The BEAMA Electric Vehicle Infrastructure Project

# Guide to Electric Vehicle Infrastructure

## Best practice guidance: Modes, plugs/socket-outlets and their domestic, public and commercial application

This guidance document presents the position of industry today for the best practice use and application of the electrical infrastructure for the charging of electric vehicles. This guide is intended for use by organisations providing advice and guidance to consumers on the day-to-day use of electric vehicle infrastructure.

**May 2012**

# Guide to Electric Vehicle Infrastructure

BEAMA is the Association for the British Electrotechnical Industry.
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# Introduction

There are many changes within the electrotechnical industry visible today as we work towards targets for renewable energy generation, carbon emission reduction and improved energy management. The expanding e-mobility market presents great opportunities for manufacturers in the UK to provide an interoperable infrastructure for a mass market of electric vehicles. With the growth of the electric vehicle market, private and public transport is now providing a new interface with the grid. In response to this BEAMA is providing a focus for the development of electrical infrastructures for electric vehicles, to ensure this interface is, safe, 'smart' and interoperable.

The UK Government is projecting tens of thousands of electric vehicles to be in use in the UK by 2015 with acceleration in this ownership between 2015 and 2020. Forecasts for market development are of course difficult to predict as market acceptance will be dependent on many variables, including oil prices, electricity prices, infrastructure availability and consumer acceptance.

Market figures to end of March 2012[1].

| | |
|---|---|
| Installed chargepoints [2] | **>3,000** |
| Claims made through the Plug-in Car Grant | **1,276** |

The availability of infrastructure is of course something we are able to influence now, and is the key focus of BEAMA's activity within this sector. With so many electric vehicles potentially on UK roads it is of utmost importance that consumers are encouraged to charge their vehicles responsibly and safely, limiting the impact on the local electricity networks while maximising the potential for carbon reduction and energy management.

BEAMA has therefore developed this guide in collaboration with a range of organisations to provide a view of the current availability and best practice use of charging infrastructure in the UK. We recognize there will be a mix of vehicle technologies moving forward, including plug-in hybrid and pure electric vehicles. The scope of this guide currently covers pure electric vehicles and the charging practice of a standard 24kw battery. It is anticipated that subsequent versions of the guide will be produced to reflect the development of the infrastructure and vehicle technologies available in the UK.

BEAMA would like to thank all those who have contributed to the guide.

***Dr Howard Porter***

***Chief Executive***

***British Electrotechnical and Allied Manufacturers' Association (BEAMA)***



[1] Department for Transport, December 2011, http://www.dft.gov.uk/topics/sustainable/olev/plug-in-car-grant

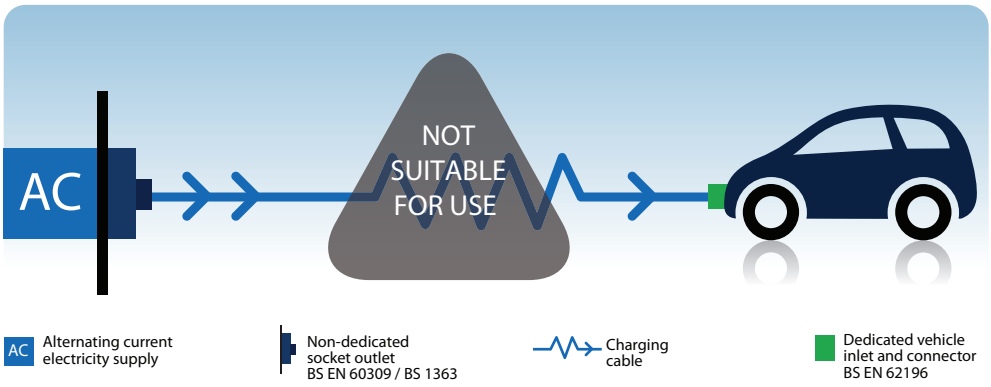
[2] This figure includes publically accessible, domestic and private workplace chargepoints. 1,673 delivered through the Plugged-In Places program, of which 60% are publically accessible. The remainder have been installed by private sector organisations and other local authorities.

# Summary

This section provides a summary of the BEAMA recommendations for charging modes and plug and socket types. These are based on technical and safety assessments of the current technologies available on the UK market. For the background and justification on all issues the main text should always be consulted.

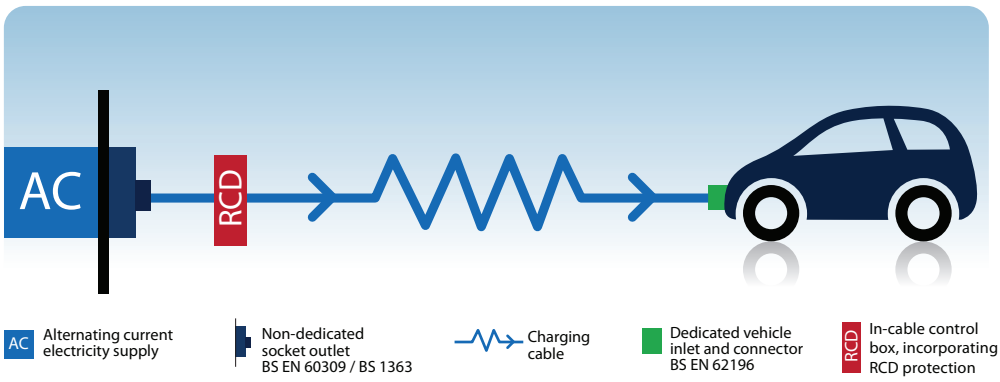
## 1. CHARGING MODES FOR HOME AND PUBLIC CHARGING

There are a number of options available in the UK for the charging of electric vehicles. A range of factors will influence a consumer's decision to adopt any of the following modes and types of infrastructure, including the vehicle type, desired speed of charge, long-term interoperability and UK wiring regulations. The following set of recommendations is based on the current development of products and standards, and aims to promote safe and energy efficient charging practices.




***A***
*Mode 1 charging: Non-dedicated circuit and socket-outlet, charging without cable-incorporated RCD protection*

Mode 1 should not be used for the charging of an electric vehicle because RCD protection, which is necessary for a safe charging system, cannot be guaranteed at all outlets.

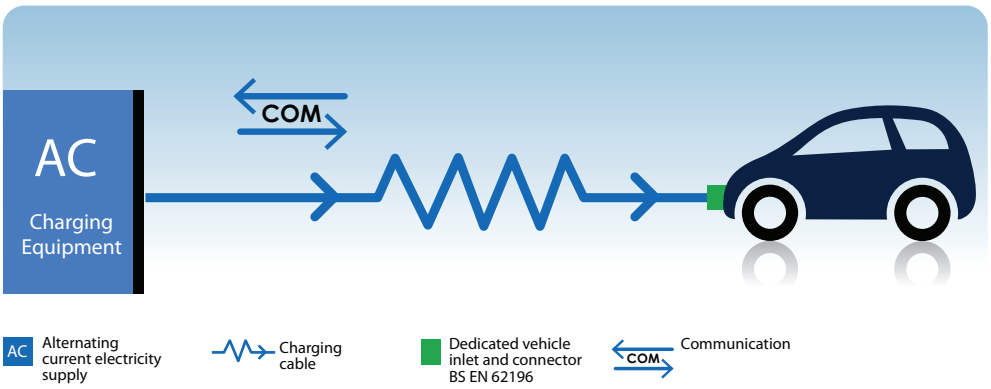



***B***
*Mode 2 charging: Non-dedicated circuit and socket-outlet, charging with cable-incorporated RCD protection*

Mode 2 can be used for the charging of an electric vehicle in locations where there is no dedicated charging installation (Mode 3 or 4, see below), and for use by legacy vehicles. Mode 2 cables are provided with an in-cable control box (including RCD), set and adjusted to a specific charging power, and guarantee the provision of RCD protection during charging.

***C***

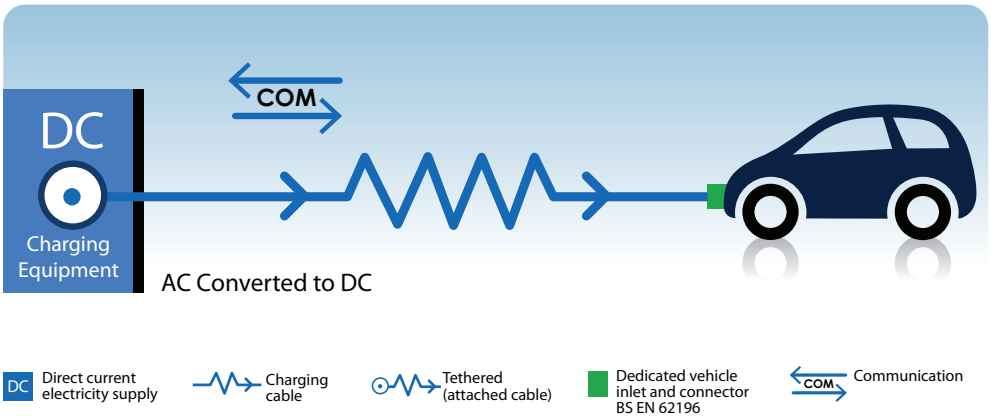
*Mode 3 charging: Fixed and dedicated socket-outlet*




Mode 3 can be used for the charging of an electric vehicle and this is the preferred solution in the long term. Mode 3 chargers are defined in 2 configurations, either with a tethered cable or a dedicated socket-outlet.

