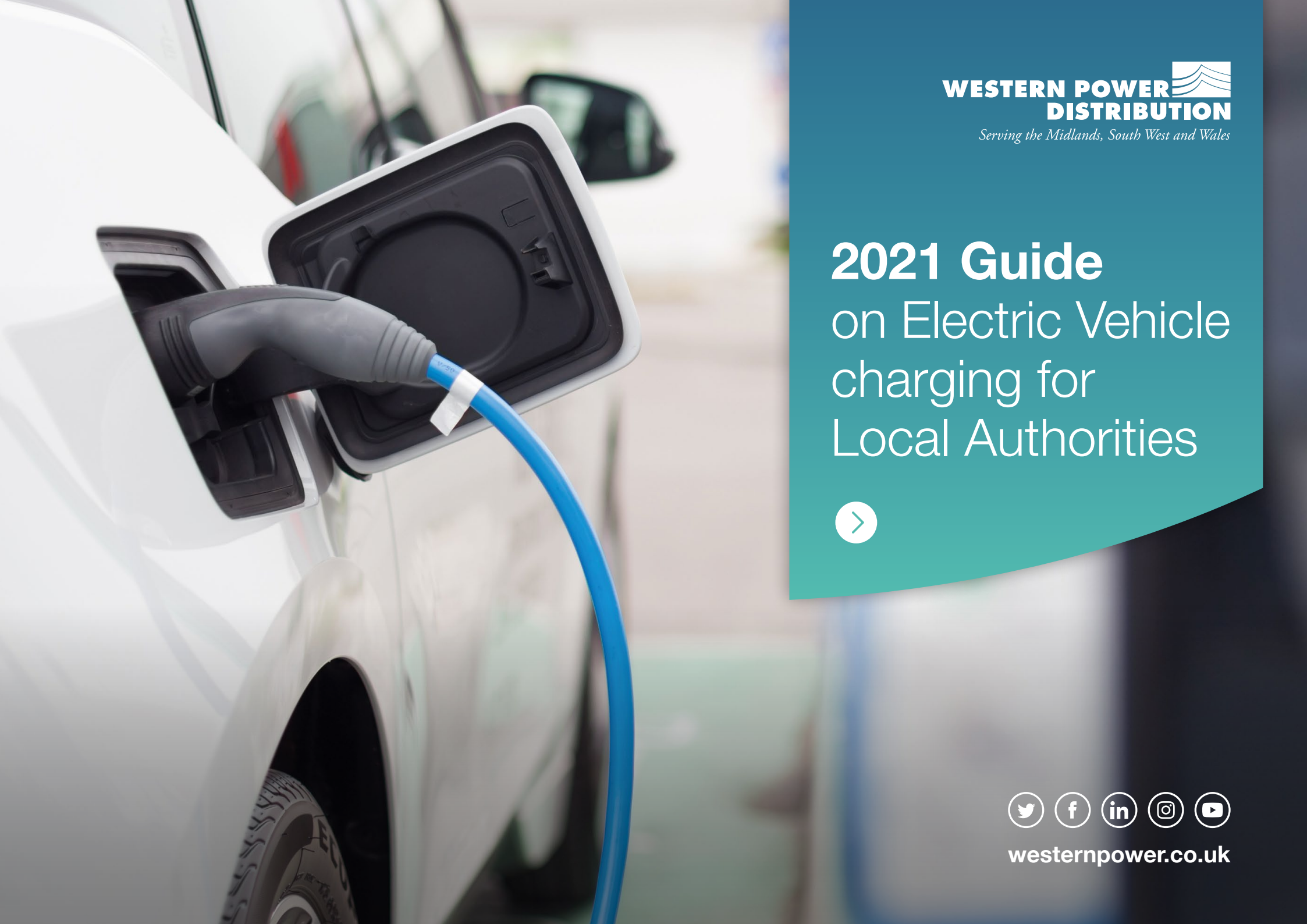


WESTERN POWER DISTRIBUTION

Serving the Midlands, South West and Wales

2021 Guide on Electric Vehicle charging for Local Authorities

westernpower.co.uk

Who is this guide for?

