A guide on electric vehicle charging and DNO engagement for local authorities

UKEVSE

UK ELECTRIC VEHICLE SUPPLY EQUIPMENT ASSOCIATION

WESTERN POWER DISTRIBUTION

Serving the Midlands, South West and Wales

Who is this guide for?

This guide is intended for local authorities who are considering buying and installing electric vehicle (EV) charge points to support staff, visitors and local residents who drive EVs.

What is this guide about?

The transition to EVs is expected to play an important role in achieving the UK's targets for decarbonising the transportation sector, as well as helping to reduce air pollution. Based on 2018 Future Energy Scenarios published by National Grid, there are already more than 130,000 electric vehicles on UK roads and that number is predicted to rise to 36 million by 2040. This growth will lead to increased demand for publicly accessible charge points and it is important to ensure that everyone can have easy access to a well-structured EV charging network across the UK. Local authorities can help support this transition by investing in charge points and by the advice and support provided to others who are interested in investing in local charging infrastructure.

This guide lays out the fundamentals of what is required during a charge point installation project; from equipment considerations through to location choice and stakeholder involvement. It also explains the important role the Distribution Network Operator (DNO) plays in providing power to the charge points and why contacting them early in the process of planning new charge point installations will be beneficial.

What is a Distribution Network

A Distribution Network Operator (DNO) is a company licensed to distribute electricity in the UK. It is responsible for the distribution of electricity downstream from the national transmission grid, to industrial, commercial and domestic users. It also maintains and operates the underground cables, overhead lines and substations.

When new charge points are installed, it is the DNO that connects them to the local power network.

DNOs do not supply the electricity. Electricity suppliers pay DNOs to distribute electricity through the network to homes and businesses. Customers can choose from many different suppliers.

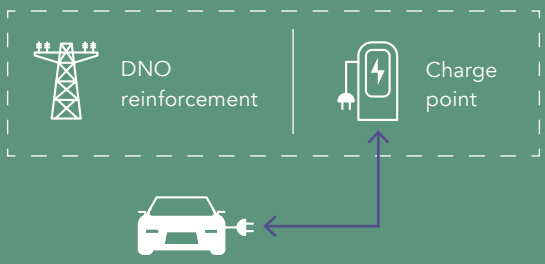
How can DNOs help?

The cables and substations that make up the electricity networks are assets with a long operational life and the networks we have today are the result of many years of planning and development. It is recognised that a rapid growth in EV uptake will lead to EV charging at a wide variety of locations. These additional connections to the distribution network will each need to be assessed to determine if there is available capacity or if local upgrades will be needed.

An early engagement with the DNO and a qualified electrical contractor can help identify whether your proposed location has adequate capacity to meet the charging demand and the DNO can also help identify alternate locations with spare capacity. If there is enough capacity from the existing supply, no network reinforcement will be required. If any reinforcement is needed, it will be your local DNO who will provide this. The DNO will also provide quotations for new connections and upgrades to existing ones. The scope of this upgrade and reinforcement may extend to include increases in capacity for existing transformers, distribution overhead lines and cables to meet higher peak demand and lower impedance connections. Cost calculations for grid network investments will vary depending on the local situation but a guide is provided on page 8.

When thinking about planning to get charge points installed and operational, it is important to think of the process from the energy system perspective – with the DNO providing the critical link to an electrical power supply. Put simply, any plan to install EV charging infrastructure needs to consider both the charge point hardware installation and necessary grid network reinforcement.

Figure 1: EV charging infrastructure installation



Your DNO needs to be properly engaged and consulted to coordinate and facilitate the connection of charge points to the network. Your DNO needs to understand how much electricity demand the charge points will require and the required connection characteristics to help ensure the local low voltage and medium voltage network have sufficient capacity and are designed to prevent issues for other local electricity users.

What are the key considerations?