***D***

*Mode 4 charging: Dedicated rapid charging, DC supply*



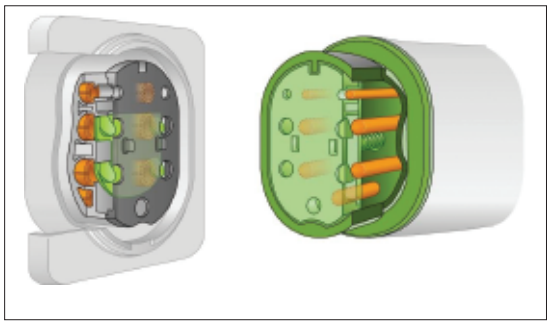

Mode 4 is a necessary service function for rapid charging, for use as roadside assistance and service station charging on long journeys.

## 2. PLUGS AND SOCKET-OUTLET SYSTEMS

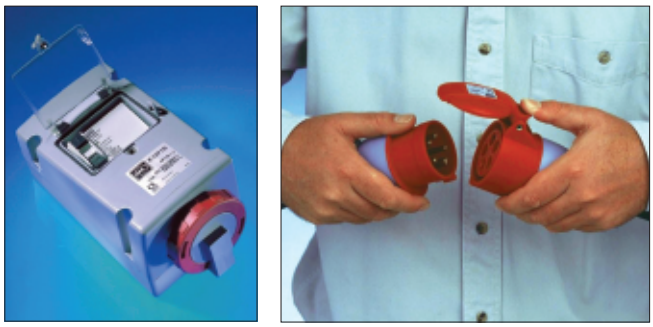
There are a number of different plug and socket-outlets available on the UK market. The following plug and socket-outlets can be used for the charging of an electric vehicle. For their specific characteristics and use cases please consult the main text in this guide.

- Type 1 IEC 62196-2 plug and socket-outlet

- Type 2 IEC 62196-2 plug and socket-outlet



- Type 3 IEC 62196-2 plug and socket-outlet



- BS EN 60309 industrial plug and socket-outlet

- BS 1363 domestic plug and socket-outlet

# Background

BEAMA is the independent expert knowledge base and forum for the electrotechnical industry for the UK and represents the UK electrical infrastructure industry in Europe. Representing over 200 manufacturing companies in the electrotechnical sector, BEAMA has significant influence over UK and international political, standardisation and commercial policy.

In March 2011 BEAMA formed a new project to work on the development of the electrical infrastructure for electric vehicles. This was initiated due to the high level of involvement current BEAMA members have within this sector. It was apparent that work needed to be done to establish an industry association to represent UK infrastructure manufacturers in the development of UK and European policies and technical standards.

BEAMA members provide a range of electrical products required to build a national and international infrastructure for electric vehicles. It is of great importance to the manufacturers that their products are used responsibly by consumers and that consistent guidance is given to users when they decide on the method by which they charge their vehicle. This guide has been developed to ensure that users handle the power supply required for the charging of an EV in a safe and responsible way.

A key objective for BEAMA, and the purpose of this guide, is to develop consistency in the messages and guidance provided to consumers. It is BEAMA's priority to ensure charging is made easy, while encouraging safe product use and confidence in the market through the provision of consistent industry guidance.

BEAMA has developed this first edition of the 'Guide to Electric Vehicle Infrastructure'. The content of this document may be used to advise marketing material, consumer guidance and advice services for the electric vehicle market.

This guide supports two related industry publications: The IET Code of Practice on Electric Vehicle Charging Equipment Installation[3], published January 2012, and the SMMT Electric Car Guide 2011[4]. The BEAMA guide will be annually reviewed to consider new technologies on the market and advances in standardisation, informing the development of consumer guidance. The BEAMA Guide to Electric Vehicle Infrastructure also supports the Office for Low Emission Vehicle's Plug-in Vehicle Infrastructure Strategy, 'Making the Connection'[5].

[3] *IET Code of Practice on Electric Vehicle Charging Equipment Installation* http://www.theiet.org/resources/standards/ev-charging-cop.cfm

[4] *SMMT Electric Car Guide* http://www.smmt.co.uk/2011/06/smmt-publishes-new-2011-electric-car-guide/

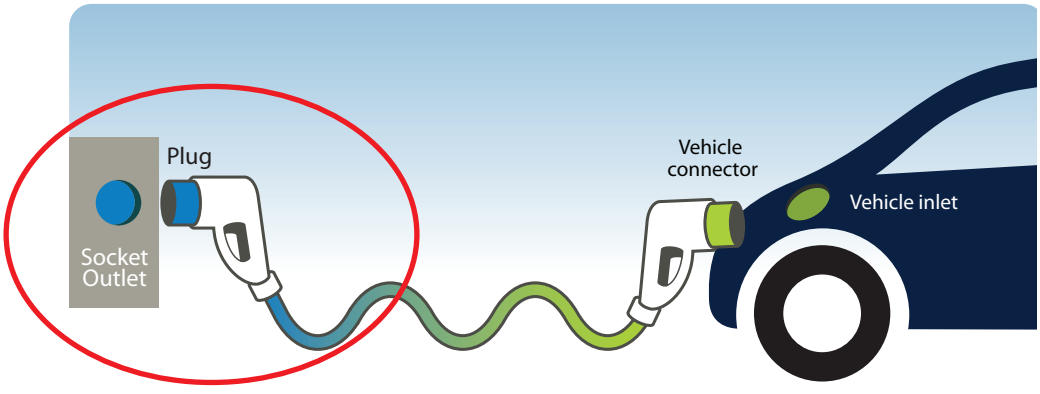
[5] June 2011, *Making the Connection: The Plug-in Vehicle Infrastructure Strategy, Office for Low Emission vehicles* http://www.dft.gov.uk/publications/plug-in-vehicle-infrastructure-strategy

# A. Charging Systems for Electric Vehicles

The UK electric vehicle sector is growing rapidly in response to the need for low carbon solutions for private and commercial transport. The low carbon vehicle market is a necessary step in achieving a 50% reduction in greenhouse gas emissions by 2027 and improvements in urban air pollution levels.[6]

This guide focuses on the use of electrical equipment for charging electric vehicles; therefore it does not consider types of vehicle inlets and connectors. For further information regarding the vehicles themselves please refer to the SMMT Electric Car Guide[7].

***Figure 1:*** *Guide focus*




[6] *Fourth Carbon Budget covering period 2023-2027, 50% on 1990 emission levels http://www.decc.gov.uk/en/content/cms/emissions/carbon_budgets/carbon_budgets.aspx*

[7] *SMMT Electric Car Guide* http://www.smmt.co.uk/2011/06/smmt-publishes-new-2011-electric-car-guide/

# 1. Charging Modes

There are 4 key modes (as defined in the standard BS EN 61851-1) for the charging of an electric vehicle, as summarised below:

***Mode 1 charging:* non-dedicated outlet – BS 60309-2[8] and BS 1363 – 3pin[9]**

***Mode 2 charging:* non-dedicated outlet – BE EN 60309-2 and BS 1363 – 3pin with 'in cable' RCD protection**

***Mode 3 charging:* dedicated outlet – Type 2, 3 – IEC 62196-1 (BS EN 62196-1)[10]**

***Mode 4 charging:* rapid, DC charging**

The following section details the technical requirements for each mode of charge in the UK and the corresponding guidance for the best practice use of each mode. The practical application of these different modes will be presented in chapter 3, where a scenario based approach has been adopted.

The time taken to charge the battery of an electric vehicle is dependent on rated current of the plug and socket-outlet and therefore the power supply and maximum current carried to the battery. The battery type and range will also influence the time required for a full charge, therefore the below information provides a general and not exact indication of charging times.

***Table 1:*** *Charging times and related electricity supply*[11].

| Charging time for a typical 24kWh battery | Power Supplied | Voltage | Maximum current | Mode | Speed |
|---|---|---|---|---|---|
| 10.4 hours | 2.3kW | 230 | 10A | 2, 3 | SLOW |
| 8.3 hours | 3kW | 230 | 13A | 2, 3 | SLOW |
| 6.5 hours | 3.7kW | 230 | 16A | 2, 3 | SLOW |
| 3.2 hours | 7.4kW | 230 | 32A | 3 | FAST |
| 1.6 hours | 14.5kW | 230 | 63A | 3 | FAST |
| 1.04 hours | 23kW | 230 | 100A | 3 | FAST |
| 29 minutes | 50kW | 400-500VDC | 100 – 400A | 4 | RAPID |
| 15 minutes | 100kW | 400-500VDC | 100 – 400A | 4 | RAPID |

[8] BS EN 60309-2: 1999 – Plugs, socket-outlets and couplers for industrial purposes. Dimensional interchangeability requirements for pin and contact tube accessories.

[9] BS 1363:1995 – 13A Plugs, socket-outlets, adaptors and connection units.