This guide is intended for local authorities who are considering buying and installing battery electric vehicle (BEV) charge points for their fleet, to support staff, visitors and local residents who drive cars and or light goods vehicle BEVs.

The transition to BEVs is expected to accelerate as in April 2020 company car owners will benefit from 0% with Benefit in Kind tax on company vehicles, this change will play an important role in achieving the UK's targets for decarbonising the transportation sector, as well as helping to reduce air pollution.

Who is this guide for?

Based on Future Energy Scenarios published by National Grid, there are already more than 373,600 plug-in cars and 10,300 light vans in October 2020, this data is from SMMT, 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 as some 40% of vehicles owned in the UK don't have off-street parking, it is important to ensure that everyone can have easy access to a well-structured EV charging network across the UK.

As of 15/02/21 there were 37,990 EV connections at 21,901 locations in 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 to the Local Authority.

Locating your Site

A very simple way to find out who your Local Distribution Network Operator is by going to:

www.energynetworks.org

Then scroll down to find:

Who's my Local Energy Network Operator?

Once you have found this area, you type in your post code and click Go. This will then provide you with who your electricity Distribution Network Operator is, and who your gas network operator is.

What is a Distribution Network Operator?

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 electricity suppliers.

Before installing EV Charge point there is a need to download the common EV and HP application form the Electricity Networks Association, the trade body for the DNOs, please go to:

https://energynetworks.org/electricity/futures/electric-vehicles-and-heat-pumps.html

At this site there is detailed information as to how to assess the load of the business and other valuable information, it would be advantageous to read the available information. Once the ENA EV and HP connection form has been downloaded and completed it then needs to be sent to your host DNO who you located earlier.

Your local DNO is Western Power Distribution, you can forward your duly completed form to the following email address:

wpdnewsupplies@westernpower.co.uk

For additional information on electric vehicles on the WPD website can be found at: https://www.westernpower.co.uk/smarter-networks/electric-vehicles

How can DNOs help?

The cables, overhead lines and substations that make up an electricity networks are assets with a typical fifty year life. Networks installed 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 need to be assessed to determine if there is available capacity or if local upgrades will be necessary.

An early engagement with the DNO and a qualified electrical contractor can help identify whether the proposed location has adequate capacity to meet the charging demand. If there is enough capacity from the existing supply, no network reinforcement will be required. If any reinforcement is needed, it will be the local DNO who will provide this.

The DNO will also provide quotations for new connections and upgrades to existing ones.

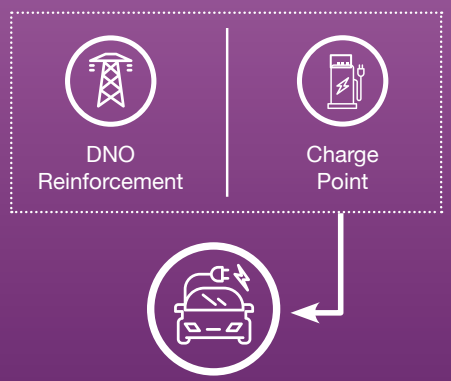
The scope of the upgrade and reinforcement could extend to include increases in capacity for existing transformers, distribution overhead lines and cables to meet the new higher peak demand and lower impedance connections.

Cost calculations for grid network investments will vary depending on the local situation but a guide is provided on **page 18**.

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.

The DNO needs to be properly engaged and consulted to coordinate and facilitate the connection of charge points to the network. The DNO needs to know the size and type of EV chargers 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.

