Design Manual
NR/GN/CIV/200/13

Electric Vehicle Charging Points and Associated Infrastructure

Image 0.1
Public parking with charging points for electric vehicles

Document verification

Verification

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Disclaimer

How to use the guidance suite

The Network Rail Document Suite

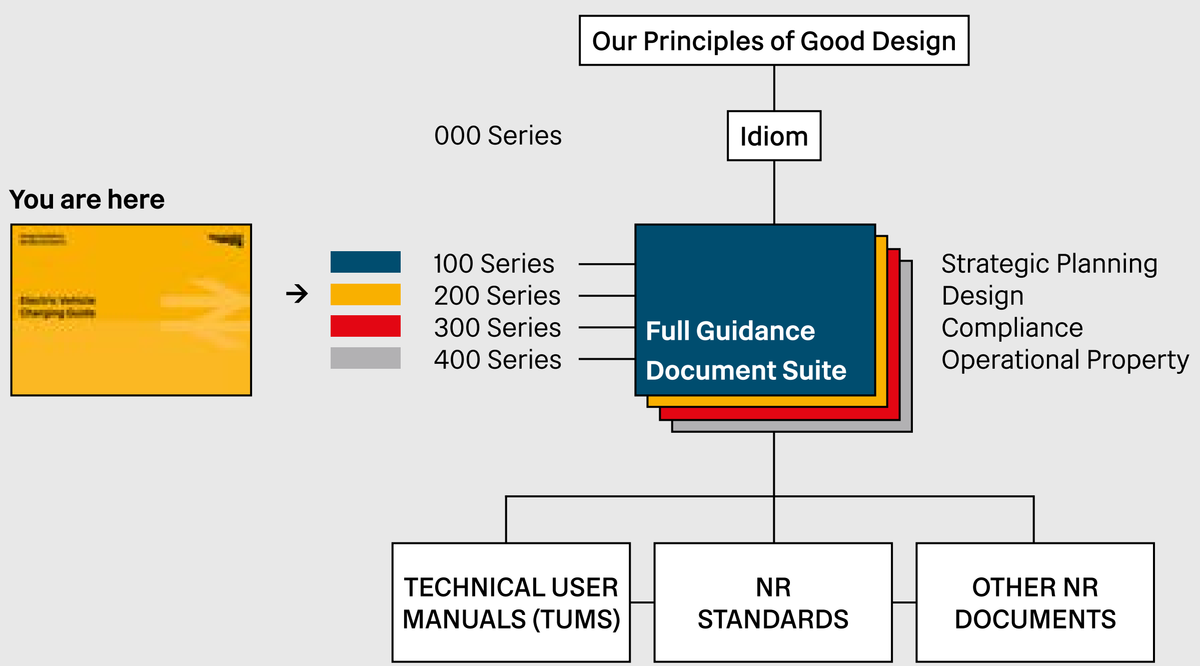

Figure 0.1 Network Rail Document Suite Summary

References to other documents

- Code of Practice Guidance
- National Standard
- Network Rail document
- European Standard

Example

European Standard

PRM TSI: 4.4.1
Information regarding the level of accessibility of all stations must be freely available. Operating rules shall be made to ensure that information regarding the level of accessibility of all stations is available.

A full list of relevant documents, and other guidance suite documents is contained in the appendix.

About this document

The Electric Vehicle Charging Points and Associated Infrastructure Design Manual is intended to be informative and provide guidance on the requirements and considerations for Electric Vehicle Charge Points (EVCPs) across the Network Rail estate.

The intended audience for the manual are project managers, asset managers, designers and persons that are involved in the provision of EVCPs.

This Design Manual is contained in a single document divided over four sections:

1

Section 1
Introduction

Provides background information about the Network Rail sustainability strategy, Electric Vehicle strategy and building asset types considered in the guide.

2

Section 2
EV Charging Explained

Informative section about electric vehicle charging including vehicle types, charger types, consumption recovery and regulatory requirements.

3

Section 3
EV Charging Design Considerations

Provides guidance on considerations to assist with planning and design of EV charging infrastructure to meet Network Rail requirements and aspirations.

4

Section 4
Handover and maintenance

Provides guidance on handover and maintenance requirements, as well as monitoring, warranties and faults.

A

Appendix A

Good and bad practice

B

Appendix B

Glossary
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Hint and tips
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To return to the contents page you can click on the Double Arrow symbol.

Image 0.2
Public parking with charging points for electric vehicles

Electric Vehicle Charging Points and Associated Infrastructure Charging Guide

Section 1: Introduction

1

1.1 Introduction

1.1.1 Purpose

As part of the Network Rail decarbonisation programme, Network Rail's Fleet Division is transitioning their vehicle fleet to electric vehicles. This coupled with the UK government commitment to transition to zero emission vehicles (ZEVs) has led to a requirement for provision of electric vehicle (EV) charging infrastructure across the estate.

The Electric Vehicle Charging Points (EVCPs) and Associated Infrastructure Design Manual has been prepared in anticipation of the increase in installation of electric vehicle charging infrastructure across the estate.

It is an informative guide which also presents good practice in the approach to EV charging infrastructure provision, which should be consistent nationally across stations, managed stations and stations as part of the franchised estate.

This guide aims to supplement NR/L2/CIV/902 Level 2 Standard Specification for Electric Vehicle Charging Points (EVCPs) and associated infrastructure.

1.1.2 Scope

The Electric Vehicle Charging Points and Associated Infrastructure Design Manual provides an overview for the provision of public and company EV charging facilities.

The guidance is based on best practice, benchmarking, available published advice and research, and standards and specifications where they currently exist. The guidance refers to a range of Network Rail and external standards that can help users with their projects.

The intended audience for the Electric Vehicle Charging Points and Associated Infrastructure Design Manual are project and delivery teams including:

- → Asset owner-maintainer
- → Contractors / project delivery
- → Designers and architects
- → Project managers
- → Project sponsors
- → Network Rail property
- → Parking management companies
- → Station managers / Stations team
- → Public and private transport operators and service providers
- → Funders
- → Others involved in EV charging infrastructure projects

Image 1.1: Electric vehicle (EV) charging at an electric vehicle charging point (EVCP)

Section 1: Introduction

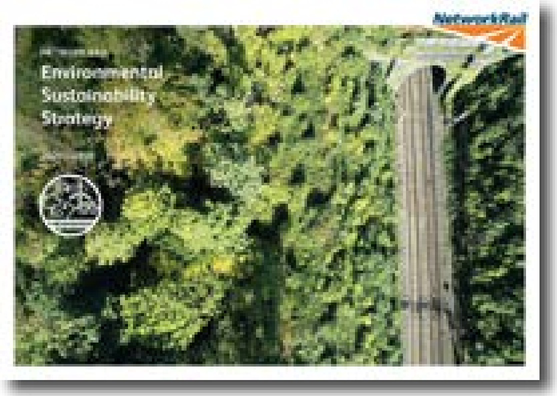
1.2 Strategy

1.2.1 Our strategy, vision and core priorities

Delivering a sustainable railway network is at the heart of Network Rail's vision. Our vision is to serve the nation with the cleanest, greenest mass transport system, which is enabled by smart decision making to support long-term positive social and environmental impacts.

We have identified four core priorities which are at the heart of delivering our sustainability ambitions.

Strategy

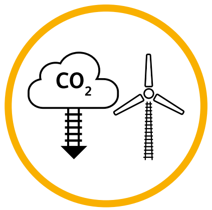


Vision

"Our vision is to serve the nation with the cleanest, greenest mass transport. We want to put passengers first, help passengers and freight users to make green choices, support local communities and be a good neighbour."

Core Priorities

A low emission railway



We need to decarbonise our network by transitioning away from fossil fuels to clean, renewable, low-carbon energy.

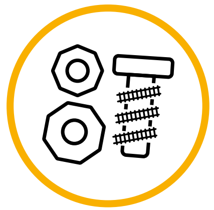
A reliable railway that is resilient to climate change

We want to minimise disruptions caused by more frequent weather events to ensure we can run the railway safely and on time.

Improved biodiversity of plants and wildlife

We want to protect, maintain and enhance biodiversity across our network.

Minimal waste and sustainable use of materials



We have to use less, manage unavoidable waste and contribute to a more circular economy which uses minimal virgin resources, and seeks maximises our asset's value across their lifecycle

1.2.2 Fleet strategy

Running and looking after the railway network requires a large fleet of vehicles and machinery which operate both on and off the track. Our road vehicle fleet is planned to transition from fossil fuel and Ultra Low Emission Vehicles (ULEVs) to zero emission vehicles (ZEVs) in line with the initial Department for Transport (DfT) targets, plan as shown below. An increase in EV charging infrastructure is required to support this transition across the UK.

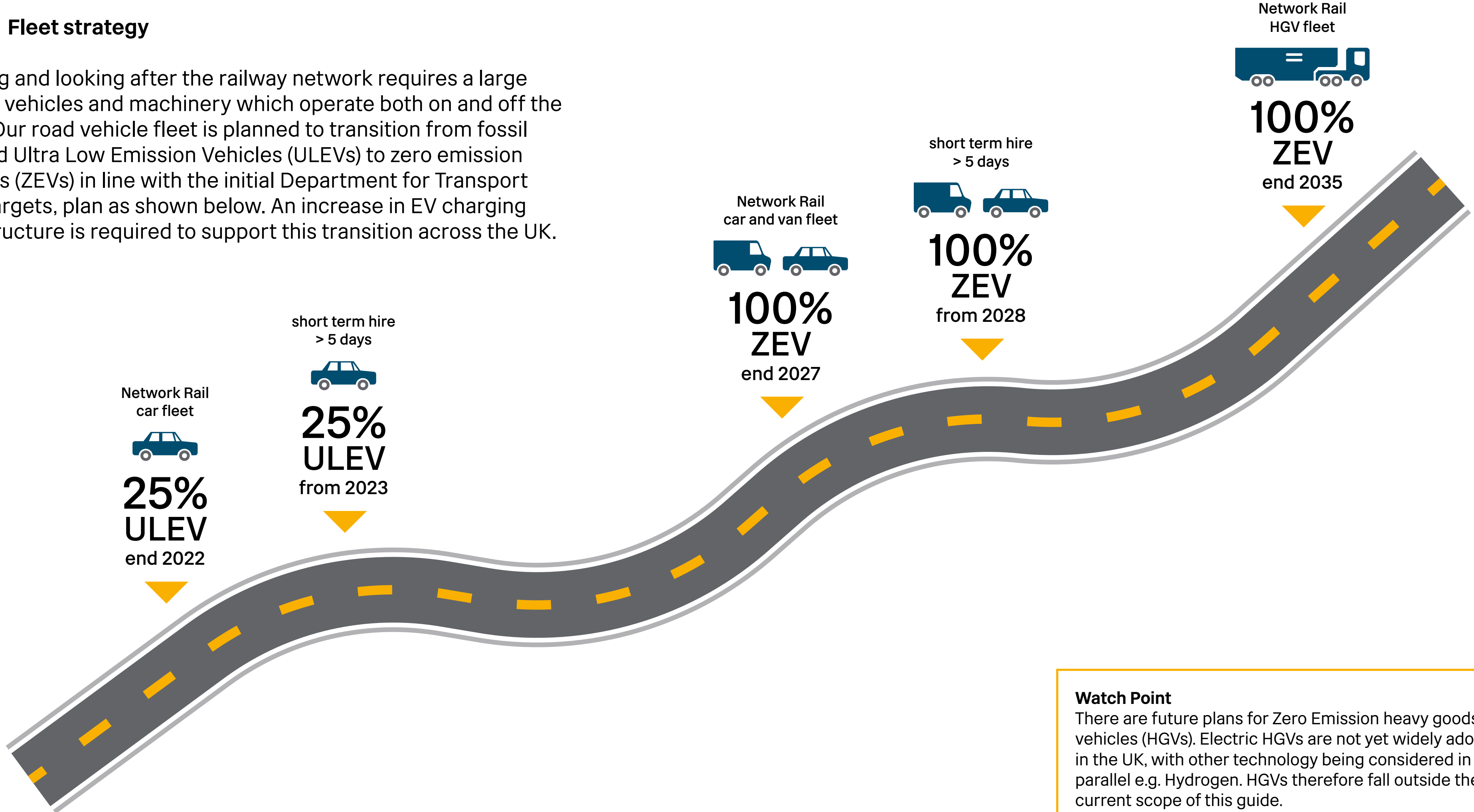


Image 1.2: Network Rail fleet transition roadmap

Watch Point
There are future plans for Zero Emission heavy goods vehicles (HGVs). Electric HGVs are not yet widely adopted in the UK, with other technology being considered in parallel e.g. Hydrogen. HGVs therefore fall outside the current scope of this guide.

1.3 Network Rail Typical Buildings

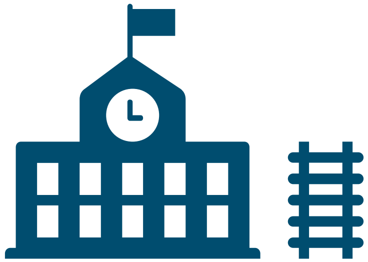
1.3.1 NR estate

Network Rail owns, operates and manages a diverse property estate across Great Britain.

In order to determine the amount and type of EV chargers to be provided, an understanding of the building/site should be sought along with how it is used.

Typical examples of the types of buildings and sites that might require EV charging are given on the following pages with considerations to be taken into account.

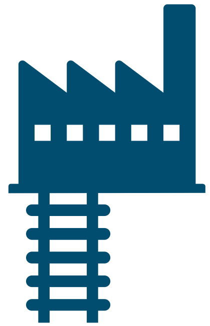
Network Rail document
NR/GN/CIV/100/02 The DfT categorised rail stations by size, journeys made and revenue. Refer to Station Design Guidance Manual for details of station categories.



Rail stations

Stations vary in size from large national hub stations to small unstaffed stations. Considerations include:

- → Station type
- → Passenger numbers and requirements
- → Staff numbers and requirements
- → Charging speed: people parking to ride the train might be leaving the car for most of the day
- → Disability access
- → Other visitors (to stations with retail or office workspace)

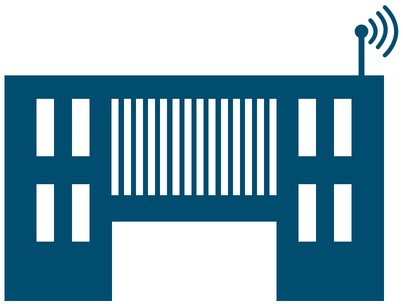


Maintenance depots

Maintenance depots are habited mainly by depot staff and occasional visitors. Considerations include:

- → Staff numbers and requirements, shift working
- → Charging speed: depot staff parking habits
- → Fleet vehicle parking and charging requirements

1.3 Network Rail Typical Buildings



Rail Operating Centres (ROCs)

ROCs are usually habited by signalling staff and due to their location might also include fleet staff and vehicles.

Considerations include:

→ Staff numbers and requirements, shift working

→ Fleet vehicle parking and charging requirements

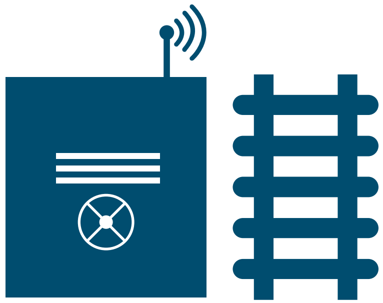
Maintenance Delivery Units (MDUs)

MDUs are usually habited by staff that maintain railway infrastructure and include storage, office and changing facilities, signalling staff and due to their location might also include fleet staff and vehicles.

Considerations include:

→ Staff numbers and requirements, shift working

→ Fleet vehicle parking and charging requirements



Lineside buildings

Lineside buildings are smaller equipment buildings which contain equipment and infrastructure connected to the railway line i.e. point heating supplies, signalling power supplies, telecoms equipment. Considerations include:

→ Usually unstaffed

→ Generally no parking requirements

1.3 Network Rail Typical Buildings

Rail offices

Network Rail have offices which house rail staff, these might be corporate offices, offices housing supply chain staff or temporary project offices.

Considerations include:

- → Staff numbers and requirements
- → Shift working & weekend working
- → Visitor parking and charging requirements
- → Accessible parking/charging requirements based on staff numbers

Private car parks

Some Network Rail sites include private third party operated car parks that service the associated rail building. Coordination with car park operators to assure consistency and safety at these car parks is key to any EV charging installation project.

British Transport Police

The British Transport Police have their base of operations in multiple types of Rail buildings. Consultation with the British Transport Police liaison for each individual project should be carried out to understand EV charging requirements for police vehicles.

Electric Vehicle Charging Points and Associated Infrastructure Charging Guide

Section 2: EV Charging Explained

2

2.1 Electric Vehicle Types

2.1.1 Electric vehicle (EV) types

There are different types of EVs available in the market. There are EVs that operate solely by using battery power, others use an internal combustion engine together with an electric motor, there are also EVs that use fuel cells. An in-depth explanation on the different types of electric vehicles is given below. It should be noted that this guidance only applies to charging infrastructure for Battery Electric Vehicles (BEVs) and Plug-In Hybrid Electric Vehicles (PHEVs).

Battery Electric Vehicles (BEVs)

Battery Electric Vehicles (BEVs) are also known as All-Electric Vehicles (AEVs) because they run exclusively on a battery powered electric motor and do not use an internal combustion engine. The electricity that drives the BEVs is stored in rechargeable batteries which requires regular charging to replenish its energy.

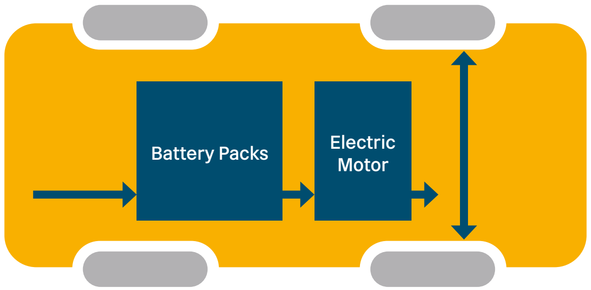


Image 2.1: Battery Electric Vehicle (BEV)

Fuel Cell Electric Vehicles (FCEVs)

Fuel Cell Electric Vehicles (FCEVs) use hydrogen fuel cell technology to generate electricity, which powers the electric motor. They are also known as Zero-Emission Vehicles (ZEVs).

The hydrogen gas stored in high-pressure tanks reacts with oxygen from the air to produce electricity, emitting only water vapour as a by-product. The chemical energy of the fuel is converted to electricity to feed the electric motor.

FCEVs offer longer ranges and quick refuelling times. Their significant drawback is that the infrastructure for hydrogen refuelling is currently limited.

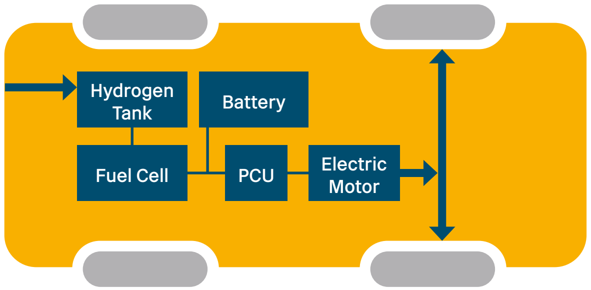


Image 2.2: Fuel Cell Electric Vehicle (FCEV)

Plug-In Hybrid Electric Vehicles (PHEVs)

Plug-In Hybrid Electric Vehicles (PHEVs) use both an internal combustion engine with an electric motor and a rechargeable battery pack.

