nationalgrid

A local authority guide to EVs

For converting their fleet to zero emission or battery electric vehicles and DNO engagement 2022

Electricity Distribution

nationalgrid.co.uk

Contents

Summary of terms

Abbreviation	Term	Abbreviation	Term	Abbreviation	Term
A	Ampere	ENA	Electricity Networks Association	MV	Medium Voltage
ACEA	European Automobile Manufacturers Association	ESA	Electricity Supply Area	MVA	Mega Volt Ampere
BAU	Business As Usual	ES	Energy storage (battery)	MW	Mega Watt
BEIS	Department for Business, Energy & Industrial Strategy	ESG	Environmental, social and governance	MWh	Mega Watt hour
BEV	Battery Electric Vehicle	EU	European Union	NGED	National Grid Electricity Distribution
BEV HGV-SH	Battery Electric Vehicle Heavy Goods Vehicle-Short Haul	EV	Electric Vehicle	NGET	National Grid Electricity Transmission
BEV HGV-LH	Battery Electric Vehicle Heavy Goods Vehicle-Long Haul	EVSE	Electric Vehicle Supply Equipment	OEM	Original Equipment Manufacturers
CBA	Cost-benefit analyses	FCEV	Fuel Cell Electric Vehicle	Ofgem	Office of Gas and Electricity Markets
CCC	Committee for Climate Change	GHG	Greenhouse Gas emissions	PLC	Program Logic Controller
CSE	Centre for Sustainable Energy	GWh	Giga Watt hour	PV	Photo Voltaic (Solar)
CCS	Combined Charging System	HGV	Heavy Goods Vehicle	RIIO-ED1	Revenue = Incentives + Innovation + Outputs – Electricity Distribution 1
CO2	Carbon Dioxide	kVA	Kilo Volt Ampere	RIIO-ED2	Revenue = Incentives + Innovation + Outputs – Electricity Distribution 2
CPO	Charge Point Operator/s	ICE	Internal Combustion Engine	SCADA	System control and data acquisition
DFES	Distribution Future Energy Scenarios	kW	Kilo Watt	SMMT	Society of Motor Manufacturers and Traders
DfT	Department for Transport	kWh	Kilo Watt hour	TCO	Total Cost of Ownership
DSR	Demand Side Response	LCNF	Low Carbon Network Fund	TDH	Total Harmonic Distortion
DNO	Distribution Network Operator	LCT's	Low Carbon Technologies	UGC	Underground cable
DSO	Distribution System Operator	LV	240/400V Low Voltage	UK	United Kingdom
DWPT	Dynamic Wireless Power Transfer	m	Million	UKPN	United Kingdom Power Networks
EMS	Energy Management System	MCS	Mega Watt Charging System	VAT	Value Added Tax

Who is this guide for?

This guide is intended for Local Authorities (LA) within the National Grid Electricity Distribution area who operate fleets of heavy goods vehicles (HGV's), light commercial vehicles (LCV's) and cars, for those looking to reduce their carbon foot print by converting their fleet to Zero Emission or Battery Electric Vehicles.

Currently almost all the five million commercial vehicles in the UK are powered by fossil fuels. With the net zero clock ticking, many LA fleet operators are now looking at what options are available and which is the most efficient route possible to reduce emissions.

At this time OEM's of cars, LCV's and HGV's are electrifying their vehicles via the battery electric route as this is the technology which is the most advanced and would allow the LA to place a planned conversion program in place.

The majority of OEM's of heavy vehicles are saying fuel cell vehicles will be available towards the end of this decade, which time wise does not leave the LA much time to convert their fleet and ensure they have the infrastructure in place and meet their respective climate emergency plans.

The transportation sector is one of the largest contributors to greenhouse gas (GHG) emissions. Data from BEIS in 2019 shows transport caused 27% of total U.K. greenhouse gas emissions.

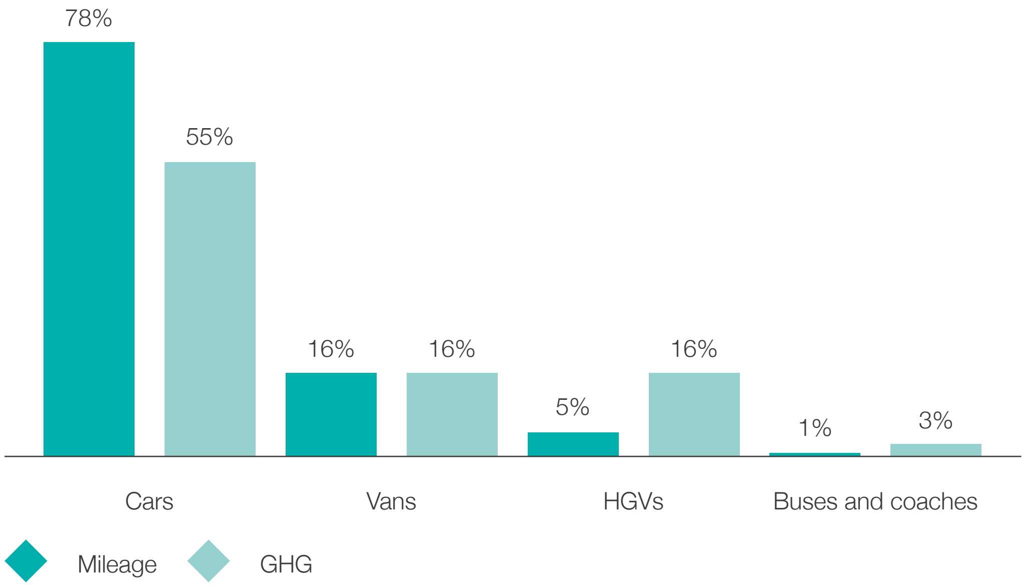
These GHG's can stay in the atmosphere for over 100 years. They act as a blanket around the Earth that traps energy in the atmosphere and causes it to warm.

At a lower level, emissions can create a brown pollution haze called smog, which can make it difficult to breathe and lead to asthma and other health issues.

HGV's only account for 5% of the total mileage in the UK but produce 16% of the GHG's, LCV's only account for some 16% of the total vehicle mileage in the UK and produce 16% of the total GHG emissions. While cars account for 78% of the total mileage in the UK and 55% of the GHG emissions.

Converting the LA fleet to zero emission vehicles will automatically reduce the LA's carbon emissions.

Emissions and mileage for cars, vans, HGVs and buses in 2019



There are basically three zero emission vehicle HGV types:

a) The Fuel Cell Electric Vehicle (FCEV) features a fuel cell stack, compressed or liquid hydrogen storage tank and a smaller on board battery pack to buffer for peak loads.

b) The Battery Electric Vehicle (BEV) HGV has a large on-board battery pack where the maximum percentage charge of the Lithium battery is capped to 80% of charge thus ensuring long-term durability of the battery.

c) The catenary wire charged BEV HGV, this is basically a BEV HGV with a small battery which is supplemented by charging along the route via a catenary system.