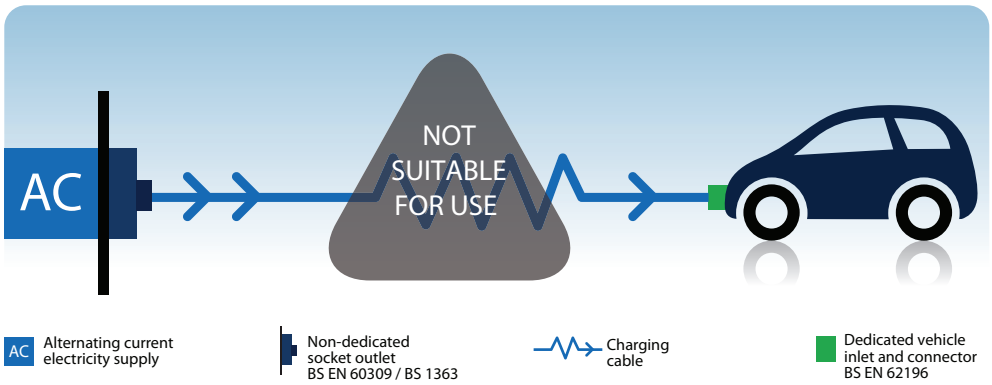
[10] BS EN 62196-2: 2011 – Plugs, socket-outlets, vehicle couplers and vehicle inlets. Conductive charging of electric vehicles. Dimensional interchangeability requirements for a.c. pin and contact-tube accessories.

[11] Please note this provides a broad assumption on charging times and will be dependent on the individual requirements of a given vehicle model, with regards to battery size and recommended guidance provided by the vehicle manufacturer. The times indicated are estimated based on the time it would take to charge a car with a typical 24kWh battery.

## 1.1. MODE 1: Non-dedicated circuit and socket-outlet

- The electric vehicle is connected to the main 230V AC supply network (mains) via a fixed, non-dedicated standard BS 1363, 13A, 3-pin socket-outlet or a single phase 16A BS EN 60309-2 socket-outlet located on the power supply side.
- The electric vehicle is connected to the main AC supply network (mains), and is supplied with a current not exceeding 13A from a BS1363 domestic socket-outlet, and not exceeding 16A from the BS EN 60309-2 industrial socket-outlet
- There is no in-cable control box; therefore it cannot be assumed that RCD protection is provided during charging.

***Figure 2:***
*Mode 1 charging*




Mode 1 should not be used for the charging of an electric vehicle because RCD protection, which is necessary for a safe charging system, cannot be guaranteed at all outlets. Even if RCD protection can be guaranteed in the owner's home, away from the home protection cannot be guaranteed.

## 1.2. MODE 2: Non-dedicated circuit and socket-outlet, charging with cable-incorporated RCD

- The electric vehicle is connected to the main 230V AC supply network (mains) via a fixed, non-dedicated standard BS 1363, 13A 3-pin socket-outlet or a single-phase 16A or 32A BS EN 60309-2 socket-outlet located on the power supply side.
- Specific vehicle models will have guidelines, developed by the vehicle manufacturer, which must be followed. These guidelines will recognise the specific needs of that vehicle. Some vehicle manufacturers de-rate the domestic Mode 2 charging system to 10A. In the interest of having one harmonised household charging current across Europe this may be appropriate.
- Control and protection functions are permanently installed for personal protection from electric shock within the charging cable. An in-cable control box incorporates built-in RCD protection and pilot signal functions to provide basic communication. The inline control box is positioned along the charging cable within 0.3m of the plug, and sets and adjusts the specific charging power.
- The safety of the equipment and the user is dependent on the state of the pre-existing electrical network and compliance with the latest standards as outlined in chapters 3 and 5.

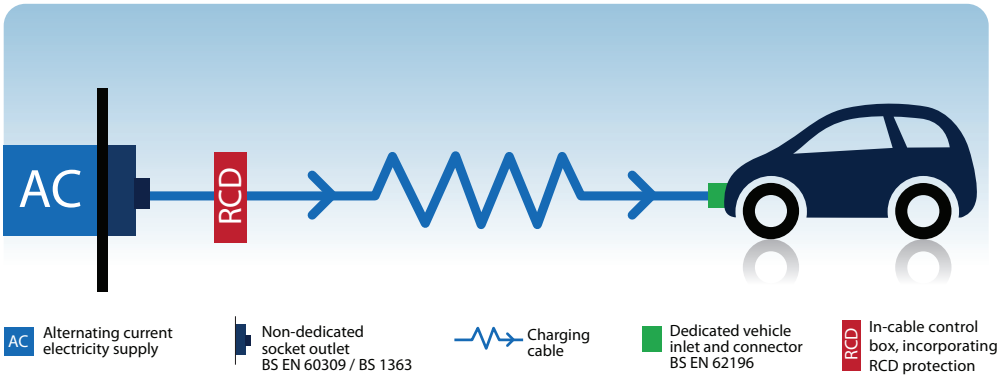



***Figure 3:***
*Mode 2 charging*

Provided vehicles are supplied and operated with only Mode 2 cables, Mode 1 is not required. Mode 2 cables are provided with an in-cable control box (including RCD), set and adjusted to a specific charging power, guaranteeing the provision of RCD protection during charging.

Mode 2 can be used for the charging of an electric vehicle, in locations where there is no dedicated charging installation (Mode 3 or 4, see below), and for use by legacy vehicles.

The pre-existing electrical installation in the property must be checked by a competent person and should be compliant with current industry standards and regulations. Specific guidelines developed by vehicle manufacturers for electric vehicle models must also be followed.

| Pros | Cons |
|---|---|
| Low installation cost | Slow charge of 8-12 hours (depending on the current rating of the charging system, 13A or 10A) |
| Interoperable across UK residential properties | No communication / 'smart' functions |
| RCD protection guaranteed | Susceptible to the misuse of extension leads and adaptors not capable of withstanding the current of an EV charge. |

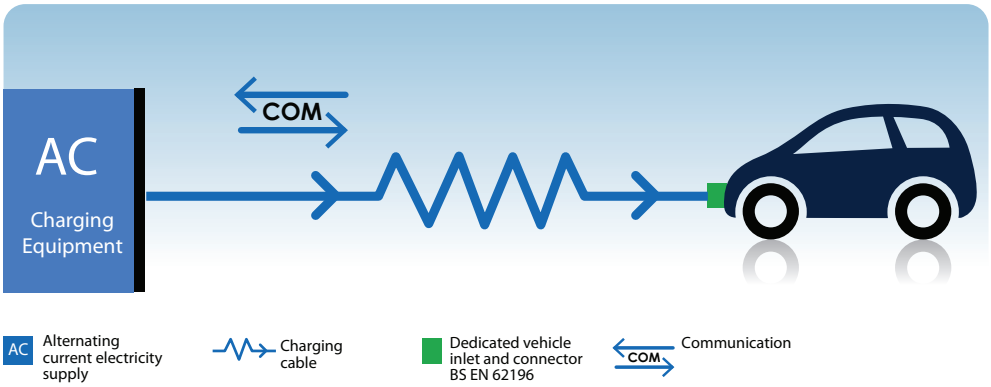
***Table 2:***
*Mode 2 Pros and Cons*

## 1.3. MODE 3: Fixed and dedicated chargepoint

- The electric vehicle is typically connected to a 16A or 32A single phase AC supply network (mains) using a dedicated connector and dedicated circuit. The connection can be three phase.
- In both cases additional conductors are incorporated into the charging cable to allow communication between the vehicle and the charging equipment.
- Communications functions are a major part of the Mode 3 charging system in light of the roll-out of smart meters and the future smart grid in the UK, with the emphasis on providing measures for off-peak charging and energy management for the consumer charging at home. The functionality for this is already built into the Mode 3 charger, future-proofing the installation for future 'smart' applications.

- Control and protection functions (load controller, contactor, Surge Protective Device, RCD) are permanently installed within the chargepoint which is permanently connected to the AC supply network (mains).
- Mode 3 includes a socket-outlet incorporating a pilot wire which ensures that the conductive parts and connectors connection is well established. Mode 2 has the same function in its cable. However due to the fact that the additional protection is part of the cable system there is no guaranteeing that if the cable is damaged this function will not be affected.
- In practice, Mode 3 chargers are designed in two different configurations. They can be found with either a tethered cable which is common in, but not limited to, domestic installations or with the dedicated socket-outlet, most commonly found in UK public charging infrastructure. The public, Mode 3 charger will have the ability to measure energy used, allowing for electricity billing for electric vehicle charging to take place.
- Mode 3 public charging equipment can be installed with an energy meter which supports billing/Pay-As-You-Go transactions based on energy consumption when used by a customer to charge an electric vehicle. This is also required for energy management purposes.
- Specific vehicle models will have guidelines, developed by the vehicle manufacturer, which must be followed. These guidelines will recognise the specific needs of that vehicle.
- The safety of the equipment and the user is dependent on the installation, the connected electrical network and compliance with the latest standards as detailed in chapter 3.

***Figure 4:***
*Mode 3 charging*




Mode 3 can be used for the charging of an electric vehicle. This is the preferred solution in the long-term, recognising industry's move towards the use of dedicated charging systems[12] allowing for 'smarter' charging capabilities, in line with industry's objectives for improved energy management.

The installation must be installed by a competent electrician and should be compliant with current industry standards and regulations.[13] Specific guidelines developed by the vehicle manufacturers for electric vehicle models must also be followed.