The user of a PHEV can choose the type of fuel the vehicle is going to use from: conventional fuel (such as petrol), alternative fuel (such as bio-diesel), and a rechargeable battery pack.

A PHEV vehicle can operate in 2 main modes:

- → All electric mode, in which the electric motor and battery power the vehicle; and
- → Hybrid mode, in which both the battery and the internal combustion engine are employed.

Usually, the user will charge the PHEV and the electric motor will provide a certain range of all-electric driving. Once the battery charge depletes, the vehicle switches to the internal combustion engine or operates in hybrid mode, utilizing both the engine and the electric motor. PHEVs can be charged either by connecting them to Electric Vehicle Supply Equipment (EVSE) or via regenerative braking, in which case the electric motor acts as a generator and uses the energy to charge the battery.

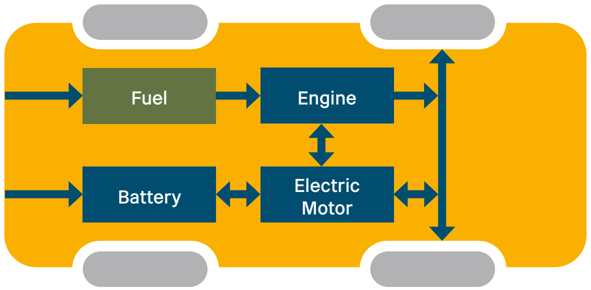


Image 2.3: Plug-In Hybrid Electric Vehicle (PHEV)

Hybrid Electric Vehicles (HEVs)

Hybrid Electric Vehicles (HEVs) do not have a plug-in charging capacity and they cannot run solely on electricity.

They rely on regenerative braking and the internal combustion engine to charge the battery. The electric motor assists the engine during acceleration and low-speed driving, which reduces the fuel consumption and vehicle emissions.

The fuel tank supplies energy to the engine like a regular car. The batteries run an electric motor. Both the engine and electric motor can turn the transmission at the same time.

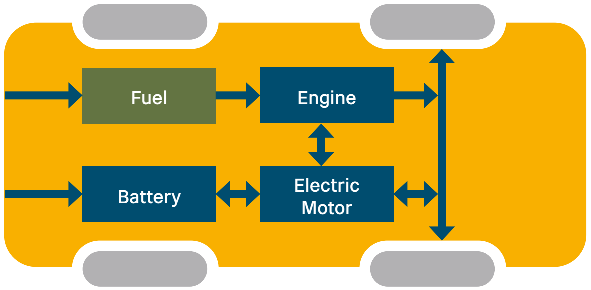


Image 2.4: Hybrid Electric Vehicle (HEV)

2.2 EV Charging Explained

2.2.1 AC vs DC charging

Drivers might need to charge their EVs at home, and away from home, which means access to public charge points is critical. Charging can be either by AC (alternating current) or DC (direct current).

AC Charging

AC is available straight from the grid. The battery in an EV runs on DC. This means the current from an AC charger must be converted from AC to DC before it can be used to power the EV battery. To make this happen, the current is passed through the EV's onboard charger, which regulates the voltage and current. The speed of charge depends on the onboard charger's power output. This means that even if an EV is charged with a relatively powerful 22 kW AC charger, the power the battery receives, and therefore how quickly it reaches capacity, depends on the capabilities and limitations of the on-board charger.

DC Charging

DC charging tends to be found at dedicated DC charging points away from home, which offers higher power and faster charging speeds. In DC charging, the energy is sent directly to the battery, bypassing the potentially limiting onboard charger. DC chargers start at around 20 kW up to more than 150 kW in line with the wider availability of bigger EV battery capacities. DC charging offers higher power and faster charging speeds.

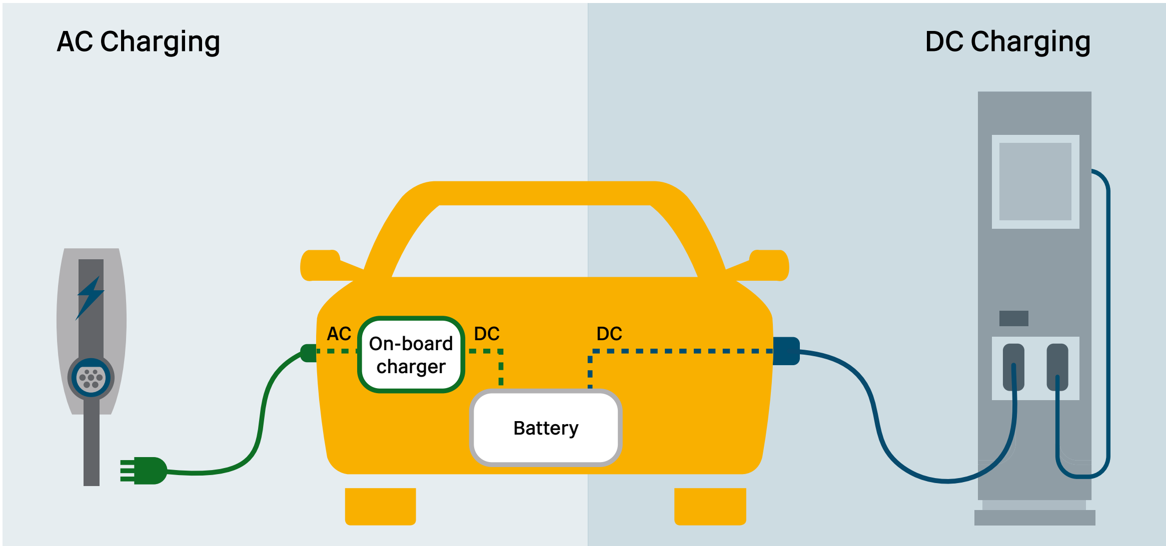


Image 2.5: AC vs. DC Charging

2.3 EV Charging Points

2.3.1 Charging modes for EVs

Depending on the type of charging connector used there are four different modes of EV charging. Approved Document Part S stipulates that Mode 3 should be the minimum requirement (Mode 1 and 2 provided for information only).

BS EN 61851-1 standard defines the four different modes for electric vehicle charging:

Mode 1: Non-dedicated circuit and socket outlet

This system is the simplest and uses standard socket outlets not exceeding 16 A (single or three phase) and uses the power and protective earth conductors between the AC supply and the vehicle. **This system is no longer considered a 'mainstream charging technology', and is not recommended.**

Mode 2: Non-dedicated circuit and socket outlet, cable incorporated Residual Current Device (RCD)

This system is similar to Mode 1 charging, in that it uses an AC connection, providing charging currents of 10 A or less, using power and protective earth conductors between the AC supply and the vehicle, in addition to a control pilot function and system of protection against electric shock. **This system is no longer considered a 'mainstream charging technology', and is not recommended.**

Mode 3: Dedicated EV charging system (AC) - AC EV equipment permanently connected to an AC supply network

In this mode the user connects the EV to the grid via a specific socket, plug and a dedicated circuit. Mode 3 can be used in residential, commercial and public charging and the charge unit can be various sizes depending on the application.

Mode 4: Dedicated EV charging system (DC) - DC EV Supply equipment

This is the only mode for DC charging, via a dedicated circuit and plug and usually at public charging points only. The conversion of AC to DC is carried out within the charging station, which allows for power of around 20 kilowatts (kW), or higher if the supply to site permits.

Watch Point
There are future plans for a wireless charging standard under the series BS EN 61890. Wireless Charging is not yet widely adopted and is not commercially available in the UK so falls outside the current scope of this guide.

Mode 3

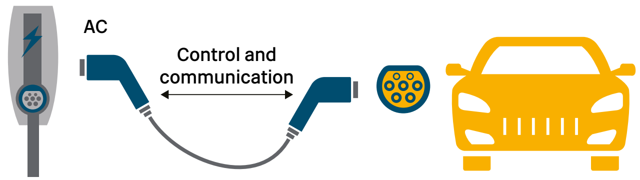


Image 2.6: Mode 3 - Dedicated EV charging system (AC)

Mode 4

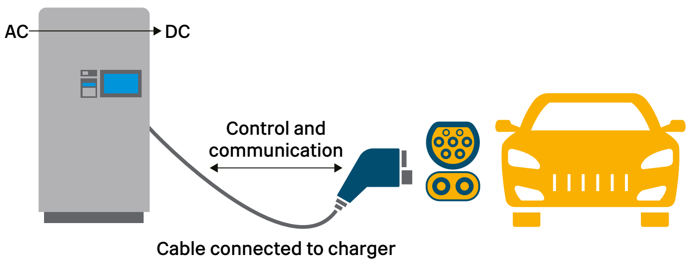


Image 2.7: Mode 4 - Dedicated EV charging system (DC)

2.4 EV Charging Connectors

2.4.1 EV charging connector types

One important component of the charging infrastructure are the EV charging connectors, sockets and plugs that are used to connect the EV to the Electric Vehicle Supply Equipment (EVSE) and represent different power delivery capabilities and charging speeds.

The EV connectors can vary significantly depending on the type of EV and EVSE. The UK uses several different types. These AC/DC connector types define the electrical characteristics, voltage, and power levels used for charging EVs.

Tethered vs untethered

Generally, EV charger connector cables can be tethered or untethered. A tethered charger features a permanently attached cable, whereas untethered chargers have a detachable cable. DC chargers typically use tethered cables that are permanently connected to the charging unit.

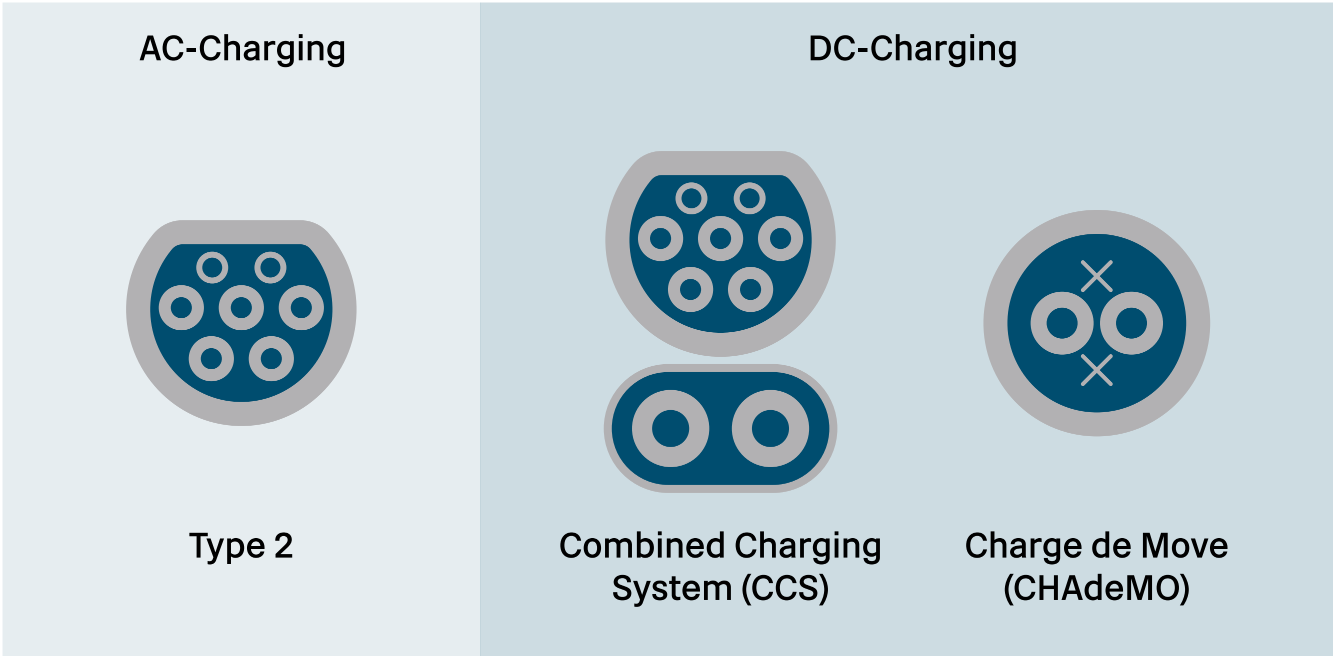


Image 2.8: EV charging connector types

IEC 62196 Type 2

The IEC 62196 Type 2 connector is the standard AC connector type used for charging in Europe.

The connector features 7 pins and it can support both single phase and three phase charging.

The power delivery of Type 2 charging stations can range from 7 to 22 kW, depending on the charger's capacity and the vehicle's onboard charger.

Type 2 charging stations are commonly installed in homes, workplaces, and public charging locations.

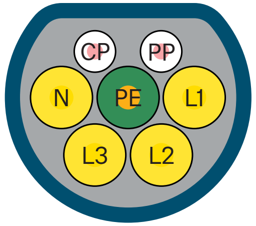


Image 2.9: IEC 62196 Type 2 connector

Combined Charging Systems (CCS)

The CCS connector is the primary DC fast charging standard used in Europe. It combines the IEC 62196 Type 2 plug with 2 additional high-speed charging pins.

DC Fast Charging, also known as Mode 4 charging, provides rapid charging for EVs. It delivers power in the form of direct current (DC) instead of alternating current (AC).

DC Fast Charging stations are equipped with high-power chargers that can deliver significantly higher charging rates compared to Type 2 AC chargers.

The charging power of DC Fast Chargers can range from 20 kW to over 350 kW, depending on the charger's capacity and the capabilities of the EV.

DC Fast Chargers are commonly found along highways, major travel routes, and public charging networks.

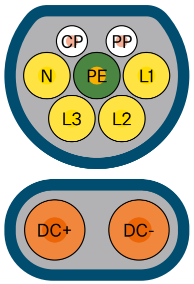


Image 2.10: Combined Charging Systems (CCS) connector

CHArge de MOve (CHAdeMO)

The CHAdeMO is a fast charging DC connector that was developed in Japan and is used for high power DC fast charging.

The CHAdeMO protocol can provide a wide range of charging rates from 20 kW up to 100 kW.

The CHAdeMO protocol has a unique design that complies with the CHAdeMO fast-charging standard. It features a large, high-current DC connector with multiple pins and a locking mechanism.

The CHAdeMO protocol competes with CCS, but since 2014 CCS has been required on all EVs sold in Europe.

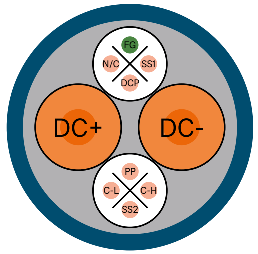


Image 2.11: CHArge de MOve (CHAdeMO) connector

2.5 EV Charging Point Speeds

2.5.1 EV charging point speed - considerations

Most vehicles using charging are unlikely to require a full charge – particularly those that will be mainly charged en route or at home overnight.

Considering the time taken typically to reach different levels of charge can help to determine the best charging speed for chargers. This will also help avoid a mismatch between how long vehicles are typically parked for (or should be parked for) and how long they will require to charge.

The following table provides some indicative charging times by charging amount and charging speed based on current vehicle and charging specifications:

Charging amount	7 kW	11 kW	22 Kw	50 kW	150 kW
Full charge (0 - 100%)	5 - 18 hours	4 - 12 hours	2 - 6 hours	1 - 2.5 hours	<0.5 - 1 hour
Half charger (50 - 100%)	2.5 - 9 hours	2 - 6 hours	1 - 3 hours	0.5 - 1.5 hours	10 - 30 minutes
50 miles range	2 - 2.5 hours	1.5 - 2 hours	0.5 - 1 hour	15 - 30 minutes	<10 minutes
100 miles range	3.5 - 5.5 hours	2.5 - 3.5 hours	1 - 1.5 hours	0.5 - 1 hour	10 - 15 minutes

* Maximum charge speeds vary between vehicles. Most EV models in production are able to charge to at least 50 kW and this is developing quickly. Some new high-end models are able to charge at speeds of up to 350 kW.

Table 2.1 Time to charge to different levels of charge by charger speed

Assumptions:

- → Based on a sample of typical battery capacities and ranges of mass-production battery electric cars and vans. Examples extend from super-mini vehicles (with c.30 kW battery) to large SUV (c.100 kW) offering a typical range of between 100 to 350 miles.
- → Data based on typical manufacturer's specification, with typical battery range assumed to be at least 10% below advertised maximum
- → Actual charge speeds will be lower than the charger speed. Assumed 15% loss during energy transfer
- → Based on BEVs, PHEVs only. Plug-in hybrid vehicles typically offer lower battery capacity with a range of <40 miles
- → Actual range will be affected by wider factors including outside temperature and use of vehicle heating, air conditioning, etc. during a journey

2.6 EV Charger Types

2.6.1 Typical offerings

The table below shows the different type of chargers, power rating ranges, typical charge times and locations where these are likely to be installed.

Type	AC Destination	DC Destination	DC fast	DC High Power
Typical size	7 - 22 kW	20 - 25 kW	50 - 150 kW	150 - 400 kW
Typical charge time	4 - 16 hours	1 - 3 hours	20 - 90 minutes	10 - 20 minutes
Typical locations	Long stay car parks Workplace, station, office Home Park & Ride locations Overnight fleet	Office, workplace Hotel and hospitality Parking structures Fleet charging Public or private campus	Retail, grocery, mall High turnover parking Convenience fuelling stations Fleet charging	Highway corridor travel Highway rest stops Petrol station areas Bus stations
Typical scenario				

Table 2.2 Public and commercial car charging - use cases. Charging service should match charging application and demand.

Watch Point
Dynamic load management to reduce overall charging load might be an option for commuter station car parks where passengers typically park for 7+ hours. This might bring financial benefits in offering consumers affordable charging prices at lowers speeds. Dynamic load management is explained on page 38 and this should be discussed as an option with the project sponsor.

2.7 Building Regulations

2.7.1 Building regulations requirements

The building regulations for England and Wales and Scotland include requirements for EV charging infrastructure. The minimum stipulated requirements are reproduced below for reference. The latest building regulation requirements should be checked before embarking on any EV charging infrastructure project to assess where this is applicable.

> **Note**
> Building Regulations powers are devolved in the UK. This means that Scotland, England, Wales and Northern Ireland have their own set of Builidng Regulations. At the time of writing this manual, approved Document S applies to Wales as well as England.

2.7.2 Minimum building regulation requirements (England and Wales)

Non-residential

Every new building and every building undergoing major renovation where more than 10 car parking spaces are created:

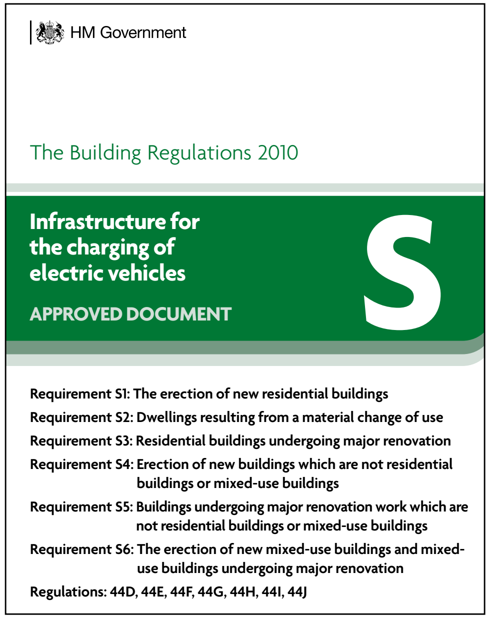
- → One parking space should be provided with an active EVCP.
- → 20% of the spaces are required to have infrastructure installed for future EVs.