With LCV's and cars there are basically two zero emission vehicle types:

a) The Fuel Cell Electric Vehicle (FCEV) features a fuel cell stack, compressed hydrogen storage tank and a smaller on-board battery pack to buffer for peak loads.

b) The Battery Electric Vehicle (BEV) LCV and car has a relatively large on-board battery pack.

The transition to BEV's is accelerating, according to the latest SMMT data the adoption of BEV cars has seen a year on year increase of 35.4% in new BEV cars, LCV's saw a record 12,759 battery electric vans purchased. In Q1 of 2022 there were some 68 BEV HGV's purchased, this represented a 119% increase on Q1 of 2021.

Why do LA's need this change?

The UK government has set dates for the end of the sale of new ICE HGV's, LCV's and cars. These dates will be one of the drivers for the adoption of zero emission vehicles in the UK.

The forthcoming 2030 ban on the sale of new ICE LCV's and cars, and the 2040 ban on the sale of new ICE HGV's is a key driver in accelerating the uptake of electric vehicles, which requires a suitable charging infrastructure to be in place.

The Department for Transport (DfT) CO2 regulatory framework mandates vehicle manufacturers to implement the ban. With the majority of LA's having declared climate emergencies there is now the need for the respective LA's to reduce their carbon emissions to meet their respective net zero targets.

As a consequence of the reporting of their Carbon emissions, transport typically would produce about 27% of carbon emissions so would be a sensible route to convert to non-fossil fuel. It also gives the LA's seven years to convert to zero emission fleets and ensure they have the infrastructure in place to keep the zero emissions vehicle running.

The rise in E-commerce caused by the pandemic, has seen an increase in freight volume in cities and shifted logistics vehicles to local streets and "A roads". Because of the urban population density, urban freight is responsible for one quarter of urban transport emissions in most cities and built-up areas.

As the BEV HGV market grows, electrification of logistics vehicles can play a significant role in reducing air pollution in cities and built-up areas. Cities across UK and Europe have significant potential to push investment to electric HGV's and LCV's, for example London's Ultra-Low Emission Zone which charges £100 for non-compliant HGV's and £12.50 for all non-Euro 6 LCV's per day. Currently the Netherlands is one of the few countries that explicitly aims to phase out combustion engine trucks and buses from cities in between 2020 and 2030. This bottom-up pressure will further incentivise vehicle makers to invest in zero emission HGV's, LCV's and buses, as a coalition of cities can constitute the majority of the population on the continent.

Other LA guides

The Midlands Net Zero Hub have produced a guide to the planning, design and procurement of the electrical infrastructure that will meet the needs of a depot that has committed to BEVs and is confident that BEV's can fulfil all daily, weekly and annual 'duty' requirements. This can be found at:

midlandsnetzerohub.co.uk/energy-projects/electrification-of-depots/

Cenex focuses on low emission transport & associated energy infrastructure and operates as an independent, not-for-profit research technology organisation (RTO) and consultancy, specialising in the project delivery, innovation support and market development.

Cenex can be approached by an LA to produce a comprehensive assessment of the infrastructure needed to support the decarbonisation of their fleet. Cenex have created a Depot Charging and Optimisation Assessment guide which can be found at:

cenex.co.uk/app/uploads/2022/10/FINAL-EIGER-CS.pdf

The Energy Savings Trust have produced a guide which is intended to help integrate electric cars and vans into smaller fleets (i.e. five to 100 vehicles) but the ideas and principles can be applied to fleets of any size or complexity, whatever your starting point or ambition.

It also provides whole life cost examples to illustrate how to build a business case. The guide can be found at:

energysavingtrust.org.uk/wp-content/uploads/2020/10/EST0018-001-EV-Guide-for-Fleet-Manager-WEB.pdf

HGVs

Under the current Driving Licence regulations any vehicle over 3.5 tonnes is classed as requiring an HGV licence. People who passed their driving test before 01/01/97 can drive up to a 7.5 tonne vehicle with their Category B licence.

Any typical LA fleet depot will contain a mixture of 26 tonne Rubbish Collection Vehicles (RCV's), HGV's, LCV's, road sweepers, gritters, mini road sweepers, busses, mini busses and cars.

As the majority of HGV's purchased in the UK are made in the EU, the recent introduction of Regulation (EU) 2019/1242 of the European Parliament and of the Council of 20th June 2019 setting CO2 emission performance standards for new heavy-duty vehicles and amending Regulations (EC) No 595/2009 and (EU) 2018/956 of the European Parliament and of the Council and Council Directive 96/53/EC will impact the UK, therefore the UK needs to be proactive and start addressing this issue now.

Yes, at this time there is consternation, about should the zero emission HGV's be BEV HGV's, catenary HGVs or Hydrogen fuel cell HGV's. Well looking at the problem logically, there is only one technology which is ready to go now and is able to hit the 15% reduction emissions target by 2025, it is the BEV HGV's[1].

Half of EU's total truck activity (in tonnes.km, which is a good proxy for CO2 emissions) are driven over distances of less than 300km.

These trips can be covered today by electric trucks, thanks to new models currently coming to the market with about 300km range (enough to cover nine trips out of ten).

But limited supply and lack of charging strategy currently slows down the uptake. It is expected that the range of the electric trucks available will swiftly increase to 500km, covering about three quarters of the driving range kilometres during the 4.5 hour driving period and 19 trips out of 20.

These distances tie in neatly with the driving hour's directive which is 4.5 hours driving followed by a 45 minute break. In the UK 4.5 hours of driving equates to about 300 to 400kms. The new high power MCS charging system will then be able to provide a battery refill in the 45 minute break.

Even in an early stage of adoption of BEV HGV's with low fleet penetration levels, the maximum allowable distance between charging stations on the motorways and A roads will need to be set, not only due to the expected vehicle ranges of BEV HGV-LH trucks but, more importantly, because of the HGV Driver Regulation on driving times and rest periods[2].

[1] Why is this? When you speak to the HGV OEM's the view is fuel cell HGV's will only be ready at the end of the 2020's. Therefore to tie in with Regulations (EC) No 595/2009 and (EU) 2018/956 of the European Parliament and of the Council and Council Directive 96/53/EC. Which basically says the following: - This regulation requires CO2 emissions from heavy-duty vehicles such as trucks and buses to be reduced by 30%, by 2030, with an intermediate reduction target of 15%, by 2025, in addition by 2025, manufacturers will be required to ensure that at least a 2% market share of the sales of new HGV vehicles is made up of zero-and-low-emission vehicles, to counteract steadily increasing road traffic emissions, of which around one quarter is accountable to heavy-duty vehicles and busses. Failure to meet these targets means that the HGV OEM'S will be hit with a fine 60 times greater than the fine of €95 for every gram CO2/km of excess emissions per vehicle, car OEM manufacturer's face.

[2] The rules show a maximum daily driving periods of 9 hours (10 hours in exceptional cases) and minimum rest periods of (at least) 9 hours. In addition, mandatory breaks of 45 minutes every four and a half hours are legally required which can be split into two breaks of 30 and 15 minutes. These time windows will be used for recharging, at least to the extent that the vehicle can safely arrive at the next destination (including a reasonable safety margin and that in cold weather the batteries don't perform as well, especially if they have not been pre-conditioned prior to starting off).