Charge point specifications

EV charge points are mainly defined by the power they can produce and the how quickly they can charge an EV. The Connector Type is also a consideration as there are different charging plug standards and configurations for slow or fast charging compared with rapid charging, as well as direct current (DC) charging when compared with standard alternating current (AC) charging.

The following table represents the various charging options available to plug-in car drivers based on a 30kWh battery.

Charge point type	Power transfer		Typical charging time	Recommended location
Slow	≤3kW	Single phase	8-12 hrs	Parking on public streets, in public car parks, leisure facilities, shopping centres and tourist attractions, workplace parking and depots
Fast	≤7kW	Single phase	3-4 hrs	
	<22kW	Three phase	1-2 hrs	
Rapid	≤43kW	Three phase	80% in 20-30 mins	Public parking, taxi ranks, bus depots and motorway service areas
	≤50kW	DC		
Super-rapid	≤43kW	Three phase	<20-30 mins	
	≤50kW	DC		

Power requirements

The table below outlines the design requirements for the connection of EV charge point equipment to new and existing supplies.

Charge point type and power output per outlet	New energy supply capacity required per charge point now	New energy supply capacity per charge point for future-proofing
Slow or Standard 2.4kW or 3kW	Generally not required	80 or 100Amps AC single phase (for a faster charge point)
Fast 3.7kW AC	Generally not required	80 or 100Amps AC single phase (for a faster charge point)
Fast 7kW AC	Generally not required	Three phase AC supply; 80Amps per phase (for a faster or rapid charge point)
Fast 11kW AC	Three phase AC supply; 16Amps per phase	
Fast 22kW AC	Three phase AC supply; 32Amps per phase	
Rapid 20kW DC	Three phase AC supply; 32Amps per phase	Three phase AC supply; 80Amps per phase
Rapid 43kW AC	Three phase AC supply; 100Amps per phase	Three phase AC supply; 100Amps per phase
Rapid 50kW DC	Three phase AC supply; 100Amps per phase	Three phase AC supply; 100Amps per phase
Supercharger 130kW DC*	Three phase AC supply; 200Amps per phase	Three phase AC supply; 200Amps per phase

*Higher power superchargers are under development and testing at the time.

Technical considerations

Harmonics

The electricity network has an alternating current waveform (A.C.) and the power flow within an electric vehicle is direct current (D.C.), therefore a converter is required to change to waveform from A.C. to D.C. to be able to charge an electric vehicle. During the conversion from A.C. to D.C. a side effect of the process is the creation of harmonic currents which have a negative impact on electrical systems and can cause overheating of conductors, transformers and electronics. DNO's have to ensure that harmonic currents are kept within safe levels and will therefore request information regarding the harmonic emissions from the proposed installation to ensure that the connection design mitigates these concerns. Unsafe levels of harmonic current emissions are overcome by ensuring that the impedance of the connection is suitably low. Typically, the larger the connection capacity, the lower the required connection impedance.

WPD have undertaken an innovation project to measure harmonic currents emitted by charging electric vehicles and it has been determined that the existing standard design of low voltage connections will permit the connection of one 32A electric vehicle charge point.

However, to overcome harmonic emission concerns a single 50kW (Rapid charger) would have to be installed within a range of 45 to 200m from the supplying substation (depending on make and model).

It is essential that the harmonic emission of the appliances that you wish to purchase is identified prior to making your order because there can be a large discrepancy between appliances and some makes / models will require stronger connection characteristics. This may result in the DNO rejecting installations or requiring reinforcement costs to be able to accept the connection. Manufacturers will make a declaration of the required "fault level power" to mitigate harmonic concerns and the lower the number the easier it is for the DNO to make a connection.

Earthing

Electric vehicle charge points will typically require a TT Earthing system designed and built by the installer, this Earthing system will ensure that the users and installation remains safe during a fault scenario. The Institution of Engineering and Technology wiring regulations require there to be a separation of 10m or more between bonded metalwork connected to Earthing zones of different types e.g. PME or SNE. However, WPD have recalculated this requirement in line with the Code of Practice for the installation of Electric Vehicle Charge Points and have determined the below segregation requirements.