Product requirements

- → Minimum 7 kW socket, Mode 3, with smart functionality.

Interoperability of public chargers

- → Full access to EV drivers.


HM Government

The Building Regulations 2010

Infrastructure for the charging of electric vehicles

APPROVED DOCUMENT

S

Requirement S1: The erection of new residential buildings
Requirement S2: Dwellings resulting from a material change of use
Requirement S3: Residential buildings undergoing major renovation
Requirement S4: Erection of new buildings which are not residential buildings or mixed-use buildings
Requirement S5: Buildings undergoing major renovation work which are not residential buildings or mixed-use buildings
Requirement S6: The erection of new mixed-use buildings and mixed-use buildings undergoing major renovation
Regulations: 44D, 44E, 44F, 44G, 44H, 44I, 44J

Image 2.12: Building Regulations Part S (England and Wales)

2.7.3 Minimum building regulation requirements (Scotland)

Non-residential

Every new building and every building undergoing major renovation where more than 10 car parking spaces are created:

- 1 in 10 parking spaces should be provided with active electric vehicle charge points.
- 50% of the spaces are required to have enabling infrastructure installed for future EVs.

Product requirements

- Have charge point sockets with a nominal rated output of not less than 7 kW.
- A charge point with multiple sockets should be capable of providing this output from each socket simultaneously.
- Be fitted with a universal socket (also known as an untethered electric vehicle charge point).
- Be fitted with an indicator to show the equipment's charging status that uses lights, or a visual display.

Interoperability of public chargers

- Full access to EV drivers.

Interoperability of public chargers

Any accessible parking spaces not already provided with access to an electric vehicle charge point socket should be provided with such a facility to the same extent as standard parking spaces.

For further information
Refer to Building Regulations Part S (England), or Scotland Building Standards, Non-domestic technical handbook (Scotland).

Image 2.13: Scotland Building Standards, Non-domestic technical handbook

Watch Point
Infrastructure installed for future EVs should also include for future capacity within switchgear and associated cabling.

2.8 Smart EV Networks

2.8.1 Features of a Smart EV Network

Smart EV Networks harness the potential of energy use data and the latest energy innovations to deliver significant benefits for consumers. Features of a Smart EV Network include the following:

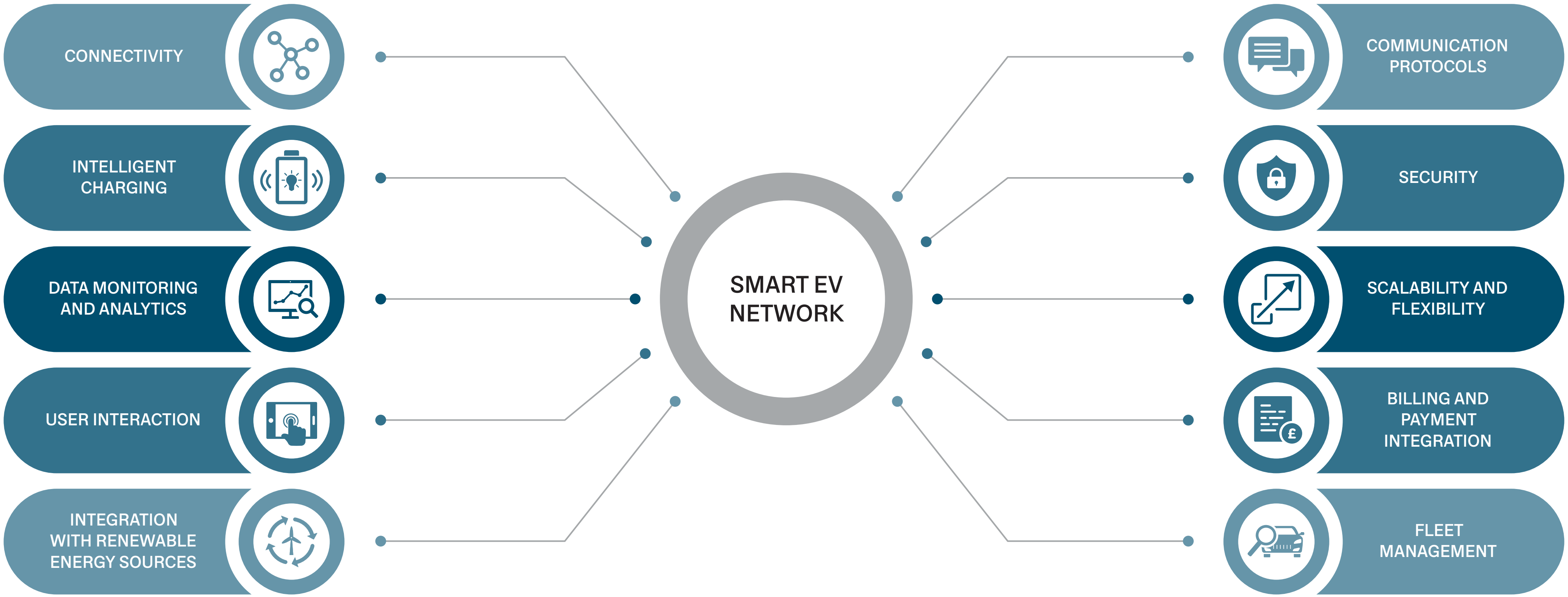


Image 2.14: Features of a Smart EV Network

2.8.2 Features of a Smart EV network explained

Connectivity

Smart EV chargers should be able to connect to a network, such as the internet or a central management system, allowing for remote monitoring, control, and data exchange. The most reliable connections would be achieved with electric charging units that accept hard wired data networks. Other options available include mobile data and Wi-Fi however these are less resilient.

Intelligent Charging

Smart chargers can support features like load management, which optimises charging schedules to minimise peak demand on the grid, and dynamic pricing, allowing for charging during off-peak hours when electricity costs are lower.

Data Monitoring and Analytics

These chargers gather and analyse data about the charging session, energy consumption, and user behaviour. This information can be used to optimise charging efficiency, troubleshoot issues, and provide detailed reports.

User Interaction

Smart chargers often have user-friendly interfaces, such as mobile apps or touchscreens, enabling users to monitor charging progress, set preferences, schedule charging sessions, and receive notifications.

Integration with renewable energy sources

Some smart chargers support integration with renewable energy systems, allowing users to prioritize charging with solar or wind power when available. This promotes the use of clean energy and reduces reliance on the grid.

Communication protocols

Smart chargers should support industry-standard communication protocols, such as Open Charge Point Protocol (OCPP), enabling interoperability and integration with various charging networks and energy management systems.

Security

Since smart chargers are connected devices, they should have built-in security features to protect against unauthorized access, data breaches, and potential cyber threats.

Scalability and flexibility

Smart EV chargers should have the flexibility to support different charging standards, such as AC or DC charging, and be scalable to accommodate future technological advancements and increased demand.

Billing and payment integration

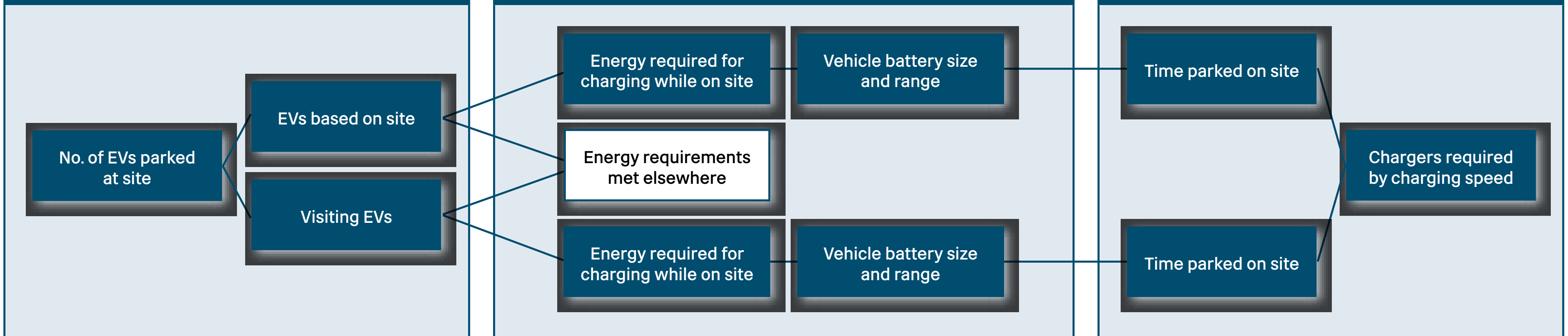
Some smart chargers have built-in payment systems, making it convenient for users to pay for charging services, while also enabling detailed billing for commercial or public charging stations.

Fleet Management

Smart chargers can offer fleet management capabilities, allowing businesses to monitor and control charging sessions for multiple EVs, track energy usage, and utilize advanced reporting and analysis tools for efficient fleet operations.

2.9.1 EV charging point selection

There are a range of key considerations when calculating how many chargers will be required and what speed of charging will work best.



1 How many EVs are you providing for?

Factors to consider:

- → How many vehicles are parked on the site and who is driving them?
- → Predicted fleet size?
- → What proportion of vehicles are based here outside operating hours?
- → What types of vehicle are they?
- → How quickly are these to likely to transition to zero emission fuels (i.e. what proportion are likely to be EVs in 5 years, 10 years, etc.)?
- → What are the future requirements?

2 How much of their charging requirements are you looking to meet?

Factors to consider:

- → What is the typical weekly mileage of the vehicles to be charged at this site?
- → What proportion of their charging is likely to be met at this location? (e.g. are they parked at home/at another depot overnight? Will this be their cheapest/most convenient charging option?)
- → How many charges will be required each week to deliver this charging (considering mileage, usage, battery size and range)?
- → How long does it take to charge the EV at different charging speeds?

3 How many chargers do you require for this and of what type?

Factors to consider:

- → How regularly are vehicles parked here?
- → How long are vehicles typically parked for?
- → How does this vary by vehicle type/customer group?
- → What is the slowest charging speed that could deliver the required energy in this time?
- → What is required to be provided now? What passive provision is required?

Image 2.15: Key considerations for EV charging point selection

2.10 Proprietorship

2.10.1 Business models

There are a range of business models available for private and public charge points, each with their own benefits and drawbacks. The selection of the most appropriate model requires trade-offs between the share of risk, up-front capital investment required and (for public charging) potential revenues. The most typical models are shown here.

Model	Overview	Applicability	Pros	Cons
Own and operate	→ Host buys and installs equipment → Host operates using own / licenced software → Host responsible for maintenance, repair and renewal	→ Private and public charging → More commonly used for private than public	→ Full control to host → All charging revenue to host	→ High up-front cost → Complexity / in-house expertise required → All risk with host
External operator	→ Similar to own and operate, but with third party to operate and maintain equipment → For public charging, this will typically include billing and payment	→ Private and public charging → Has been most common model for public charging	→ Fewer risks owned by host → Fewer in-house requirements	→ Less control / flexibility for host → Reduced share of charging revenue
Lease ownership	→ Hardware is owned by the supplier and leased to the host → Can range from leasing and operation of charging to full turn-key solution (including groundworks and installation)	→ Private and public charging → Increasingly common for public rapid / ultra-fast charging (50 kW or more)	→ Lowest up-front cost → Fewer risks owned by host	→ Typically inflexible with long lease → Higher annual costs / low share of revenue to host
Concession	→ Groundworks are undertaken by host → Charge points installed, operated and maintained by 3rd party under fixed term concession agreement with payment to host	→ Public charging → Mostly used for rapid / ultra-fast charging (50 kW or more)	→ Lower up-front cost and risks for host → Higher revenue share than lease	→ Lower revenue than ownership → Less flexibility than ownership

Table 2.3 Typical business models

2.11 Consumption Recovery and Billing

2.11.1 Public and private charge points

Network Rail sites might require a combination of public and private charge points which require different approaches to operation and billing.

Station car park customer charging

→ To be accessible to all car park customers.
→ Usually paid for in addition to parking charges.
→ Typically billed based on energy consumed.
→ Charging is subject to Public Charge Point Regulations 2023 which require that chargers:
  → Enable contactless payment (chargers over 8 kW only).
  → Enable "roaming" payment by at least one roaming provider.
  → Are supported by 24 hour staffed helpline (available throughout year).
  → Display the total price for charging and rates in pence per kilowatt hour.

Table 2.4 Public charging - typically operated and maintained by third party charge point operator

Network Rail fleet charging	Staff, contractor and other third party charging
→ Often restricted to pre-approved company vehicles. → Energy consumption monitored and billed to business. → Typically linked to charge point operating software licenced to business. → Not subject to Public Charge Point Regulations.	→ Access subject to company policy. → Typically require registration / pre-approval. → Charges for energy consumed (if any) as set out policy. → Typically involve same charging assets as for Network Rail Fleet. → Unlikely to be subject to Public Charge Point Regulations (unless available to public).

Table 2.5 Private charging - typically in-house operation and maintenance

2.11.2 Parking usage and overstay

Overstay charges are commonly used for paid public charging to prevent non-charging vehicles blocking access for others. These are typically calculated by how long a vehicle remains parked and plugged in once fully charged.

There are a variety of measures that can be implemented to assure that charge points are kept available when not in use, ranging from signs and guidance to physical access restrictions.

Information and education → **Strict enforcement**

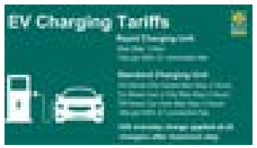
- Clear signalling of bays as EV only through marking and signage.
- Clear policies for staff and visitors.

- Online information on availability.
- Pre-booking for EV bays (for example through booking app).

- Registration and approval of which vehicles can use charging and when to prevent mis-use.
- Reminder sent to driver to move vehicle.

- Penalty charges for vehicles parked in EV charging bays not connected to charge.

- Overstay charges for EVs no longer charging / parked beyond permitted time.



- Smart barriers to prevent unapproved parking.

2.12 Innovation

2.12.1 Renewables integration

Buildings which have on site renewable systems have the option to utilise the power generated by the renewables to assist EV charging via a load management system. In this scenario any excess energy provided by the renewables can be redirected to the EV charging equipment instead of passing back to the grid, to minimise the use of grid power.

2.12.2 Vehicle to Grid (V2G) and Vehicle to Building (V2B)

Vehicle to Grid (V2G) is a concept undergoing extensive trials throughout the UK. It is the bi-directional flow of energy to and from a vehicle, with the stored energy within the vehicle made available on demand for utilisation by the electricity grid (V2G) or the building (V2B).

This has the potential to assist the energy networks in the following instances:

- → Frequency response
- → Time shifting of demand
- → Increased storage for renewable energy generation
- → Reduction of expensive grid upgrades

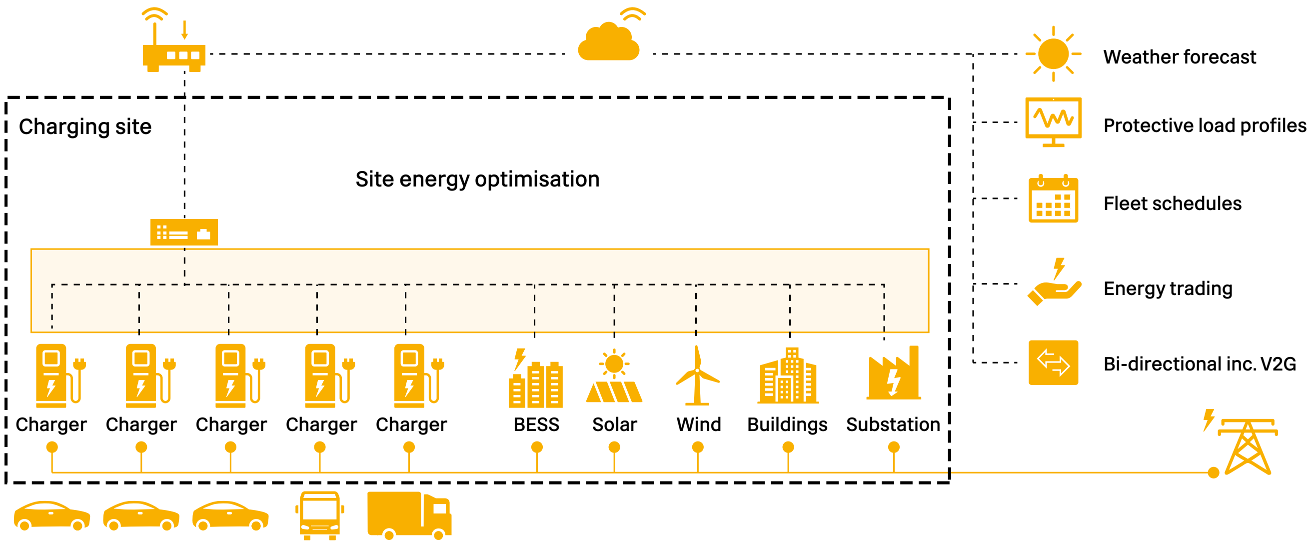


Image 2.16: Site energy optimisation system

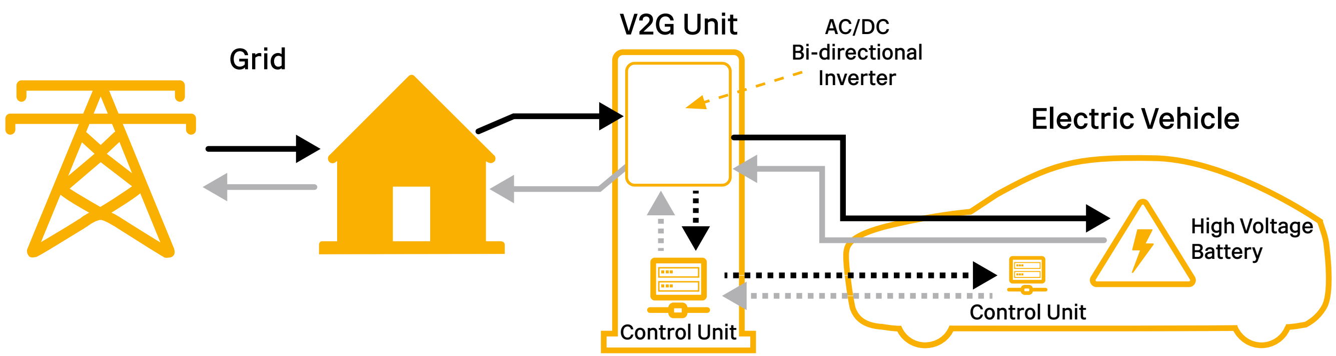


Image 2.17: Typical Vehicle to Grid (V2G) arrangement

Electric Vehicle Charging Points and Associated Infrastructure Charging Guide

Section 3: EV Charging Design Considerations

3

3.1 Introduction

3.1.1 Introduction

When initiating the design process for the installation of dedicated conductive charging equipment for the charging of pure electric (BEV), plug-in hybrid electric vehicles (PHEV), and a design team should be assembled and key stakeholders identified. The following list provides considerations that should be explored by the design and installation teams.

