nationalgrid.co.uk

2021 Guide on electric vehicle charging and DNO engagement

For local businesses who plan on converting their fleets to electric

nationalgrid

Who is this guide for?

This guide is intended for local businesses within the National Grid Electricity Distribution area who operate fleets and are considering buying and installing battery electric vehicle (BEV) charge points to support their business.

It is relevant to all customers with a fleet of BEVs, be they HGV, light goods or car.

Even if a business does not operate their own fleet, it will be of interest if they plan to support their staff who might drive private BEVs, and all their visitors who drive BEV cars and light goods vehicles.

The transition to BEVs is now accelerating as in April 2020 company car owners began to benefit from 0% 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.

SMMT figures show there were already more than 273,500 plug-in cars and 8,800 light vans on our roads at March 2020.

Based on Future Energy Scenarios published by National Grid Electricity Distribution, 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.

Businesses 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 Businesses.

Who is this guide for?

This document sets out how National Grid Electricity Distribution can help to ensure the network exists so that businesses within the National Grid Electricity Distribution area are able to install EV Chargers for their proposed fleet of BEVs and are subsequently able to charge their vehicles in the manner convenient to them.

Locating your Site

A very simple way to find out who your Local Distribution Network Operator is by going to:
energynetworks.org/operating-the-networks/whos-my-network-operator

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(s) there is a need to download the common EV and HP application form from the Electricity Networks Association, the trade body for the DNOs, please go to:
energynetworks.org/operating-the-networks/connecting-to-the-networks/connecting-electric-vehicles-and-heat-pumps

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.

If your local DNO is National Grid Electricity Distribution, you can forward your duly completed form to the following email address: **nged.newsupplies@nationalgrid.co.uk**

For additional information on electric vehicles on the National Grid Electricity Distribution website can be found at:
nationalgrid.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 suitably 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 **here**.

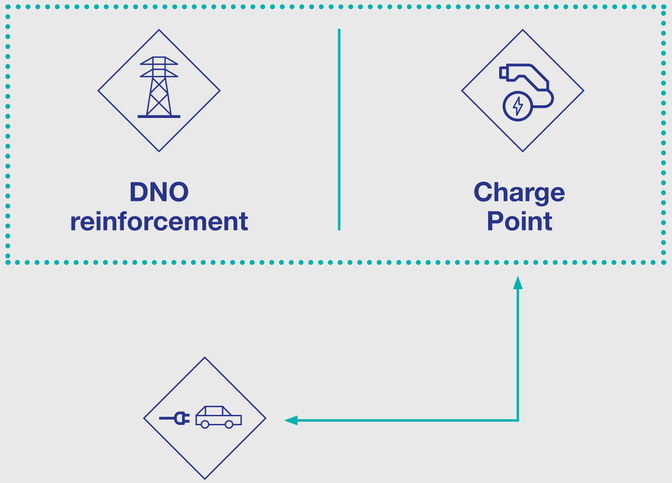
When thinking about planning to get charge points installed and operational, it is important to think of the process from the energy system perspective – with the DNO providing the critical link to an electrical power supply.

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 also 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 power quality issues for other local electricity users.

Figure 1: EV charging infrastructure installation



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 power quality issues for other local electricity users.

Charge point specifications

EV charge points are mainly defined by the power they can produce and the how quickly they can charge an BEV.

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	Ideal for vehicles that will be parked for periods of eight 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			

CHAdeMO
50 kW DC

Tesla Type 2
150 kW DC

CCS
50-350 kW DC

Type 2
43 kW AC

Power requirements and supply capacities

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

Rapid chargers

- 50 kW DC charging on one of two connector types, either the CHAdeMO or CCS charging standards.
- 43 kW AC charging on one connector type, the type 2.
- 100+ kW DC ultra-rapid charging on one of two connector types, either the CHAdeMO or CCS charging standards.
- 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 vehicle as fast as possible.

Depending on model, EV cars or light vans can be recharged in as little as 20 minutes, though an average new EV would take around an hour on standard 50 kW 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.

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.

Larger business and commercial customers, usually above 50kVA demand, 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 be beneficial for 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 the new 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 business 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 business work and do your vehicles remain on site overnight?
2) Will you be allowing your staff to charge their personal BEVs thus utilising your work EV charge points during normal working hours?
3) What charging regime will be best suited to charge your fleet vehicles and provide fully charged BEVs 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 National Grid Electricity Distribution 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 search for the EV Database UK and check for the maximum charge per hour figure for your given vehicles).

When 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:

A) 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.

B) 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.

C) Smart Charging

Smart charging is where an intelligent system controls when and how much a BEV 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.

D) 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.

E) 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 BEVs, 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).

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 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 to 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 pavement and 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 dependent on the land owner/s involved.

If a new distribution substation is required typically a 4m by 4m site is required for a ground mounted substation which would supply the electricity to your business. 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.
- **Crossing third party land** – if the cable we need to use to give you power passes through or over third party land before it connects in your meter cabinet within your boundary, your DNO will need to obtain consent from the relevant authority.
- **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 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.

Getting power to your site

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	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	80 or 100Amps AC single phase (for a faster charge point)
Fast 11kW AC	Three phase AC supply; 16Amps per phase	Three phase AC supply; 80Amps per phase (for a faster or rapid charge point)
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 this 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.

National Grid Electricity Distribution 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.

It is essential that the harmonic emission of the appliances that you wish to purchase are 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.

Your DNO planner will be able to advise on the network harmonic impact of any chargers you are considering.

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, National Grid Electricity Distribution 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 National Grid Electricity Distribution buried earthing systems (including buried LV metalwork and traditional Paper Insulated Lead Covered cables) by the required distance detailed in Table 1 below:

Table 1 – Segregation requirement between Earthing Zones

Connection:	Single Phase or Unbalanced Three 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.

Cost of installation and commissioning

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

- how many charge points are required?
- how many EVs will be charging at any one time?
- if all the vehicles to be charged are BEVs?
- how quickly they need to be charged?
- how much spare capacity is available in the business premises?
- how much of the spare capacity is from the existing electricity network?
- the cost of possible network reinforcement.

	Demand or Connection Size Required			
	< 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
Space 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]	National Grid Electricity Distribution Plant 3300(W) x 2400(D) Metering items 1000(W) x 2200(H) x 390(D)[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?

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).
- Make initial contact with your DNO to submit an enquiry and discuss network capacity at your business location.
- Appoint a suitably qualified 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.
- 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.
- Discuss tariff options with your electricity supplier.
- 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 new electricity connections are described as fast (up to 22kVA) and Rapid (50-140kVA).

This section provides illustrative costs and times for the power supply to be connected to different types of charge points including details of the connection characteristics of multiple installations of Rapid charge points.

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

Key points to consider

The cost and time for each charge point project will always be location and application specific. The above costs 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.

It is essential that the appliances that you wish to purchase are identified prior to making your order because there can be a large discrepancy between appliances and some makes and models will require stronger connection characteristics.

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:

r-e-a.net/resources/rea-cenex-procurement-guidance/

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, in fact trails are ongoing at this time.

National Grid Electricity Distribution plc
Avonbank
Feeder Road
Bristol
BS2 0TB

nationalgrid.co.uk

September 2022. BLU24486/PR