[12] *June 2011, Making the Connection: The Plug-In Vehicle Infrastructure Strategy, Office for Low Emission vehicles http://www.dft.gov.uk/publications/plug-in-vehicle-infrastructure-strategy*

[13] *IET Code of Practice on Electric Vehicle Charging Equipment Installation http://www.theiet.org/resources/standards/ev-charging-cop.cfm*

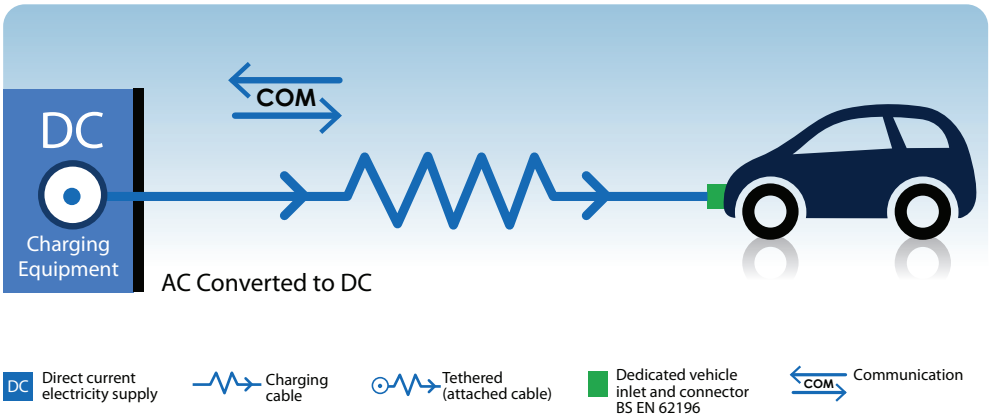
| Pros | Cons |
|---|---|
| Fast charge (1 – 4 hours) | Additional cost of fixed installation |
| Communication between the vehicle and the chargepoint | If domestic installations provide a tethered charging cable, the vehicle connector will be specific to the owners vehicle and the inlet on the car side |
| Provides the functionality for 'smart charging' | Private Mode 3 chargers can only be installed in certain types of buildings. Off-street parking or a garage is required. |
| Compatibility and connection with the Smart Grid | |
| Control and protection functions permanently installed | |
| Load controller | |
| Suitable for domestic and public installations | |

***Table 3:***
*Mode 3 Pros and Cons*

## 1.4. MODE 4: Rapid, dedicated chargepoint, DC connection

- The electric vehicle is indirectly connected to the main AC distribution network through a standard external charger.
- AC single phase or three phase current is converted to DC inside the charging equipment using rectifiers.
- They operate at a much higher voltage and current, 500V and 125A, providing a rapid charge to the battery.
- The DC current is supplied to the electric vehicle through a charging cable permanently attached to the dedicated DC Mode 4 chargepoint.
- Control and protection functions are permanently installed.
- Due to the high current required for rapid charging, Mode 4 chargepoints are not suitable for domestic installations.
- Mode 4 public charging equipment can be installed with an energy meter which supports billing/ Pay-As-You-Go transactions based on energy consumption when used by a customer to charge an electric vehicle. This is also required for energy management purposes.

***Figure 5:***
*Mode 4 rapid charging*




This is a necessary service function for rapid charging, for use as roadside assistance and service station charging on long journeys. The electrical installation must meet current industry standards and regulations and specific guidelines developed by the vehicle manufacturers for electric vehicle models must also be followed.

***Table 4:***
*Mode 4 Pros and Cons*

| Pros | Cons |
|---|---|
| Rapid charge (20mins approximately) | Not suitable for domestic installations |
| Control and protection functions permanently installed | Higher cost of installation |
| Communication between the vehicle and the chargepoint | Higher load on a local electricity network. |

## 1.5. The use of cable reels, extension leads and adaptors

Under Standard HD 60364-7-722:2012, 'Requirements for special installations or locations – Supply of electric vehicle', the use of 'portable socket-outlets are not permitted' for the charging of electric vehicles.[14] Therefore the use of cable reels, extension leads and adaptors is strongly ill advised.

[14] *Ratified and to be published shortly*

# 2. Plugs and Socket-Outlets

The following plugs and socket-outlets can be used for the charging of an electric vehicle. Their characteristics are documented below and specific use cases outlined. The electrical installation must be compliant with current industry standards and regulations.

## 2.1. TYPE 1, IEC 62196-2 (BS EN 62196-1)

- Single phase
- Maximum current 32A
- Maximum voltage 250V
- 5 pins/socket tubes

***Figure 6:***
*IEC 62196-2 Type 1 Plug and socket-outlet*

Type 1 plug and socket-outlets can only be used with single phase supplies for the charging of electric vehicles.

## 2.2. TYPE 2, IEC 62196-2

- Single or three phase
- Maximum current 70A single phase, 63A three phase
- Maximum voltage 500V
- 7 pins/socket tubes

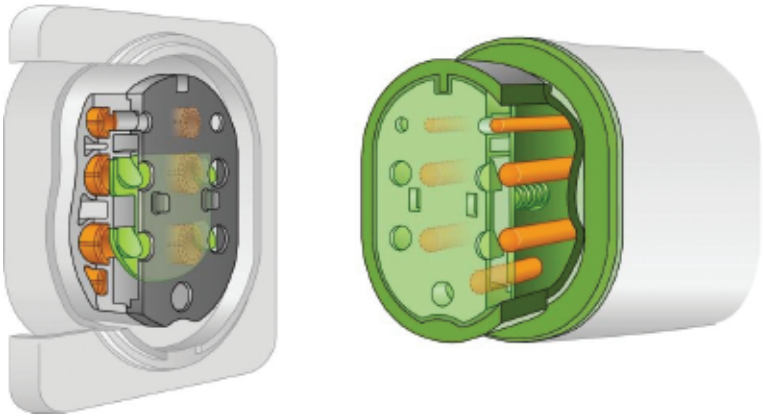
***Figure 7:***
*IEC 62196-2 Type 2 Plug and socket-outlet*

OLEV is committed to funding only Type 2 infrastructure for publicly accessible chargepoints as part of the Plugged-In Places projects. Effective from April 2012.

## 2.3. TYPE 3, IEC 62196-1

- Single phase or three phase
- Maximum current 32A (single and three phase)
- Maximum voltage 500V
- 5 or 7 pins/socket tubes
- Developed by the EV Plug Alliance
- With shuttered plug pins and socket-outlet contacts
- IP4X and optional IP55

***Figure 8:***
*IEC 62196-2 Type 3 Plug and socket-outlet*



## 2.4. UK EXISTING PLUG AND SOCKET SYSTEMS

In order to facilitate the market penetration of electric vehicles, the availability of the existing electrical infrastructure (BS 1363 and BS EN 60309-2) must be ensured. With regards to existing plug and socket-outlet systems such as those complying with BS EN 60309-2 or BS 1363:

- Existing systems are safe provided they comply with their standard and are used in accordance with specific guidelines developed by electric vehicle manufacturers.
- For electric vehicle charging, both shuttered and un-shuttered socket-outlets are safe in the appropriate circumstances; that is, domestic or public applications.

### 2.4.1. BS 1363 domestic plug and socket-outlet

- The normal domestic AC power plugs and socket-outlets used in the UK
- With shuttered socket-outlet contacts and sleeved plug pins
- Maximum current 13A

***Figure 9***
*BS 1363 13A domestic plug and socket-outlet*

Household plugs and socket-outlets can be used for the Mode 2 charging of an electric vehicle in domestic properties where there is no available dedicated charging infrastructure (Mode 3 or 4). They can also be found in some public dedicated charging points, for use by legacy vehicles, motorcycles and quadricycles.

### 2.4.2. BS EN 60309-2 industrial plug and socket-outlet

- BS EN 60309-2 socket-outlets normally provide solutions for industrial applications including construction sites, camp sites and marinas, but electric vehicles can also be safely charged from the BS EN 60309-2 socket-outlets using Mode 2 or Mode 3.
- The rated voltage of the plug is identified by colour.

  The most common colour codes are blue and red, with 'blue' signifying 200 to 250V and 'red' signifying 380V to 480V.

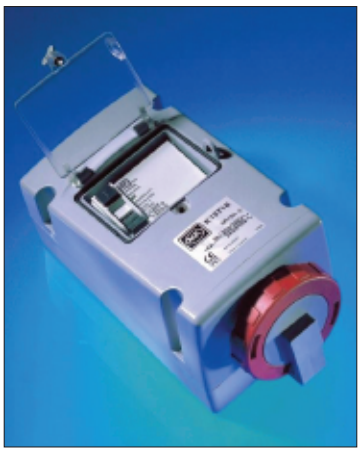


***Figure 10:***
*BS EN 60309-2 industrial plug and socket-outlets*

# 3. Application

## 3.1. HOME CHARGING OF ELECTRIC VEHICLES

It is anticipated that the majority of electric vehicle charging will take place at home. This is the desired method of charging providing benefits not only to the consumer but also to the UK energy system as a whole.