LCVs

With the right policy, will, and charging infrastructure in place, the UK road freight could be decarbonised to a great extent during the 2020's.

Currently with cars and LCV's the manufacturer can site the EV charger port anywhere on the vehicle. This poses a problem when trying to optimise the charging area to be inclusive for all cars and LCV's and for those parties that suffer motorbility issues.

Unlike HGV's there is NO Standard location for the charger input port on an LCV, on all HGV's it is behind the left hand front wheel at hip height, this means the layout of the charging hubs will always be the same and can cover off for the physical size of the HGV.

Because LCV's don't have a charger input port location standard this means different OEM's install the charger input point in different locations meaning the charging hubs can't be optimised. They have to cater for every eventuality which means space will be at a premium at van charging hubs, brought about by the lack of an LCV charger input port location standard.

This becomes critical at motorway service areas as there is a requirement for a finite number of parking bays, installing BEV charger bays take more space, so reduces the number of existing bays even for optimised situations, so for the un-optimised situation as exists for LCV's and cars more space is required. This leads to a Planning issue for the MSA's.

It is recommended that the location of the EV charger input to the cars and LCV's needs to be high in ones consideration because it could well impact on the space requirements in their depot when charging.

Remember LCV's can be large therefore take up a fair bit of real estate and if you don't think about where the charger port this will cause a problem.

Remember, Rapid chargers and Ultra Rapid chargers have tethered leads of a finite length, so the lead length and charging input location on the LCV will impact and maybe leave the second bay unusable while that particular LCV is charging.

With the UK government phasing out new ICE sales by 2040 for HGV's and 2030 for LCV's and cars to achieve this level of decarbonisation, then a concerted effort needs to be applied to ensuring there is a network of rapid and ultra rapid chargers situated around the UK to enable HGV's, LCV's and cars to travel the length and breadth of the country.

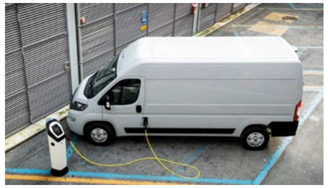
BE HGV charging port – position standardised.

Daimler HGV behind left front wheel

Scania HGV behind left front wheel

LCV's – charging port position anywhere on the vehicle.

Toyota van left rear quarter charging



Fiat van left middle charging

Ford van front of van charging

VW van right rear quarter charging

Cars

If the charging input location on vans and cars was standardised this would make the design of EV charging hubs or even stand-alone chargers much easier to site.

They could then generally become more user friendly for disabled or reduced mobility drivers when they need to charge their BEV vehicles, simply because once one starts increasing the power output of the charger so going from a 50kW to a 350kW EV charger by default the tethered leads become larger and heavier.

Therefore if you are having to cater for charger input locations anywhere on the vehicle, the tethered lead needs to reach all charger input sites on the vehicle, so weight of the lead becomes an issue.

If BEV LCV's could standardise on a charger input location this would beneficial for all parties and is something that should be strived for by lobbying all relevant parties to change the standard.

Another point to bear in mind when installing EV chargers for cars if you had twenty parking spaces for ICE cars and you decided to convert those spaces to publicly accessible EV charging bays then the spaces available will drop to fifteen bays, this is to cater for mobility issues etc.

Develop an EV strategy and an associated business case

Developing a de-carbonised transport or BEV HGV, LCV and or car strategy may seem like an obvious place to start, but, it is more than simply setting a long-term goal with objectives.

With a fleet of vehicles it is important it is important you understand what you have signed up for at your depot, factory or office location where the charging will take place in terms of electrical infrastructure and electrical capacity, the number and type of vehicles you will be running, and the hours they are running i.e. are the drivers "hot seating[3]" the HGVs and LCVs? What the routes they will take? How much charge they will need? Through predictive analytics, you can understand the charging needs of the vehicles, whether depot charging will be sufficient and or the best locations for your vehicles to charge.

In the UK, the LCVs and cars that can be rapid charged with a CHAdeMO connector include the Nissan Leaf, Mitsubishi Outlander PHEV, Toyota Prius Plug-In, Nissan e-NV200, Kia Soul EV Mk1, Citroen Berlingo Electric Mk1, Citroen C-Zero and the LEVC London Taxi.

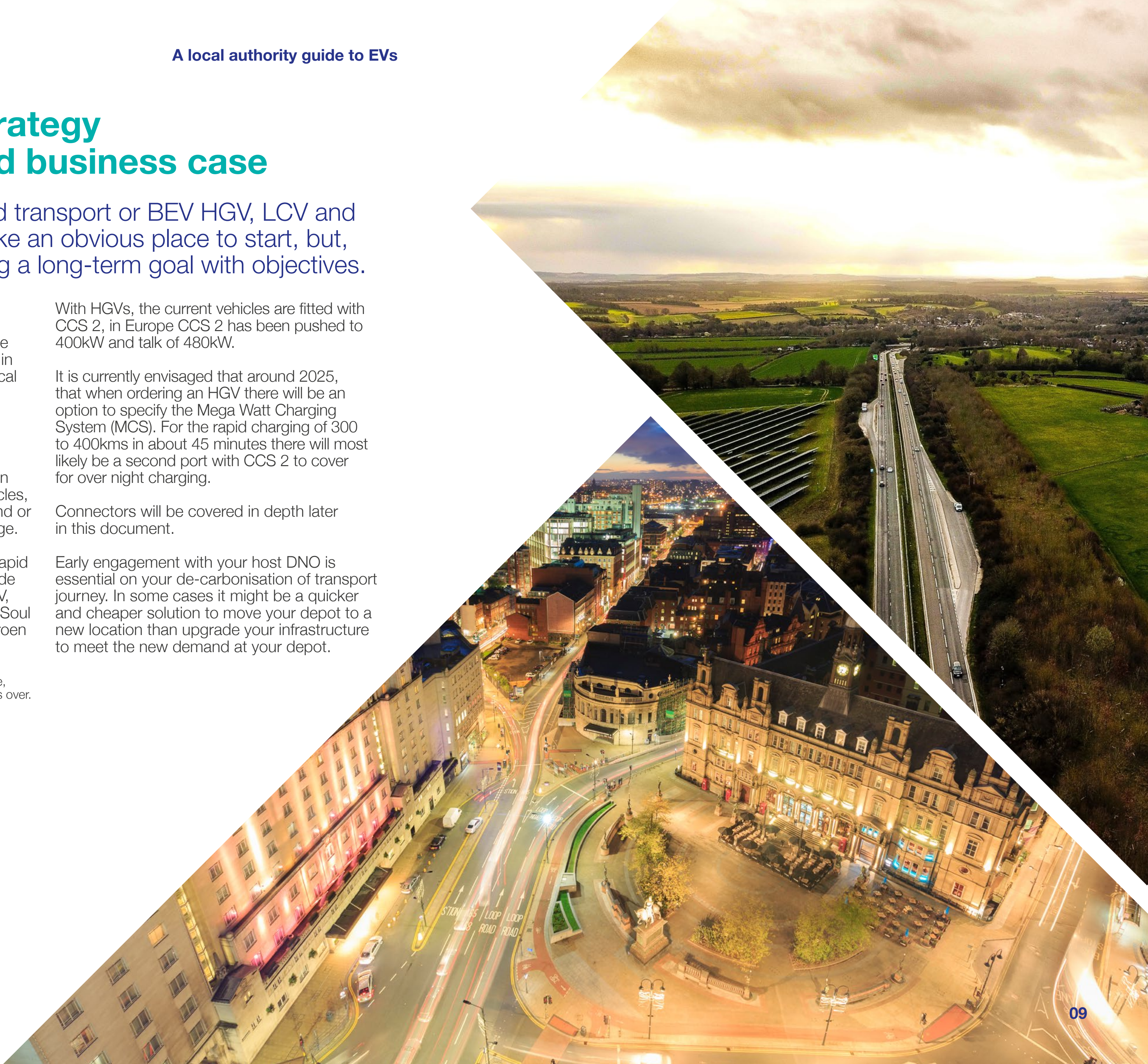
[3] Hot seating – Where multiple drivers share one vehicle, i.e. when one driver's hours finish the next driver takes over.