- → Utility Connections
- → Electrical Supply Capacity
- → Load Management
- → Earthing
- → Metering
- → Lighting
- → Voltage Surges
- → Circuit and Cable Design
- → Additional Protective Measures
- → LV Infrastructure Design
- → Communication and Security
- → Risks
- → EV Charging Layout Planning
- → EV Signage

Code of Practice Guidance

Prior to undertaking the design and installation of Electric Vehicle Charge Points (EVCPs) initial checks are required to be undertaken. For this purpose, the Institute of Engineering and Technology (IET) Code of Practice for Electric Vehicle Charging Equipment Installation contains a checklist for commercial and industrial installations. This checklist is divided into 3 specific sections consisting of:

- → **Pre-installation** – Captures the preparation for the design of the installation.
- → **Physical installation** – Captures checks to evaluate the installed equipment and check it is in an appropriate location considering the local environment and installation conditions.
- → **General requirements** – Captures checks that the completed installation meets the design and that the testing regime has been adhered too.

3.2 Utility Connections

3.2.1 Incoming electrical supply

The introduction of electric vehicle charging infrastructure to an existing or new site is likely to place significant growth in power demand. On smaller Network Rail buildings this might have a significant impact to the incoming electrical supply. Early assessment and consultation with the Distribution Network Operator (DNO) is key to the success of EV charging infrastructure introduction.

3.2.2 Utility connections

The Energy Networks Association (ENA) require every EV charger installation be notified to the local DNO. Dependant on the criteria the notification might be required before the installation or within 28 days of the completion of the installation. Refer to the EVCP Connection form on the ENA website for the notification requirements. The application form should be completed by a competent person and submitted to the DNO.

Notification to the DNO of the installation of new EV charging infrastructure is necessary to assess if the local power network can safely and reliably accommodate the increased demand, and new load type.

EV charging can lead to an increase in harmonics within the electrical system. As EVs require a DC supply, the conversion from AC requires a rectifier in the vehicle or the charger to complete that conversion which can introduce harmonics. Harmonics can cause a variety of power quality issues including heating in neutral conductors and poor performance in electronic devices. In addition, the DNO might insist that a harmonic assessment is required before granting a new connection or increase to the supply.

The ENA detail the requirements for harmonic assessments in ENA Engineering Recommendation G5/5.

Load balancing is another important consideration when installing EV charge points. Engineers should seek to design electrical loads to be balanced across a three phase system where possible, to avoid phase imbalance issues which could lead to overheating, inefficiency and potential increased energy costs.

To assure that harmonics are within the required limits, using a power quality analyser or suitable power and energy logger will allow an engineer to monitor and report on these values pre and post-installation. This provides the opportunity for mitigation action to prevent potential charges from the supply company, costly malfunctions or avoidable downtime. In addition, most units will also provide load testing functionality allowing you identify load imbalances.

3.2 Utility Connections

Key design considerations

For new electrical work, alteration or addition, BS 7671 sections 132 and 133 sets out fundamental requirements, all of which should be considered and verified before EV work proceeds. These include:

- → Supply characteristics – voltage, frequency, number of phases, max demand
- → Adequacy of existing supply to supply the load
- → Adequacy of any existing switchgear and cabling to supply the load and provide safety
- → Adequacy of existing earthing and bonding arrangements for safety
- → Adequacy of existing supply intake equipment such as DNOs cut out, metering, meter tails, etc.

The exact details of the proposed EVs and charging requirements should be established before any design and installation of the charging provisions commence.

1 Scottish & Southern Electricity Networks
2 SP Energy Networks
3 Northern Powergrid
4 electricity north west
5 nationalgrid
6 UK Power Networks

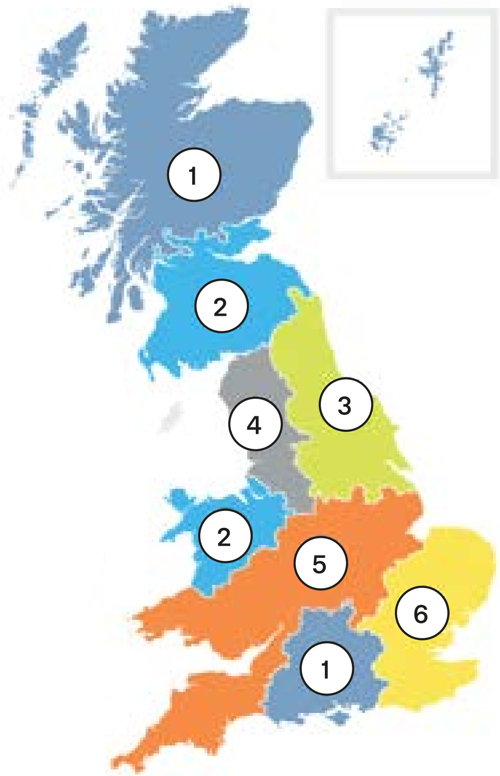


Image 3.1: Energy Network Operators in Great Britain

3.3 Electrical Supply Capacity

3.3.1 Electrical supply capacity

The electrical supply capacity to the building should be checked to assure that this is adequate for the EV charging infrastructure.

In order to check the supply capacity, a load profile should be produced to confirm the proposed maximum demand.

When compiling the load profile the sum of all the EV charging equipment at full rating should be assumed, unless a load curtailment arrangement limiting the load to a specific level is in place. Any areas of concern regarding the assessment of the supply capacity (including EVs) should be discussed with the project owner.

Section 722 of BS 7671 - The IET Wiring Regulations provides guidance and permits the use of load curtailment including load reduction and disconnection.

Key design considerations

Section 3 of the IET Code of Practice for Electric Vehicle Charging Equipment Installation provides suggested solutions when the existing electrical supply capacity is not sufficient:

- → Limiting the maximum current capacity of the charging equipment
- → Implementing load management strategies
- → Uprating the incoming power supply

In assessing the load characteristics, the designer should take the following factors into account:

- → Location of the charging points with reference to the electrical supply point
- → kilo Volt Amprere (kVA) demand of the combined additional EV chargers and the existing load
- → Power Factor of the whole installation
- → In rush and starting currents
- → Harmonics of the whole installation

3.3.2 Existing sites

In existing installations where EVs are planned to be added and where building records do not accurately detail the existing supply capacity and load profile, further assessment on-site should be carried out to determine this information.

The existing supply capacity should maintain 20% spare capacity following the new maximum demand calculation.

But first...
If existing capacity information does not exist, power logging of a minimum one week period should be performed on the existing installation to understand the spare capacity available. The impact of seasonal load fluctuations should also be considered when assessing existing maximum demand.

The following Institute of Engineering and Technology (IET) publications contain content related to maximum demand and diversity in installations of differing complexity when assessing existing or new infrastructure.

- → Electrical Installation Design Guide: Calculations for Electricians and Designers
- → Code of Practice for Electric Vehicle Charging Equipment Installation

Following the assessment of maximum demand, the project owner and designer might conclude that the solution should be an application for a new dedicated EV supply or alternatively; slower chargers, de-rating of chargers, renewable power supplies or battery energy storage systems could be considered.

Image 3.2: Commercial, industrial and domestic power analysing data logging

3.4 Load Management

3.4.1 Dynamic load management

To enable load curtailment an EV load management software program or system can help manage and optimise the charging of EVs in a location. The application aims to balance the peak electricity demand of multiple EVs connected to the grid, allowing efficient and reliable charging while minimising the strain on the electricity grid infrastructure, and in turn reducing the site's electricity connection requirements.

EV charging stations consume a large amount of power over a long period of time when in use. Load Management systems might also be considered as part of a safety feature to protect the electrical infrastructure whilst maintaining efficient and optimal operation of the charging infrastructure.

Many manufacturers and third party providers have load management systems that offer basic to advanced solutions. Three possible load management systems are explained in more detail in the load management system table on the next page.

Key design consideration

→ The choice of load management software implementation depends on various factors such as the scale of the infrastructure; the facility and use and the requirements of the DNO connection.

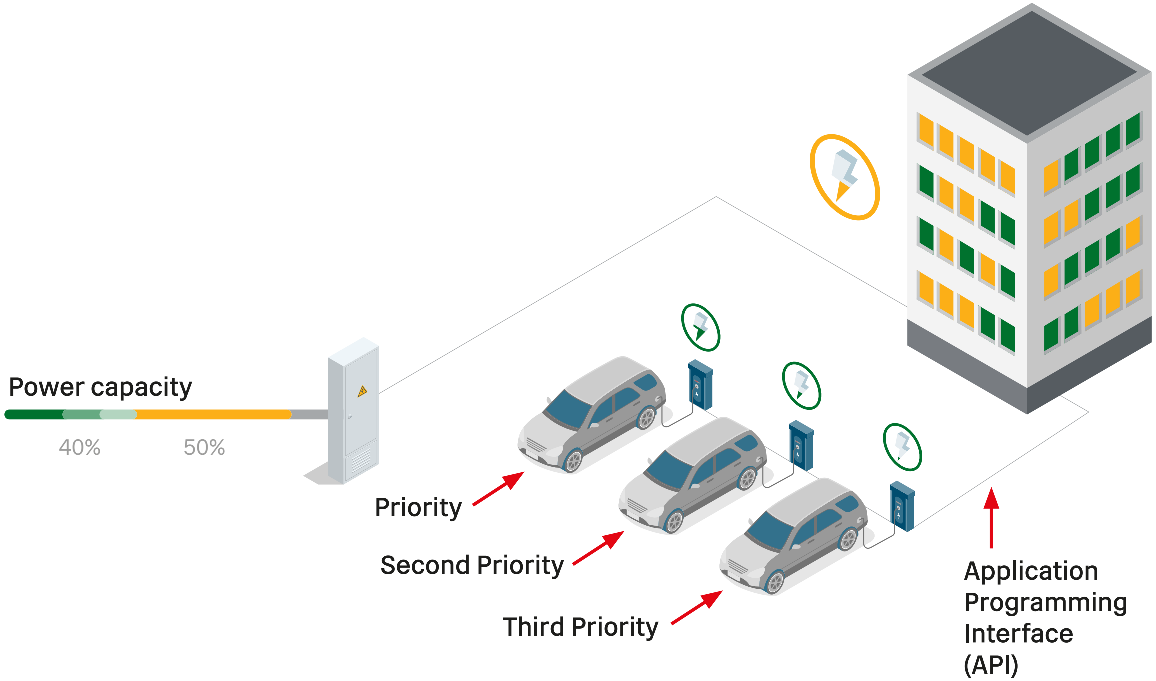


Image 3.3: Dynamic load management example

Load Management System	Options	Suitable for	Example
Static Load Management	The static load management system is the most basic form of load management. EV chargers operating on this system will be limited by a power limit for all the chargers on the same system. The load limit will then be distributed evenly among the chargers in use. Often manufacturers can provide an offline solution which does not require an internet connection.	Public car parks with a restricted DNO load.	4 x 7.2 kW, 32A, single phase smart chargers are installed. The power limit of all 4 chargers is set to 40A: - If 1 charger is used, it can charge the car at 32 A. - If 2 chargers are used, each charger will charge each car at 20 A. - If 3 chargers are used, each charger will charge each car at 13.33 A. - If all 4 chargers are used, each charger will charge each car at 10 A. - If 2 charger finish charging, the 2 other chargers will charge each car at 20 A.
Dynamic Load Management	The dynamic load management system enables flexibility in load distribution, allowing users to optimise charging strategies based on their specific requirements and priorities. Dynamic load management systems are software-based. The software allows the user to manage the remaining available power dynamically and balances between the EV chargers in the most efficient way or prioritise one or several EV chargers based on occupancy. Alternatively, if prioritisation is configured for one or several charging points, the software can smartly manage the power distribution. In this scenario, when the power demand exceeds the available capacity, the software can put vehicles on standby until sufficient power becomes available. The software can manage a waiting list, allowing charging to be prioritised and organised. An internet connection is required (Wi-Fi, Global System for Mobile Communications (GSM), or a hard wired data connection).	Fleet, staff and pool car parks with a restricted DNO load.	Option 1: Equal Share First EV to have an active charge session will have full power until another EV starts charging. When a second EV starts charging the site capacity is equally shared between the active chargers. For example: - 2 chargers: both receive 50% of available power; - 3 chargers: both receive 33% of available power; - 4 chargers: both receive 25% of available power; etc. Option 2: First In First Out (FIFO) Every charger has a minimum default budget to always allow a minimum budget for charging. The remaining capacity is then assigned as per first in, first out (FIFO) logic. First EV to have an active charger session will have full power until charging is stopped by user/vehicle. Second EV to start charging will get a reduced charging budget, which will increase as soon as the first EV has finished charging.
Active Load Management	The active load management system operates under an electrical load limit however, consumption is based on the real-time usage of the site. As a site uses more or less energy and the available power for the chargers' changes, the load management system will actively adapt to accommodate to the buildings capacity. When the site power consumption is high, there will be a reduction in power available to the chargers and vice versa. Active load management is more advanced than Static systems as the management station will analyse all power consumption across the main electricity board to optimise usage whereas the static solution will distribute the desired load limit across chargers in use. An internet connection required (Wi-Fi, GSM, or a hard wired data connection).	Active management is highly recommended for light/ heavy commercial sites and large fleets where other electrical loads should be taken into consideration. Existing sites, new sites, and sites with a restricted DNO load.	15 x 22 kW, 32A, three-phases chargers are installed. However, the building only has 500A per phase available. In this case, Active Load Management assures that the EV chargers will not overload the building. The system will operate as follows: If other appliances consume a total of 350 A, the software will automatically set up the power limit of the system to 150 A. When all 15 chargers operate simultaneously, each charger uses 10 A. If other appliances consume a total of 50 A, the software will automatically set up the power limit of the system to 450 A. When all 15 chargers operate simultaneously, each charger uses 30 A. If other appliances consume more than 430 A, the master controller will pause all the charging sessions and wait until the site has more available power.

Table 3.1 Load management systems

3.5.1 Earthing

In considering the installation of an electric vehicle charging point the designer should comply with BS 7671 Requirement for Electrical Installations including those regulations in section 722: Electric Vehicle Charging Installations. Further details on EV earthing can also be found in the IET Code of Practice for Electric Vehicle Charging Equipment Installation.

Typical earthing arrangements

TN-S: If a guaranteed TN-S system can be assured (as might be the case with a privately owned transformer) and TN-S configuration is provided throughout, this system can be used to charge an EV either within a building or outside, provided that the requirements for earthing and bonding contained within BS 7671 are met.

In the case of a public supply network provided by a DNO, these systems might not be guaranteed to be true TN-S systems back to the source of supply, due to ongoing network changes, repairs and modifications. In this instance, it is suggested that such DNO networks are regarded as TN-C-S systems, for the purposes of EV charging.

National Standard

For definitions of earthing arrangement types refer to
BS 7671 Requirements for Electrical Installations (IET Wiring Regulations)

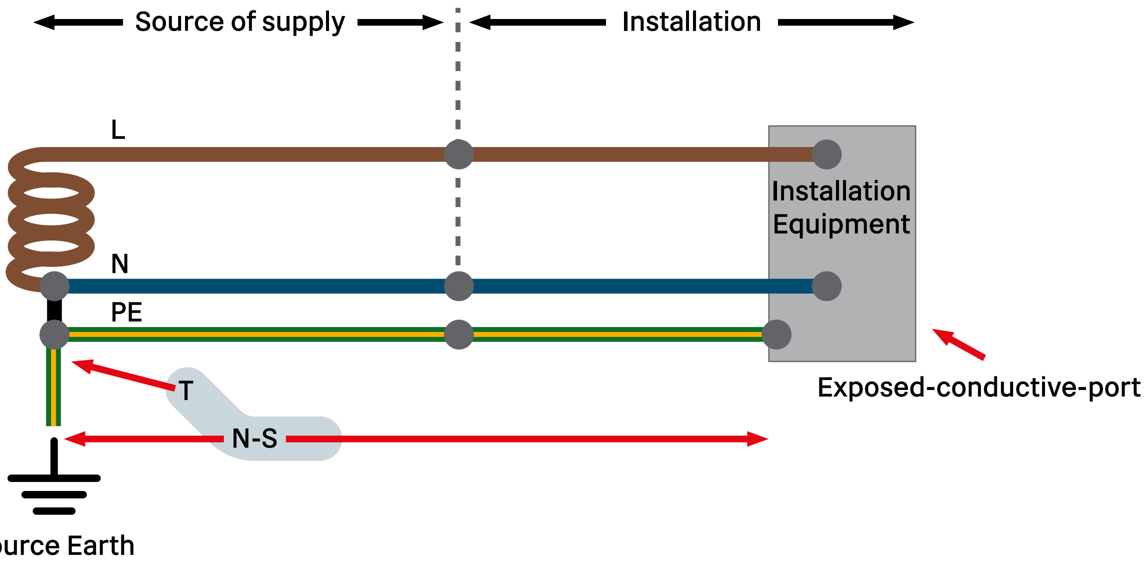


Image 3.4: TN-S system

TN-C-S (PME): Ordinarily, TN-C-S earthing offers a reliable way to provide installations with an earthing facility, usually by the provision of a consumer's earthing terminal taken from the neutral conductor at the supply intake position. However, on the rare occurrence of an open circuit fault on the Protective Earth Neutral (PEN) conductor serving the installation, dangerous voltages above true earth potential can appear on all conductive parts of the installation, and other installations connected to the same source of supply, giving rise to potential shock hazards.

Additionally, 'diverted neutral' currents can endeavour to return to the origin of the supply, via protective conductors, which might in some instances give rise to overheating and fire risks. Conventional circuit protective devices such as fuses, circuit breakers and Residual Current Devices (RCDs) cannot protect against these occurrences, and it is for reason that BS 7671 prohibits use of TN-C-S earthing on many 'special installations' (usually where earthing and bonding might be incomplete, or for installations considered being outside the equipotential zone, created by earthing and bonding).

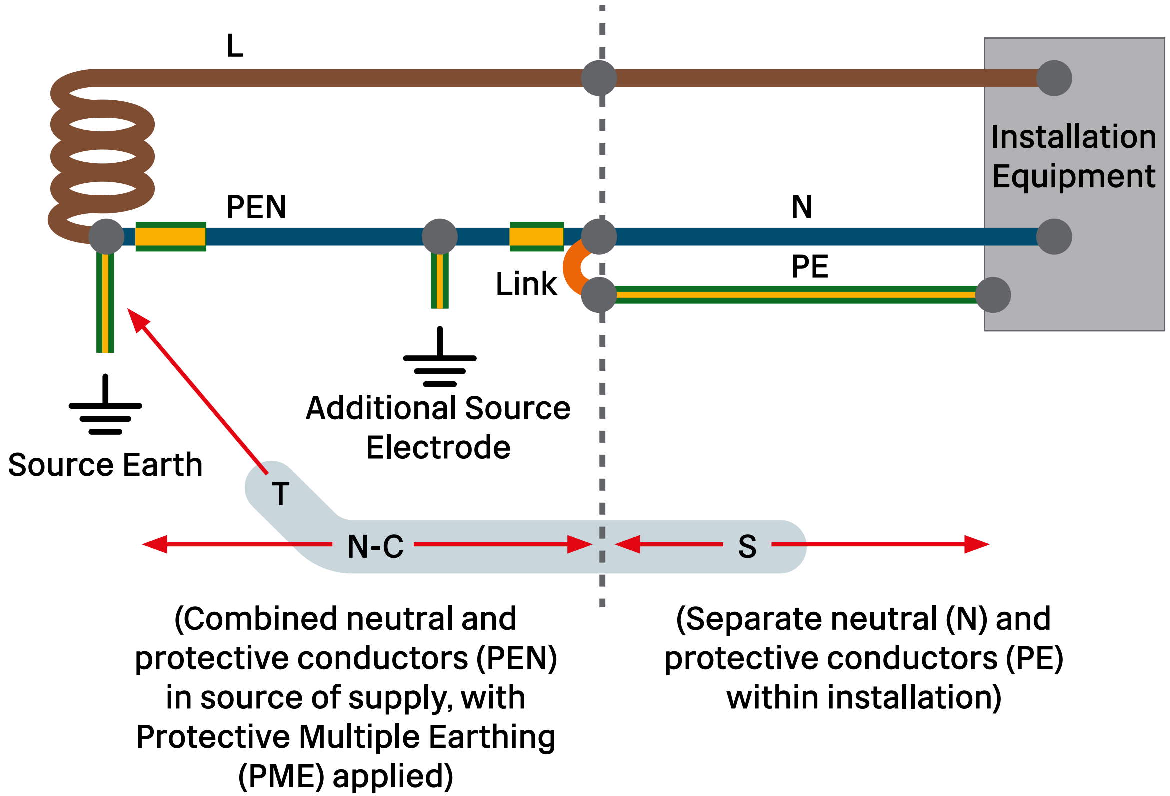


Image 3.5: TN-C-S system

The diagram below shows the risk in the event of an Open Circuit on a Protective Earth Neutral (PEN).