By utilising off-peak electricity the consumer can benefit from lower cost energy tariffs, utilising lower carbon energy, which maximises the environmental benefits of electric vehicle use. The off-peak charging of electric vehicles minimises demand on the local network, limiting the level of local network reinforcement and additional generating capacity that would be necessary if everyone charged during peak periods. Such upgrades could be very costly.

As the amount of renewable energy feeding into the national grid increases, fluctuations in supply will occur as the weather conditions determine the level of electricity production. It is through the development of a 'smarter' grid and the installation of smart appliances in the home, including Mode 3 electric vehicle chargers, that we will have the ability to manage these additional peaks and troughs in energy supply through the intelligent control of electric vehicle charging. This is referred to as 'dynamic demand response' and can be maintained through the bi-directional communication functionality which is built into the chargepoint, allowing communication to and from the electric vehicle and the chargepoint.

Household appliances rarely exceed 2kW, and therefore consumers are seldom aware of the risks entailed in handling electrical equipment that does. Electric vehicle charging equipment is an example of this and can entail risks if electric vehicles are not charged responsibly and through a domestic electrical system which is in accordance with UK national wiring regulations (BS 7671). Considering the range of circumstances presented to consumers for the charging of their electric vehicle a number of frequently asked questions have been selected, and answered below.

### Frequently asked questions

***a. How can I maximise the speed of my electric vehicle charge at home?***

Table 1, in chapter 1, outlines the approximate charging times for a standard 24kw battery. Charging in a domestic property can be carried out at 13A, 16A or 32A. The precise level of charging current will be dependent upon the installation and type of plug and socket-outlet fitted. To optimise the speed of an electric vehicle charge a dedicated charging system can be installed, compliant with BS EN 62196, ensuring charging is undertaken in accordance with UK wiring regulations and standards.

Circuits supplied through dedicated electric vehicle plug and socket systems complying with BS EN 62196, meet the requirements of safety standards and therefore all necessary safety requirements for the handling of power supplies required for the fast charging of an electric vehicle.

***b. How can I maximise the environmental benefits of owning an electric vehicle, while limiting the cost of home charging?***

A Mode 3 charging system is accepted as best practice for the provision of future 'smart' charging and energy management capabilities.

Some 'smart' features are already available, including dedicated electricity tariffs for electric vehicle owners, providing cheaper overnight (off-peak) electricity rates for the charging of an electric vehicle.

While long-term objectives for intelligent charging in the home are developed BEAMA support the use of timers, enabling consumers to charge their vehicles off-peak, overnight, taking advantage of lower cost electricity tariffs. Any timer used for the charging of an electric vehicle must be suitably rated and meet national standards. As we move to a 'smarter' charging system and grid interoperability the use of timers will not be necessary.

**c.** ***I am visiting a friend who doesn't have a dedicated electric vehicle socket-outlet and Mode 3 system. How should I charge my vehicle responsibly from my friend's residential property?'***

In order to facilitate the market penetration of electric vehicles, the availability of the existing infrastructure (BS 1363 and BS EN 60309-2) for vehicle charging must not be impeded. The long-term objective is not for this to be the primary means of charging a vehicle, but it must remain as an option to allow drivers to continue journeys and charge where dedicated infrastructure is not available.

The move towards the use of Mode 3 or Mode 4 dedicated charging systems is motivated by the long-term industry objectives for improved energy management in the home. The objective must be to provide communication between the electric vehicle and the installation to allow 'smart' solutions providing measures for off-peak charging and energy management for the consumer charging at home by providing control over charging periods. This level of interoperability requires a Mode 3 charging system.

People and equipment safety depends on the state of the pre-existing domestic electrical wiring, which may have deteriorated or not upgraded to the latest standards. Therefore BEAMA only supports the use of electric vehicle charging equipment if the electrical installation within a property fits within the following criteria.

- The household wiring and installation has been checked by a competent electrician ensuring it meets with current standards and regulations. The OLEV Plug-In Vehicle Infrastructure Strategy states that 'owners who plan to charge their vehicles at home should have their wiring checked to ensure that it is appropriate.'
- If using a Mode 2 system the domestic 3 pin socket-outlet used to connect the vehicle to the network must fully comply with the standard BS 1363;
- The complete charging system must comply fully with UK wiring regulations (BS 7671);
- Guidance produced by electric vehicle manufacturers, specific to a vehicle's particular needs, must be observed when deciding on the method of charging;
- Under Standard HD 60364-7-722:2012, Requirements for special installations or locations – Supply of electric vehicle, the use of 'portable socket-outlets are not permitted' for the charging of electric vehicles. Therefore the use of cable reels, extension leads and adaptors is strongly ill advised.

If the above criteria cannot be met the vehicle user and the property from which the electric vehicle is being charged may be exposed to risks.

### 3.1.1. Examples of infrastructure used for domestic charging

The following modes can be used for the charging of an electric vehicle from a residential property:

- Mode 2
- Mode 3

Two examples of dedicated Mode 3 chargepoints for residential use are shown below. For guidance on the installation of charging infrastructure please refer to the IET Code of Practice for Electric Vehicle Charging Equipment Installation.

***Figure 11***
*Mode 3 wall mounted chargepoints with tethered cable.*

## 3.2. PUBLIC CHARGING OF ELECTRIC VEHICLES

### Frequently asked questions

***a. Where is public charging infrastructure being installed in the UK?***

While it is foreseen that the majority of charging will take place at home, a significant level of publicly accessible charging infrastructure is being installed across the UK in order to ensure electric vehicle users can top-up their battery charge.

The UK Government made available £30 million match-funding for eight pilot projects across the UK to install and trial recharging infrastructure[15], establishing eight local charging networks. These, Plugged-In Places' are providing a focus for the development of regional networks of public, residential and commercial infrastructure. The eight Plugged-In Places are:

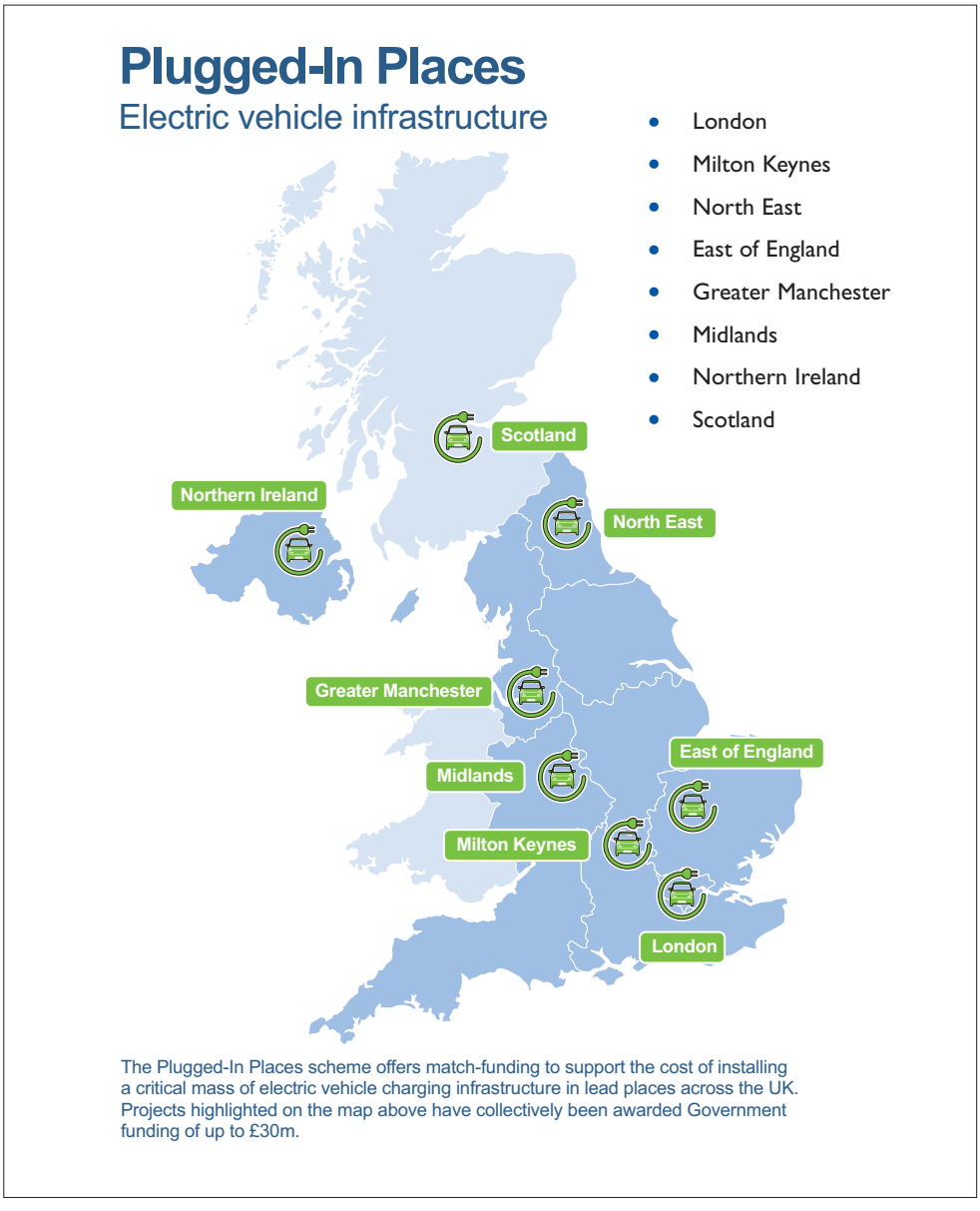



***Figure 12:*** *Map showing locations of UK Plugged-In Places regions*

[15] June 2011, *Making the Connection: The Plug-In Vehicle Infrastructure Strategy, Office for Low Emission vehicles* http://www.dft.gov.uk/publications/plug-in-vehicle-infrastructure-strategy

This initiative has enabled the private sector to enter the market and make significant investments in recharging infrastructure, meaning the creation of an extensive public charging network, achieved with less public money spent. For example, by the end of this year, one such private sector organisation expects to have the UK's first privately funded large scale network set up in 100 towns and cities, providing 4,000 electric vehicle charging bays, and other organisations are emerging with national charging ambitions and business models.