With HGVs, the current vehicles are fitted with CCS 2, in Europe CCS 2 has been pushed to 400kW and talk of 480kW.

It is currently envisaged that around 2025, that when ordering an HGV there will be an option to specify the Mega Watt Charging System (MCS). For the rapid charging of 300 to 400kms in about 45 minutes there will most likely be a second port with CCS 2 to cover for over night charging.

Connectors will be covered in depth later in this document.

Early engagement with your host DNO is essential on your de-carbonisation of transport journey. In some cases it might be a quicker and cheaper solution to move your depot to a new location than upgrade your infrastructure to meet the new demand at your depot.



Cost comparison of EV to ICE

A simple way to check which system will work for you as your de-carbonised transport route is to carry out a comparison of similar types of BEV vehicle vs FCEV vs ICE vehicle costs by bringing each vehicle type down to a cost in pence per kilometre. One method is shown below.

Transport costing can be defined by the acronym DAVID: - D = Driver, A = Administration (overhead costs), V = Vehicle cost, I = Inspection costs, D = Depreciation costs.

It is the process of identifying, calculating and recording items of expenditure incurred in the operation, maintenance and administration of the activity. It's important to identify the costs the transport incurs.

This is fairly straight forward as costs are normally broken down into two categories:

1) vehicle standing or fixed costs

2) vehicle running or variable costs.

Combining the two gives the total operation cost. Looking at cars, if you take the UK's top selling battery electric car is the Tesla Model 3 Long Range which can travel 4.6 miles per kWh.

The current 2022 Model 3 Long Range has an 82kWh battery, giving it a 374 miles of WLTP range. That equates to 4.6 miles per kWh.

One of the UK's best-selling ICE cars is the Ford Puma 1.0 Eco boost, this gives 51.4 mpg according to the WLTP test.

Converting the current E10 petrol, which has 10% ethanol, into energy gives 9.6kWh per litre, and 4.5 litres to the gallon gives 43.2kWh per gallon.

Substituting these figures into the WLTP MPG figures you get is 1.19 miles per kWh.

Therefore by converting the petrol to an electric equivalent via the WLTP system, the Ford Puma uses 3.41 times as much energy as the Tesla per mile.

This figure goes to prove that the typical "Well to Wheel efficiency" of an ICE vehicle of about 35% is not far from the truth. With battery electric vehicles this efficiency factor is typically given as about 83%.

The same calculation could be carried out for any vehicle type.

By using the above method and going back to paragraph 2 understanding your fleet number, vehicle types, daily mileage driven and current miles per gallon of diesel or petrol used for each vehicle. Then back using the following formula you can derive the minimum battery size required for each vehicle:

Daily mileage of relevant vehicle divided by fuel economy of relevant vehicle = fuel used.

Fuel used times 4.546 litres = litres of fuel per vehicle.

Litres of fuel used times by relevant conversion factor* = minimum battery capacity for selected vehicle.

* Diesel conversion factor = 10kWh/litre;

* E10 petrol conversion factor = 9.6kWh/litre.

HGV charging

So where can BEV HGV's be charged? There are three locations these can be broken down as.

Depot charging

Is likely to be the first focus of electrification efforts as early adopter LA's can easily install the exact chargers, they need for their use case.

Typically for HGV's these will be 100 or 150kW rapid chargers. Understanding the various vehicle use cases would help give insight for network design.

Destination or opportunity charging

In all use cases, loading and unloading cargo is an important scheduling component next to driving and resting times. If these time frames were used for charging the vehicle, the vehicle would be able to do multiple trips without returning to the depot.

It is important to note that opportunity charging requires a close co-operation between a user and their customer, e.g. grocery stores or industrial plants, thus enabling them to charge while waiting to load/unload.

Public hub charging or on-route charging

When a scheduled trip exceeds the range of an electric truck, roughly 100-300km for early models, the dispatcher will have to schedule an additional stop, which would tie in with the drivers required driving break for charging at a public ultra-rapid charger hub.

Currently HGV's use CCS 2 for charging this will most likely change in 2025 when MCS becomes available.

The analytics will tell how many depot chargers you'll require, what specification you will need and what size and type of charger they should be.

This will allow you to make sure you have resilient EV infrastructure in place to enable electrification, while optimising the costs and meeting your sustainability targets.

Closely related to this is developing a business case to move forward with electrification, which assesses the financial impact, the long-term benefits, and scalability of your operations. Without a well planned EV adoption strategy, no fleet manager or other business leader will be able to successfully adopt electric vehicles into their organization's fleet.

Of course, budget is the likely number one concern. You need to know how much you can spend before you start making decisions on what type of electric vehicle you will be choosing and the type of charging equipment you will be installing. You'll have to figure out the maximum number of miles a fleet vehicle will drive each day. Then, from there decide which type of commercial EV charging infrastructure you are going to need.

Usually, this is determined once you know which electric vehicle you will be charging and how many vehicles will need to be charged at one time.

What type of chargers do you want to invest in? There are three different types of EV charging and the time they take to charge is different.

Some EVs cannot charge with all the available types of charging and some vehicles have a limit on how fast they can charge. We take a deeper dive into the different levels of EV charging here.

HGV charging

The Megawatt Charging System (MCS)

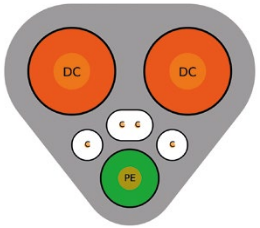
Is a charging connector for BEV HGV's. The connector is rated for charging at a maximum rate of 3.75 megawatts (3,000 amps at 1,250 volts) direct current (DC), this system should be available in 2025.

The MCS connector is expected to be the worldwide standard charging connector for large and medium commercial vehicles. It is also envisaged to roll out to airports and harbours.

