NF90

Plugging in to the future

- electric vehicle charging and new homes

NHBC FOUNDATION

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- electric vehicle charging and new homes

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NHBC Foundation

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The NHBC Foundation

The NHBC Foundation, established in 2006, provides high quality research and practical guidance to support the house-building industry as it addresses the challenges of delivering 21st century new homes. To date we have published over 80 reports on a wide variety of topics, including the sustainability agenda, homeowner issues and risk management.

The NHBC Foundation is also involved in a programme of positive engagement with the government, academics and other key stakeholders, focusing on current and pressing issues relevant to house building.

To find out more about the NHBC Foundation, please visit **www.nhbcfoundation.org.** If you have feedback or suggestions for new areas of research, please contact **info@nhbcfoundation.org**.

NHBC is the standard-setting body and leading warranty and insurance provider for new homes in the UK, providing risk management services to the house-building and wider construction industry. All profits are reinvested in research and work to improve the construction standard of new homes for the benefit of homeowners. NHBC is independent of the government and builders. To find out more about NHBC, please visit **www.nhbc.co.uk**.

Chairman Foreword

Around the end of this decade the UK government will ban the sale of new petrol and diesel cars and vans, and as a result there will be a rapid increase in the number of electric vehicles (EVs) needing to be charged. The infrastructure required to support this transition is significant. In 2019 the Department for Transport launched a consultation on facilitating EV charging in new homes and buildings undergoing major refurbishment, with the intention of introducing a new Building Regulations approved document in England. In 2020 the Welsh Senedd published an electric vehicle charging strategy confirming similar intentions. In 2021 the Scottish government started consultation on EV charging infrastructure, again with the intention of including provision within the Building Standards. It is expected that similar regulations will also be brought forward in Northern Ireland.

This NHBC Foundation publication, prepared by Cutland Consulting Limited, looks at what is a fast-changing landscape. As recently as 2018 the Foundation published 'Futurology', which talked about every home having an electric car by 2050. In February 2019 we published 'Watts in store?', which started to consider the role that EVs might play in household battery energy storage. At the time of writing, the Intergovernmental Panel on Climate Change (IPCC) has moved from trying to limit global temperature rises to 1.5ºC to accepting that even with significant reductions in emissions, temperatures are likely to increase beyond 1.5ºC within 20 years. This reinforces the need for urgent action to implement measures which can make a rapid and practical impact on cutting emissions.

This publication provides guidance on the current state of play with electric vehicles and chargepoints, and what house builders will need to provide within the curtilage of a single dwelling or where the development has off-plot or shared parking. The report considers the safety aspects of installation and provides a comprehensive list of standards to be consulted. It also stresses the importance of early engagement with the relevant Distribution Network Operator to ensure that there is sufficient electrical capacity to the development site. The report finishes off with a look at future technology, some of which may appear sooner than expected. We hope that this publication will prove useful in extending understanding of the challenges and opportunities for the industry in what will unquestionably be a fast-moving context.

Rt. Hon. Nick Raynsford
Chairman, NHBC Foundation

Contents

1 Introduction

Emissions of greenhouse gases due to human activities continue to increase. The Intergovernmental Panel on Climate Change (IPCC) stated in August 2021 that unless there are immediate, rapid and large-scale reductions in greenhouse gas emissions, it will be impossible to limit global warming to 1.5°C or even 2°C above pre-industrial levels. With 1.5°C of global warming, which is possible within 20 years, there will be increasing heat waves, longer warm seasons and shorter cold seasons. At 2°C of global warming, heat extremes will more often reach critical tolerance thresholds for agriculture and health[1].

The government has stated that the UK should achieve net zero greenhouse gas emissions by 2050, and has put in place or announced many policies to this end. One such policy is that by 2035 all new cars and vans should be fully zero-emission at the point of use[2], as a result of which electric vehicles (EVs) will become the dominant technology.

This has significant implications for house builders, designers and architects, since the resulting increase in electric vehicle ownership will require homes to be provided with the necessary equipment for residents to charge their EVs at home. This publication discusses the key issues facing builders, designers and architects of new homes as they respond to this forthcoming requirement.

2 The policy context

In 2019 the UK's Committee on Climate Change (CCC) recommended that the nation's contribution to limiting global warming should be to attain net-zero greenhouse gas emissions by 2050. The Committee stated that this is both necessary, feasible and cost-effective[3]. The scale of action required will have to cover all sectors including road transport, which currently contributes some 25% of the UK's emissions[4]. The overall aspiration has been enacted in law through an amendment to the Climate Change Act 2008[5].

Specifically, the government announced in 2017 that from 2040 no new cars or vans may be fuelled wholly by petrol or diesel. The date was subsequently brought forward to 2030. Then from 2035 hybrid vehicles[a] will not be allowed to be sold either, meaning that new cars and vans will be forbidden from using any petrol or diesel[6].

To meet this challenge, it has been estimated that the UK needs 4.1 million EV chargepoints by 2030, from a figure of 182,000 chargepoints in 2019[7].