EV charging infrastructure installation



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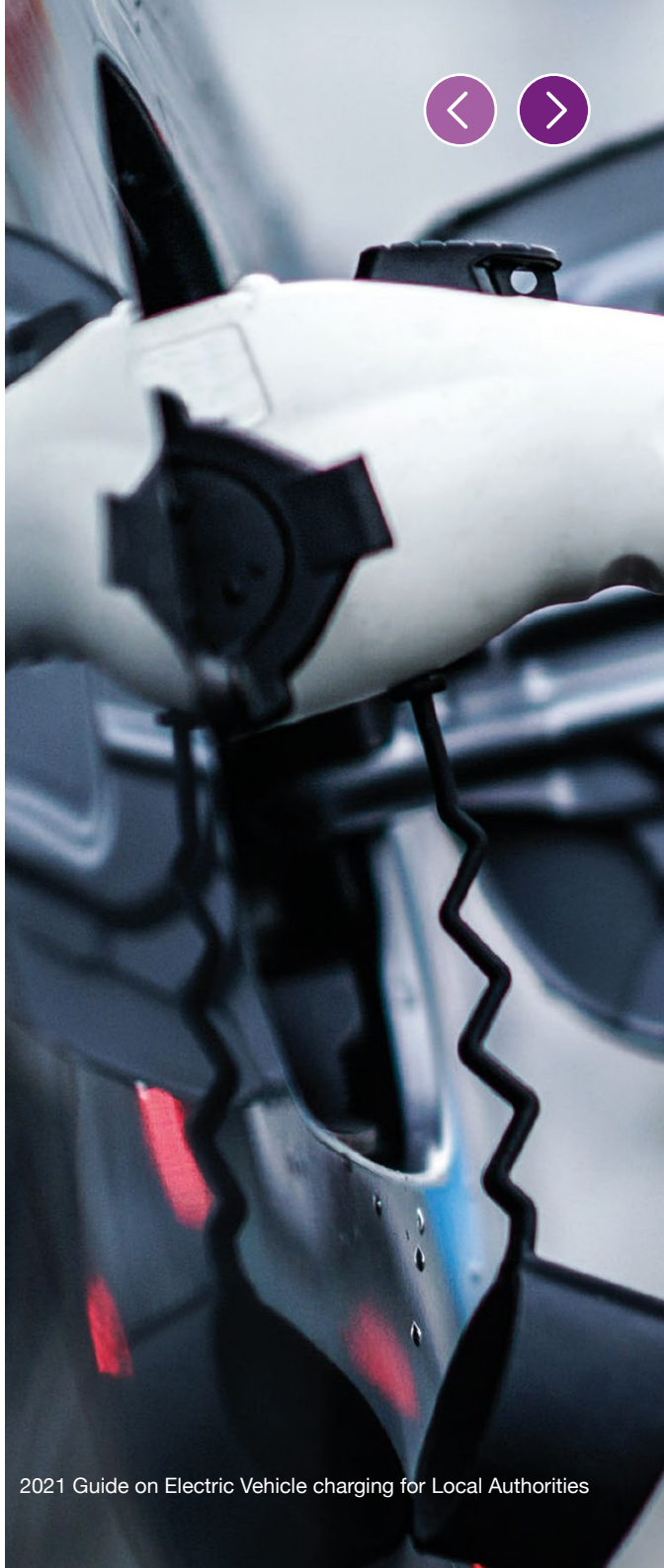
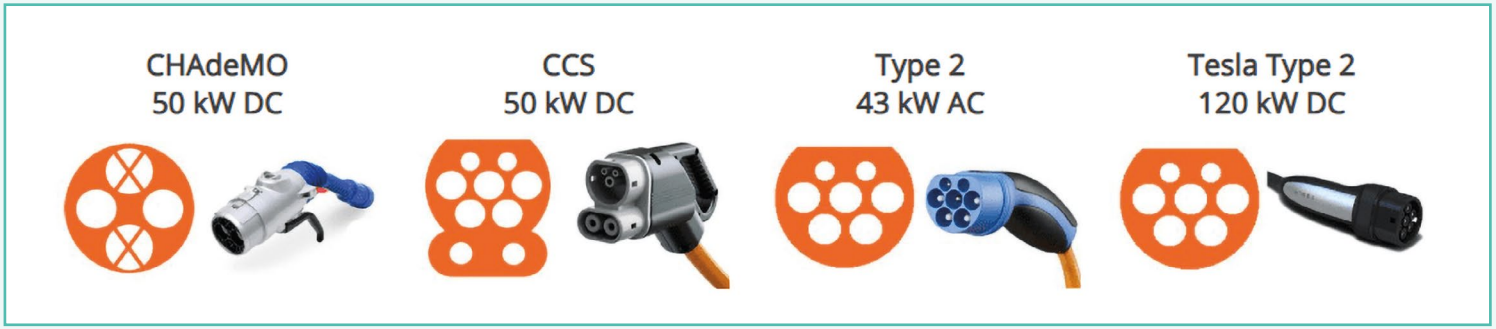


Charge point specifications

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.

