reducing NO_2, those measures should be preferred.

There are CAZs that cost the driver a fee to enter, but there are also some which are free. The CAZ framework is a useful guide for all local authorities, not just those identified in the NO_2 plan, to help address all sources of pollution, including particulate matter, to reduce public exposure using a range of measures appropriate to the particular location.

The entry fees only apply to older, higher-polluting models to standards set out in the framework, in order to target air pollution. Local authorities set the level of fee for vehicles entering the zones.

Another way local authorities are trying to improve air quality is through the Low Emission Zones (LEZ) and Ultra-Low Emission Zone (ULEZ). The Greater London LEZ was introduced in 2008 to encourage the most polluting diesel vehicles driving in London to become cleaner. The London ULEZ has been in place in central London from April, 2019. Most vehicles will need to meet new stricter exhaust emission standards or pay a daily fee to travel within the area. From October 2021 the London ULEZ will expand to the North and South Circular Roads.

23 Nitrogen Dioxide in the United Kingdom, April 2004, uk-air.defra.gov.uk/assets/documents/reports/aqeg/nd-summary.pdf

24 www.gov.uk/government/publications/air-quality-plan-for-nitrogen-dioxide-no2-in-uk-2017

25 www.assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/612592/clean-air-zone-framework.pdf

All cars within the expanded zone will need to meet the ULEZ emissions standards or pay a daily fee. **EVs and a number of efficient hybrids are exempt from these fees. Vehicles meeting the emission standards of Petrol Euro 4 and Diesel Euro 6 are also exempt**.

For further information regarding if your vehicle is affected by the London LEZ or ULEZ, visit the TfL website.[26]

6.2 Automated and Electric Vehicles Act 2018

The Automated and Electric Vehicles Act[27] (AEVA) provides the government with powers to improve the charging experience for EV owners and drivers should the market not deliver this.

6.3 Alternative Fuels Infrastructure Regulations 2017

The Alternative Fuels Infrastructure Regulations[28] (AFIR) (2017) are designed to regulate the way that hydrogen and electricity are supplied to vehicles across the EU, with the hope of reducing dependence on oil in the transport sector.

In terms of electrical vehicle chargepoints, it introduces requirements to ensure greater accessibility and allows drivers to recharge their vehicles without having to subscribe to charging networks and be in possession of multiple RFID access cards.

These regulations increase visibility of chargepoints, ensuring operators make chargepoint location data available in an open and non-discriminatory format.

The policies aim to make owning and using an electric vehicle as straightforward as possible and demonstrate that the government is creating the right framework in order to accelerate the change.

Emission standards: Euro (3,4,5 or 6). Stringent standards for the acceptable limits for exhaust emissions of new vehicles sold in EU member states.

26 tfl.gov.uk/modes/driving/low-emission-zone/check-if-your-vehicle-is-affected?intcmp=2266

27 www.legislation.gov.uk/ukpga/2018/18/contents/enacted

28 www.legislation.gov.uk/uksi/2017/897/contents/made

7. The future of charging an EV

7.1 Wireless charging

Inductive, or wireless, charging uses an electromagnetic field to transfer energy between an electric car and a charging pad through electromagnetic induction, instead of a plug and socket connection. This is a promising technology which could revolutionise electric vehicle use without the need for charging cables. To charge the vehicle, the user just has to park over the inductive charging 'pad'.

Currently, wireless charging is not widespread in the UK, but it is anticipated this will change in the coming years. The government has dedicated £20 million for static and semi-dynamic wireless charging solutions for commercial vehicles. This may mean taxis are able to charge wirelessly whilst waiting at the rank, and delivery vehicles can charge wirelessly at depots.

Dynamic wireless charging is also being researched. This uses the same technological principles as stationary wireless charging but the chargepoints are embedded in the road networks, so drivers can top up their car as they drive along. This would result in less stationary charging as vehicles can travel longer distances whilst not losing charge when driving.

The Office for Low Emission Vehicles is currently running a competition which is providing £40m for research and development projects which develop on-street and wireless charging infrastructure.

Wireless charging

8. Glossary

Term	Definition
AC	Alternating current – the current in the circuit changes direction 50 times a second (Hz) for UK mains
CCS	Combined charging system- allows AC charging using the Type-1 and Type-2 connectors
CHAdeMO	A charging protocol for delivering a DC supply to plug-in vehicles. CHAdeMO is primarily used by Nissan, Kia and Mitsubishi
DC	Direct current – the electric current only flows in one direction
Grid balancing	Redistributing the demand on the grid by moving usage from peak times to off-peak times
kW	Unit of power
kWh	Unit of energy
NEDC	New European Driving Cycle is a driving cycle, designed to assess the emission levels of car engines and fuel economy in passenger cars. It has since been replaced in 2017 by the Worldwide Harmonised Light Vehicle Test Procedure (WLTP), which is a more accurate laboratory test.
Peak demand	The time period where the highest amount of electricity is being used from the grid (~17.00 – 20.30)
Regenerative braking	Converting the kinetic energy of the vehicle whilst braking into electricity, which is stored in the battery
Suppliers	Companies that sell gas and electricity to households and businesses, and bill them for their energy consumption
Tariffs	The price that suppliers charge their customers per kilowatt hour of energy consumer

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Energy Saving Trust
30 North Colonnade
Canary Wharf
E14 5GP
Phone: 020 7222 0101

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