In July 2019 the Department for Transport (DfT) released a consultation on changes that it proposed making to the English Building Regulations to facilitate EV charging in new homes and buildings undergoing material change of use to create a new home[8]. The new regulations (provisionally to be known as Part S) were expected to be released in the fourth quarter of 2021, to come into force in 2022. The requirements are essentially that EV chargepoints must be installed where there are parking spaces physically adjacent to the home (defined legally as 'within the site boundary of the dwelling')[b].

The sections of this guide which relate to Part S of the English Building Regulations are based on the proposals set out in the 2019 DfT consultation, which were still current as at Q3 2021. Similar although not identical sets of requirements are expected for Scotland[9], Wales and Northern Ireland.

DfT considered excluding the chargepoint itself, and instead just requiring the installation of cabling routes, cables and the necessary electrical capacity at the distribution board (or even the cabling routes alone). This would be less costly for the developer than a full chargepoint, and would help future-proof new homes by making the later installation of a chargepoint cheaper for the residents. However, DfT considered that the need for an electrician to visit the home at a later date would be a potential barrier to future electric vehicle purchase. Furthermore, as cabling routes would be less visible to residents than an actual chargepoint, it was thought that excluding the chargepoint would miss an opportunity to encourage EV uptake.

a A hybrid vehicle is one powered by a combination of petrol/diesel and electricity. See Section 3 for more detail.
b This also applies to some types of off-plot and shared parking. See Section 5 for more detail.

The Part S requirements are summarised as follows, with more detail given in Sections 3 and 4 of this guide.

- minimum chargepoint power 7kW, which effectively disallows charging via a home's normal 13A sockets;
- the control circuitry and basic safety electronics must be contained within the chargepoint, rather than inline in the cable. This is known as 'mode 3' charging;
- chargepoints must comply with the appropriate parts of BS EN 61851-1[10];
- chargepoints should be 'untethered', i.e. there should be a universal connector that allows any vehicle's charging cable to be plugged in, rather than a fixed attached lead;
- the location of chargepoints must comply with the Equality Act 2010 and the accessibility requirements set out in Building Regulations Part M, to ensure that all sectors of the population can use them[11,12];
- the installation, addition or alteration of dedicated circuits (including earthing and bonding arrangements) for EV chargepoints is notifiable building work;
- electrical safety is likely to be outside the scope of the new regulations because it is covered by other legislative requirements. These include Building Regulations Part P, the Electricity at Work Regulations HSR25, BS 7671:18th edition IET Wiring Regulations (2018) + Amendment 1 (2020) and the IET Code of Practice for Electric Vehicle Charging Equipment Installation (henceforth in this guide referred to as 'the IET Code of Practice') [13,14,15,16];
- sites will be exempt from the chargepoint installation requirement in areas where significant electrical capacity reinforcement is needed (to be determined on a capital cost basis, the details of which vary depending on the region of the UK).

Chargepoints must also be 'smart', i.e. designed to manage and optimise the supply of electricity to the vehicle over time, although this will be mandated through different regulations[17].

A government department, the Office for Zero Emissions Vehicles (OZEV) has been set up in order to drive this and other EV polices and initiatives.

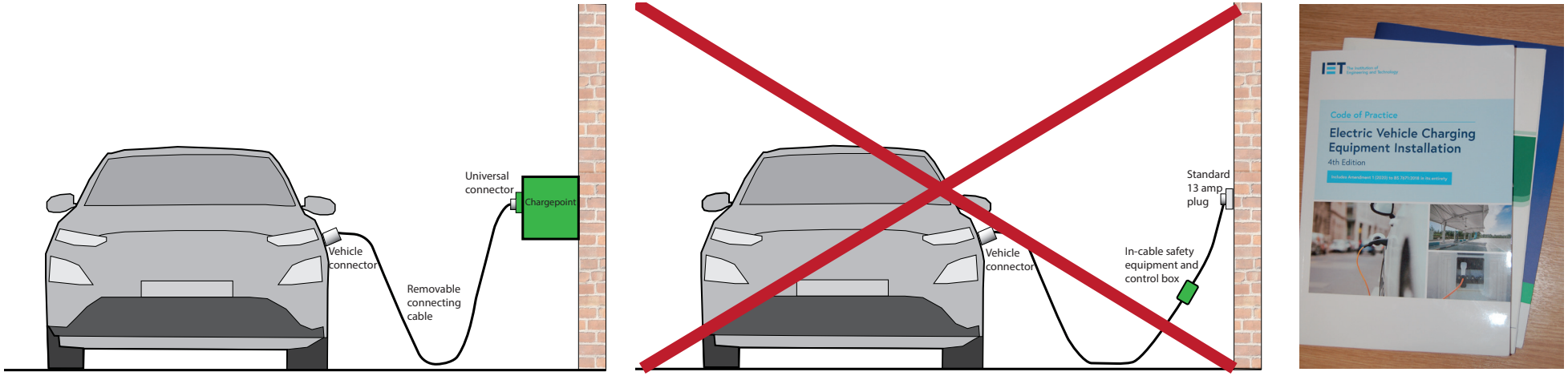


Figure 1 Mode 3 charging

3 The basics of electric vehicles and chargepoints

3.1 Types of electric vehicle

The term 'electric vehicle', or EV, includes both fully-electric vehicles and various types of hybrid vehicle. All hybrids are powered by a petrol/diesel internal combustion engine in conjunction with one or more electric motors. The terminology of EVs, especially hybrids, can be confusing.