Currently type testing is on-going and CharIN, Scania and Alpitronic announced the connector design for the MCS charging system on 15/06/22 at EVS35 in Oslo.
It is envisaged that a second CCS 2 charging port will be adjacent the MCS charger port. This CCS 2 charger port would be there to provide the overnight 150kW charging to the HGV. Of course, budget is the likely number one concern. You'll have to figure out the maximum number of miles a fleet vehicle will drive each day.

Then, from there decide which type of commercial EV charging infrastructure you are going to need. Usually, this is determined once you know which electric vehicle you will be charging and how many vehicles will need to be charged at one time.

HGV Megawatt Charging System



The actual MCS female charger plug shown on the left is mounted on a tethered lead. It can be seen it's similar to the proposed plug coloured layout shown opposite.

HGV charging

Combined Cycle System (CCS 2)[4]

The current CCS 2 standard provides an 800V DC and a maximum of 500A DC. The EU are already running up to 400kW CCS 2 chargers. Current BEV HGV's are fitted with CCS 2, BEV HGV's manufactured post 2024 would be fitted with the new MCS charging system and the vehicle would most likely that a second CCS 2 charging port will be adjacent the MCS charger port for the overnight charging. The majority of new LCV/cars available in the UK and Europe use the CCS 2 charging system.

CCS 2 vehicle charging input port

CCS 2 charger plug

The specifications of the anticipated CCS update have not yet been precisely defined. All features of previous versions shall be preserved to ensure backward compatibility. Potential additional features include:

- bi-directional power flows
- inductive charging
- wireless charging communication
- bus charging with "pantograph" current collector
- charging communication.

Generally two types of communication can be differentiated.

Load balancing

CCS differentiates between two methods of load balancing.

1) Reactive load balancing allows changing the energy flow from EVSE to EV instantaneously to a specific limit.

2) Scheduled load balancing supports reactive load balancing and additionally a planning of the energy flow from EVSE to EV with e.g. different power limits and cost indicators over time. It may for example be used to optimize energy distribution in a smart grid.

Charging authorisation modes

For charge authorisation, generally two approaches are foreseen.

1) With "plug and charge", the user plugs in their vehicle and an automated authentication and authorization process is started without any further user interaction. Payment is performed automatically.

2) With "external payment", the user must identify with an RFID card at the terminal, conduct a payment with a payment card, or access an app before they can proceed with charging.

[4] The proposal for a "Combined Charging System" (CCS) was published at the 15th International VDI-Congress of the Association of German Engineers on 12 October 2011 in Baden-Baden. CCS defines a single connector pattern on the vehicle side that offers enough space for a Type 1 or Type 2 connector, along with space for a two-pin DC connector allowing charging at up to 200 amps. The standardization in IEC 62196 part 3 for higher-current charging connectors brought about various systems: Type 1 was used primarily in North America and Japan, and Type 2 variants elsewhere. For DC charging, the SAE and European Automobile Manufacturers Association (ACEA) made a plan to add common DC wires to the existing AC connector types such that there would be only one "global envelope" that fitted all DC charging. They noted in a press release that most cars cannot charge faster than 50 kW, so that was the first common power output of CCS stations to be built during 2015. The next step was the standardization of stations with 150 kW output that they showed in October 2015, looking to a future system with 350 kW output.

Charging systems available to LCV's and cars

So where can BEV LCV's and cars be charged? There are four definite locations, but not all drivers will be able to use the fourth location as one has to bear in mind that 40% of homes in the UK don't have off street parking available to charge at home, all four locations can be broken down as follows.

Depot charging

Depot charging is likely to be the first focus of electrification efforts as early adopter logistics companies can easily install the chargers, they need for their use case.

Understanding the use case of the vans and cars would help give insight for the types of chargers required i.e. fast or rapid or a mixture of both.

If the vans will be left overnight in the depot then 7.4kW chargers could be sufficient, if those same chargers are then utilised by the staff when they come to work they could charge the personal BEV cars and the company generate some revenue from the chargers.

You could have a couple of rapid chargers to provide a quick turn-around for out of the ordinary events like a driver could not get overnight charging for whatever reason.

If the chosen charging location has a three phase supply then installing three phase chargers would provide the option of being more flexible with your charging as the chargers are three times faster than the equivalent size single phase charger, the purchase price difference is negligible between single phase and three phase chargers.

Using tethered chargers also has its benefits, there is less likelihood of the leads being misplaced or lost.

Home charging

It's also possible if the driver of the van or car has off street charging and is prepared to charge the vehicle at their home.

This becomes rather easy if all your company vehicles have a "tracker" system fitted because of the GPS fitted into the tracker, because the tracker knows where the vehicle is and that the vehicle is being charged.

Therefore the company then knows the instant the vehicle is plugged in and charging at the drivers home and how many kWh were charged into the battery, with that data then payroll can automatically add the funds to the next pay cheque for that particular employee.

Destination or opportunity charging

In all logistics use cases, loading and unloading cargo is an important scheduling component next to driving and resting times.

If these loading and resting time frames were used for rapid charging the vehicle, the vehicle would be able to do multiple trips without returning to the depot.

It is important to note that opportunity charging requires a close cooperation between a logistics supplier and their customer, e.g. grocery stores or industrial plants, thus enabling them to charge while waiting to unload.

If the driver had a unique RFID card that would tell the destination company that you had arrived and were charging and then they would know the number of kWh's they had provided and the payment could be per week or month or whatever.

Public hub charging or on-route charging

When a scheduled trip exceeds the range of an electric van or car, roughly 100-300km (or 62 to 186miles) for early models, the dispatcher will have to schedule an additional stop for charging at a public rapid charger.

These will be CCS 2 and currently up to 350kW in the UK and 400kW in the EU. The CCS 2 rapid chargers would fulfil your needs for a quick 30 to 45 minute charge, provided the LCV is capable of accepting the high levels of charge rate.

Charging systems available to LCV’s and cars

CCS 2

The majority of new LCV/cars available in the UK and Europe use the CCS 2 charging system. As this is the same system described in the HGV section nothing further shall be added.

AC charging

Is maximised to three phase 43kW on a type 2 connector, currently not many vehicles are capable of charging using this system. Normally the AC charging is done at 7.4kW single phase or 22kW three phase. The 22kW is three 7.4kW chargers one charger for each phase therefore this type of charger is three times faster than the single phase charger.

The maximum AC charging available is restricted to three phase 43kW on a type 2 connector, currently no new vehicles are capable of charging using the 43kW system. The pre February 2019 Renault Zoe was the only main stream vehicle in Europe to offer this system.

Type 2 vehicle charging input port

Type 2 or Mennekes plug

The various charger designs of charger for cars and vans that are currently available in the UK are shown across with the maximum power output that are available at certain charge point operator’s sites. It should be noted for completeness the Tesla connector has been shown as the early generations of Model S and X use the Tesla type 2, all new 2022 models of European/UK Tesla’s are now CCS 2 equipped.