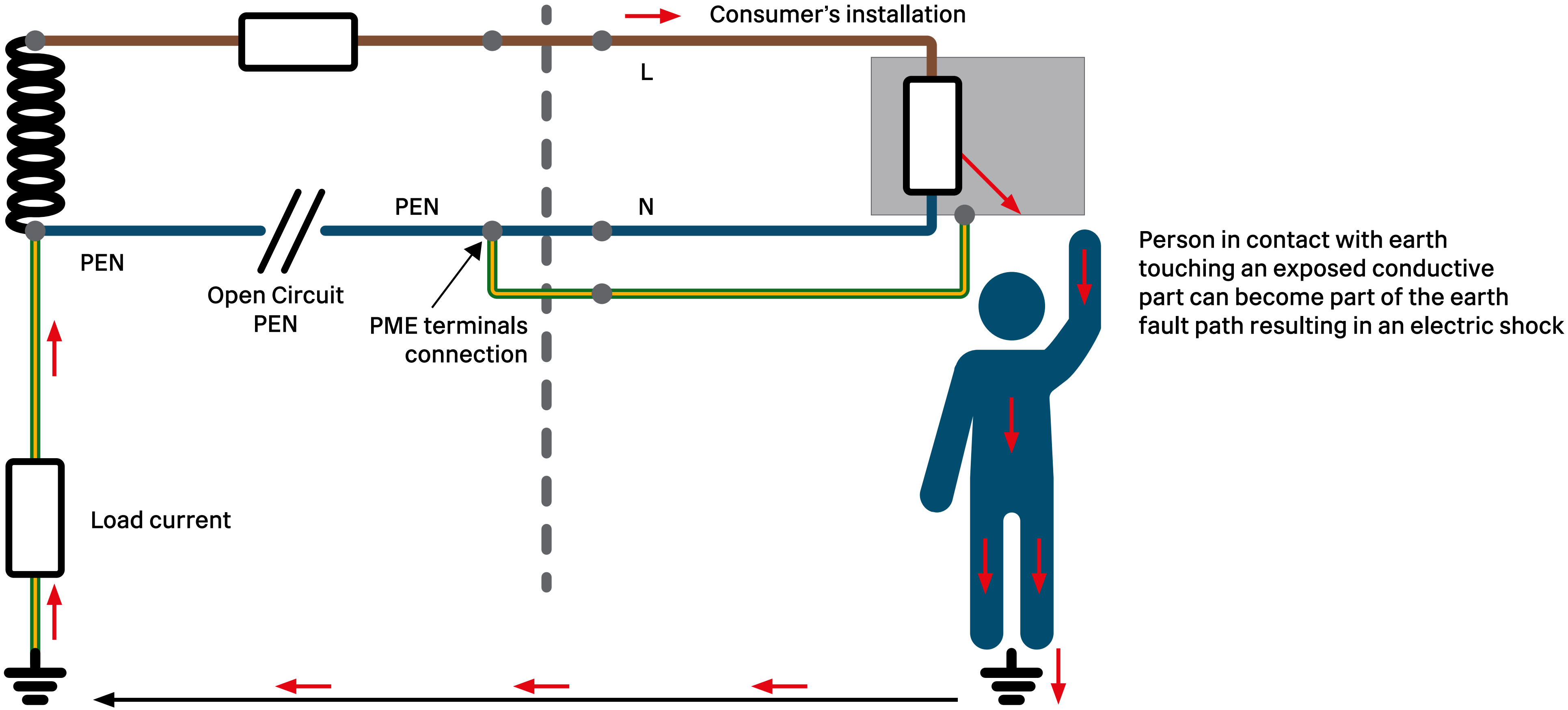


Image 3.6: Open Circuit on PEN risk diagram

TT systems afford an earth electrode at the supply transformer in addition to an earth electrode at the consumer installation. These systems have particular requirements for compliance with BS 7671 however converting part or all of an installation to a TT system might be beneficial when considering an electric vehicle charge point installation.

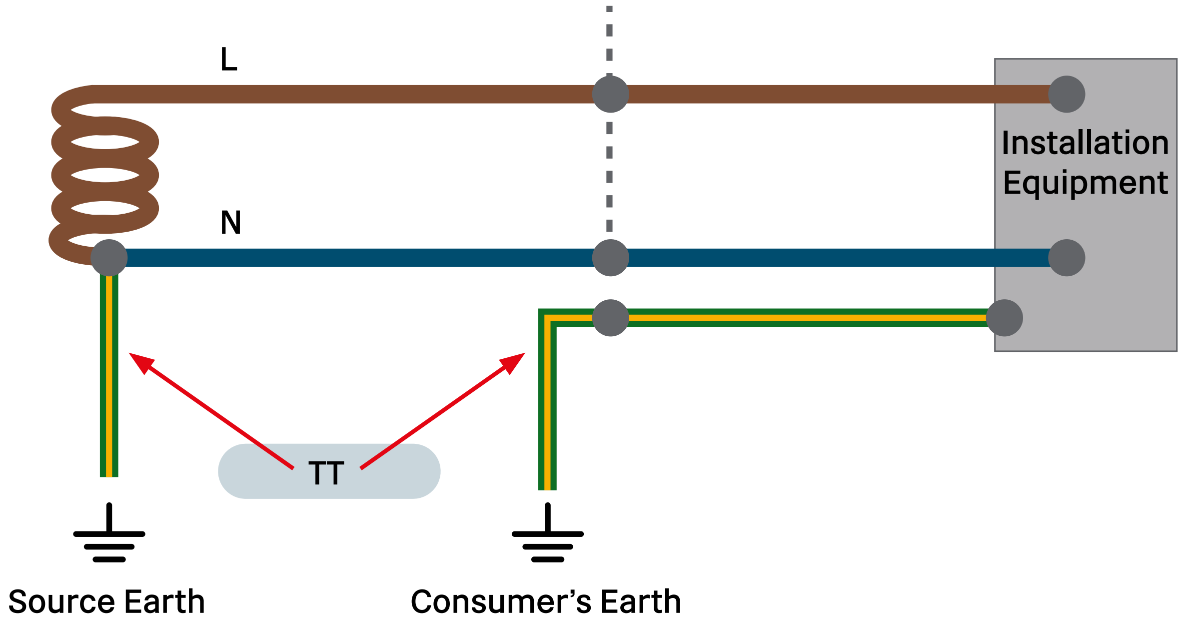


Image 3.7: TT system

Earthing arrangements

BS 7671 states that a PME earthing facility should not be used as the means of earthing for the protective conductor of an EVCP located outdoors unless one of the methods described in regulation 722.411.4.1 is utilised.

For example, where EV installations are connected to a PME earthing system and the installation is outside of a building then BS 7671 has requirements for the voltage between the earth terminal and earth to be limited to 70V rms in the event of an open circuit fault in the PEN conductor. Alternatively, this requirement might be met on a 3 phase installation where all 3 phases are evenly loaded and balanced. Further guidance on this and other methods of compliance can be found in Annex 722 of BS 7671 and Annex J of the IET Code of Practice for Electric Vehicle Charging Equipment Installation.

Where the requirements of PME installations cannot be practically achieved (as described above), and the vehicle charging is required from a PME sourced electrical installation with the charge point external from the source building, the electrical designer might consider the following options:

i. TT earthing for each individual charge point – this approach is commonly used where external buildings are supplied from a PME supply and the earthing systems are independent of each other.

> **Watch Point**
> Consideration and risk assessments should be given with regards to the impact of extraneous and exposed conductive parts of the TT and PME systems for above ground and buried services or the benefits of the separate earthing systems might not be gained.

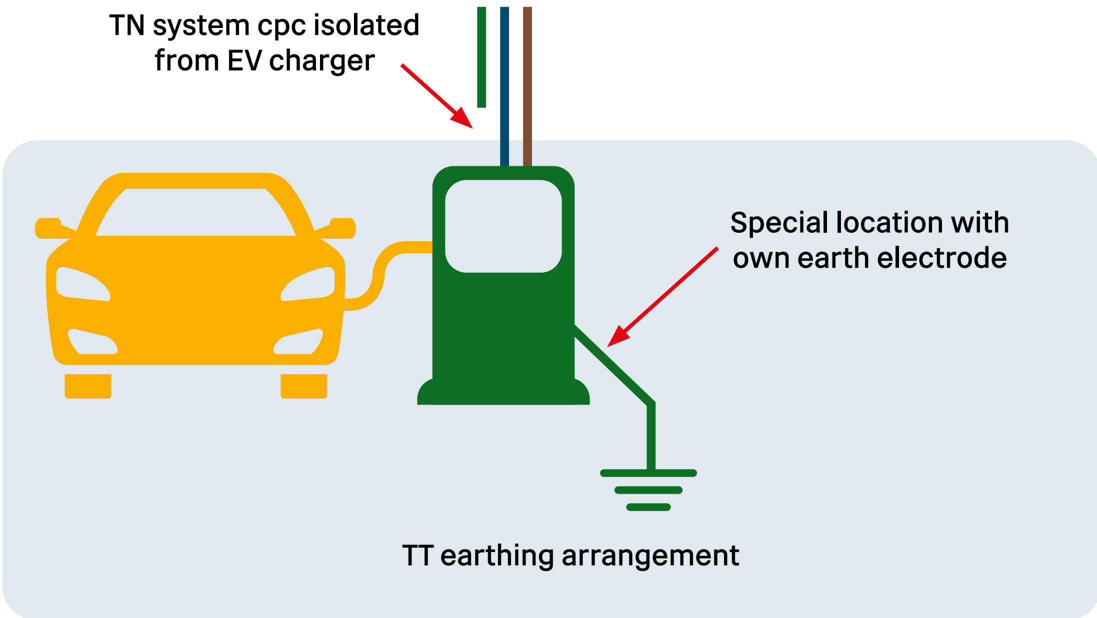


Image 3.8: TT earthing arrangement example

3.5 Earthing

ii. Convert the whole installation to a TT earthing system. This option is only likely to be suitable for smaller installations; however for larger installations the additional requirements for earth fault protection will require additional RCDs and residual current circuit breakers with overcurrent protection (RCBOs) to be introduced upstream in the existing network. This will attract increased costs and the likelihood of remedial works to rectify existing dormant 'faults' and accumulated earth leakage in existing circuits.

Watch Point
With a more complex RCD arrangement, selectivity between devices might be difficult to achieve. This should be assessed by the designer.

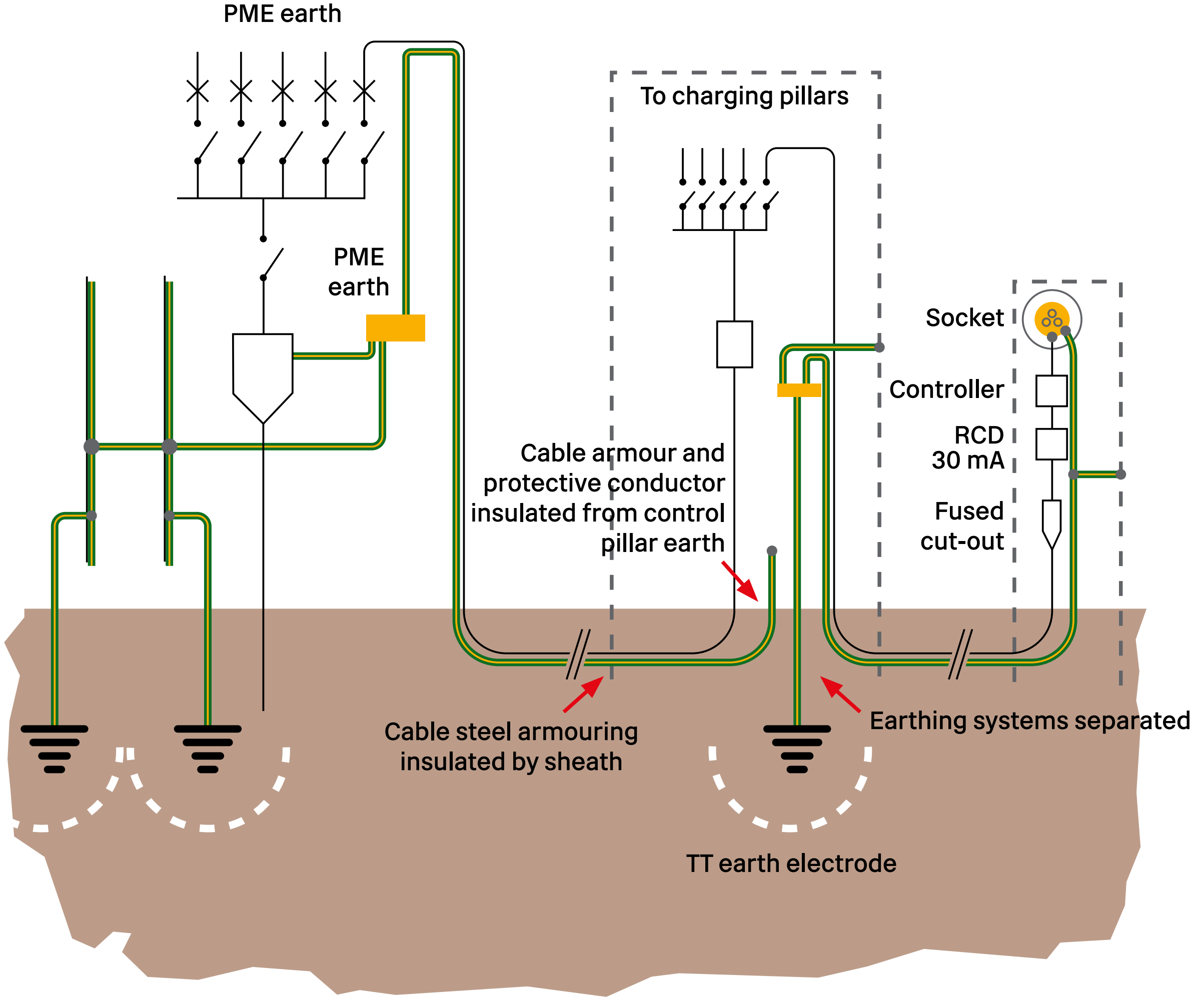


Image 3.9: Typical small external installation utilising a separate dedicated TT earthing system

iii. The use of an isolation transformer to serve an individual EV charging point can overcome the issues posed by open circuit faults in the PEN conductor of the supply; its basic principle being as shown below:

> **Watch Point**
> As with other solutions to the "PME problem" it might be that suitable isolation is provided within or part of bespoke charge equipment. These three options should be thoroughly checked by the designer before committing to a solution.

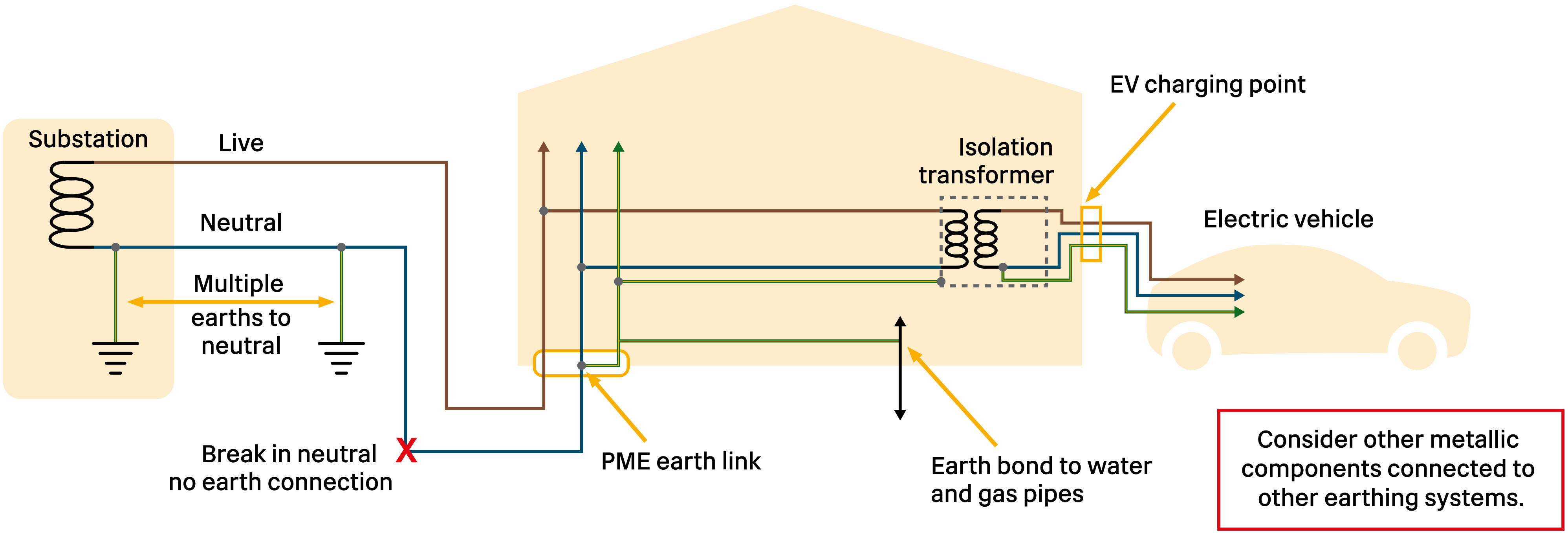


Image 3.10: Typical isolation transformer arrangement

3.5 Earthing

TT earthing risks

When installing an EVCP, earthing is important to assure electrical safety and to protect users in the event of a fault. Earth rods (electrodes) are used to assure protection is offered to the user in the event of a faulty protective earth and neutral (PEN) conductor within a TNCS/PME system. However, the IET Code of Practice for Electric Vehicle Charging Equipment Installation highlights the challenges of this approach, including avoiding underground infrastructure such as buried pipes and cables when installing earth rods.