- **'Fully-electric vehicles'**[c] always operate entirely under electrical power, and need to have their batteries charged periodically by plugging in to mains electricity. There is no internal combustion engine;
- **'Plug-in hybrids', or PHEVs**, can be plugged in to mains electricity in order to charge batteries which are designed to provide the majority of the vehicle's power; the petrol or diesel engine is generally used only as a supplement, often to extend the range of the vehicle;
- **'Full hybrids'** cannot be plugged in to the mains. The petrol/diesel engine and the electric motor(s) work sometimes individually and sometimes in parallel, to drive the vehicle in a way which optimises its performance and/or economy. Under certain conditions the internal combustion engine may run simply to charge the batteries, and so full hybrids are euphemistically referred to by some manufacturers as 'self-charging hybrids';
- **'Mild hybrids'** use their electric motors only to assist the internal combustion engine, using power which is recovered into batteries as the vehicle is braking or otherwise slowing down. The electric motor(s) never drive the vehicle alone.

Care should be taken when using these terms, since different manufacturers may use them differently, and sometimes even interchangeably.

c Fully-electric vehicles are sometimes known as 'battery electric vehicles' or BEVs. This term is misleading, because all types of EV including hybrids contain batteries.

3.2 Types of chargepoint

At their simplest, fully-electric EVs and PHEVs can be connected to a home's 13A sockets using a special lead which incorporates a control box, but this is an extremely slow method of charging which is not suitable for long-term use. It is not the preferred method of either vehicle manufacturers or government, and a dedicated chargepoint connected to its own electrical circuit is recommended instead.

Residential-type chargepoints contain safety circuits and control electronics to govern the rate of charging, but still supply alternating current (AC) via a cable to the EV. The EV's internal rectifier then converts the AC to the direct current (DC) which the vehicle battery requires. It is for this reason that the dedicated external equipment is referred to as a 'chargepoint' rather than a 'charger'[d].

The terminology of chargepoints can itself be confusing, and moreover is evolving quickly. Early, often retrofitted, home chargepoints are generally referred to as **'standard'** chargepoints and typically have a power of 3.6kW. Most residential installations currently being carried out, as well as those required by the proposed Building Regulations Part S, are at least 7kW (known as **'fast'**) chargepoints.

As an example, to charge a 40kWh typical small car battery fully from empty takes around 11 hours using a 3.6kW chargepoint, or close to six hours using a 7kW unit. Go Ultra Low (a government/industry website) provides a calculator that indicates how long it takes to charge different models of EV with various power ratings of chargepoint[18].

Some types of public and corporate chargepoints such as those found at motorway services and industrial premises have a much higher power, typically 43kW or 50kW. These may contain a rectifier as well as the control and safety circuitry, and hence can supply DC straight to the vehicle. They are referred to as **'rapid'** chargepoints, and the phrase 'ultra-rapid' is also starting to appear (when referring to even higher powers up to 350kW). By way of comparison, a 40kWh car battery can be charged to the 50% level in around 20 minutes using a 50kW rapid chargepoint.

Rapid and ultra-rapid chargepoints need not concern the house building industry at present, since the focus is likely to remain on fast (7kW) chargepoints for the foreseeable future.

d By contrast, the domestic devices commonly referred to as 'chargers' (for example those used for mobile phone charging) include the rectifier, and supply DC via their cable to the appliance.

3.3 Types of connecting cable

As well as several different types of EV and several different types of chargepoint, there are several different types of cable connector fitted to EVs.

Most EVs currently sold in Europe have a 7-pin connector known as a 'Type 2' (or 'Mennekes') connector[e]. Some EVs may also have one of two types of DC connector known as 'CHAdeMO' and 'CCS'[f] for use with rapid chargepoints when away from home. This need not concern house builders however, for the reason explained in the box below.

Not all plug-in EVs can charge at the faster rates, and no EV can accommodate all of the connector types. But even EVs which can only accept the standard rate of charge can be connected to a fast chargepoint, since the vehicle and the chargepoint itself will regulate the charging rate to suit.

To overcome the variety of connector types, DfT proposes that new homes should be provided with untethered chargepoints. These do not have a fixed cable, but instead accept any vehicle's own connecting cable via a universal connector at the chargepoint end.

So, as long as house builders install fast (minimum 7kW), untethered chargepoints their customers will be able to charge any plug-in EV regardless of the vehicle type and that of its connector, over a convenient duration.