The majority of new LCV and cars in the UK and Europe use CCS 2. But there are vehicles that can be rapid charged with a CHAdeMO connector include the Nissan Leaf, Mitsubishi Outlander PHEV, Toyota Prius Plug-In, pre 2022 Tesla Model S and Model X (when fitted with an adapter), Nissan e-NV200, Kia Soul EV Mk1, Citroen Berlingo Electric Mk1, Citroen C-Zero and the LEVC London Taxi.

Charging systems available to LCV's and cars

HGV, LCV and car selection

When choosing your fleet vehicles be mindful of your typical route journeys and patterns and if rapid charging is required, then when selecting vehicles look for what the maximum rapid charging power the vehicle can accept, plus the amount of miles per hour of charging the battery can take, the higher the number, then the better the vehicle's ability to maintain the battery at a steady temperature i.e. the battery thermal management system is good.

Where long journeys are added, or where home charging is not practical, then a whole new range of criteria need to be considered, for example does the BEV have the facility to use ultra-rapid charging and what is the maximum rapid charging is the battery capable of accepting?

The lower the kW figure the vehicle can accept the longer the time spent charging the vehicle at an ultra-rapid charger, ideally this charging could coincide with the scheduled driver break period.

BEV have the facility to use ultra-rapid charging and what maximum rapid charging is the battery capable of accepting?

A place to check for non-biased information on all BEV cars is **ev-database.uk**

A place to check for non-biased information on all BEV LCVs is **parkers.co.uk/vans-pickups/for-sale/new**

Note: other sites are available.

A quick look at the cheat sheets at the bottom of the website will show the complete list of vehicles available shown with the typical range, for a starting position this gives a good overview.

Once a selection has been made by clicking the chosen vehicle a detailed appreciation of that vehicle is given, which will then fine tune the selection process and help meet all the criteria the household had laid out previously.

An important point to bear in mind is check if the LCV/car battery can be pre-conditioned prior to its first journey of the day this has a big effect especially in winter because it gets the battery up to operating temperature prior to the vehicle even turning a wheel meaning the vehicle will provide more miles per charge compared to an identical LCV/car which did not pre-condition before driving off.

Charging systems available to LCV's and cars

Model	Max kW rapid charger	Battery capacity	Range	Power usage	Charge time @7.4kW	Rapid charge time	Rapid charge ability
Nissan Leaf e+	100kW	56kWh	200 miles	280 Wh/mile	6.5 hrs	35 mins	240 miles per hour
Tesla Model S	250kW	90kWh	345 miles	305 Wh/mile	15.25 hrs	23 mins	630 miles per hour
Kia e-Niro 64kW	80kW	64 kWh	245 miles	260 Wh/mile	6.5 hrs	44 mins	230 miles per hour
Polestar 2	151kW	78kWh	240 miles	305 Wh/mile	12 hrs	32 mins	320 miles per hour
Tesla Model 3	250kW	76 kWh	285 miles	265 Wh/mile	11.75 hrs	21 mins	570 miles per hour

Another point to bear in mind with LCV/cars is that if you use different vehicle makes within your fleet than there is a strong likelihood the charger port location of each vehicle type will be sited in a different position this could impact on where and how you site the charger locations.

Also think about whether you would be charging your vehicles at the same time as loading the vehicle as having the charging port near the back doors could seriously impact loading with a forklift for example.

If a BEV LCV or car comes with say a 75kWh battery not all of the capacity of the battery is usable, for example a car can have a 75kWh battery but only 72.5kWh is usable, because of the way EVs work, you'll never actually have access to the full battery capacity.

That's because the car's management system prevents the battery from either becoming 100 percent fully charged or 100 percent discharged to preserve its efficiency and extend its usable life.

The same principal applies to BEV HGV's where the HGV's battery thermal management system only allows the battery to be charged to 80% state of Charge to preserve its efficiency and extend its life.

An average BEV with a battery capacity of 40kWh and a range of 135 miles will consume around 2,900 kWh if driven for 10,000 miles per year. That would equate to a similar amount of electricity consumption to an average domestic house per year.

For 10,000 miles an electric car will cost £435 per year for energy, assuming 15p/kWh.

A petrol car would cost £1,475, assuming 40mpg and £1.30/l.

These costs are based on the prior electricity cost increase, they are typical costs and depend on how the respective vehicles are driven etc.

Charging systems available to LCV's and cars

EV charger location

Having decided upon the charging regime, you will need to identify the ideal location for your Electric Vehicle Supply Equipment (EVSE) in relation to your fleet's route.

Installing EVSE at the workplace is a must, but what if your employees can't drive back to the office?

EV fleet managers monitor many different metrics than conventional fleet managers do, including state of charge, charging information, where the EV is charged, and how much energy the cars consume.

EV fleet managers need to find ways to increase battery life, reduce operating costs, and optimize fleet performance.

This is where the different charging locations come in to play. The depot charging will provide the power for the vehicles to leave the depot with a full charge. If the truck is a short haul HGV, then is there a possibility to use opportunistic charging at a drop off point while waiting to unload?

There will be a need to hold discussions with the various sites to see if they are prepared to enter into the sort of agreement.

The various mainstream designs of chargers for cars and vans that are currently available in the UK are shown across with the maximum power output that are available at certain charge point operator's sites.

It should be noted for completeness the Tesla connector has been shown as the early generations of Model S and X use the Tesla type 2, all new 2022 models of European/UK Tesla's are now CCS 2 equipped.

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 LV	8-12 hrs	Ideal for vehicles that will be parked for periods of 8 hours or more.
Fast	<7kW	Single phase LV	3-4 hrs	
	<22kW	Three phase LV	1-2 hrs	
Rapid	<43kW	Three phase LV	80% in 20-30 minutes.	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 using CCS 2	<43kW	Three phase LV	<20-30 minutes.	
	<50kW DC			
Ultra-rapid using MCS	<43kW	Three phase LV	For a 750kWh battery to 80% less than 30 minutes.	These high power chargers are for very quick turnaround, idea for the 45 minute driver break period. Require an 11kV or 33kV supply.
	Up to 3000A DC @ 1250V DC			

Charging systems available to LCV's and cars

Power requirements and supply capacities

The adjacent drawing shows the CharIN proposed layout for MCS charging, one needs to bear in mind the real estate which will be required.

Charging station position relative to parking places

Drivers should have no challenges bringing connectors to charging inlets, 500A cables don't bend easily and 1000A+ cables even less so.

Cable management

The EVSE cable should not be lying on the ground, once charging is complete there should be "parking" position
for the tethered lead to prevent damage.

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

Rapid chargers - DC

- 50 to 350kW DC charging CCS 2 charging.
- 1 to 4MVA DC ultra-rapid MCS charging.

Rapid charger - AC

- 43 kW AC charging on one connector type, the type 2.

All rapid charger units have tethered cables.

Rapid chargers are the fastest way to charge an EV. Rapid devices supply high power direct or alternating current – DC or AC – to recharge a vehicle as fast as possible.

Larger business and commercial customers, usually above 50kVA demand, have a supply capacity which is agreed with their host 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.