The public charging infrastructure is being strategically placed, in areas easy to locate and access, identifying where the infrastructure is most needed, for example, in car parks, shopping centres, park and ride sites and town centres.

### *b. How can I find public charging infrastructure?*

Various membership programmes and infrastructure providers make individual records of chargepoint locations available to electric vehicle drivers. However, while some of these membership programmes are now being interlinked, there has been no UK centralised record for the location of charging infrastructure.

In order to help electric vehicle drivers access chargepoints, the Government is developing a National Chargepoint Registry (NCR). This is a database of publicly accessible chargepoints across the UK, available on data.gov.uk. It is envisaged that the Registry will be fully developed and tested over the coming months, allowing businesses to innovate and provide products, such as satnav and mobile apps, for electric vehicle owners to access.

### c. How can I access charging infrastructure?

Electric vehicle charging infrastructure may be provided in a variety of locations including on-street, in a public or private car park, at your place of work or in your home. Normally for home charging your installer will inform you how to access the device as will your employer where charging is provided in the workplace.

To use a charger in a public location such as on-street or in a public car park that is not a pay-as-you-go system, you will need to be a member of an electric vehicle scheme. These schemes exist across the UK and as part of the membership package you will be issued with a card.

This card can be used with any public chargepoint that is linked to your membership programme. The charging points normally carry a logo which identifies which membership cards can be used. Simply present the card to the chargepoint and it will be unlocked for you.

Some of the membership programmes are now being interlinked so that you can use your card to access changing points across the UK.


***Figure 13:*** *Source London electric vehicle membership scheme. Example of RFID card and the charging points installed in public locations accessible using the Source London membership card.*

### *d. What infrastructure is being provided to enable longer journeys?*

The majority of trips made in a vehicle are well within the range of an electric vehicle battery. 95% of journeys made in Great Britain are less than 25 miles[16], and the average length of a journey is only 8.4 miles.

Mode 4 chargers are available for the rapid charging of electric vehicles, enabling drivers to have the available option to extend their journeys beyond the standard range of their battery. Plans are being developed to install Mode 4 chargers across the UK to provide a network of rapid charging enabling a charge time of approximately 20 minutes. This infrastructure will be installed in particular geographic areas where it is most needed, for example, installation at motorway service stations will allow for longer journeys across the country.

#### 3.2.1. Examples of infrastructure used for public charging

The following modes can be used for the public charging of an electric vehicle:

- Mode 3
- Mode 4 (with tethered cable)

Examples of the dedicated chargepoints available for installation in public places are shown below. For guidance on the installation of charging infrastructure please refer to the IET Code of Practice for Electric Vehicle Charging Equipment Installation.

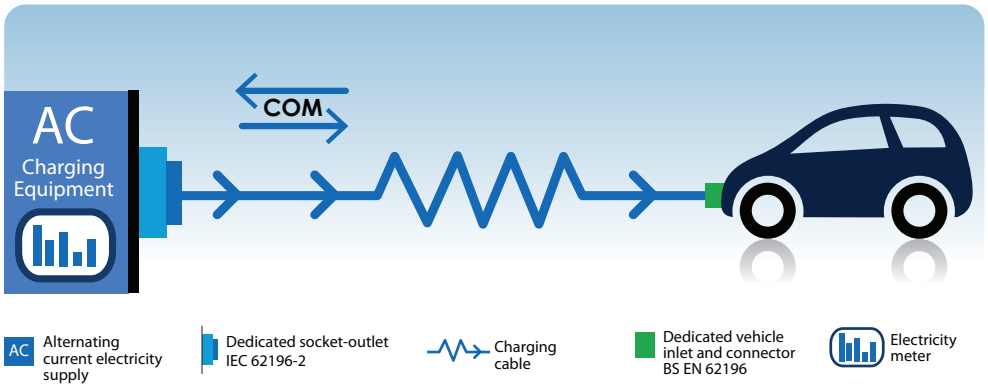



***Figure 14:*** *Public charging infrastructure*

Public charging equipment can be installed with an energy meter which supports billing/Pay-As-You-Go transactions based on energy consumption when used by a customer to charge an electric vehicle. This is also required for energy management purposes.

[16] *National Travel Survey 2010*, Average number of trips by trip length and main mod: Great Britain 2009 www2.dft.gov.uk/pgr/statistics/datatablespublications/nts/latest/nts2009-03.pdf

***Figure 15:***
*Mode 3 public chargepoint. Meter and socket-outlet.*


***Figure 16:***
*Mode 4 public chargepoint. Meter and tethered cable for DC charging.*

## 3.3. COMMERCIAL AND FLEET CHARGING INFRASTRUCTURE

The commercial use of electric vehicles will constitute a large part of the e-mobility market. To date more than half of all new electric vehicle sales have been for business and fleet use. This is driven by the cost incentives for businesses in running an electric or hybrid fleet, as well as acknowledging a company's corporate social responsibility to reduce carbon emissions and improve the environmental impact of commercial activity. With the introduction of the Plug-in Van Grant[17] it is likely that the commercial use of such vehicles will continue to grow.

The development of cost effective solutions for infrastructure to support fleets of electric vehicles is very important. In addition, drivers of electric vehicles are likely to charge during the day at work and this will be a necessary infrastructure base, secondary to charging at home over night.

Issues related to energy densities and maximum energy demand for fleets may emerge as the commercial use of these vehicles becomes more prevalent. The commercial charging of vehicles will be governed by specific site policies and the electrical responsibilities of the site owner.

Companies wishing to adopt an electric vehicle fleet can install Mode 3 chargers, like the one shown below, along with specific fleet management services which can ensure charged vehicles are always available for use. The specifications for fleet infrastructure are the same as those documented for public charging applications, however in this case you may wish to install multiple points, depending on the number of vehicles being used. For further guidance on the development of an electric vehicle fleet please see Plugged-in Fleets, A Guide to Developing Electric Vehicle Fleets[18] published by The Climate Group in February 2012.


***Figure 17:***
*Mode 3, 22kW electric vehicle charge-points.*

[17] http://www.dft.gov.uk/topics/sustainable/olev/plug-in-van-grant/

[18] The Climate Group, 2012, Plugged-in Fleets, A Guide to Developing Electric Vehicle Fleets http://www.theclimategroup.org/_assets/files/EV_report_final_hi-res.pdf

# B. Charging Systems for Electric Motorcycles

The UK electric powered two wheeler (ePTW) sector is expanding rapidly, driven by the need for a greener, low emission transport alternative. Registration figures indicate that in excess of 3,000 ePTWs are now on the UK's roads.

The Electric Powered Two Wheeler (ePTW) sector has sought out solutions to the issues of design, manufacture and sales of a new generation of electric powered two wheeled vehicles, creating a route to market that is designed to meet the demands of a new generation of commuters.

ePTWs have a key role to play in any low carbon transport, particularly in the urban commuter sector. For solo commuters, the ePTW offers an emission free, congestion proof, time saving and more efficient transport option. With an average urban commute of 9 miles, and no requirement to exceed 40mph, 75% of the current crop of ePTWs is capable of matching the needs of the today's urban commuter.

## 4. CHARGING MODES FOR ELECTRIC MOTORCYCLES

The following section details the technical requirements for the charging of electric motorcycles and the corresponding guidance on the best practice use of charging equipment for electric motorcycles.

## 4.1. HOME CHARGING OF ELECTRIC MOTORCYCLES

Home charging is being embraced by many new designs with the introduction of removable 'cartridge' type battery packs which can be removed from the machine and recharged in the home or office.

- The electric motorcycle is connected to the main AC supply network (mains) via a fixed, non-dedicated standard BS 1363, 13Amp, 3-pin socket-outlet.
- There is no in-cable control box, or built-in control on the motorcycle side during charging. It is recommended that an in-line RCD is installed in the house/domestic outlet being used to charge the motorcycle.
- The safety of the equipment and the user is dependent on the state of the pre-existing domestic electrical wiring and compliance with the latest standards as outlined in chapter 5. The pre-existing electrical installation in the property must be checked by a competent electrician.

