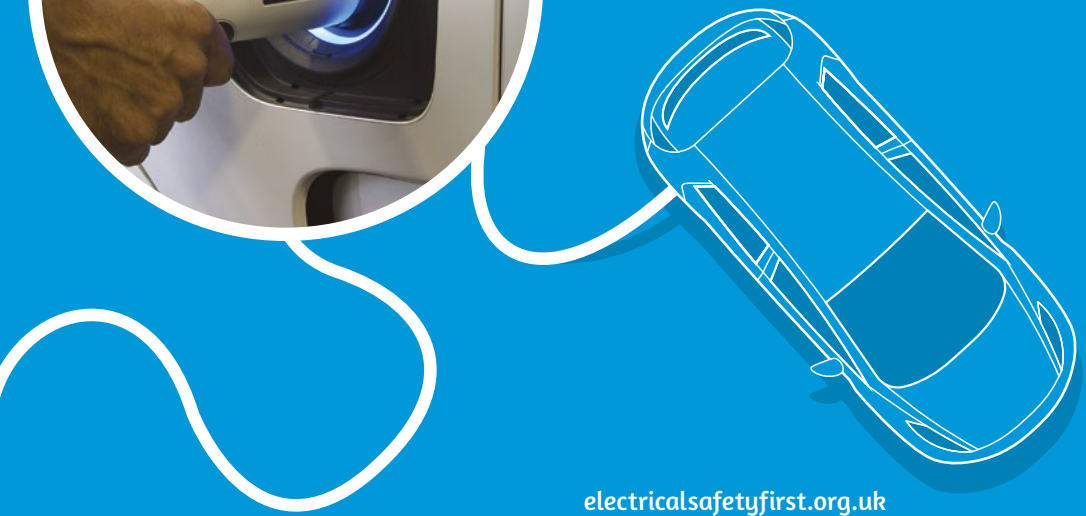
Electrical Safety First

The UK's electrical safety experts

Electric vehicle safety

Glovebox guide to electric vehicles



electricalsafetyfirst.org.uk

In our modern world, electricity is an essential part of our daily life. So it is not surprising that we forget its inherent risks and potential dangers. Yet electricity causes around half of all fires in UK homes. And in 2015-2016, they were responsible for 1,380 deaths and injuries – an average of 27 each week, or 4 a day.

Electrical Safety First is the leading UK charity dedicated to reducing fires, deaths and injuries arising from electricity.

Photography by Joe Harding www.in-motionimages.co.uk

INTRODUCTION

Today, we are at the start of a smart energy revolution, which will see technology like energy storage, smart appliances and electric vehicles, become an even greater element in the fabric of everyday life.

Our analysis shows in the last six years alone, the number of 'plug-in' electric vehicles (EVs) has increased by 1480%. So Electrical Safety First has designed this guide, to provide you with all the essential information you need to know about EVs - with a particular focus on the safety issues to be aware of.

While this guide is intended primarily for 'pure' electric cars (variously known as BEVs and simply EVs), the information provided here will also be of use for hybrid vehicles.

EVs: SOME DEFINITIONS

Essentially there are only really two types of electric vehicles or cars – those that run via electric battery only and those that use both a combustion engine and an electric battery. However, as with all new technologies, there is no consistent or agreed terminology but the information below provides some generally agreed terms.

- **Battery Electric Vehicles (BEVs or EVs)**. Usually simply known as 'EVs', or even 'pure' EVs, these cars use a large capacity battery and one or more electric motors to drive the vehicle. The battery is charged from the electricity supply network when the vehicle is not in use and some energy may be recovered during braking. The key difference to traditional cars is that EVs do not use gears – just more or less electric current, making the motor turn faster or slower. Nor do EVs have a clutch - they simply provide direct acceleration and what is known as 'regenerative braking'. In other words, when you push the brake, the momentum of the car helps to recharge the battery - providing 'free' charge power when you slow down.

- **Hybrid Electric Vehicles (HEVs)** typically have two sources of energy: an internal combustion engine, diesel or petrol, and a battery. The vehicle automatically selects the most fuel efficient source of power to meet the driver's commands and may use them simultaneously. The internal combustion engine and vehicle braking and recovery systems are used to help charge the battery.
- **Plug-In Hybrid Electric Vehicles (PHEVs)** are – as you would expect - hybrid electric vehicles which can also be charged directly from the electricity supply network. PHEVs generally have a longer range than HEVs when running on battery-only.
- **Range-Extended Electric Vehicles (REEV)** or **Extended-Range Electric Vehicles (E-Rev)**. These vehicles have a plug-in battery pack and electric motor, as well as an internal combustion engine. The difference from a plug-in hybrid is that the electric motor always drives the wheels, with the internal combustion engine acting as a generator to recharge the battery when it is depleted.