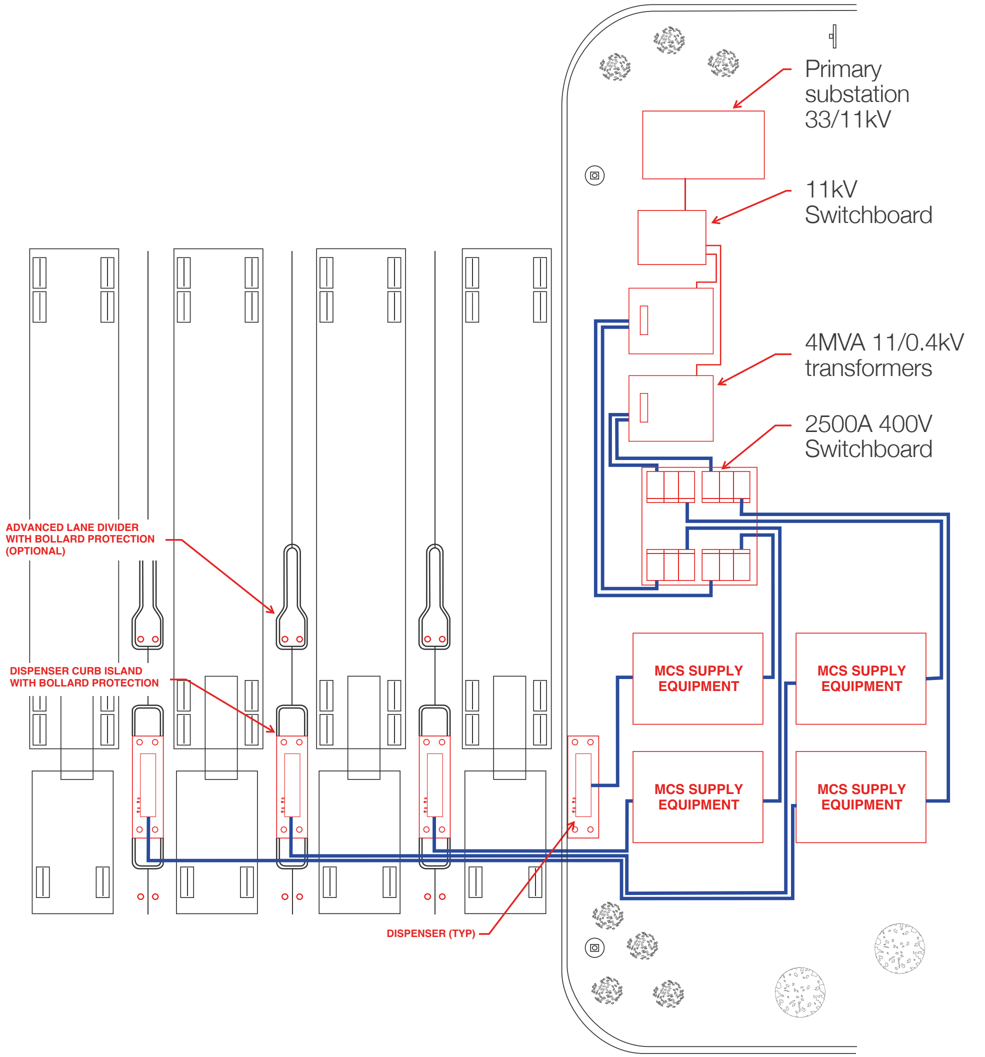
In the first instance it would be beneficial for the business to look back at their last 18 to 24 months of electricity bills to get a better understanding on what their consumption figures are in relation to their agreed capacity.

Capacity may already exist for the new chargers. For example they have a 500kVA connection and are only using 175kVA, there is a spare 325kVA 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.

The CharIN proposed layout of a four bay mega watt charging network complete with ancillary equipment



Charging systems available to LCV's and cars

Capacity constraints to install chargers

One of the primary challenges to fleet electrification is making sure your vehicles have sufficient electrical capacity to charge. Your depot site/s will have a maximum capacity limit, which may not be sufficient for the fleet of new chargers you will require, so an early discussion with your host DNO is absolutely advisable, the earlier you start having this discussion the easier the journey will be.

There is a balancing act with capacity because faster chargers – which are more attractive for obvious reasons – use more capacity and will be more expensive to purchase. Ultimately this means some upfront investment may be required to build additional infrastructure to cater for the charging.

If these costs appear to steep then consider Charging as a Service (CaaS), charger suppliers like Heliox offer this service, this turns the cost from Capex to Opex and usually there is no up front cost just a monthly cost once the equipment starts getting used.

The complete charging solution **1 monthly fee**

Upgrading	Essential maintenance	Design
Energy management	Operation	Manufacturing
Back office chargesight	Installation	Assembly

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:

- what hours does your business work and do your vehicles remain on site overnight?
- will you be allowing your staff to charge their personal EVs, if you are also installing fast chargers on your site, thus utilising your work EV charge points during normal working hours?
- what charging regime will be best suited to charge your fleet vehicles and provide fully charged EVs for the business working hours?
- how many fleet vehicles will you have?
- 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.
- are the vehicles capable of accepting high rates of charge without damaging the battery?

(If you are unsure search for the Parkers guide and check for the maximum charge per hour figure for your given vehicles.)

Smart charging and vehicle prioritisation

Smart charging and vehicle prioritisation solutions can automatically decide which vehicles to charge, by how much, and for how long.

The technology provides the ability to charge the HGVs overnight and for how long (usually when everything else is switched off in the depot and there is spare capacity available), or only charge certain vehicles part of the way to save capacity.

This solution could allow you to stay within your maximum capacity agreement, meaning you don't have to invest in new electrical infrastructure. Smart charging systems will also consider your business' needs and ensure that all vehicles always have enough charge to make their deliveries on time.

The most efficient smart charging solutions may also reduce recharging costs for your fleet because they could manage charging to occur when electricity is cheaper. This is where you may also consider which energy tariff to use, depending on your long-term plans.

Once you have answered these questions on the previous page 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 assess which option is best suited to your EV charging needs. For example:

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.

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.

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.

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).

Payment and management solution

Once you have a charging solution that works for your business, it's time to manage your fleet on a day-to-day basis.

There are two main options here: fleet charging for all your vehicles at a central depot, or charging by individuals, where employees top-up at public points.

The first is more straightforward for tracking, however for many organisations individual charging will be more cost effective. But one needs to bear in mind there are some 80 Charge Point Operators (CPO's) in the UK, usually they require membership and a RFID card.

When looking for the best solution for your company with respect to en-route charging looking for Interoperability (authentication/ payment/billing) of CPO's is a must.

If your routes include Europe then finding CPO's that connect themselves to EU wide aggregators/roaming platforms is essential, drivers will not want to use Apps /cards which work with only one CPO brand, it maybe that PnC (plug and charge) will most likely be part of this solution.

Local Authorities are becoming more concerned with how socially responsible they are.

With Scope 1 carbon emissions becoming more important it's more likely that Local Authorities will adopt Zero Emission FCEV or BEV HGV's, LGV's and other BEV models into their fleet so that they can reduce their carbon footprint.