The customers buried TT earthing system shall be segregated from any WPD buried earthing systems (including buried LV metalwork and traditional Paper Insulated Lead Covered cables) by the required distance detailed in Table 1:

Connection:	Single Phase or Unbalanced 3 Phase Connection	Balanced Three Phase Connection
Minimum Segregation	3.6m	0.3m

Table 1 – Segregation requirement between Earthing Zones

The above requirements impact on the installation of electric vehicle charge points positioned within the street or verge and may require the installed device demand to be balanced across the three available phases. A device that can draw power evenly across a three phase supply (even if the output is single phase) will only require 0.3m segregation from other bonded earthing systems.

Glossary of terms

TT Earthing – Terra Terra earthing where the earthing electrodes are customer owned and installed at the installation

PME Earthing – Protective Multiple Earthing system, the DNO provides an earth terminal that is connected to multiple earth electrodes positioned along the LV network

SNE Earthing – Separate Neutral and Earth, the DNO provides a continuously separate earth conductor that is connected to the star point of the transformer

Fault Power Level – If a short circuit were to occur, how much power would flow during the fault – this is an indication of how low the impedance of the network is e.g. a high fault level (measured in power) would signify a low impedance circuit.

Harmonics – harmonic currents have a waveform frequency different to that of the fundamental 50hZ sinewave, the DNO will typically request the 2nd-50th harmonic current waveforms/emissions, the 2nd harmonic current is twice as fast as the fundamental waveform and therefore has a frequency of 100hZ and so on.

Charge Point Placement

New electricity connection costs can impact on the financial viability of electric vehicle charging installations and therefore many local authorities may wish to utilise existing connections. Electrical infrastructure for large connections to town halls and similar buildings may easily be able to accommodate EV charging however existing street furniture connections will most likely require remedial works. There is capacity within the distribution system for 'Fast' charging but capacity will most typically need to be created for 'Rapid' charging.

Street Side

Electricity connections for street lights were designed for a demand of around 50 watts and 'fast charging' has a rating of up to 7360 watts (32A) single phase. Therefore, even though the cut-out (fuse head) may have an item rating of 5750 watts / 25A single phase – the electrical infrastructure will most likely not permit the increased demand due to thermal overload of the 'looped' conductors and the voltage drop across the circuit.

In addition, street furniture connections most typically have a PME Earthing system and cannot be converted to a TT Earthing system without thought of the segregation requirements detailed above.

Car Parks

Typically car parks have a low powered electricity connection to run a few lights and a parking ticket machine, therefore to provide multiple charge points of varying capacity a new electricity connection will be required. High powered supplies will have to be 'secure' and to ensure compliance with high level regulations a 'Ringed' high voltage main may be required where a new conductor will have to be installed from the new substation to the electricity network.

WPD's largest distribution transformer is rated at 1000kVA and this substation could provide 135 vehicles with a 32A / 7.36kW 'Fast' charge but would require the space of 3 – 4 parking bays for the WPD and customer apparatus. A 'Fast' charger will charge a typical electric vehicle within 3 - 4 hours and is therefore suitable for long stay car parks used by commuters. The same sized set up could provide power to 20 'Rapid' chargers with a maximum rating of 50kW each and these chargers are more suitable for short stay parking.

Taxi Ranks and Similar Charging

Due to the short waiting time of a taxi between fares, a 'Rapid' charge point would be most suitable to ensure that the vehicle range is maintained. The space requirement for a rapid charger will prohibit locations without off street parking and in addition the location will require a strong electricity connection. The electricity network within congested city centres may already be at or around capacity and therefore the charge points may require a dedicated connection from the nearest substation and this substation may require a transformer upgrade. Therefore, charge point installations located closer to existing substation installations would be recommended to maintain a lower connection charge.