TYPES OF EV CHARGING

The two main factors to consider when charging an EV are charging speed and type of connector. Different EVs offer different charging speeds – so you need to be clear about which systems can be used with your vehicle. And which type of charging speed best suits your lifestyle.

The length of time EV batteries take to recharge is determined by how many kilowatts (kW) the charging station can provide and how many the car can accept – the higher the wattage, the faster the charge. The following different rates exist.

SLOW CHARGING RATE: 3KW

Slow charging is most suited to the home or office, where vehicles can be charged throughout the day or overnight. Alternatively, the battery can be topped up while shopping, or visiting an area. Charging a car from flat or 'empty' (either at home or at a charging station), on a full slow charge will typically take around eight hours.

FAST CHARGING RATE: 7-22KW

A fast charging point will take around three to four hours to fully charge the batteries from flat. Most public charging stations offer this rate and you may also be able to opt for a fast charge box to be installed at home. However, we strongly advise checking with your installer to ensure that your electrical installation can deal with the higher electrical load required. This is particularly important if you live in an older house - especially if it was constructed before 1919.

RAPID CHARGING RATE: 43-50KW

Only a few EVs are compatible with rapid charging, which will allow an 80% charge from flat, in as little as 30 minutes. Public charging points that offer rapid charging aren't as common as fast chargers, but Tesla has its own proprietary network for use exclusively with its cars.

SUPER CHARGING RATE: 150KW

Shell has announced that it is launching 'super chargers', which will provide an 80% charge in ten minutes, at selected filling stations.

CHARGING CONNECTORS

As previously noted, new or emerging technologies tend not to provide defined ‘standardized’ equipment. So, in addition to various types of EVs and charging rates, there are also different types of charging connector.

There are two connectors to consider: the one that plugs into your car, and the one that connects to the power source to charge your EV.

Slow chargers at home plug into a standard UK three-pin socket (and sometimes an industrial socket like the one caravans and builders use).

Most public charging stations also provide slow charging via a UK13 amp socket, as well as fast or rapid charging options. Rapid charging takes place via a lead tethered to the station but fast charging can be via a tethered lead or a specific EV socket – usually similar to one shown below.

So you need to make sure that you are using a charging point with a connector that fits your car. And you may want to obtain different cables to fit different connectors, if you are using public charging points offering different charging rates. Fast and rapid chargers use thicker (higher rated) cables than those used for lower speed, home-based charging, to deal with the increased electric current.

Mennekes Type 2
European plug used by cars such as the Renault Zoe and Kangoo

Chademo
Fast dc plug used by cars such as the Nissan Leaf and the Citroën C-zero

TYPE 2 CCS
European plug used by makes such as BMW and Volkswagen

CHARGING – HOME AND AWAY

Charging an EV is very simple - you just plug it in! As research shows that the average UK driver covers just 25 miles a day, most charging is more likely to occur at home.

TRAVELLING FURTHER

For longer journeys, an increasing number of motorway services provide charging stations; and some foresighted employers are already installing them at work-places.

When it comes to on-street charging, research indicates that EV growth is four times the rate of available charging points, with the investment and installation of them varying widely between local councils. A number of websites – for example, thechargingpoint.com, zap-map and openchargemap.com – can help you find your closest charging point.

The UK's publically accessible charging station network is owned and operated by several different companies. Most of these are energy firms, and many require you to register with them and carry a swipe card to use their machines, although some also offer a smartphone app. When using a public charge point controlled by an app, make sure your mobile phone reception is good enough to receive data – or you could wait a while for the instruction to reach the charge point. It can be particularly problematic in multi-story car parks, or busy places such as a concert or theme park.

If you're planning on using your EV for long journeys and are likely to visit lots of different regions, you will probably need to register with more than one provider. Zap-map and similar websites can provide you with further details and a list of the different public charging networks.