Watch Point
Before any groundworks or installation of earth rod systems commence, investigations should be carried out to ascertain the extent and location of existing underground infrastructure e.g. ground penetrating radar survey

Earth electrode size

Where earth electrodes are used they should be sized in accordance with Annex G of the IET Code of Practice for Electric Vehicle Charging. Multiple earth electrodes might be required, and guidance on the separation of earth electrode zones can be found in Annex H of the Code of Practice.

For further arrangements, see BS 7430 Code of Practice for Protective earthing of electrical installations.

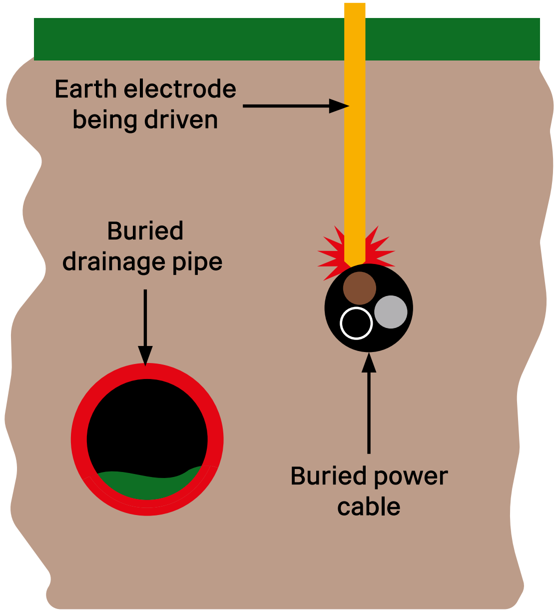


Image 3.11: TT earthing risk image

Simultaneous contact assessment

Where a dedicated TT earthing system arrangement has been implemented then an assessment should be carried out to establish if possible contact between the charging equipment/vehicle being charged and any exposed-conductive-parts or extraneous-conductive-parts connected to other earthing systems is possible.

Third party installations nearby should be considered when assessing simultaneous contact. In situations where adjacent electrical installations have metallic services, e.g. buildings and perimeter fencing, near to the EVC installation (or connected vehicle) that are bonded to a PME system, further assessment of the risk should be carried out. Coincidental touch potential could be achieved by buried services connected to the building PME system and where the service is less than 2.5m from the EVCP TT system.

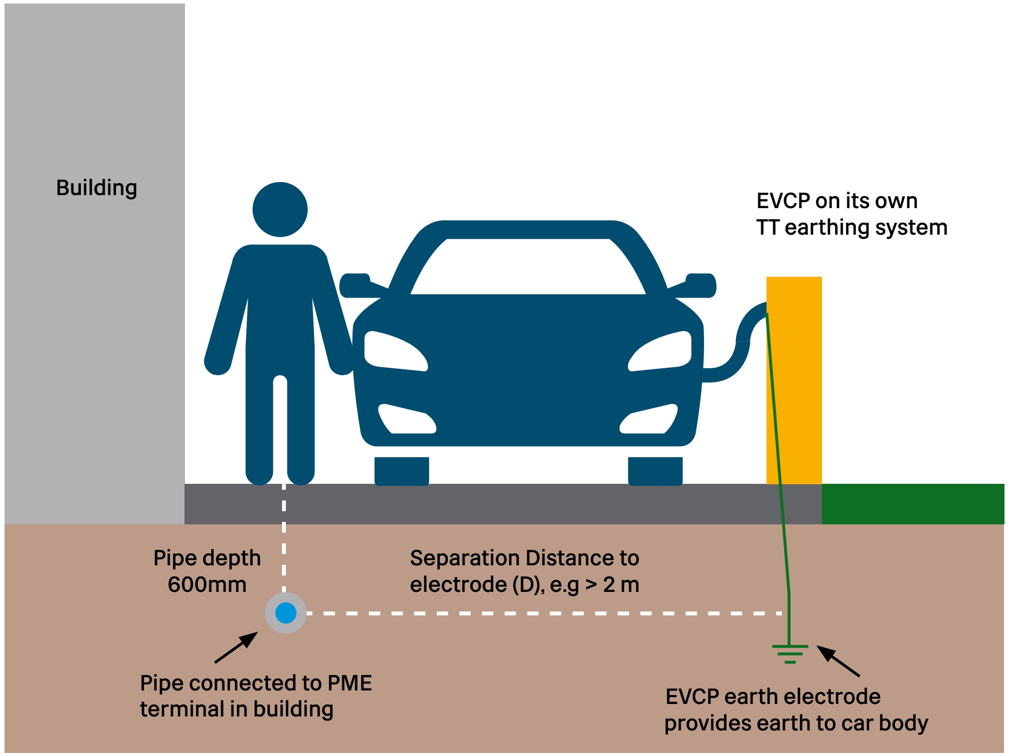


Image 3.12: Simultaneous contact image

Rail specific earthing considerations

The effects of traction power networks should be considered when siting EVCPs. The implication of stray current and earthing requirements is far reaching and guidance on the requirement for Earthing and Bonding can be found in the IET Guide to Earthing and Bonding for AC Electrified Railways. It should be noted that the LV installation on rail sites which include traction power systems may have their earth connection 'gapped' from the DNO earth.

When assessing the impacts of stray currents, existing metallic parts in proximity should be considered (including Glass Reinforced Plastic (GRP)) items such as fencing, handrails etc.

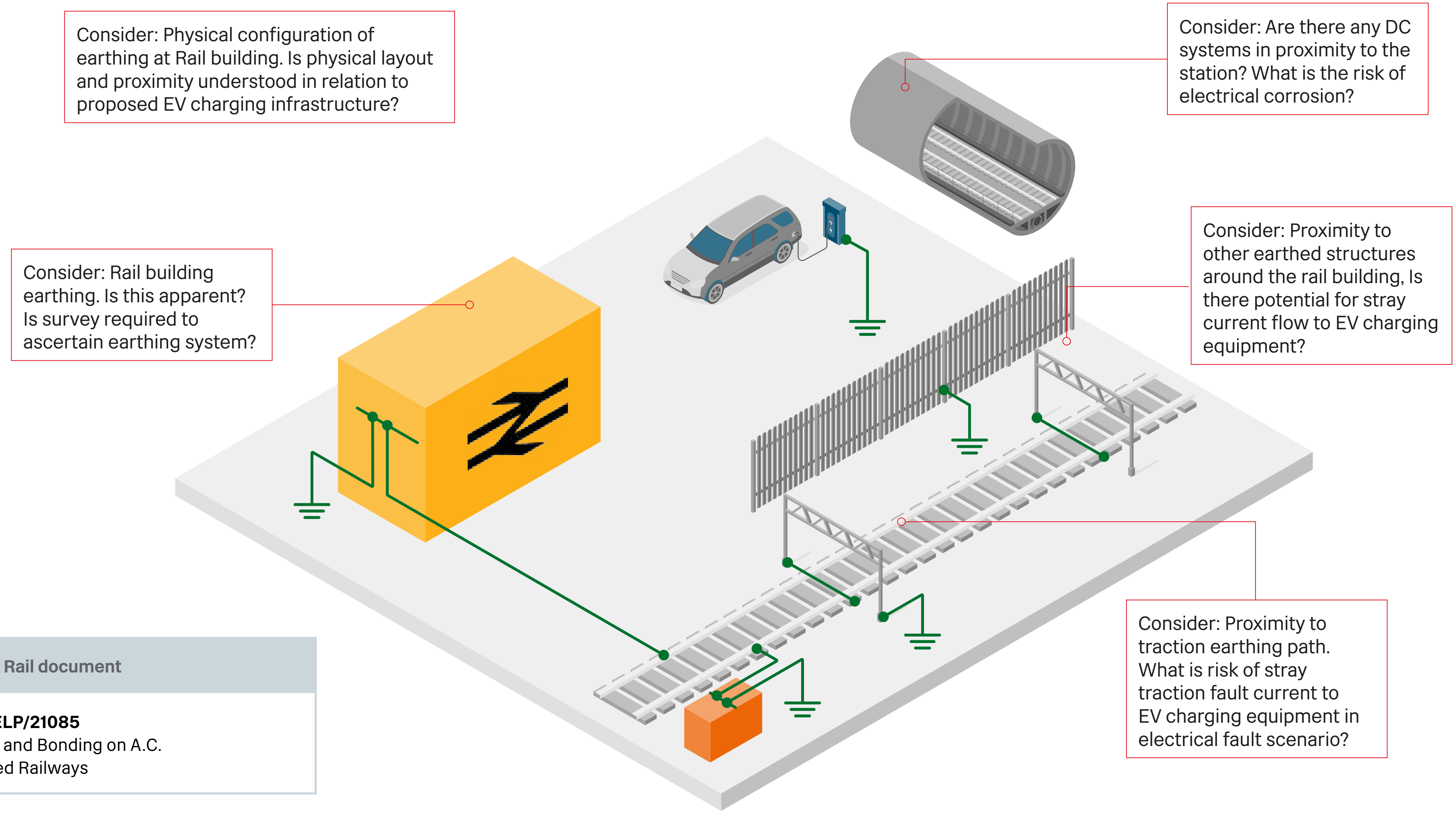
Effective earthing at EV charging stations adjacent to railways is crucial to assure safety as it minimises the risk of electric shock and prevents voltage potential differences between different earthing points. Effective earthing systems redirect any fault currents away from the charging units, railway tracks and nearby infrastructure safeguarding personnel vehicles and the working railway infrastructure itself.

EVCPs located close to railway lines where 25kV traction power is in use should also comply with electromagnetic compatibility regulations. A suitably compliant earthing system mitigates the potential for electromagnetic interference, preventing disruption to railway systems, signalling and other communication equipment. This is necessary for the operation of both the charging infrastructure and the railway network.

Network Rail operate both AC and DC traction railway systems. Within DC traction areas consideration is to be given to EV installations in proximity to the operational railway where DC stray current corrosion might be a risk.

Image 3.13: Electric traction power and rail track

3.5 Earthing



Network Rail document

NR/L2/ELP/21085
Earthing and Bonding on A.C. Electrified Railways

Image 3.14: Isometric diagram showing earthing considerations

Other EV earthing options for PME arrangements

Where a PME system is used for the supply to an EV charging installation then the use of Open PEN (Protective Earth Neutral) detection technology is permitted by BS 7671 however at the time of writing the devices used to detect the Open PEN fault do not have a definitive product standard, and also BS EN 61851 and BS 7671 are in conflict over their use.

Where Open PEN detection technology is used it should not be relied upon as the sole or basic means of protection, in line with ENA G12 requirements, with evidence of this provided within the design. Some DNOs require the owner of Open PEN devices to also demonstrate that the device is fit for purpose and they would expect the following:

1. A detailed description of the method of detection including the theory on how it works.

2. Confirmation that the device is compliant with relevant standards (as there are currently no specific standards for these devices) in the following areas:

   → Environmental compatibility.

   → Physical construction of the unit.

   → Isolation mechanism.

3. Confirmation in the form of independent performance testing and documented evidence that the device has the following characteristics:

   → It detects all types of neutral fault conditions likely to be encountered on the low voltage distribution network, under typical system and environmental conditions.

   → On detection of a neutral fault condition the device makes the circuits safe by isolating the phase, neutral and earth conductors and locks out.

   → The device does not falsely operate under expected network operating conditions.

   → The device is fail-safe to prevent the operation of the charger if any major or significant component in the device fails."

Installation recommendation

As rail installations have specific requirements with regards to earthing and bonding, coupled with the fact Open PEN devices currently do not have a recognised product standard and DNOs apply additional restraints on their use, at the time of writing this technology is not recommended for protection against a broken PEN conductor on rail installations.

Watch Point
BS 7671 does not deal with the safety requirements for the construction of electrical equipment. Where equipment to be used is not covered by a British or Harmonised Standard, or is to be used outside the scope of it's standard, it is the responsibility of the electrical installation designer/specifier to establish that the manufacturer of the equipment has assured that the equipment satisfies the safety objectives of the relevant Directive(s).

3.6 Metering

3.6.1 Metering

Where the requirements of Part L of the Building regulations in England and Wales, or Section 6 of the Scottish Building Standards are required, sub-metering might be required.

In addition, where the use of the EVCPs are billed on an energy usage basis then a meter that is suitable for billing purposes should be utilised.

Measuring Instruments Directive (MID) approved instruments have passed specific conformity assessment procedures and have MID markings which allow the instruments to be used in the UK. The aim of the directive is to create a single market in measuring instruments for the benefit of manufacturers and, ultimately, consumers across Europe.

The metering might be installed in the feeder pillar cabinets or utilising on-board meters in the EVC. These measure, record and display the amount of electrical energy used.

Image 3.15: Feeder pillar mounted meters

Image 3.16: Example EVC with inbuilt energy meter

European Standard

For billing purposes it is necessary that a metering device is compliant with the **Measuring Instruments Directive (MID 2014/32/EU).**

3.7 Lighting

3.7.1 Lighting

Providing adequate task lighting is a requirement for users of the EVC equipment and surrounding areas. In addition to the fundamental lighting principles applied to the designs of car parking areas there is a requirement to assess the increased lighting levels required for an EVC charging bay or charging area and the designer should consider the following:

BS EN 12464-2 Light and Lighting – Lighting of workplaces part 2 and The Society of Light and Lighting provides recognised guidance on lighting levels however as EV charging is a fast-developing market no direct reference is made to this type of area. Suitable lighting should be provided to enable the EVCP to be operated safely, including visibility of 'on-screen' instructions where provided. The final lux level should be established by consultation with key stakeholders.

The lighting should consider the following factors:

- EV Charging Cables connected between vehicle and EVC;
- EV connection points are lit adequately;
- Ability to read instructions;
- Ability to read EVC display; and
- Surrounding environment that might cause shadowing.

The lighting design should consider both horizontal planes of the working surface (car body height) and the vertical plan of the vehicle and charging unit.

Lighting consistency should be maintained throughout the charging areas and should offer a significant difference to the illumination levels in the nearby areas.

As the nature of EV charging produces a vehicle pedestrian intersection the designers should also consider the glare from vehicle headlights and lighting should be sufficient to enable pedestrians to move safely and be seen by drivers.

Watch Point
Lighting design should consider the impact of nearby local lighting, the protection of wildlife and or any planning requirements. A co-ordinated lighting strategy might be required involving Network Rail, local authorities, 3rd party owned lighting systems and ecologists.

Network Rail document

NR/GN/CIV/200/11
Parking and Mobility at Stations Design Manual

Image 3.17: Public parking with charging points for electric vehicles

3.7 Lighting

Safety

Appropriate lighting plays a vital role in the safety of EV charging stations. Well-lit areas enable owners and users to charge their vehicles during night-time or low-light conditions with ease and confidence. Adequate lighting reduces the risk of accidents, enhances visibility, and deters potential criminal activities, making it crucial for public and private charging stations alike. Consideration of emergency lighting should be made where escape lighting might be required or for evacuation purposes and safety i.e. typically within covered car parks.

Lighting provides some security in terms of comfort. This could be supplemented by the inclusion of Closed Circuit Television (CCTV) and when used overtly can be a deterrent to crime and anti-social behaviour. A CCTV system could be linked to the parking management and Automatic Number Plate Recognition (ANPR) system and located at strategic locations such as EV parking bays and could also integrate with an overarching parking strategy.

Energy Management

When considering energy management of the lighting installation the designer might opt to include sensor activated lighting to provide an increased level of lighting in the EV parking bays whilst occupied and set back to a standard level for car park lighting when not occupied.

Visibility

Well-designed lighting helps enhance the accessibility of EVCPs. Illuminated signs and improved visibility enables EV drivers to easily locate charging stations, especially in large parking lots or unfamiliar locations. This promotes convenience and minimises confusion, giving users a positive charging experience.

Image 3.18: Example of installation featuring CCTV and lighting for secure charging at night.

3.8 Voltage Surges

3.8.1 Voltage surges

The effect of voltage surges might impact the continued service of necessary vehicle charging equipment and the charging of EVs. In line with Section 422 of BS 7671 surge protection devices should be considered.

Voltage surges on an electrical system can occur from switching of large loads, either within the installation or on the supply network locally. Voltage surges might occur by a lightning strike (either directly or indirectly) or might also result from faults on the HV or LV power network.

All electrical systems and equipment are designed to operate safely at specific voltage ranges. Surges in the electrical system can be of a magnitude far in excess of these safe working ranges therefore causing damage to the systems and equipment. The resultant effect of this might cause fire, permanent equipment damage resulting in lost time, money and in term of vehicle charging a loss of charge and possible damage to the EV.

The inclusion of surge protection is necessary for maintaining functional supply, critical systems, damage prevention, safety and costs. Surge protection is provided at differing levels in an installation with the finer levels of protection provided closer to user's sensitive equipment. In some cases, surge protection is built into the charging equipment. Where this is not the case protection should be provided close to the equipment and in most cases, it should be fitted at the final circuit distribution board.

3.8.2 Lightning protection systems

Depending on the location, a lightning protection risk assessment should include the impact of EVC equipment, e.g. where the equipment is mounted at high level (top level of a multi-storey car park).

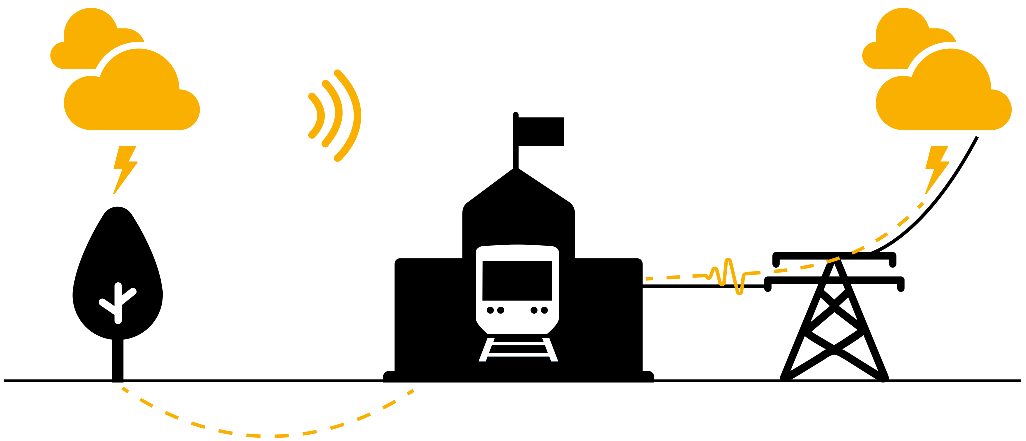


Image 3.19: Lightning protection system image

But first...
High-rise buildings often surround a railway, but they do not always protect the rail corridor, so direct and indirect lightning strikes to railway buildings and the railway overhead electrification lines are credible risks. It is important to mitigate the risks associated with lightning strikes with a robust risk assessment and protection systems. It is likely that final system design should include surge protection.

3.9 Circuit and Cable Design

3.9.1 Circuit and cable design

Cable selection and design principles should be considered for the whole EVC electrical distribution system in line with BS 7671.

When considering the circuit design of several EVCs for an installation items to be considered in the design should be:

- Total Load of EVC
- Existing or new earthing arrangement
- Arrangements for metering
- Type of wiring systems
- Cabling routes
- Type and size of protective devices - Miniature Circuit Breakers (MCBs), Residual Current Devices (RCDs), Moulded Case Circuit Breakers (MCCBs)
- Selectivity and co-ordination of protective devices
- Distribution system and sub distribution boards
- Dedicated circuits to each EVC (no ring circuits)
- Isolation of circuits
- Location of feeder pillars
- Location of EVC

BS 7671 requires that manufacturer's instructions should be followed for installation and maintenance.