Charge point type	Power transfer		Typical charging time	Recommended location
Slow	<3kW	Single phase	8-12 hrs	Ideal for vehicles that will be parked for periods of 8 hours or more.
Fast	<7kW	Single phase	3-4 hrs	
	<22kW	Three phase	1-2 hrs	
Rapid	<43kW	Three phase	80% in 20-30 mins	These chargers are ideal for vehicles that need a quick turnaround or vehicles that have large batteries installed like HGVs with 250+kWh batteries.
	<50kW DC			
Super-rapid	<43kW	Three phase	<20-30 mins	
	<50kW DC			



Power requirements and supply capacities

Larger business and commercial customers, usually above 50kVA demands, have a supply capacity which is agreed with the DNO.

The business may also pay availability charges based on this capacity. It might be that, due to changes in business processes or general energy efficiency, this supply capacity is greater than the business current usage.

In the first instance it would pay the business to look back at their last 18 to 24 months of electricity bills to get a better understanding on what their consumption figures are in relation to their agreed capacity. Capacity may already exist for chargers.

For example they have a 250kVA connection and are only using 175kVA, there is a spare 75kVA which could be used to supply the EV chargers, it would be expedient in the first place to utilise this spare capacity instead of paying for a bigger connection.

The capacity may also allow a business to create a plan, with a smaller provision of charge points in the early days and a larger provision, with a supply upgrade, at some time in the future when more BEVs are operating for them. A key consideration is to assess the number and types of EV charger points that a Local Authority would like to install.

Understanding the way in which you already use electricity

Once you have worked out your charging requirements there is a need to understand when your company or business will be actually charging the vehicles during each 24 hour period of the days.

A couple of points to consider: -

1. What hours does your LA Depot work?
2. Will you be allowing your staff to charge their personal EVs thus utilising your work EV charge points during normal working hours? This could generate revenue for your Local Authority.
3. What charging regime will be best suited to charge your fleet vehicles and provide fully charged EVs for the business working hours?
4. How many fleet vehicles will you have?
5. What is the typical kWh size of the batteries? There are many ways we can help you to manage how much power you are taking from the electricity network, which can help to reduce the cost of getting more power to your site and any charging costs.
6. Are the vehicles capable of accepting high rates of charge without damaging the battery? (If you are unsure Google the EV Database UK and check for the maximum charge per hour figure for your given vehicles.)

Once you have answered these questions you will have a better understanding of what capacity of charging you will require and at what time of day you will require it. With this information your assigned supply capacity for your site and with the knowledge you have about the amount of electricity you use during the different parts of the 24 hour day this will allow you to look at various options like:

Optimising your existing power supply

If you can modify how you already use power at your site, you may be able to free up capacity at certain times of the day for EV charging. For example, if you have a building onsite that you are able to reduce the amount of power used for machinery, heating or lighting, you could save a significant amount, rather than paying for more capacity on the network.

On-site generation and battery storage

If you are able to store electricity through another source i.e. a stationary battery, you could then use this stored power to charge your EVs, meaning you would not need to take power from the network. If you already have or could install on-site generation i.e. solar panels, you could then produce your own electricity, charge your stationary battery, and charge your vehicle(s).

Smart Charging

Smart charging is where an intelligent system controls when and how much an EV will charge.

This can help the grid cope better with increased demand from new technologies and in turn help you charge at a lower cost.

Timed profile connection

This is an agreement you have with your network operator that you are only able to charge at certain times of the day. By sticking to the pre-agreed schedule, you can save costs by not having to upgrade your connection. This works particularly well if you only need to charge your vehicles at night, as there is less strain on the network.

Load management

Load management controls the power that supplies your charge points to ensure you do not go over your overall supply limit.

This means you can still use many chargers at the same time, but they will charge at a slower rate.

Getting power to your site

If you are unable to choose one of the above methods to “control” your load then, you will need to speak to your network operator like your host DNO to provide more power to your site before your charge point is installed.