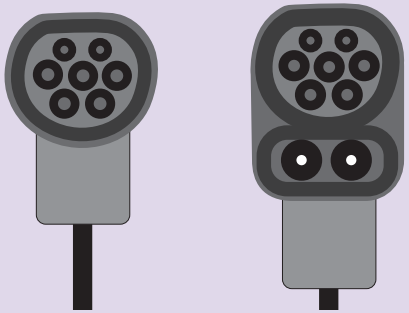


Figure 2 Type 2 (left) and CCS (right) connector configurations

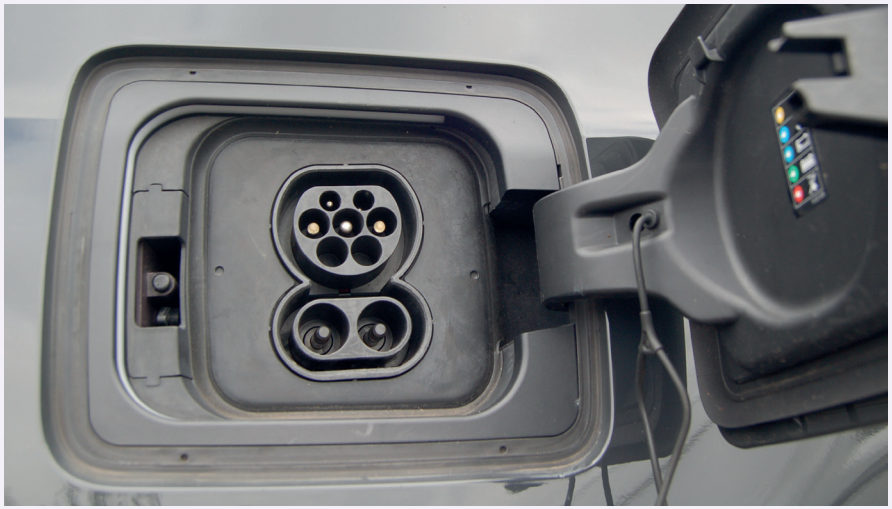


Figure 3 Type 2 (top) and CCS (bottom) sockets as typically fitted to EVs

e Although a few makes, especially older EVs, have 5-pin 'Type 1' connectors.

f Combined Charging System. A 'CCS 2' connector, for example, combines a Type 2 AC connector with a two-pin DC connector, to enable charging at a wider variety of public chargepoints.

4 Charging electric vehicles at home; the essential issues for house builders

4.1 Chargepoint power

As previously discussed, house builders will be required to install fast (minimum 7kW), untethered, smart chargepoints in all new homes that have a parking space within the site boundary of the home[g]. Many new homes have a 100 amp connection as standard, and in most cases it is possible to accommodate a 7kW chargepoint within this connection. This means that on a single-home basis there is often no additional electrical capacity cost as a result of adding a 7kW chargepoint.

That said, it is essential that expert advice is followed, as per the following section.

4.2 Electrical connection

Expert advice on the installation of chargepoints should be sought at the earliest possible stage.

All relevant standards must be followed, including Building Regulations Part P, the Electricity at Work Regulations 1989, BS 7671, BS EN 61851, the IET Code of Practice and the forthcoming Part S[10,13,14,15,16].

Electricians should demonstrate appropriate competence to install EV chargepoints. For example, they could be qualified to install chargepoints under OZEV grant schemes, and/or certified and registered by the Electric Vehicle Consumer Code, EVCC[19].

It is also essential that house builders engage at an early stage with the relevant Distribution Network Operator (DNO) to ensure that the electrical supply to the site has sufficient capacity for the number of chargepoints being installed. The procedure in Section 11 of the IET Code of Practice may be used for this purpose.

Current residential-scale chargepoints only require a conventional single-phase electricity supply. However, at least one DNO is now routinely fitting a three-phase supply to every newbuild plot in order to provide a degree of future-proofing.

g Subject to the exemptions previously discussed.

It is up to the house builder whether they actually use this three-phase provision from day one, but since the marginal cost of providing the cabling is at a minimum at the construction stage of a home, it is considered prudent by the DNOs to install the three-phase infrastructure. This is particularly the case given the expected future increase in electric heating, despite the low heat demand of new homes[20]. It would also enable the future installation of a more powerful rapid chargepoint should the residents so wish.

Once again it is clear that house builders should engage with their DNO at the earliest possible stage.

Earthing of chargepoints requires particularly careful consideration. Many different configurations of earthing exist in practice (e.g. TT, TN-S, TN-C-S or PME), and it is not unknown for a manufacturer of chargepoints to suggest an earthing arrangement which other organisations deem to be non-compliant.

It is beyond the scope of this publication to offer detailed technical advice on earthing. The complexity of the subject means that it is not possible to offer a 'one size fits all' solution, and this is reflected in the fact that earthing systems are often designed by lightning protection specialists rather than general electricians. The standards and documents listed in this guide provide the relevant detail with which developments must comply.