Fundamental Design principles should be applied and guidance can be found in the IET Electrical Installation Design Guide (Calculations for Electricians and Designers) and Appendix 4 of BS 7671 for calculation of current carrying capacity and voltage drop for cables. BS 7671 Appendix 4 also advises on how to determine the cross-sectional area of a conductor which is dependent on, amongst other factors, the type of overcurrent protection provided. In addition the IET Guidance note 6 gives further information on cable sizing.

All design and installation activities should be carried out by suitably skilled persons as defined in Part 2 of BS 7671.

Regulation 16 of the Electricity at Work Regulations 1989 requires persons to be competent to prevent danger and injury. The HSE publication HSR25 provides guidance on this.

Watch Point
Skilled person (electrically). Person who possesses, as appropriate to the nature of the electrical work to be undertaken, adequate education, training and practical skills, and who is able to perceive risks and avoid hazards which electricity can create.

City & Guilds have recognised Level 3 qualifications for design and installation of electric vehicle charging equipment.

- **2921-31** Design and installation of domestic and small commercial electric vehicle charging installations.
- **2921-32** Design and Quality Assurance of Largescale electric vehicle charging installations.
- **2921-33** Installation and maintenance of Largescale electric vehicle charging installations.

3.10 Additional Protective Measures

3.10.1 Final circuit protection

As common to other special locations covered by BS 7671, certain measures are required to be considered when assessing shock protection, these include:

- Final circuit(s) of a TN supply serving an EV charging point should not include a combined neutral and protective (PEN) conductor.
- Each EVCP should be supplied individually by a final circuit protected by an overcurrent protective device, details of this arrangement can be found in the typical EV distribution layouts below. It is important to note that the 'dedicated final circuit´ is between each EVCP and its origin of supply and could be within an EVCE that has multiple charging points e.g. dual output charger.
- Every EVCP should be protected by a 30 mA RCD. RCDs conforming to one of the following standards should be used for EVCP:
  - BS EN 61008-1
  - BS EN 61009-1
  - BS EN 60947-1
  - BS EN 62423
  - BS IEC 62955

3.10.2 Correct RCD

Protection of the final circuit to the charging equipment should be a specific type of RCD.

For mode 3 and 4 charging, the equivalent of a Type B RCD protection is required, as follows:

- Use of a Type B RCD: or
- Type A RCD: in conjunction with an RDC-DD; or
- Type F RCD, in conjunction with an RDC-DD.

Where the EVCE does not have DC fault protection inbuilt, then the designer should select the appropriate RCD device. The British Electrotechnical and Allied Manufacturers' Association (BEAMA) 'Guide For Residual Current Device (RCD) Protection Of Electric Vehicle (EV) Charging Installations' provides useful guidance for the selection of RCD devices.

RCDs should disconnect all live conductors.

It should be noted that Network Rail operate both AC and DC traction railway systems. Within DC traction areas (mainly in the southern regions) consideration is to be given to EV installations within 30 m of the operational railway, as this might necessitate the use of DC immune RCDs.

Watch Point
BS 7671 Regulation 722.531.3.1 stipulates that RCDs should disconnect all live conductors (including the neutral) – which might rule out many types of RCBO, which can only interrupt one pole.

Network Rail document

NR/GN/ELP/27274
Guidance for Electrical Installations on Rail Premises (including Plugs, Sockets, Trailing Leads & Appliances)

RDC-DD: Residual Direct Current – Detecting Device monitors and detects DC residual current. RDC-DDs are intended to disconnect the power supply to the EV charging equipment if DC residual current is detected on the AC side of the installation which could impair the operation of Type A and Type F RCDs.

RCD	Use for EVC	Comment
Type AC	NO	NOT TO BE USED ON EVC
Type A	YES	EVC IN CONJUNCTION WITH RDC-DD
Type B	YES	
Type F	YES	EVC IN CONJUNCTION WITH RDC-DD

Table 3.2 RCD suitability for EVC installations

3.11 LV Infrastructure Design

3.11.1 LV infrastructure design

When considering the locations of feeder pillars and cable duct routes the designer should focus particular attention to soft dig areas for ease of installation, expansion and maintenance.

Once the load characteristics have been determined and the physical location of the EV chargers are established the designer is advised to identify a suitable distribution network to supply the EVC with future provisions in mind. Where additional load and spare distribution board capacity is available the addition of a sub-distribution board might be the most straight forward option to implement.

This option does present its own challenges in regards to assuring circuit configuration maintains selectivity of protective devices and the potential of large cables where long distances are involved.

Where larger networks of EV chargers, or where it has been established that DC chargers are advised, the designer and client might conclude that an additional dedicated mains supply from the DNO is the most suitable option.

This option has the benefit of a simplified network where the DNO supply could be located close to the EVCs eliminating large sub distribution supply cables. The DNO supply, metering and final distribution circuits could be located in the same room or a dedicated feeder pillar cabinet. Examples are shown below.

Watch Point
Some DNOs might not accept two sources of supply from their network entering the same site, which might mean an upgrade of the supply is the only solution.

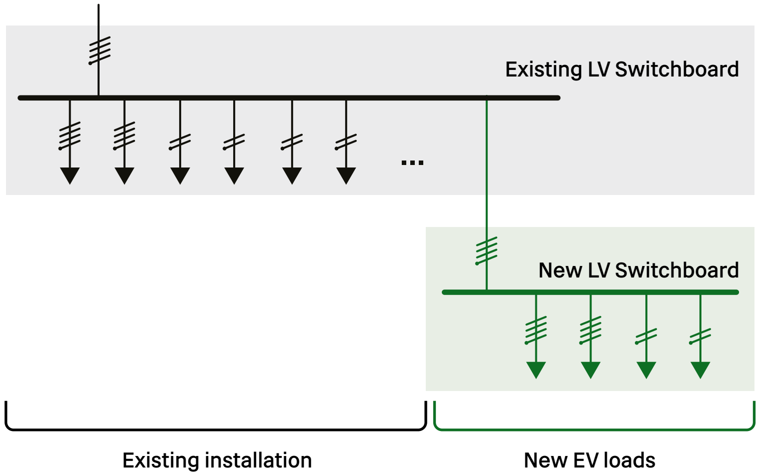


Image 3.20: Typical distribution layout coordinated with existing infrastructure

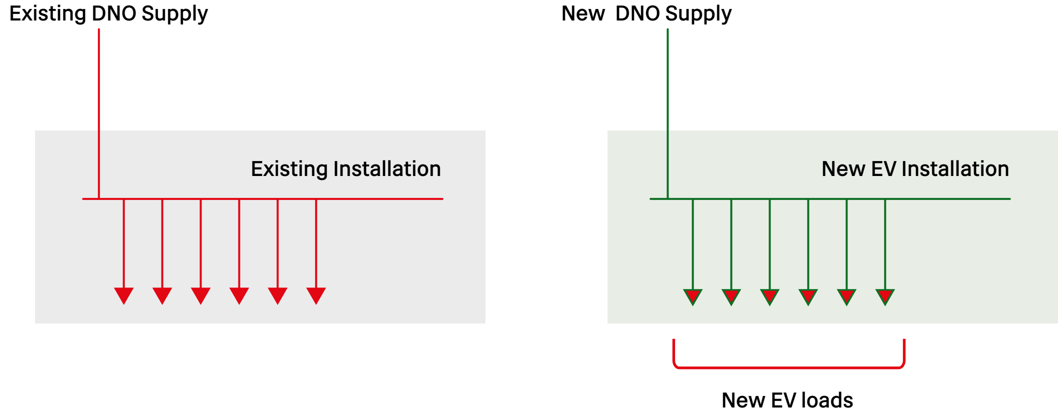


Image 3.21: Typical distribution layout with new DNO supply

Wiring system, cable containment, ducting and feeder pillar routing and locations

All wiring systems should be suitable for the environment in which they are installed.

When considering a suitable wiring system for EVCs, all environmental conditions should be considered. The route of this wiring system might be exposed to public areas and might require additional protection from interference and vandalism. EVC locations in works depots where the risk of significant impact damage to the wiring system is increased, this should be mitigated in the selection and design.

Most EVCs are likely to be installed externally and require trenching to the location with the use of armoured cable, ducts and warning tapes required. In these cases, the location of the EVCE might be influenced by the type of ground conditions, soft dig routes should be the primary consideration.

It is necessary to consider cabling infrastructure route to the EVC, including any additional infrastructure requirements for future expansion. Ducts should be sized to account for total capacity including future expansion requirements.

Support from the civils designer is recommended for below ground trenching routes and configurations giving a preference to soft dig areas.

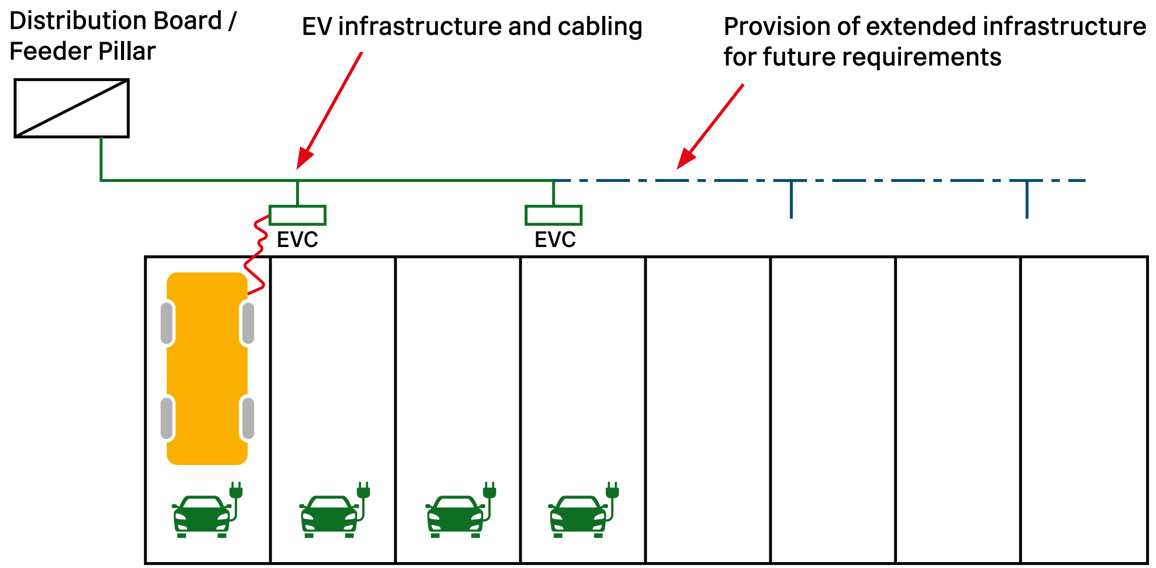


Image 3.22: Example routing diagram

3.11 LV Infrastructure Design

This image details an example boundary mounted EV charger installation. The dual charger provides an adequate division between the bays. This layout is typical for retrofit installations.

Typically a localised feeder pillar might contain the EVC sub distribution board and metering, or new DNO supply which will prevent the requirement for many final circuits requiring ducting from a nearby building.

Image 3.23: Herne Hill - Example of installation with feeder pillar for EV

Key design considerations

- Duct installations / containment should be provided from a suitable electricity supply at the building or development site to the installation position for each charge point.
- The design of the installation should identify and make provision for any intermediate switchgear or other control apparatus required to manage the distribution of the electrical supply to each charge point or future charge point location.
- The size, specification and bend radius of all cable ducts / containment should be based upon the confirmed type of cabling required to meet the required power supply at each outlet. Underground cable duct installations should meet BS EN 61386-24 – Conduit systems for cable management - Particular requirements.
- Where possible cabling infrastructure should installed in soft dig or where applicable wall mounted.
- All underground cable ducts should meet the positioning and colour-coding standards in the National Joint Utilities Group ‘Guidelines on the Positioning and Colour Coding of Underground Utilities’ Apparatus’.
- The point where a cable duct enters a building should be sealed to prevent water ingress and attack by vermin, and to comply with all relevant Building Regulations requirements. Where a charge point is not fitted as part of initial work, enabling/passive infrastructure should be provided.
- Enabling infrastructure such as feeder pillars, switches, earth electrodes and concealed ducting for cable runs for passive EV provision should be installed at the time of construction. This should enable the installation of charge points and any intermediate control equipment without the requirement for additional builderswork other than at the equipment installation points.
- The termination points of cable ducts should be located to provide adequate space for future installation and ongoing maintenance of a charge point.
- Termination points for future connections should be weather sealed but clearly identified and accessible. Location of future charge points should be identified by durable, weatherproof signage with text not less than 25 mm high noting “Dedicated position for electric vehicle charge point”.

3.12 Communication and Security

3.12.1 Communication

The EV charging units should have Open Charge Point Protocol (OCPP) capability. In addition, when considering communications for public use the requirements in The Public Charge Point Regulations 2023 should be implemented.

The OCPP is a standardised communication protocol used in the EV charging industry. It enables interoperability between different charging station hardware and software, allowing EV charging stations from different manufacturers to communicate with central management systems and billing platforms.

By implementing OCPP, charging station operators can connect their stations to various central management systems and service providers, regardless of the equipment's brand or model. This interoperability enables flexibility in network management, software integration, and payment solutions and back end developments, e.g. pre booking EV slots, knowing when chargers are faulty etc. Moreover, it simplifies the process of scaling EV charging infrastructure, as operators can easily add, remove, or replace charging stations without facing compatibility limitations.

> **Note**
> Cat 6 data, Mobile or Wi-Fi coverage might be required. Some EVSE manufacturers require a minimum of 3G coverage, however this might not be the most reliable and might not be supported in the future. Consideration should be given to hard wired CAT 6 data cabling.

Considerations for network interfaces should be undertaken:

- → Electromagnetic compatibility (EMC)
- → Network management and security which might be managed in line with corporate strategies and policies, driving the selection of products or protocols.

3.12.2 Security

Connecting an EV to an existing information and communications technology (ICT) network might provide an opportunity to compromise the security of either the EV or the network to which it is connected.

Targeted theft of an EV and its connection to a previously visited charging system could provide a channel to compromise cyber security in a vulnerable ICT network. Reference should be made to European Telecommunications Standards Institute (ETSI) Technical Specification 103 645, BS EN 27001:2017 and PAS 1192-5:2015 when EVs are connected via apps and internet of things to a network.

3.13 Risks

3.13.1 Introduction

Considerations about potential risks when designing electrical vehicle charging systems:

- → Electrical safety
- → Fire risks
- → Structural implications (existing car parks)

The Fire Protection Association have produced recommendations within RC59: Recommendations for fire safety when charging electrical vehicles. These recommendations also include a check list which has been designed for use by premises operators.

3.13.2 Electrical safety

Key electrical considerations have been highlighted below in relation to electrical safety.

- → A circuit intended to supply an EV should be fit for purpose and suitable for the electrical load. The circuit should be dedicated to the use of the chargers, and not be part of a ring main or used for other purposes.
- → EV equipment should be suitable for the load and provide protection against external influences, such as mechanical damage and ingress of water.
- → When a charger is found to be faulty, its use should cease immediately and it should be isolated and locked out, with a suitable warning sign being displayed prominently until satisfactory repairs have been made by a competent technician.
- → Emergency manual isolation of EVCPs should be provided to assure safe shutdown of equipment in the event of a fault on the mains electrical supply. The isolation point(s) should be prominently signed and strategically located where it will be readily accessible to trained staff and firefighters.
- → Emergency isolation switches should incorporate lock out facilities to prevent unauthorised reinstatement during maintenance and emergencies.
- → In a covered car park automatic fire detection should be interfaced so as to isolate the power supply to all vehicle chargers in the event of the fire alarm actuating.

3.13.3 Fire risks

EVs might be located in several locations such as:

- Public Outdoor Area
- Secure Outdoor Area
- Roof top level
- Covered Car Parks
- Basements

EV fires can burn hotter and last longer than non-electric vehicle fires. The project team are required to be cognisant of issues which may impact EV siting and a fire risk assessment is to be carried out at the early stages when planning an EV charger installation project.

When planning EV charger installations, consideration should be given to locating these in the open air to minimise potential for fire spread within the structure, and away from building fire escape routes.

Watch Point
Early engagement with building insurers is critical when planning EV charger installations. Building insurers should be consulted prior to commencement of any installation works to understand if any impact to insurance policies and premiums.

If EVCPs are planned within covered car parks and basements, then the level of fire protection will be much greater compared to open air locations. Due to the intense and prolonged nature of fires involving lithium-ion batteries, careful consideration should be given to the design of active and passive fire protection arrangements. There should also be liaison with the fire and rescue service concerning access for fire-fighting.

Further guidance on fire safety recommendations can be found in the Fire Protection Association RC 59: Recommendations for fire safety when charging electric vehicles, and the Office for Zero Emission Vehicles (OZEV) publication on Fire Safety of Electric Vehicles in Covered Car Parks. The latter provides case studies highlighting mitigation measures for existing covered car parks and new covered car parks.

3.13.4 Structural risks

When retro fitting car parks an important consideration is the weight of EVs. Therefore, when planning EV locations, the weight of EVs should be considered. This could mean weight limits are imposed or buildings strengthened. Structural elements might also require improved fire resistance as EV fires burn longer than fossil fuel vehicles exposing the structure to a potentially greater risk.

3.14 EV Charging Layout Planning

3.14.1 Location of charge points

Charge points should not be located on an existing access route and should not present an obstruction to pedestrians, cyclists or vehicles.

Location of charge points should enable charging to take place without charging cables crossing or otherwise obstructing pedestrian, cycle or vehicle routes, including drop kerbs between road and pedestrian surfaces.

Charge points should be positioned in relation to parking spaces to minimise the risk of accidental damage, for example, from vehicles projecting over kerbs.

Where a protective barrier is provided, this should not impede the use of the charge point.

Where a charge point serves more than one parking space it should be provided with one charge point socket per parking space (with each socket able to deliver a minimum of 7 kW simultaneously) and be positioned to enable safe and convenient use of all outlets at the same time.

EVCP locations should avoid junctions, crossing and other vehicle/pedestrian intersections to avoid the risk of obstructing visual sightlines between motorist and pedestrian.

To enable installation, maintenance and ease of use:

- → Floor mounted charge points should be installed so that there is not less than 1500 mm between the sides, and 500 mm between the rear, of the charge point enclosure and any adjacent wall or similar obstruction.
- → Wall mounted charge points should be installed so that there is not less than 800 mm between the charge point enclosure and any adjacent wall or similar obstruction.
- → Charge points should be installed with the lower edge of the charge point enclosure between 700 mm and 1000 mm from floor level.
- → Explosive environment assessment - Special requirements are required where hazardous environments are adjacent to the proposed EVC locations. This might be applicable to depots and yards where refuelling of rolling stock takes place, or car parks adjacent to a fuel filling facility.

Watch Point

- → Planning consent (or permission) for charge points might be required under certain circumstances.
- → An Environmental Impact Assessment (EIA) should be undertaken to assess the local environmental restrictions, e.g. EVCPs should not be located on flood plains or near to Japanese knotweed, and light pollution impact should be mitigated.