Your DNO will be happy to discuss your power requirements prior to you making an application. Once submitted your DNO project designer will produce an electrical design which will tell you how they will get power directly your site.

They will send you a quotation for the work that the DNO needs to do. Once you have reviewed, accepted, and paid for your quotation, your DNO will discuss what they need to do to get the right size cables from their network to your site and provide you with a date to carry out the necessary work. In urban areas the means of supply is normally via underground cable, depending on what voltage level your company/business is supplied at i.e. 11kV or LV will dictate the type of underground cable connection.

Typically the cables are run in the sidewalk and fall under the New Roads and Streetwork Act when digging in the road or sidewalk the host DNO needs to provide 12 weeks’ notice to the Local Council before work can take place.

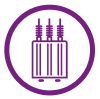
In some cases the supply is via overhead line if this needs modifying the process is more involved and requires wayleaves, Section 37 Approval and Planning Approval this can be a long defined process.

If underground cables or overhead line cross third party land there is a need to obtain wayleaves this is normally an easement for the circuit which costs money, the amount of money is variable and dependant on the land owner.

If a new 11/0.4kV substation is required typically a 4m by 4m site is required for a ground mounted substation which would supply the electricity to you company/business, one needs to remember electricity assets have a life of 50 years. The substation site will require a defined concrete slab onto which a unit substation would be placed complete with GRP enclosure.

The Cable route

Your DNO will quote for all works from our electricity network to your meter cabinet. This will be split into two parts; the “non-contestable works” being the final connection at the substation and the “contestable works” being the cabling to you meter cabinet. Your work will include the meter cabinet and all cabling to the EV charger(s) within your site.



Substation design

If you are installing lots of chargers you might need to put a substation on your land. The substation transforms the power down to a level that you can use on your site. We need space to put this substation and you may be required to arrange things like a substation foundation to allow your DNO to complete the connection. Your local DNO will help you understand the process but it is important that you have a competent electrical and civil contractor to assist you.

Your onsite works

There will be some work that will need to be carried out on site to allow your DNO to complete your network connections as smoothly and quickly as possible.

This includes:

- Excavate cable trenches
- Multi-utility arrangements
- Joint bays
- Ducting of cable services
- Trench back filling and reinstatement.

Crossing third party land

If the cable we need to use to give you power passes through or over 3rd party land before it connects in your meter cabinet within your boundary, your DNO will need to obtain consent from the relevant authority.

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

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.

Technical considerations

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.

Segregation requirement between Earthing Zones

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

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.

When planning a charge point installation, decide what charger(s) suits the business needs best:

Rapid chargers

- **50kW DC charging on one of two connector types, either the CHAdeMO or CCS charging standards.**
- **43kW AC charging on one connector type, the type 2.**
- **100+kW DC ultra-rapid charging on one of two connector types.**
- **All rapid units have tethered cables.**

Rapid chargers are the fastest way to charge an EV, often found at motorway services or locations close to main routes. Rapid devices supply high power direct or alternating current – DC or AC – to recharge a car as fast as possible.

Depending on model, EV cars can be recharged in as little as 20 minutes, though an average new EV would take around an hour on standard 50kW rapid charge point. Power from a unit represents the maximum charging speed available, and times are quoted for a charge to 80%. This maximises charging efficiency and helps protect the battery.

Note: Tesla model S and X use the Tesla Type 2 connector which is capable of 150kW D.C.

Fast Chargers

- **7kW fast charging on one of three connector types.**
- **22kW fast charging on one of three connector types.**
- **11kW fast charging on Tesla Destination network.**
- **Units are either untethered or have tethered cables.**

Fast chargers are typically rated at either 7kW or 22kW (single-phase or three-phase 32A). The vast majority of fast chargers provide AC charging, though some networks are installing 25kW DC chargers with CCS or CHAdeMO connectors.

Charging times vary on unit speed and the vehicle, but a 7kW charger will recharge a compatible EV with a 40kWh battery in 4-6 hours, and a 22kW charger in 1-2 hours. Fast chargers tend to be found at destinations such as car parks, supermarkets, or leisure centres, where you are likely be parked at for an hour or more.

Once the charger type has been chosen then it is sensible to take into account the key considerations and prepare a feasibility study that can be shared with the internal stakeholders and the local DNO.