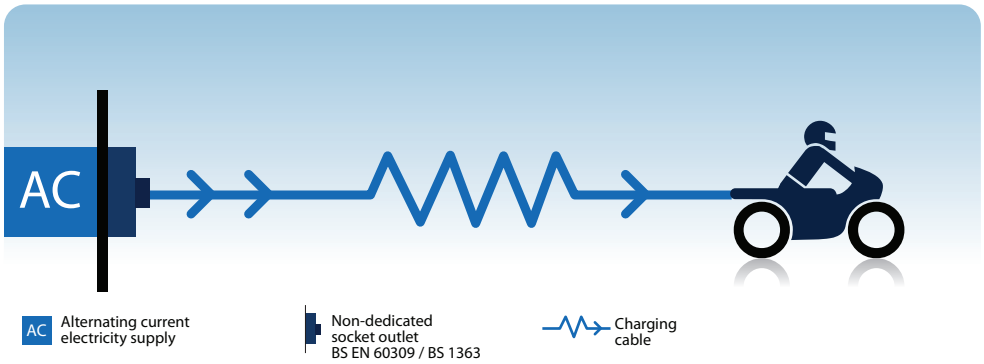



***Figure 18:***
*Electric motorcycle charging, non-dedicated socket-outlet*

Electric motorcycles are charged using a Mode 1 system; therefore there are inherent risks in the absence of RCD protection. If there is no dedicated charging infrastructure available for use, it is strongly recommended that RCD protection is installed for the charging of electric motorcycles from BS 1363 socket-outlets. Provided there is guaranteed provision of RCD protection during charging, the use of BS 1363 meets the required needs for the charging of electric motorcycles.

Specific guidelines developed by vehicle manufacturers for electric motorcycle models must also be followed.

## 4.2. PUBLIC CHARGING OF ELECTRIC MOTORCYCLES

Almost all of the current fleet of ePTWs in the UK carry an on-board charging cable fitted with a BS 1363 3 pin socket-outlet.

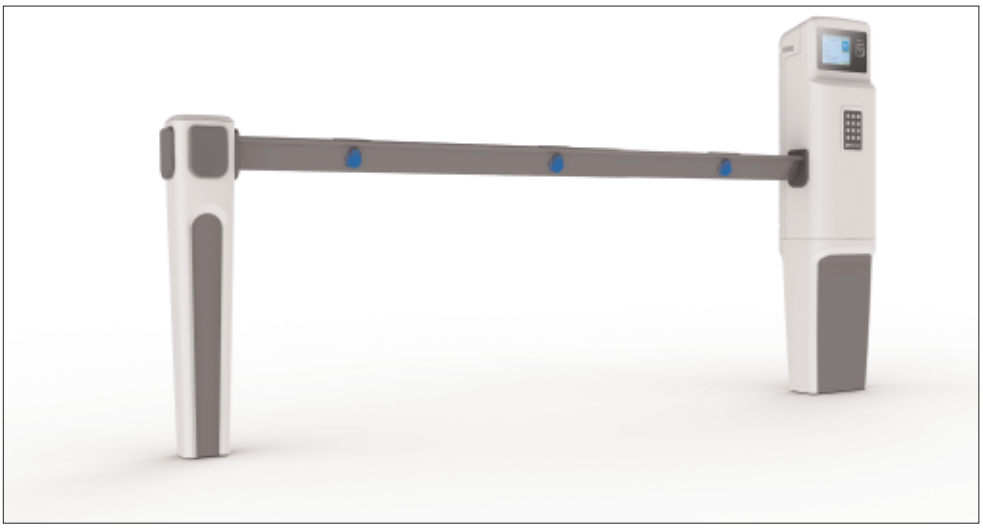
Electric motorcycles can charge in public areas using existing public infrastructure where a BS 1363 socket-outlet is provided. However, in many cities motorcycle parking is free, but only in dedicated motorcycle parking bays and currently very few are equipped with dedicated charging infrastructure.

### 4.2.1. SPECIFICATIONS FOR ePTW PUBLIC CHARGEPOINTS

- Able to deliver 13A for up to six hours per charge
- Protected from rain and the ingress of other foreign objects
- Locked or closed when not in use
- Access and power provided only to identified persons
- Plug locked in the station during the charging period

Below is an example of the type of dedicated charging point available for use by electric motorcycles in the UK.

***Figure 19:***
*Public chargepoint for electric motorcycles*



# C. Technological Development

## 5. Standards

### 5.1. CURRENT STANDARDISATION ACTIVITY

With the growth of the electro-mobility market internationally and throughout Europe, there are now requirements for standards and regulatory frameworks to be developed for the industry. Growth in the market will be facilitated by the development of standards which will help to remove market barriers and improve client acceptance.

The European Commission/EFTA issued the mandate M/468 to CEN and CENELEC on European Electro-mobility standardisation in 2010. This mandate aims to:

- Ensure interoperability and connectivity between the electricity supply point and the charger of electric vehicles, including the charger of their removable batteries, so that this charger can be connected and be interoperable in all EU states.
- Ensure interoperability and connectivity between the charger of electric vehicle- if the charger is not on-board, and the electric vehicle and its removable battery, so that a charger can be connected, can be interoperable and charge all types of electric vehicles and their batteries.
- Appropriately consider any smart charging issue with respect to the charging of electric vehicles.
- Appropriately consider safety risks and electromagnetic compatibility of the charger of electric vehicles in the field Directive 2006/95/EC (LV) and Directive 2004/108/EC (EMC).

This concerns all electric vehicles, including mopeds, two-and three-wheel vehicles and quadricycles (category L1-L7) as well as four wheel vehicles (category M1 and M2).

The current acceleration in the industrial development of electric vehicles and associated infrastructure has now led to acceleration in standardisation work. There are a number of national, European and international standards committees relevant to the development of an interoperable and functional electric vehicle infrastructure network. These include the IEC, ISO, ITU-T, CEN, CENELEC, ETSI and BSI. It is therefore a complex working environment dealing with many cross-sector issues. A recent memorandum of understanding between ISO and IEC will improve the close coordination of activities, while CEN and CENELEC have agreed to collaborate on the standardisation subjects to avoid duplication of activity.

The communications aspects of electro-mobility standardisation are to be dealt with in other existing groups, including the CEN, CENELEC and ETSI Smart Grid Co-ordination Group and the similar CEN, CENELEC and ETSI Group for Intelligent Transport Systems.

Several relevant standards are in the process of being finalised in Europe and have already been published by IEC:

***Table 5:***
*Relevant standards*

| Standard | Definition |
|---|---|
| **BS 7671** | Requirements for electrical installations. The national standard in the UK for low voltage electrical installations. |
| **BS EN 60309 and IEC 60309** | International standard for plugs and socket-outlets and couplers for industrial purposes. |
| **BS 1363** | British standard which specifies the most common type of domestic AC power plugs and socket-outlets used in the UK. |
| **BS EN 62196 and IEC 62196** | Plugs, socket-outlets, vehicle couplers and vehicle inlets. Dimensional interchangeability requirements for A.C. pin and contact-tube accessories. The present standard allows for the use of the same socket-outlet format for all applications from single phase to 3 phase and from 16A to 63A with auxiliary contacts. |
| **IEC61980** | International standard for electric vehicle inductive charging systems |
| **IEC 60364-7-722 and CENELEC HD 60364-7-722** | Requirement for all AC charging installations to be protected by a residual current device (RCD), which will protect against electric shock in case of failure of the isolation. Published, in 2011, based on IEC 61851-1, specifying the modes of charging. |
| **BS EN 61851** | Under preparation and will specify general provisions for the installation which will ensure safety for fixed installations of charging stations. |
| **HD 60364-7-722:2012** | Ratified and proceeding to publication. 'Requirements for special installations or locations – Supply of electric vehicle'. |

# 6. Inductive and other Wireless Charging Systems

Inductive charging technologies for electric vehicles are not yet commercially available on the UK market but are currently being trialled through pilot projects. Standards are currently being developed for this technology to enable the wireless charging of electric vehicles.

The 10-year-old standard IEC 61980, Vehicle Inductive Charging Systems, requires revision and rewriting which is to be done by a Joint Working Group (JWG) of ISO/IEC.

JWG ISO/IEC PT61980 of ISO TC22/SC21, Electrically Propelled Road Vehicles and IEC TC69, Electric Road Vehicles and Electric Industrial Trucks, are working on standards for the wireless charging of electric vehicles, in close cooperation with SAE (J2954; USA) and the relevant European mirror committee CENELEC TC69X.

## 6.1. IEC61980 "ELECTRIC VEHICLE INDUCTIVE CHARGING SYSTEMS"

### Introduction

Part 1 of this standard covers general requirements for electric vehicle inductive and/or the wireless transfer of electric power including general background and definitions. This standard is developed for the manufacturers' convenience by providing general and basic requirements for inductive and/or wireless transfer of electric power to the electric vehicle.

### Scope

This standard applies to the equipment for the wireless bidirectional transfer of electric power from the supply network to electric vehicles for purposes of supplying electric energy to the Rechargeable Energy Storage System (RESS) and/or other on-board electrical systems in an operational state when connected to the supply network, at standard AC supply voltages per IEC 60038 up to 690 V.

The aspects covered include the characteristics and operational conditions of the supply equipment to the vehicle. This standard includes standards for electromagnetic compatibility, electrical safety, operational characteristics functional characteristics and communication.