3.14.2 Layout considerations

Where projects are governed by building regulations the minimum number of charging bays allocated can be mandated by such regulation as can the number of parking bays requiring EV cabling infrastructure.

When space planning for EV charging bay the design team should consult Network Rail Parking and Mobility at Stations Guide NR/GN/CIV/200/11 for further guidance.

Key considerations

- → Where EV charging points are designed for disabled users a standard 1200mm transition zone between spaces for should be maintained. Potential trip hazards, such as trailing charging leads should be avoided
- → Tethered cable storage should be made available
- → Space should be considered for suitable ventilation particularly for rapid and ultra-rapid DC charging equipment
- → Ease of access and maintenance should be factored in to any design
- → Chargers should be provided with mechanical protection from impact by a vehicle through such measures as, bollards, tyre stops or protective cage
- → Adequate lighting should also be available for safe connection and use of an EVCP
- → Public charging points should be sited so as to accommodate the widest diversity of requirements as per the Equality Act 2010. This will include wheelchair users, parents and those with mobility issues.

Watch Point
ICEing is a term used to describe an internal combustion engine vehicle parking in a EV charging bay without requiring to use the charging unit thereby preventing an EV vehicle being charged. The act of 'ICEing' can be avoided by considering locations away from the main building frontage as suitable EV charging bay locations. The spaces closest to the building are the most popular with all vehicle users. Locations for EVC should also avoid potential hiding places or locations for anti-social behaviour.

Image 3.24: Example of poor accessible design

Watch Point
When planning/siting EV charging equipment, a Diversity Impact Assessment (DIA) is required to be undertaken.

Network Rail document

NR/GN/CIV/200/11
For further information about EV parking bays, including dimensions of bays.

3.14 EV Charging Layout Planning

National Standard

Additional guidance on delivering accessible charge points is contained within **PAS 1899 – 'Electric vehicles – Accessible Charging – Specification'**

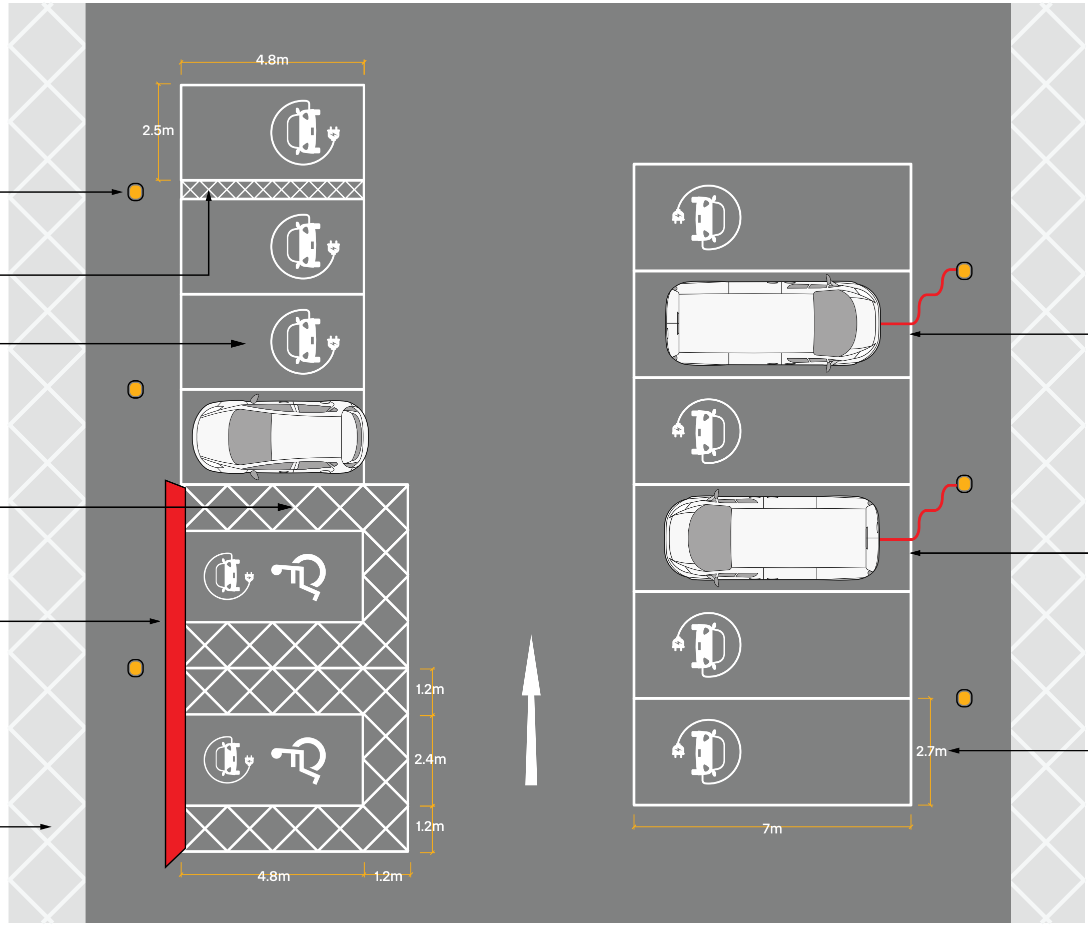


Image 3.25: Space planning considerations

3.14.4 Protection from impact

Due to the nature of vehicle charging the EVC units are mounted close to parking spaces and might be subject to impact from vehicle parking. EVC equipment should be installed in locations that minimise the likelihood of vehicle damage caused by the vehicle parking. This risk is increased where the driver is advised to reverse towards the EVC equipment.

Where it is likely that the position of the EVC equipment cannot prevent a possible collision and subsequent damage, additional barriers or protective posts should be installed. The positioning of these barriers and posts should be so arranged for accessible parking spaces clear access should be provided for wheelchairs and other aids to enable the user to operate the equipment, socket outlets and controls as required by BS 8300-1. Consideration of cable management or user instruction is advised to prevent unnecessary trip hazards.

Charging points should be protected against mechanical damage by vehicles. They should be installed above ground level and be located on a raised island or be protected by kerbs or metal barriers. Charging points should also be protected against the ingress of water and foreign objects.

Image 3.26: Example of general EVC barrier design

3.15 EV Signage and Branding

3.15.1 EV signage

Clear signage and painted bays help EV drivers find chargepoints, understand any restrictions and should prevent them from being blocked by petrol or diesel vehicles.

Signage on private land can be of the landowner's choice, but as a minimum the DfT guidelines should be followed.

Image 3.27: Typical EV signage

Typical Requirements:

→ EV spaces should be clearly marked and identified as EV only (see DfT signage standards).

→ Public charge points might be subject to additional requirements, including displaying the energy tariff either on the charge point or on an electronic device.

→ Direction signage can be useful to direct users to the charging equipment.

Image 3.28: Network Rail fleet EV charging bays

3.15.2 Branding

To support a standardised approach to charging infrastructure, branding guidance has been produced by Network Rail. Branding information for suppliers including charger colour and logos can be found in the Electric Vehicle (EV) Charging Infrastructure Brand Guidance.


Electric Vehicle (EV) Charging Infrastructure Brand Guidance

EV Charging Infrastructure Branding

Image 3.29: Network Rail Electric Vehicle (EV) Charging Infrastructure Brand Guidance.

Electric Vehicle Charging Points and Associated Infrastructure Charging Guide

Section 4: Handover and Maintenance

4

4.1 Handover and Maintenance

4.1.1 Handover

It is important to provide all necessary documentation and conduct comprehensive handover to assure the client understands how to use and maintain the charge point correctly, promoting a safe and efficient charging experiences. The following information also needs to be included within the Health and Safety file.

Items for handover at completion

1. **Charge point user manual:** A detailed user manual should be provided that includes instructions on how to operate and use the charge point effectively and safely. It should also include any specific features or functionalities of that particular charge point model.
2. **Manufacturer contact information:** Provide the contact information of the manufacturer or supplier of the charge point. This will allow the user to reach out in case of any issues, queries, or maintenance requirements.
3. **Warranty information:** Supply details about the warranty coverage for the charge point, including the duration and what is covered. This will help the user in case any defects or malfunctions occur during the warranty period.
4. **Safety guidelines:** Provide a set of safety guidelines and precautions that should be followed while using the charge point. This should include instructions on handling electrical connections, keeping the charge point away from water sources, and other important safety measures.
5. **Electrical Certificates:** A copy of the Electrical Installation Certificate including the schedule of inspections and test results schedule.
6. **Functional demonstration:** Conduct a demonstration to show the user how the charge point works, including how to connect and disconnect the charging cable, how to initiate a charging session, and any additional features or functionalities specific to the charge point model.
7. **Check List:** A copy of the check list, which includes a check prior to the installation, a physical installation check and general requirements check.

4.1.2 Maintenance and services

Maintenance period should be provided by the Manufacturers and their guidance should be followed.

Service and response time should be considered in line with Network Rail KPIs and dependent on number of vehicles, criticality and uses of the vehicles.

It should be made clear to the users of the EVC when the units become faulty and out of use by a sign of notification on the unit's display.

The client should be provided with the instruction manual for the equipment. Where the equipment is owned and run by the client, they should be informed of any maintenance requirements for the equipment and should add the equipment to any existing maintenance schedules.

4.1.3 Monitoring and fault repair

Public charging

Monitoring

- → Charge points should be remotely monitored by the operator to assure they are in service and functioning correctly and that any faults are quickly identified.
- → Reporting from operators on key charging metrics is also recommended to assure that charge points are being operated and maintained in line with national regulations and to help identify if / when additional charging might be required and of what type.
- → Key metrics are likely to include:
  - → Reliability and uptime (the % of the hours of car park operation that the charge point is available) – regulations require that for rapid charging this is at least 99% of operating hours.
  - → Charging events by time of day (what time a vehicle is plugged in and how long they are plugged in for).
  - → Energy consumed per charging event.
  - → Display the total price for charging and rates in pence per kilowatt hour.
- → Monitoring charging events throughout the day / week can also help identify available capacity at different times (potentially for other users).

Fault repair

- → Maintenance and repair of infrastructure is typically undertaken by the CPO, though this can vary.

Table 4.1 Monitoring and fault repair - public charging

Private charging

Monitoring

- → Charge points should be remotely monitored by the operator to assure they are in service and functioning correctly and that any faults are quickly identified.
- → Key metrics around charging events, energy consumption and plug in time should be monitored to inform decision making on:
  - → Possible staff or 3rd party access to charging during periods where not being otherwise utilised.
  - → Any additional charging capacity requirements.
- → Monitoring available capacity by time of day can also help to determine the resilience of charging at the site in the event of a charger fault.

Fault repair

- → Accountability for the ongoing maintenance and repair of infrastructure should be determined ahead of installation.
- → Infrastructure important to the operation of the Network Rail fleet might require repair within 24 hours.
- → Consideration should be given to available contingency when installing charging.

Table 4.2 Monitoring and fault repair - private charging

4.1.4 Warranties

Any warranties should include as a minimum:

- → Statement that confirms that the minimum operational life of the ChargePoint is 3 years from the date of installation;
- → Statement that confirms that the warranty is valid for a period of 3 years from the date of installation;
- → Statement that confirms that any on-site assistance, repairs and replacements are provided for free;
- → Statement that confirms that the warranty covers both parts and labour;
- → Explanation of the procedures for the customer to seek the manufacturer's assistance, including contact details of the manufacturer (or the third party that provides assistance);
- → List of the evidence necessary for the customer to obtain the manufacturer's assistance; and
- → List of the exclusions and caveats that make the warranty inapplicable.

4.1.5 Faults

Where EVC equipment is installed for public charging the requirements of The Public Charge Point Regulations 2023 should be met. These include but not limited to:

- → Charge point operators should report the following data to the Secretary of State every 12 months from 2025:
  - → The total number of charge points operated during the calendar year;
  - → The reliability of the charge point operator's network of rapid charge points during the calendar year expressed as a percentage; and
  - → The reliability of each charge point during the calendar year, which should include the location and the time spent in each EVSE object status over the year.
- → Charge point operators should have a staffed 24-hour free helpline.
- → Helpline number clearly displayed.
- → Should keep a record of all calls received.
- → Submit quarterly report on breakdown of calls.

Electric Vehicle Charging Points and Associated Infrastructure Charging Guide

Appendix A

A

Appendix A
Installation examples

As-installed examples

Risks associated with EV charging are far reaching and can impact the owners and users of the infrastructure where poor planning, design and incorrect use can increase risk. The nature of EV charging can introduce risks around poor access, safety, and vandalism etc., and where possible these should be designed out. Considerations such as inclusivity are key when targeting a good standard installation and layout.

Before commencing an EV charging project, lessons learned from previous projects should be reviewed and understood for continuous improvement.

The following pages show as-installed examples of EVCP installations.

Image A.1: Example 1

Image A.2: Example 2

Example 1

Good

- → EV bay clearly marked.
- → Shared walkway between bays providing adequate space.
- → Protection barrier around EVCP.

Even better if...

- → Protection barrier provided to control cabinet in parking space.
- → Additional lighting to improve night time charging access.

Example 2

Good

- → EV bay clearly marked with charging capacity.
- → Clear signage.
- → Wide parking bay.
- → Protection barrier in front of EVCP.
- → Chargers and feeder pillar in soft dig area.

Even better if...

- → Lighting to facilitate night time charging.
- → Shared walkway between parking bays.

Image A.3: Example 3

Image A.4: Example 4

Considerations - Good Practice

- → No step/kerb to charger.
- → Good lighting.
- → Barrier protected EV charger.
- → Well sign posted or easily identified.
- → Choice of charging power and power displayed.
- → Ease of use for all.
- → Wide space for easy access.
- → CCTV coverage.
- → Not hidden away from sight.
- → Located away from premium spaces.
- → Secure Data Comms connected.

Example 3

Good

- → EV bay clearly marked and signed.
- → Protection barrier around EVC.

Even better if...

- → Wider parking bays for easier access.
- → Additional lighting to facilitate night time charging.
- → Improved charger access for people with reduced mobility.

Example 4

Good

- → EV bay clearly marked.
- → Shared walkway between bays providing adequate space.
- → Access for all to charging point.

Even better if...

- → Additional lighting to facilitate night time charging.
- → Protective barrier around charger to prevent damage.
- → Clear signage.

Electric Vehicle Charging Points and Associated Infrastructure Charging Guide

Appendix B

B

Glossary

AC

Alternating Current

AEV

All Electric Vehicle

ANPR

Automatic Number Plate Recognition

API

Application Programming Interface

BEAMA

British Electrotechnical and Allied Manufacturers' Association

BEV

Battery Electric Vehicle

CCS

Combined Charging System

CCTV

Closed Circuit Television

CCZ

Current Collector Zone

ChAdeMO

Charge de Move

CPC

Circuit Protective Conductor

CPO

Charge Point Operator

DC

Direct Current

DfT

Department for Transport

DIA

Diversity Impact Assessment (DIA)

DNO

Distribution Network Operator

EIA

Environmental Impact Assessment

EMC

Electromagnetic Compatibility

ENA

Energy Networks Association

EREV

Extended Range Electric Vehicle

ETSI

European Telecommunications Standards Institute

EV

Electric Vehicle

EVC

Electric Vehicle Charger

Appendix B
Glossary

EVCE

Electric Vehicle Charging Equipment

EVCP

Electric Vehicle Charge Point

FCEV

Fuel Cell Electric Vehicle

FIFO

First In, First Out

GRP

Glass Reinforced Plastic

GSM

Global System for Mobile Communications

HEV

Hybrid Electric Vehicle

HGV

Heavy Goods Vehicle

HSE

Health and Safety Executive

HV

High Voltage

ICT

Information and communications technology

IET

Institute of Engineering and Technology

ISO

International Organisation of Standards

kW

Kilowatt

LV

Low Voltage

MCB

Miniature Circuit Breaker

MCCB

Moulded Case Circuit Breaker

MDU

Maintenance Delivery Unit

MID

Measuring Instruments Directive

OCLZ

Overhead Contact Line Zones

OCPP

Open Charge Point Protocol

OZEV

Office for Zero Emission Vehicles

PEN

Protective Earthed Neutral

PHEV

Petrol Hybrid Electric Vehicle

PME

Protective Multiple Earthing

RCD

Residual Current Device

RCBO

Residual current circuit breaker with overcurrent protection device

RDC-DD

Residual Direct Current – Detecting Device

ROC

Rail Operating Centre

UKPN

UK Power Networks

ULEV

Ultra Low Emission Vehicle

V2B

Vehicle to Building

V2G

Vehicle to Grid

V rms

Root-mean-square voltage

ZEV

Zero Emissions Vehicle

Reference Documents

A wide range of Network Rail and industry-wide documents and guidance notes were used in compiling this Guide.

This section lists the most relevant standards and guidance documents referenced within this Guide. These documents are drawn from a range of sources and have been used in the development of this Guide. The list is not intended to be exhaustive but provide the user of this Guide with a sound basis upon which to develop any station scheme.

Relevant Network Rail Standards and Guidance documents:

- Station Design Guidance (NR/GN/CIV/100/02)
- Parking & Mobility at Stations (NR/GN/CIV/200/11)
- Guidance for Electrical Installations on Rail Premises (including Plugs, Sockets, Trailing Leads & Appliances) (NR/GN/ELP/27274)
- Electric Vehicle Charging Points and Associated Infrastructure (NR/L2/CIV/902)
- Earthing and Bonding on A.C. Electrified Railways (NR/L2/ELP/21085)

British Standards:

- BS EN 12464-2 Light and Lighting – Lighting of work places
- BS EN 27001:2017 Information technology. Security techniques. Information management systems
- BS EN 61386-24 Conduit systems for cable management. Particular requirements
- BS EN 61851-1 Electric vehicle conductive charging system. General requirements
- BS EN 61890
- BS EN 62196 Plugs, socket-outlets, vehicle connectors and vehicle inlets. Conductive charging of electric vehicles
- BS 7430 Code of practice for protective earthing of electrical installations
- BS 7671 IET Wiring Regulations
- BS 8300-1 Design of an accessible and inclusive built environment. External environment - code of practice
- BS 8300-2 Design of an accessible and inclusive built environment. Buildings - code of practice

Appendix B

Reference Documents

Regulations:

- Building Regulations Part S (England and Wales)
- Scottish Government, Non-Domestic Technical Handbook, Section 7.2.
- IET Code of Practice for Electric Vehicle Charging Equipment Installation
- IET Electrical Installation Design Guide: Calculations for Electricians and Designers
- IET Guide to Earthing and Bonding for AC Electrified Railways
- The Public Charge Point Regulations 2023
- Electromagnetic Compatibility Regulations
- Electrical Equipment Safety Regulations
- Electricity at Work Regulations 1989
- The Electric Vehicles (Smart Charge Points) Regulations 2001

Guidance, specifications and recommendations:

- ENA Engineering Recommendation G5-5
- ETSI Technical Specification 103 645
- FPA RC59: Recommendations for fire safety when charging electric vehicles
- National Joint Utilities Group (NJUG) Guidelines on the Positioning and Colour Coding of Underground Utilities' Apparatus
- OZEV T0194 – Covered car parks: fire safety guidance for electric vehicles
- PAS 1899 – Accessible electric vehicle charging
- PAS 1192-5:2015 Specification for security-minded building information modelling, digital built environments and smart asset management
- RC59: Recommendations for fire safety when charging electrical vehicles

Acknowledgements

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