Data Portal 2

Western Power Distribution provides a free online mapping service which you can register to use here: https://dataportal2.westernpower.co.uk which will help identify the location of WPD's assets and assist with the positioning of electric vehicle charging equipment - for consideration of the above technical aspects or the availability of space.

Site selection

The amount of space required for WPD's assets will depend on the magnitude of the requested demand and is subject to site specific engineering concerns. The table below provides guidance on typical space requirements of WPD assets only, in addition we must retain 24/7 unhindered access to company owned apparatus.

	Demand			
	≤ 18 kVA	≤ 54 kVA	≤ 276 kVA	≤ 1000 kVA
Suitable for	up to 2 Fast Chargers	up to 6 Fast Chargers or 1 Rapid Charger	up to 37 Fast Chargers or 5 Rapid Chargers	up to 135 Fast Chargers or 20 Rapid Chargers
Spacial requirement (mm)	350(W) x 500(H) x 210(D) [1]	450(W) x 700(H) x 225(D) [1]	609(W) x 754(H) x 250(D) [2]	3300(W) x 2400(D) (s/s) x 1000(W) x 2200(H) x 390(D)(metering) [3]

Notes;

1. Metering to be positioned > 500mm and < 1800mm from the ground
2. Equipment to be positioned > 200mm from the ground
3. Extra height may be required subject to connectivity of equipment
4. A standard parking bay typically measures 2400 mm (W) x 4800 mm (D).

Cost of installation and commissioning

The cost of charge point installation and commissioning and how long it will take depends on:

- How many charge points do you want?
- How many EVs do you want to charge at any one time?
- Which types of EV?
- How quickly do you want them to charge?
- How much is the spare capacity of the existing electricity network? What is the cost of possible network reinforcement?

Site Selection

In terms of site selection and suitability, the following should be considered:

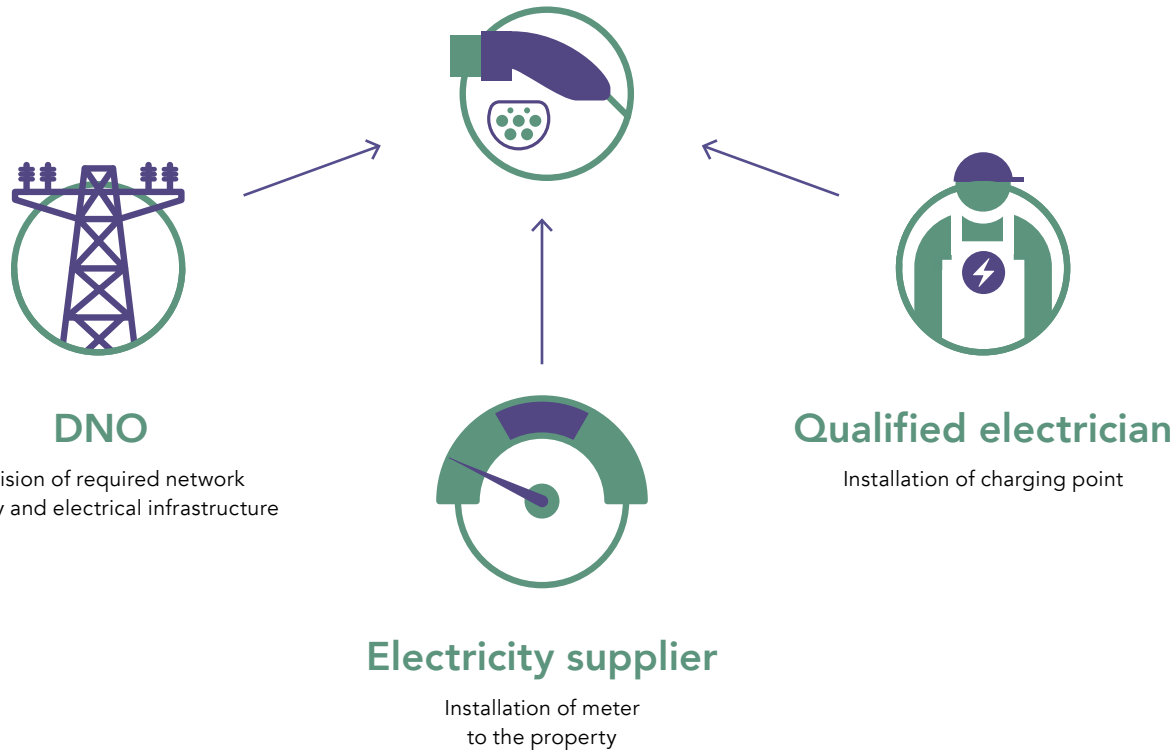
- Where is the site and what are the surroundings?
- Are there nearby amenities suitable for a captive charging audience?
- What is the site accessibility?
- Who will be the potential users?
- How far away is the DNO infrastructure?
- When is the charging infrastructure needed?
- What is the proximity to existing EV charging infrastructure?