## 6.2. SPECIFICATIONS FOR INDUCTIVE CHARGING INFRASTRUCTURE

Inductive charging can be used to re-charge an electric vehicle using an electromagnetic field to transfer energy between the vehicle battery and the electricity supply. The advantage for the charging of an electric vehicle is that there is no need for a cable connection to be made between the vehicle and the chargepoint, therefore making it easy to use and minimising the potential for misuse of a charging system.

# 7. Conclusion

With electric vehicles now providing a new interface between the transport system and the grid, within and away from domestic properties, energy management and safety is of key importance. This guide is intended for industry, in particular, consumer-facing organisations to ensure the best practice use of electric vehicle charging equipment. The guide will be annually updated to include new technologies and industry solutions for interoperability and energy efficiency as they develop onto the UK market.

It is essential consistent messages on the best practice and safe use of charging infrastructure are sent to electric vehicle drivers to ensure they are aware of how to handle high power supply currents required for an electric vehicle charge. Following available industry guidance the charging of an electric vehicle will remain a safe activity in accordance with UK wiring regulations and standards.

The growth of the electric vehicle market also provides an opportunity to support low carbon energy generation, and, in order to optimise the environmental benefits of e-mobility, off-peak charging measures should be encouraged. While there is less 'smart charging' functionality available to the consumer today, industry is working closely to ensure that this can be achieved as the roll-out of smart metering and the future smart grid evolves, ensuring the future proofing of Mode 3 installations made today. In the meantime it is important consumers are made aware of electricity tariffs currently available to encourage off-peak charging.

# i. Glossary

| | |
|---|---|
| **ABI** | Association of British Insurers |
| **ACEA** | European Automobile Manufacturers Association |
| **ACEM** | The Motorcycle Industry in Europe |
| **BEAMA** | The British Electrotechnical and Allied Manufacturers Association |
| **BEVIP** | BEAMA Electric Vehicle Infrastructure Project |
| **BSI** | British Standards Institution |
| **CEN** | European Committee for Standardisation |
| **CENELEC** | European Committee for Electrotechnical Standardisation |
| **CW** | Central White-list |
| **ePTW** | Electric Powered Two Wheelers |
| **EFTA** | European Free Trade Association |
| **eMCIA** | Electric Motorcycle Industry Association |
| **ETSI** | European Telecommunications Standardisation Institute |
| **EVSE** | Electric Vehicle Supply Equipment (electric vehicle charging equipment) |
| **IC-RCD** | In Cable Residual Current Device |
| **IEC** | The International Electrotechnical Commission |
| **IET** | The Institution for Engineering and Technology |
| **ISO** | The International Organisation for Standardisation |
| **ITU-T** | The International Telecommunication Union |
| **JWG** | Joint Working Group |
| **NCR** | National Chargepoint Registry |
| **OLEV** | Office for Low Emission Vehicles |
| **RCD** | Residual Current Device |
| **RESS** | Rechargeable Energy Storage System |
| **SAE** | Society of Automotive Engineers |
| **SMMT** | Society for Motor Manufacturers and Traders |
| **SPD** | Surge Protective Device |

# ii Definitions

**Electric vehicle**

A vehicle powered, in part or in full, by a battery that can be directly plugged into the mains.[17] The term plug-in vehicle may also be used.

**Public chargepoint**

This refers to the public accessible infrastructure installed for the charging of electric vehicles. That is, infrastructure available for use by any member of the public.

**Smart charging**

'Smart' charging is when the charging cycle of an EV can be altered by external events, including energy price and provision of low carbon energy on the network. This allows for adaptive charging habits and the more efficient management of energy used to charge an EV.

Future capabilities for smart charging are likely to include communication functions between the vehicle and a meter and potentially the grid. This will be enabled through Mode 3 charging.

'Smart' charging from public infrastructure involves additional functionality, such as the identification of chargepoint locations.

Not all 'smart' functionality is available today but in order to future proof infrastructure this is a key consideration for electrical installations in the domestic, public and commercial setting.

**Smart Grid**

A Smart Grid is an electricity network that can cost-efficiently integrate the behaviour and actions of all users connected to it – generators, consumers and those that do both – in order to ensure an economically efficient, sustainable power system with low losses and high levels of quality and security of supply and safety (The definition is given in the EU Mandate, and adopted by BEAMA Smart Grid Task Force 2011).

**Overcurrent protection device**

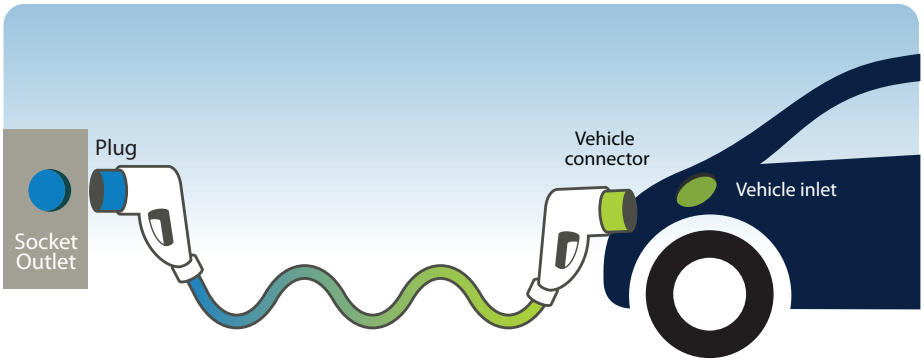
***"Overcurrent protection"*** is defined as – protection intended to operate when the current is in excess of a predetermined value. So, it follows that the definition of an ***"overcurrent protection device"*** is – a device intended to operate when the current is in excess of a predetermined value.

**Socket-outlet**

**Plug**

**Vehicle inlet**

**Vehicle connector**




[17] SMMT Electric Car Guide 2011 http://www.smmt.co.uk/2011/06/smmt-publishes-new-2011-electric-car-guide/

| | |
|---|---|
| **Category M1** | Vehicles used for the carriage of passengers and comprising no more than eight seats in addition to the driver's seat |
| **Category M2** | Vehicles used for the carriage of passengers and comprising more than eight seats in addition to the driver's seat, and having a maximum mass not exceeding 5 tonnes (ACEA) |
| **IP4X** | Protection from access to hazardous live parts by a probe of 1mm diameter penetrating the enclosure and protection from the ingress of foreign objects having a diameter of 1mm or more but no protection against the harmful ingress of water is specified (based on the BS EN 60529 requirements). |
| **IP55** | Protection from access to hazardous live parts by a probe of 1mm diameter penetrating the enclosure and protection from ingress of a harmful deposit of dust ( limited ingress of dust is permitted) and protection against the harmful effects of low pressure jets of water from all directions (limited ingress of water is permitted) (based on BS EN 60529 requirements). |
| **Legacy vehicles** | This refers to the electric vehicles sold in the UK before a dedicated charging infrastructure was developed and that are provided with a charging cable with a BS 1363 plug attached, allowing for Mode 2 charging. |

# Picture Credits

Front Cover: *EDF Energy*

Figure 6: IEC 62196-2 Type 1 plug and socket-outlet, *SAE International*

Figure 7: IEC 62196-2 Type 2 plug and socket-outlet, *Mennekes*

Figure 8: IEC62196-2 Type 3 plug and socket-outlet with shuttered outlet pins, *Schneider Electric*

Figure 9: BS 1363 13amp domestic socket-outlet, *Honeywell*

Figure 10: BS EN 60309-2 Industrial socket-outlets, 16 and 32amp, *Honeywell*

Figure 11 Mode 3 wall mounted chargepoints with attached cable, *Schneider Electric and Siemens*

Figure 12: Map showing locations of UK Plugged-In Places regions, *Office for Low Emission Vehicles*

Figure 13: Source London, electric vehicle membership scheme. Example of RFID card use and the charging points installed in public locations accessible using the Source London membership card, *Siemens*

Figure 15: Mode 3 public chargepoint. Meter and socket-outlet, *Siemens*

Figure 16: Mode 4 public chargepoint. Meter and attached cable for DC charging, *Siemens*

Figure 17: Mode 3 22kW electric vehicle chargepoints, *Schneider Electric*

Figure 19: Dedicated chargepoint for electric motorcycles, *apt technologies*

# References


BS EN 60309-2: 1999 – *Plugs, socket-outlets and couplers for industrial purposes*

BS EN 1363: 1995 – *13A plugs, socket outlets, adaptors and connection units*

BS EN 62196: 2011 – *Plugs, socket-outlets, vehicle couplers and vehicle inlets*

BS 7671: 2008 – *Amendment No 1: 2011 – Requirements for electrical installations. IET Wiring Regulations, Seventh Edition. HD 60364-7-722:2012 Requirements for special installations or locations – Supply of electric vehicle, (ratified and proceeding to publication)*

SMMT, 2011, *Electric Car Guide*

IET, 2012, *Code of Practice on Electric Vehicle Charging Equipment Installation*

Department for Transport, OLEV, 2011, *Making the Connection: The Plug-in Vehicle Infrastructure Strategy*

National Travel Survey 2010, *Average number of trips by trip length and main mode: Great Britain 2009*

The Climate Group, 2012, *Plugged-in Fleets, A Guide to Developing Electric Vehicle Fleets*

*RCD Handbook, BEAMA Guide to the Selection and Application of Residual Current Devices, 2010, http://www.beama.org.uk/en/publications/guidance-documents.cfm/RCD-handbook-dec-2010*

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