A number of websites – for example, thechargingpoint.com, zap-map and openchargemap.com – can help you find your closest charging point

RANGE

Advances in battery technology mean range is less of an issue than it used to be. Most new EVs have a range of around 100 miles. That doesn't sound like a lot but given that 80 per cent of Europeans drive less than 63 miles every day and the average UK driver travels just 25 miles, it should be more than enough for most needs. However, each make and model offers different ranges, with some offering range booster options, like bigger batteries.

Don't forget that range can be affected by bad weather – when some of the electric charge will, for example, be used to defrost and heat the car. Even bad driving habits, such as heavy stop-start braking, can affect range.

To avoid 'range anxiety' on a longer trip, here are some simple tips:

- Check charge points en route and always allow a margin for error. (Most modern EVs' sat-nav systems include charging stops when planning a route).
- If you are planning on using your EV for long journeys and are likely to visit lots of different regions, you will probably need to register with more than one charging provider.
- If you can't avoid driving in very poor weather (such as heavy fog, rainfall, high winds or ice etc.) do prepare your car before you set out. Low temperatures and using the car heater etc., can impact on the range of the vehicle. So set your controls and defrost the vehicle before you set out.

PUBLIC CHARGING COSTS

Do check the varied charges being levied by different charging operators. Although some public charging companies still offer some free charge points, not all do.

In fact, with some operators levying a fee of 30p per kilowatt-hour for electricity, if you don't plan ahead you could end up paying more than three times as much as you would on a home charger. Some network providers also make it more difficult to estimate costs by putting fees in pence per minute, rather than stating the kilowatt-hour price. And independent research claims that some charging stations don't charge at the rate you think you're paying. **Do make sure that you do your research and check your charging options in advance.**

HOME CHARGING

Electric cars can plug into your domestic power supply at home, using a standard three-pin UK domestic plug socket, just like your vacuum cleaner or TV. A new EV will be supplied with a standard EVSE (Electric Vehicle Supply Equipment) charging cable, allowing you to charge anywhere you can find a mains socket. But remember that this is never a preferred option and should be reserved for visiting friends or family who can't offer a home charge point.

People usually choose to have a dedicated home charging point installed because it's generally faster to charge and has built-in safety features. A home charging point is a compact weatherproof unit that mounts to a wall, with a connected (tethered) charging cable or a socket for plugging in a portable charging cable.

A number of companies offer a fully installed charge point for a fixed price. Many plug-in car manufacturers also have deals or partnerships with charge point suppliers - and in some cases they provide a free home charge point when you buy a new EV.

The average cost of installing a home charging point is around £1,000 but a Government grant of up to £500 is available for the installation (see details under the heading, Funding and Grants). And, as always, we strongly recommend buying your charging equipment from a reputable supplier, such as through your vehicle dealership.

THE SAFETY ISSUES

- Electrical Safety First strongly advise against using a standard 13A plug and socket to recharge an EV on a regular basis.
- A home charging point is safer and quicker than using a domestic plug socket, as it communicates directly with the car and generally has a higher power output.
- The higher-powered wall-mounted units are more expensive but do reduce the time required - by 30%-60%, depending on the vehicle - to fully charge an EV.
- Most home chargers, which are rated at 3 kW or 7 kW, are wired directly to the fixed electrical installation, on its own circuit for safety - and to enable monitoring separate from other electrical loads.
- We recommend you use a suitably qualified and competent electrician to check that your home's wiring is suitable to have a home charger fitted before it is installed – and to undertake the installation.
- The Government's Office for Low Emission Vehicles (OLEV) provides a list of authorised installers. To qualify for the grant for a home charging point, you must use a registered OLEV installer, who is suitably qualified.
- Be aware that you may need a different connecting cable for higher rates of charging from a public charging point. You are likely to need one cable with a three-pin plug (for home charging) and another cable which is compatible with public charging points.

RESPONSIBILITIES

Installers have a responsibility to inform your electricity provider - also called a DNO or Distribution Network Operator - when making modifications to a service. If you live in an older, or all-electric house, you may find that your installation won't be able to cope with the additional load required to charge an EV. In these circumstances the installer must notify the DNO. If there are no such issues, the DNO can be notified retrospectively but within 28 days.

This is important, as it allows the DNO to obtain a clear, overarching picture of the electricity network it provides – and any future work that might need to be undertaken to maintain or increase its capacity.