It is vital that the comprehensive guidance in the IET Code of Practice and the IET 18th edition Wiring Regulations is followed, along with all other standards to which they refer, to ensure that the earthing arrangements for EV chargepoints are both safe and compliant[15,16].

4.3 Physical location of chargepoints

Chargepoints may be installed outside (either on the wall of the home or as a standalone post or upstand), or in an outbuilding such as a garage. They must be easily accessible, and in particular installed to comply with the Equality Act 2010 and Building Regulations Part M[11,12].

Figure 4 Typical residential chargepoint installations

The IET Code of Practice states that chargepoints should be installed according to the manufacturer's recommendations, and located:

- a minimum distance from the vehicle being charged, to avoid trip hazards of trailing cables;
- in a way that allows free access to the vehicle by all classes of possible user;
- with the operating controls between 0.75m and 1.2m above the ground and the display screen (if any) between 1.2 and 1.4m above the ground;
- if a vehicle impact is foreseeable, then protected using barriers where necessary;
- with sufficient surrounding space to allow adequate ventilation/cooling;
- in an adequately lit area, to aid safe connection of the cable to the vehicle;
- remote from areas containing hazardous materials such as explosive gases.

Section 5 of this publication discusses additional issues that are relevant to off-plot and shared car parking.

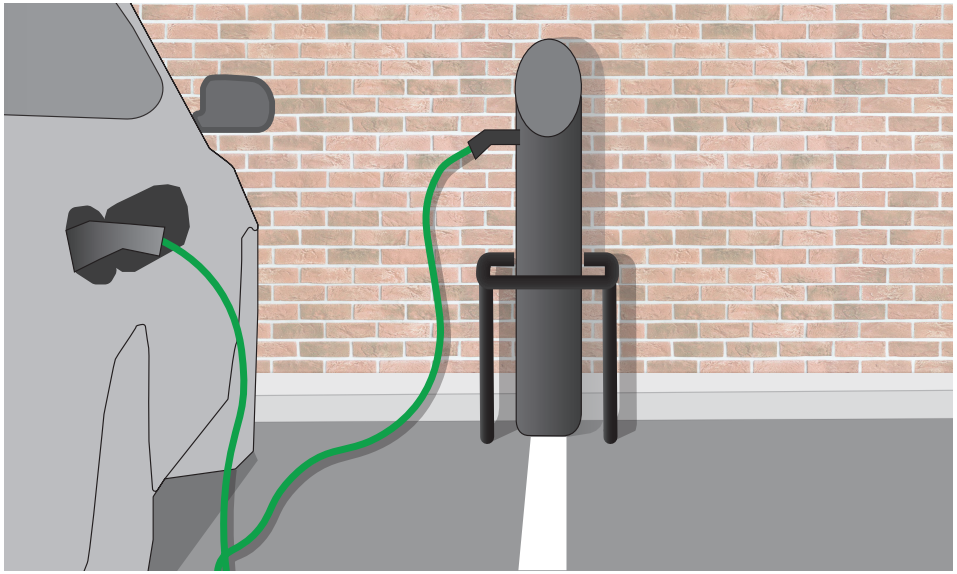


Figure 5 Chargepoint with protective barrier

4.4 Planning and notification

House builders should ensure that their submissions to local planning authorities comply with any local policies and requirements that may be in force for chargepoints. Both wall-mounted and upstand chargepoints are likely to have specific requirements for their size and position when part of a newbuild development. The permitted development rules which apply to existing homes[21] provide an indication of what local planning authorities may also require in the newbuild context, for example:

- wall-mounted chargepoints should not exceed 0.2 cubic metres in size, nor face onto and be within 2m of a highway;
- upstands should not exceed 1.6 metres in height, nor be within 2m of a highway.

DfT proposes to class electrical aspects of the installation of chargepoints as notifiable building work. As such, where the work comes under Part P of the Building Regulations it will either have to be carried out by an installer registered with an approved Competent Person Scheme or, where the work is carried out by an unregistered installer, be subject to a full Building Regulations application.

4.5 Other issues for consideration

Smart chargepoints have the ability to automatically adjust the charging power in response to an external control signal. In practice this means that a DNO can reduce the charging power or even completely defer charging, depending on the needs of the electricity network. From the residents' perspective, smart chargepoints can work with multi-rate ('time of use' or 'time of day') electricity tariffs to schedule the charging of EVs at times of lower-price electricity. Smart chargepoints can also be monitored remotely, often via a smartphone app, allowing residents to check on the state of charge of their EV.

Smart electricity meters are sometimes required to enable the above services, and in any case should be standard provision in new homes.

Some chargepoints contain specialist control systems which optimise their operation with **photovoltaic panels** (PVs) and/or **household battery stores**. Using these it is possible to increase the use of a home's surplus PV generation, reducing the amount of grid import and also reducing carbon emissions from electricity use. It is recommended that such chargepoints are installed in all new homes where PVs or batteries are being fitted as standard.