Charge Point Placement

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.

It is worth discussing requirements with the DNO perhaps a load sharing connection can be used for EV charging. 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 suitable 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

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

- **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?**
- **Where is the site, and what are the surroundings?**

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 opposite provides guidance on typical space requirements of WPD assets only, in addition WPD must retain 24/7 unhindered access to company owned apparatus.

	Typical space requirements			
	< 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
Special 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)[3,4]

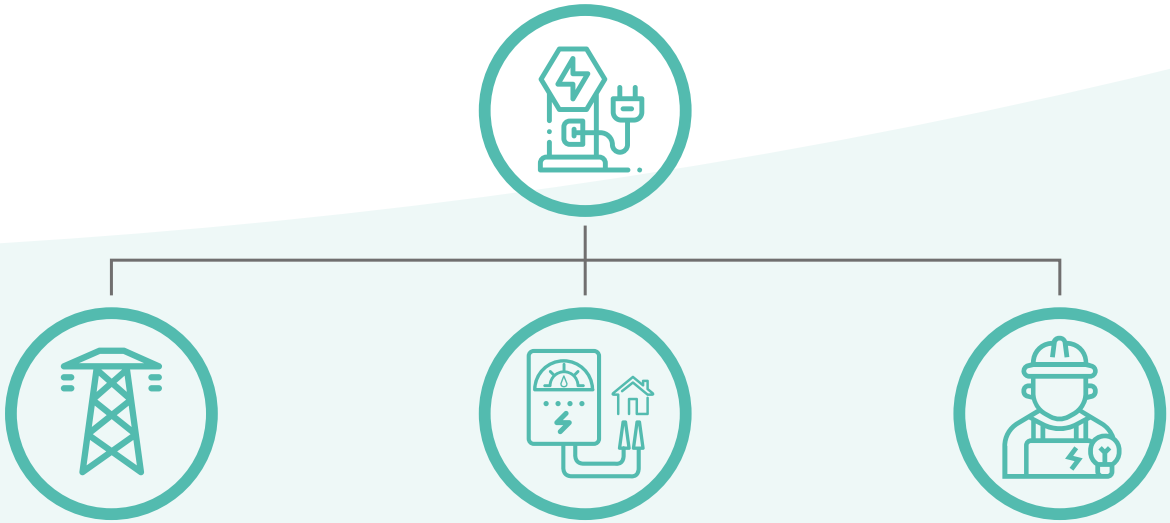
Notes:

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).

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.



DNO

Electricity Supplier

Provision of required network capacity and electrical infrastructure

Suitably Qualified Contractor

For the installation of the charging point

When? Who? Why?

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

1

- Decide on the number and type of charge point(s)
- Identify some possible locations
- 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