When planning a charge point installation it is helpful to take into account the key considerations and prepare a feasibility study that can be shared with the internal stakeholders and your DNO.

Who is involved in the electricity connection process?

Electricity connections require a number of different services. The DNO, the electricity supplier and an electrician need to be contacted and involved.

Figure 2: Required services for electricity connection



When? Who? Why?

The following steps should be followed when considering the installation of any charge point:

1
- Identify some possible locations
- Decide on the number and type of charge point(s)
- Make initial contact with your DNO to submit an enquiry and discuss network capacity at the locations concerned or request guidance for alternative locations
- Appoint an electrical contractor for the charge point installation

2
- Apply for an electrical network connection from your DNO
- Submit a map where the preferred location is marked with a circle rather than a specific point
- For multiple applications, prioritize the locations in rank order (most preferred to least preferred) if possible
- Provide your DNO with the technical data sheet for the charge point types you are planning to install

3
- Receive, review and accept the DNO design and quotation received
- Appoint an electricity supplier who will bill for the electrical energy used
- Your supplier will appoint a meter operator to install a meter for the charge point

4
- Agree start and end dates for DNO works
- Energise your charge point(s)
- Operation and maintenance

Figure 3: A stepwise approach to installing a charge point

Estimating connection cost and time

The new electricity connections are described as fast (up to 22kVA) and Rapid (50-140kVA). This section provides illustrative costs and time for the power supply to be connected to different types of charge points including a column detailing the connection characteristics of multiple installations of Rapid charge points.

Figure 4: Illustrative costs and time to install a charge point

Fast (up to 22kVA)	**Rapid** (up to 50kVA)	**Multiple Rapid** (up to 1MVA)
Number of charge points		
1 Fast charger	2 Rapid chargers	Up to 20 Rapid charge points
Approximate connection time		
8-12 weeks	8-12 weeks	4 months+
Approximate connection cost		
£1,000-£3,000	£3,500-£10,000	£70,000-£120,000
Other considerations that may affect the cost		
Street work costs	Street work costs Legal costs for easement and wayleaves	Street work costs Legal costs for easement and wayleaves Planning permission and cost of land for a substation

Key points to consider:

The cost and time for each charge point project will always be location and application specific. The costs above illustrate that some proposed locations may cost much more than others due to power supply factors. It is therefore advisable to take a pragmatic approach when it comes to locations and the choice of charging. Be prepared to be flexible and to forgo some sites to settle on the most cost- effective options.

Each project will have a planning phase, procurement phase, along with an installation and commissioning phase. When planning a charge point project, it is strongly advised that you contact your DNO early in the planning process.

As a simple rule of thumb, in your timing plan, allow as much time for information exchange and dialogue with your DNO during the planning phase as you allow for installation and commissioning.

Pre-procurement market engagement with candidate charge point providers will also help, as they have years of experience when it comes to installation and commissioning and will be able to offer helpful advice.

For more information on planning for procurement, please see the UKEVSE general procurement guidance for electric vehicle charge points, available at: **www.ukevse.org.uk/resources/procurement-guidance**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