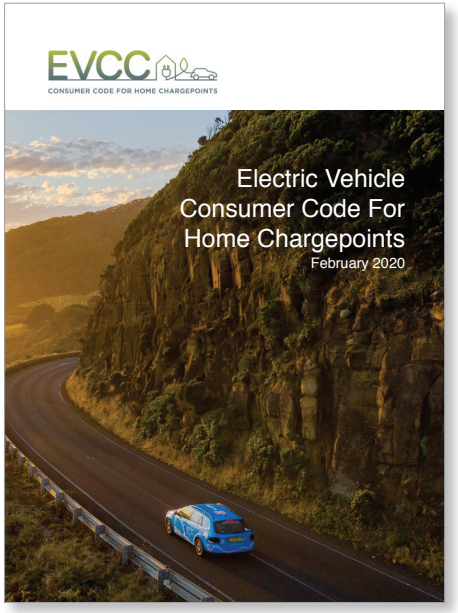
There are several types of **future-ready system**. For example, 'dumb' backplates can be wired into the home's circuits at the time of construction, and accept a variety of click-fit chargepoints when the residents purchase an EV at a later date. This would obviously reduce the house builder's costs and be more convenient for the residents than installing a chargepoint from scratch in future. Whilst this appears to be an attractive solution, it is important to note that it would not comply with Part S, which requires an entire chargepoint (as discussed in Section 2 of this guide).

Whilst there are currently **government subsidies** available for the installation of chargepoints (e.g. OZEV's Homecharge Scheme), it is important to note that they only apply in the retrofit situation - not to new homes. In any case it is imprudent for house builders to rely on such schemes when making investment decisions, due to their inevitably temporary nature.

House builders are recommended to consider **consumer redress schemes** such as the Electric Vehicle Consumer Code, EVCC[19]. Chargepoint installers registered with EVCC have to comply with general business standards (customer service, insurance, etc.), agree to an advertising code, use a model EVCC contract, comply with specific technical installation standards and demonstrate a comprehensive aftercare commitment. In particular they are required to have in place a complaints handling process that includes a dispute resolution procedure and independent arbitration services.

There will be **transitional arrangements**, with a reasonable lead-in time from the date of publishing the new regulations to their coming into force. The lead-in time is intended to be sufficient for developers, consumers, building control bodies and industry to fully understand the requirements, to set up the necessary training, access expertise and skills, and to ensure the supply chain can deliver.

The situation in **phased developments** may be complicated by the fact that the electricity infrastructure might have been installed with its capacity calculated prior to a requirement to install EV chargepoints and electric heating. The normal process in this instance (i.e. whenever Building Regulations change during a phased development) would be that if the entire development were registered for Building Regulations prior to new requirements coming into force, then the homes would not need to comply with those requirements. On the other hand, if Building Regulations registrations were being phased on a plot-by-plot basis, the Regulations in force at the time of registration of the plot would apply.



5 Off-plot and shared parking

The Part S requirement to install EV chargepoints in new homes will apply both to individual homes and to the parking spaces provided with multi-residential and mixed-use buildings.

In individual homes the intention is for there to be one chargepoint per home rather than per parking space. In multi-residential buildings with parking spaces within the site boundary of the building, a chargepoint should be provided to one space per home served by the car park[h].

If more than 10 parking spaces are provided for a multi-residential building, one chargepoint should still be provided per home served, and any additional parking spaces must have the ducting infrastructure to allow future chargepoint installations.

Discussions with the DNO should include the total power requirement of the car park, and may include additional items such as whether a landlord's supply will be used and how the residents will be billed. Several EV billing companies which manage off-plot / shared parking spaces now exist, and the number is expected to grow rapidly.

There are new chargepoints coming to market which offer load management services, local battery storage and on-site PV generation. These products can control the charge power to individual vehicles and/or shift the timing, thereby optimising the power usage of the entire car park. This could in principle enable the DNO to reduce the size (hence cost) of the connection needed.

Figure 6 Chargepoint provision in car parks

h Or to every parking space if there are fewer spaces than homes served.

Where parking spaces fall outside the boundary of a building, no provision for chargepoints need be made under Part S. It is good practice, however, to future-proof the development as much as possible. For example, install lampposts as near as possible to the kerb so that, if they are used in future to provide power to public or shared EV chargepoints, there is less likelihood of cables trailing across footpaths. This needs to be subject to local planning authority approval, which may include conflicting requirements on the siting of lampposts. In any case it is good practice to liaise with the local planning authority regarding their own EV infrastructure programme.

Consideration should also be given to the routing of underground cables if they cross land under different ownership.

Figure 7 Chargepoints situated close to the kerb

6 Advanced technologies; a brief future look

Chargepoint and electric vehicle battery development is proceeding at a rapid pace. Whilst 7kW chargepoints are currently considered to be 'fast', and only take around an hour to recharge the average daily car mileage of 20 miles, it is nevertheless possible that the norm for residential chargepoints will become faster. The potential need for three-phase supplies has been discussed in Section 4.2. Smart chargepoints, novel control strategies, on-site PVs and household battery stores will also play a part in future-proofing developments.