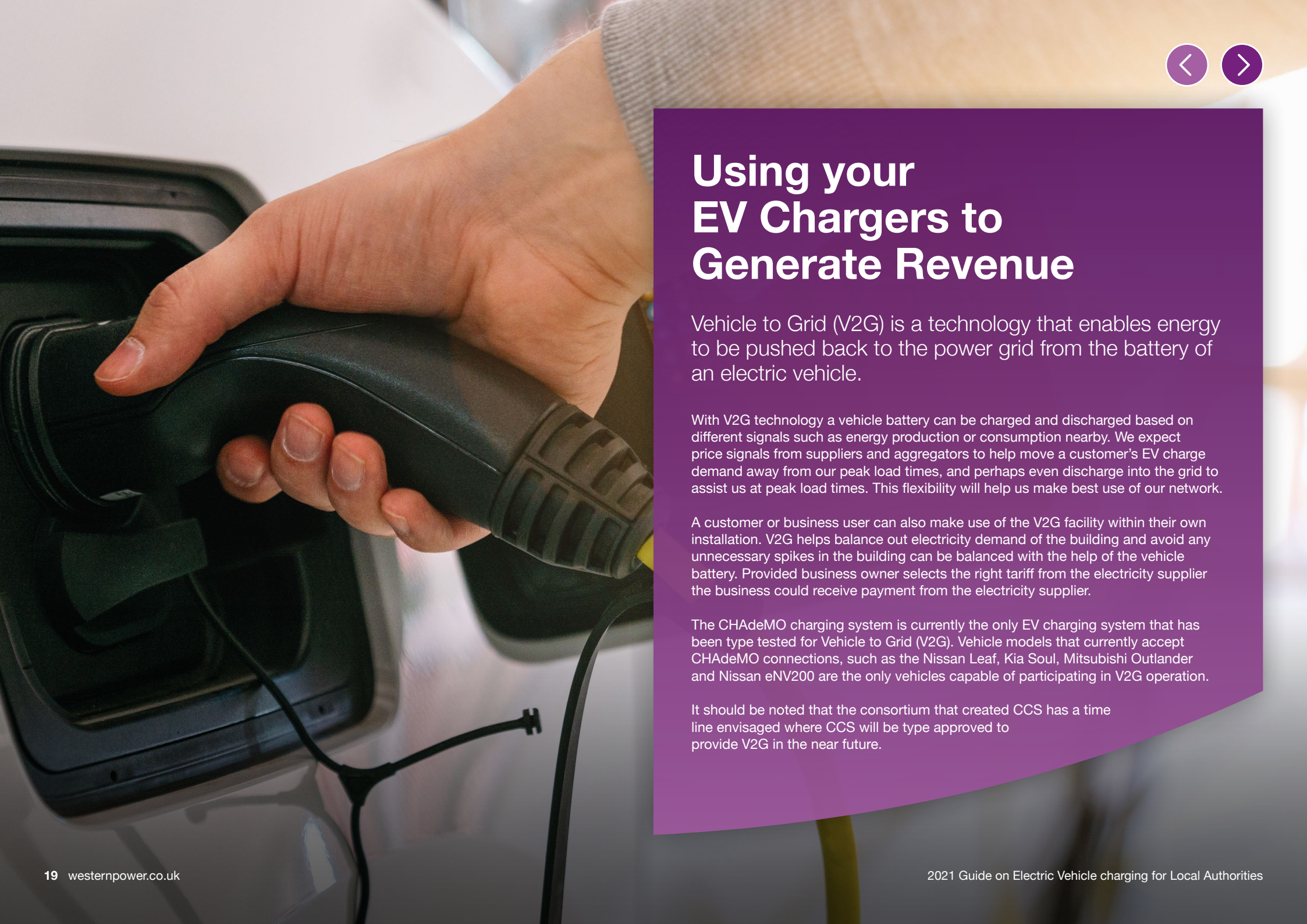
- Agree start and end dates for DNO works
- Energise your charge point(s)
- Operation and maintenance

Estimating connection cost and time

The table below 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. New electricity connections are described as fast (up to 22kVA) and Rapid (50-140kVA).

Charge point grants from the Office for Zero Emission Vehicles (OZEV) cannot currently be used to cover the cost of electricity network connections; only the charge points and related products.

Typical connector	Designation	Typical connector	Designation	
	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



Using your EV Chargers to Generate Revenue

Vehicle to Grid (V2G) is a technology that enables energy to be pushed back to the power grid from the battery of an electric vehicle.

With V2G technology a vehicle battery can be charged and discharged based on different signals such as energy production or consumption nearby. We expect price signals from suppliers and aggregators to help move a customer's EV charge demand away from our peak load times, and perhaps even discharge into the grid to assist us at peak load times. This flexibility will help us make best use of our network.

A customer or business user can also make use of the V2G facility within their own installation. V2G helps balance out electricity demand of the building and avoid any unnecessary spikes in the building can be balanced with the help of the vehicle battery. Provided business owner selects the right tariff from the electricity supplier the business could receive payment from the electricity supplier.

The CHAdeMO charging system is currently the only EV charging system that has been type tested for Vehicle to Grid (V2G). Vehicle models that currently accept CHAdeMO connections, such as the Nissan Leaf, Kia Soul, Mitsubishi Outlander and Nissan eNV200 are the only vehicles capable of participating in V2G operation.

It should be noted that the consortium that created CCS has a time line envisaged where CCS will be type approved to provide V2G in the near future.

WESTERN POWER DISTRIBUTION

Serving the Midlands, South West and Wales

Home

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