CHARGING SPACE & AVAILABILITY

Home charging is often the most convenient and cost-effective way to recharge an EV. But this usually requires off-street parking, to avoid creating a public hazard through trailing leads and cables across footpaths and public areas.

Currently, anyone can apply to their local council for a charging point on their street but the available funding pot is heavily oversubscribed. The Office for Low Emission Vehicles (OLEV) has allocated £2.5 million of funding nationally for installation costs. Individuals can apply to their local council to install a street charging point and the council decides whether to apply to OLEV for funding. However, it is worth noting that councils in London have reported that in the first round of this grant, it was already 50% oversubscribed.

One innovative solution to the charge point issue involves building charging equipment into lamp posts. Ubitricity, a German-based company, now runs a public EV charging network using lamp posts for 14 local authorities. Access is via their SmartCable, which is linked to an account and tracks electricity usage for billing.

But if you live in a flat, and don't have a drive-way, off-street parking, or a nearby charging point, you will need to charge your EV by running a cable from your home to your car. While currently inevitable, this obviously isn't the ideal charging method. Simply trailing a cable without a cable guard is very risky. In addition to the health and safety issues, if someone were to trip and injure themselves, you could be held responsible, so it is important to make this charging process as safe as possible.

CABLES AND LEADS, SLIPS & TRIPS – *SOME SAFETY TIPS*

- Cable protectors, like those used by utilities contractors, can reduce the risk of tripping to allow the safe passage of pedestrians.
- Any piece of equipment being used to cover a cable, or crossing the pavement, should be anti-slip and brightly coloured.
- Be sure to purchase any cables you need from a reputable supplier. These cables must be certified for outdoor use.
- You may want to consider if your home insurance would cover you in case of accidents.
- If you find that your cable isn't long enough, do not daisy-chain extension leads. This can overload the socket and lead to fire or risk of electric shock.
- If you have to use an extension lead, we recommend that no extension lead longer than 15 metres be used. If using a cable drum extension lead, it should be completely unwound to avoid overheating.
- Do ensure that the extension lead is plugged into an RCD protected socket or use a plug-in RCD.
- Do check your charging connecting cables regularly for wear and tear. If you spot any damage stop using it immediately and get a replacement.
- Never try to join two lengths of cable together by twisting the bare ends of wires together.
- And be sure you don't overload a socket by plugging something else into your extension lead at the same time you are charging your car.

EV BATTERIES

There are several rechargeable batteries used in EVs as there are no universally agreed industry standards.

Most EV and hybrids use a form of lithium battery. Since their first introduction in the early 1990s, Lithium-ion batteries have become an integral part of our daily lives. Their rechargeable and energy-storage properties make them ideal for a host of devices, from smartphones to laptops and, of course, EVs.

THE SAFETY ISSUES

The key safety issues with lithium batteries relate to overcharging, overheating, and damage arising from an accident, which could lead to fire. In each case, chemical reactions can get out of control, creating a 'thermal runway', leading to fire. However, as the extensive use of lithium batteries in a range of products show, much work has been undertaken to ensure their safe use by consumers. And many argue that it is safer driving a pure electric car than a petrol or diesel one, as batteries are housed in tough casings, whereas a fuel tank is often made only of fairly thin metal or plastic.

NOISE

EVs produce minimal (if any) noise, so some road users - such as pedestrians, cyclists and older or vulnerable people – may not be aware of an oncoming EV. Although some manufacturers are fitting EVs with artificial noise generators it should never be assumed that an EV is shut off simply because it is silent.

BUYING SECOND-HAND

Second-hand electric cars can make sound financial sense. You have the same running costs of a new electric car but it'll be far cheaper to buy – although you will not be eligible for the government's plug-in car grant ***(see page 17)***.

The most important check you can make, regardless of the type of car you are buying is a vehicle history check, which can be undertaken online for a few pounds. And do ensure the seller has all the relevant documents, including service history and the essential V5C (logbook). You can undertake MOT history checks online, at ***check-mot.service.gov.uk***

Usually, people's biggest concern when buying a second-hand EV is the condition of the batteries. Car manufacturers tend to offer five to eight-year warranties on EV batteries, so it's worth checking to find out how much of its warranty is left.

The latest EVs haven't been on sale for long enough to require a complete battery replacement. (Like the engines in conventional vehicles, the advanced batteries in EVs are designed for a long life but will wear out eventually). Currently, most manufacturers are offering 8-year/100,000-mile warranties for their batteries.