The Office for Zero Emission Vehicles (OZEV) and the Department for Business, Energy and Industrial Strategy (BEIS) are developing **new standards for 'energy smart appliances'** which include EVs. The standards, known as PAS 1878 and 1879, are intended to make appliances useful to smart energy systems at the grid level, to enable demand-side reduction (DSR). DSR will allow the distribution network operators to avoid grid reinforcement, reduce the need for more peak generation capacity, and achieve carbon reductions by facilitating the use of more renewable generation.

Standards are beginning to converge. The Open Charge Alliance is an international membership organisation for the EV charging industry, which defines operational protocols and certifies hardware and software as compliant with its Open Charge Point Protocol[22]. The UK Competition and Markets Authority has also carried out investigations into certain aspects of public chargepoints, with a view to improving market access generally. Somewhat ironically, the EV Plug Alliance which was formed in 2010 to unify plug standards drew up a specification for a 'Type 3C' connector which now competes in France (and to a lesser extent Italy) with the near-ubiquitous Type 2 connector. More recently the Charging Interface Initiative, CharIN, has been set up to promote consistency based on the CCS plug standard[23].

With generation intermittency increasing as a greater proportion of wind and solar energy comes online, owners of electric vehicles will be incentivised to participate in **electricity supply balancing activities at the national scale** (known as 'vehicle-to-grid', or V2G, services). With V2G, contracted energy suppliers and generators charge and discharge the batteries of privately-owned EVs at times of their choosing according to grid supply and demand, with some form of guarantee that the vehicle will be fully charged by a specified time of day. The EV owners benefit financially from the arrangement. V2G services are not yet common, but there is little doubt that they will rapidly become more widespread. Various OZEV-funded V2G demonstration projects are underway, for example 'Sciurus'[24] and 'e4Future'[25].

Wireless and other forms of contactless charging for EVs are also under development. These technologies will be particularly useful with vehicle fleets, public car parks and EV operations that have a constant turnaround, as well as for drivers who find it inconvenient or impossible to manually plug in their EVs. House builders may also choose to install wireless chargepoints as a marketing benefit. Cenex, a not-for-profit organisation which focuses on low emission transport and its energy infrastructure, is currently conducting the 'DynaCoV' feasibility study in Coventry; this project is exploring the development and implications of dynamic charging, where equipment is installed underneath road surfaces to enable EVs to recharge even as they are being driven[26].

Some local planning authorities have started to stipulate that all **site vehicles** used on a construction project should be low- or zero-emission. The subject is beyond the scope of this publication, and is intended to be the subject of a future report.