However, the cost of eventual replacement could run into several thousand pounds. To address this, many car manufacturers offer battery leasing schemes. There are advantages to paying for the batteries as part of the car or leasing them separately. If you buy them outright, all the costs are up front and you avoid paying £50-100 per month in fees and adhering to a mileage limit. But leasing the batteries means you won't have the worry or expense of maintaining or replacing them.

FUTURE-PROOFING

The National Grid has developed various models to predict just how much extra electricity will be needed to cope with the rise of the EV. For example, if people charge their cars all at the same time – say when they come home from work - it will put heavy strain on the grid, potentially leading to blackouts. But an increase in 'smart charging' would help address this.

Smart chargers will allow vehicles to draw power only when it is readily available, avoiding peak periods, yet ensuring vehicles are fully charged when required. In the future, EVs won't just draw energy from the grid, they will also feed-back into it - and people will get paid for the electricity they provide. If thousands of cars are connected together, the amount of energy provided to the grid could be substantial - and it can be varied on a second-by-second basis.

The current concern, however, is around the need for additional charging infrastructure. The Department for Transport has proposed that every new house, flat and office building, be established with external charging point installations, to ensure they are 'EV ready'.

New street light installations with built-in charging points have also been suggested, in a bid to make electric cars more attractive to road users with access to on-street parking only.

FUNDING AND GRANTS

The Plug-In Car Grant (PICG) has been provided by the Government since 2011.

Paid directly to car dealers, the grant has allowed them to discount the purchase price of plug-in hybrids and pure electric vehicles. This changed on 11th October 2018, when the subsidy for plug-in hybrids was removed.

Funding is now only available for 'pure' EVs, which are eligible for up to £3,500 of subsidy. Funding towards the installation of a home charging point is also available from Government sources ***(see page 19 for details)***.

GLOSSARY

BEVs - Battery Electric Vehicles, usually simply known as 'EVs'

DNO – Distribution Network Operators (i.e. your electricity provider).

ESF – Electrical Safety First

EST – Energy Saving Trust

EVSE – Electric Vehicle Supply Equipment (i.e. the cables etc. required to recharge your car).

HEVs - Hybrid Electric Vehicles

KWH – Stands for kilowatt-hour. EV battery size is measured in kWh, so it is comparable to litres of fuel in a petrol tank.

PICG – Plug-in Car Grant

PHEVs – Plug-in Hybrid Electric Vehicles

RANGE – The distance you may travel before running out of power

SOC – State of charge. This refers to a display which tells you the remaining battery level in percentage.

OLEV – Office for Low Emission Vehicles

FURTHER INFORMATION

The information given here is a general guide to EVs. For more detail, you may want to visit the organisations listed below:

- The Department for Transport sets regulations, laws and guidance for road users, roads and vehicles. Its website is updated regularly - ***www.gov.uk/government/organisations/department-for-transport***
- Eligibility for the Electric Vehicle Homecharge Scheme - ***www.gov.uk/government/publications/customer-guidance-electric-vehicle-homecharge-scheme***
- ENA – the Energy Networks Association can provide detailed information on charging infrastructure installation - ***www.energysavingtrust.org.uk***
- Euro NCAP – provides consumer information on the safety of new cars - ***www.euroncap.com/en***
- Go Ultra Low – a joint Government and car industry funded campaign designed to provide advice on EVs. Recipients of the Plug-in Car Grant are automatically enrolled in Go Ultra Low - ***www.goultralow.com***
- MOT history checks can be undertaken online - ***check-mot.service.gov.uk***
- OLEV - ***www.gov.uk/government/organisations/office-for-low-emission-vehicles***
- Road to Zero Strategy is the Government's plan for new cars and vans to be zero emission – ending the sale of petrol and diesel vehicles by 2040 - ***www.gov.uk/government/publications/reducing-emissions-from-road-transport-road-to-zero-strategy***
- Zap Map is just one of a number of websites showing the location of the UK and Ireland's charging points - ***www.zap-map.com***

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Electrical Safety First is the UK charity dedicated to reducing deaths and injuries caused by electrical accidents. Our aim is to ensure everyone in the UK can use electricity safely.

Electrical Safety First
45 Great Guildford Street
London SE1 0ES

www.electricalsafetyfirst.org.uk
enquiries@electricalsafetyfirst.org.uk

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(Scotland) No. SC039990