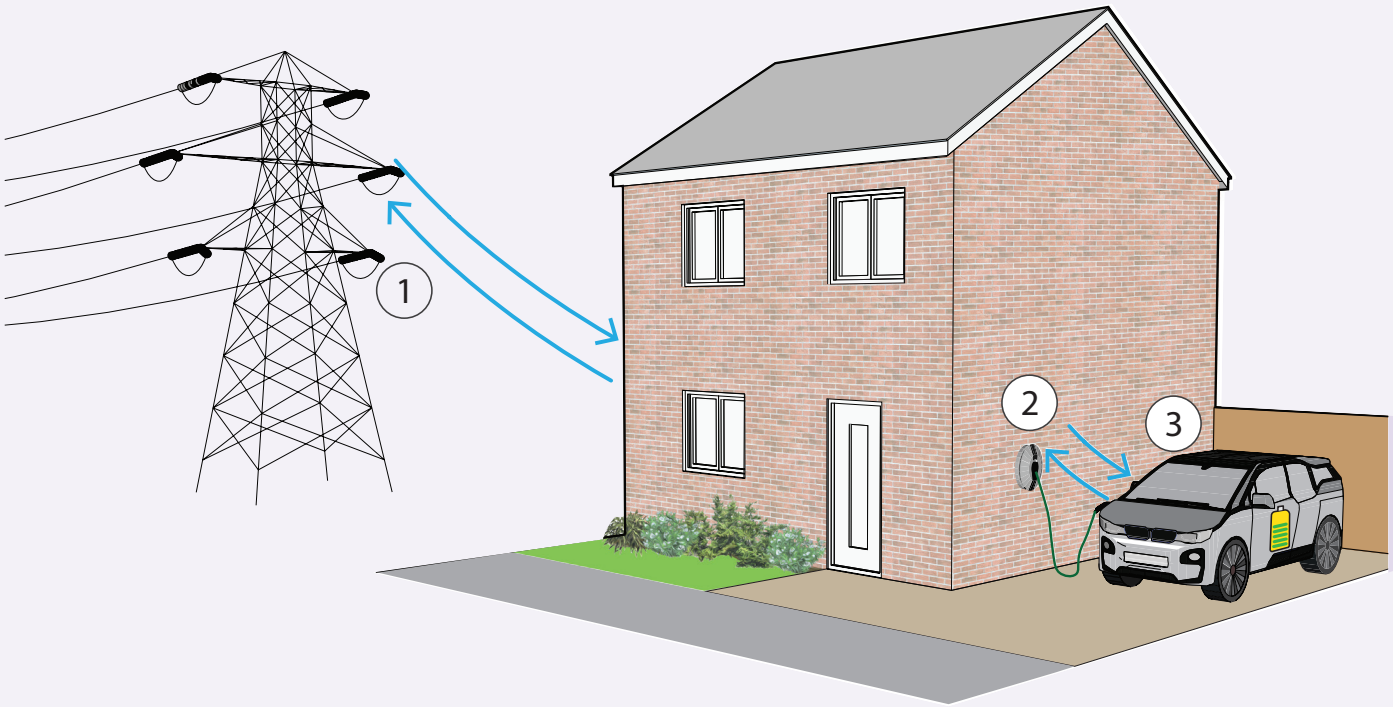


Figure 8 Vehicle-to-grid schematic:

1 The national grid may at various times have excess capacity or a shortage of supply. Electricity can flow either way, depending on the grid situation.

2 At certain times the EV battery will be charged from the grid as normal, and at other times it will supply electricity back to the grid.

3 The EV battery thereby acts as an independent battery store to assist electricity suppliers, DNOs and generators in managing grid supply and demand.

Appendix – Case Studies

Mixed-use development, East London:

https://pod-point.com/business/case-studies/residential-development

170 homes, Pontefract:

https://www.barrattdevelopments.co.uk/showcase/ashmeade-park

Apartments, Edinburgh:

https://www.eocharging.com/case-studies/2019/5/21/eo-and-cala-homes-put-residents-in-charge

Large EV-ready housing scheme, Swindon:

https://www.wichelstowe.co.uk/discover/electric-car-charging

Vehicle-to-grid:

https://www.ofgem.gov.uk/publications/case-study-uk-electric-vehicle-grid-v2g-charging

Red diesel replacement in specialist vehicles:

https://www.cenex.co.uk/case-studies/red-diesel-replacement-stakeholder-engagement-pre-innovation-study/

References

1 Introduction

1 AR6 climate change 2021:the physical science basis. Intergovernmental Panel on Climate Change. 6 August 2021.

2 Energy trends UK, January to March 2021. Department for Business, Energy and Industrial Strategy. 29 June 2021. (As at Q1 2021, remote from the point of use the national electricity generation mix comprised only 55% low- or zero-carbon sources.)

2 The policy context

3 Net zero: the UK's contribution to stopping global warming. Committee on Climate Change. May 2019

4 Transport and environment statistics 2021 annual report. Department for Transport. 11 May 2021.

5 The climate change act 2008 (2050 Target Amendment) Order 2019.

6 Outcome and response to ending the sale of new petrol, diesel and hybrid cars and vans. Department for Transport / Office for Zero Emission Vehicles. 14 July 2021.

7 Private communication. J. Savage, E.ON. August 2021.

8 Electric vehicle chargepoints in residential and non-residential buildings. Department for Transport / Office for Zero Emission Vehicles. 15 July 2019.

9 Building regulations - energy standards and associated topics – proposed changes: consultation. Scottish Government. 23 July 2021.

10 BS EN IEC 61851-1:2019, electric vehicle conductive charging system – general requirements. BSI. 29 February 2020.

11 **www.legislation.gov.uk/ukpga/2010/15/contents**.

12 Access to and use of buildings: approved document M. Ministry of Housing, Communities and Local Government. 7 June 2021.

13 Electrical safety: approved document P. Ministry of Housing, Communities and Local Government. 1 January 2013.

14 HSR25, The electricity at work regulations 1989 (third edition). Health and Safety Executive. October 2015.

15 BS 7671:2018+A1:2020, 18th edition the IET wiring regulations plus amendment 1. IET / BSI. 2018, 2020.

16 Code of practice for electric vehicle charging equipment installation, 4th Edition. IET. 2020.

17 Electric vehicle smart charging: government response. Department for Transport / Office for Low Emission Vehicles. 14 July 2021.

3 The basics of electric vehicles and chargepoints

18 **www.goultralow.com/electric-car-savings/home-charging-calculator/**

4 Charging electric vehicles at home; the essential issues for house builders

19 **www.electric-vehicle.org.uk/**

20 The future for home heating – life without fossil fuels (NF87). NHBC Foundation. 16 September 2020.

21 **www.planningportal.co.uk/info/200130/common_projects/16/electrics/2**

6 Advanced technologies; a brief future look

22 **www.openchargealliance.org/**

23 **www.charin.global/**

24 **www.cenex.co.uk/projects-case-studies/sciurus/**

25 **https://gtr.ukri.org/projects?ref=104227**

26 **www.cenex.co.uk/projects-case-studies/dynacov-dynamic-charging-of-vehicles/**

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