In addition, as more UK Towns and Cities introduce Clean Air Zones or Ultra Low Emission Zones these zones are forcing the adoption HGV's and/or LCV's into these areas because of the extra cost of entering the zones.

One solution would be to reduce the company's carbon footprint by converting to Zero Emission FCEV's, BEV's HGV's and LGV's. ESG goals are increasingly becoming a factor in long-term corporate sustainability programs.

Non-financial factors actively affect investing, prioritizing companies that use renewable energy and embrace socially conscious practices for incentives and financial support.

One way many Local Authorities are dealing with ESG concerns now is through commercial fleet electrification.

The LCV fleet, in particular, presents a unique opportunity to show investors, employees and customer's two things.

It shows that you are concerned about how a fleet can affect greenhouse gas emissions — and that you're doing something about it.

Also, by transitioning fleets to zero emission vehicles has the potential for saving the company down time in maintenance and cost with fuel and maintenance.

ESG emphasis on sustainable actions

Traditional investing is based on expected returns. Sustainable investing still looks at returns, but realises that economic success has to be balanced with practices to improve long-term outcomes environmentally and socially

Forward-thinking firms improve Environmental, social and governance ESG through diversity initiatives, an ethical focus and lower emissions. The environmental aspect of ESG includes the energy your firm uses, the resources needed, waste and pollution, and other effects.

Carbon emissions and actions you are taking to stem climate change are drawing more and more attention. Accordingly, companies are using zero emission FCEV, BEV's to meet ESG goals as they move forward. Both FCEV and BEV's reduce emissions, support clean energy initiatives, and meet government mandates.

The conversion to FCEV's, BEV HGV and LCV's will most likely require additional electrical infrastructure being laid into the depot to enable the hydrogen electrolyser to produce hydrogen or BEV vehicles to charge.

Before the company go out and purchase charging equipment, there is a need to understand the usage pattern of all the vehicles in the BEV fleet.

So, what is meant by additional electrical infrastructure? Will all the charging be carried out overnight i.e., will overnight charging be sufficient to meet the needs of BEV HGV fleet and the needs of the business? Will that night time charging still be within your agreed maximum capacity for the depot? If not then early engagement with NGED to understand your requirements is essential.

Just buying and installing battery electric vehicle (BEV) HGV and LCV charge points to support the business without first carrying out simple checks will lead to problems. It is relevant to all customers with a fleet of BEV HGV's. Even if a business does not operate their own HGV fleet, it will be of interest if they plan to support their HGV deliveries drivers who could benefit from Destination charging their BEV HGV, while making the delivery at the goods inward bay.

With the UK government mandating that all new heavy goods vehicles in the UK will be zero-emission by 2040, the UK government confirmed this on 10 November 2021.

This, combined with the UK's 2030 phase out for petrol and diesel cars and light vans, represents a world-leading pledge to end the sale of all polluting road vehicles within the next two decades. The UK became the first country in the world to commit to phasing out new, non-zero emission heavy goods vehicles weighing 26 tonnes and under by 2035, with all new HGVs sold in the UK to be zero emission by 2040.

SMMT figures show there are already more than 171,068 ULEV cars, 6,208 light vans, five buses/coaches and 37 HGVs first registered during 2020.

Based on NGED's Distribution Future Energy Scenarios, that number of ULEV HGVs within the NGED area could be between 500k and 800k by 2040.

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.

Fuel cell electric vehicles

General information

Although hydrogen is abundant on the Earth in the form of water, it requires energy to split water molecules into hydrogen molecules. Hydrogen can be made by several means, including water electrolysis, hydrocarbon reforming/gasification, renewable liquid hydrocarbon reforming, and fermentation of the biomass feed stocks.

There are many 'colours' of hydrogen – each referring to how it is produced. Green hydrogen is the only variety produced in a climate-neutral manner. It could play a vital role in global efforts to reach net-zero emissions by 2050. Green hydrogen has been hailed as a clean energy source for the future. But the gas itself is invisible – so why are so many colourful descriptions used when referring to it?

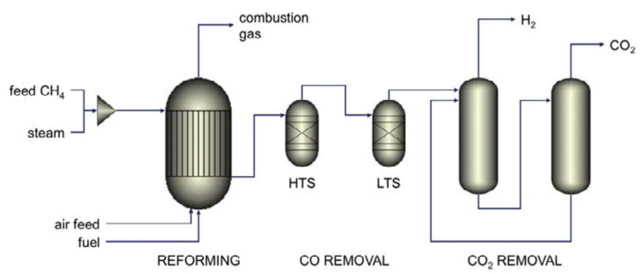
Hydrogen production

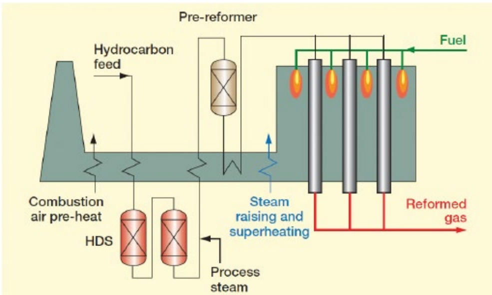
Hydrogen is produced by several means, including water electrolysis, in which water molecules are split into hydrogen and oxygen molecules. Low cost high-capacity electrolysis system is a key technology that can support greater deployment of zero-carbon hydrogen for a variety of applications and represents a technology that can potentially facilitate integration of greater renewable electricity sources.

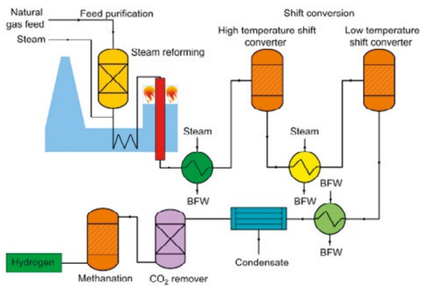
While there are several commercial electrolysis systems, proton exchange membrane (PEM) technology has emerged as a development opportunity because of its versatility. High differential operating pressure, variable operating condition potential, high current densities, high power densities, and high efficiencies are among the advantages of the PEM electrolyser over other commercial or near-commercial electrolysis technologies.

Most of today's hydrogen, is produced by steam methane reforming of natural gas. The steam methane reforming process consists of two process steps. In the first step, the major component of natural gas, methane CH4, reacts with steam to form hydrogen and carbon monoxide. In the second step, water gas shift, carbon monoxide is reacted with steam to produce additional hydrogen and carbon dioxide. Pressure swing adsorption (PSA) technology is needed for hydrogen purification in the steam-methane reforming (SMR) process, to get high purity hydrogen suitable for fuelling FCEV's.

The PSA process involves the adsorption of impurities from a hydrogen rich feed gas onto a fixed bed of adsorbents at high pressure. The impurities are subsequently desorbed at low pressure into off-gas stream which results in production of an extremely pure hydrogen product. Steam methane reforming systems have high production rates, and need large investment to install, which makes them suitable for central production facilities that produce tons of hydrogen every day.

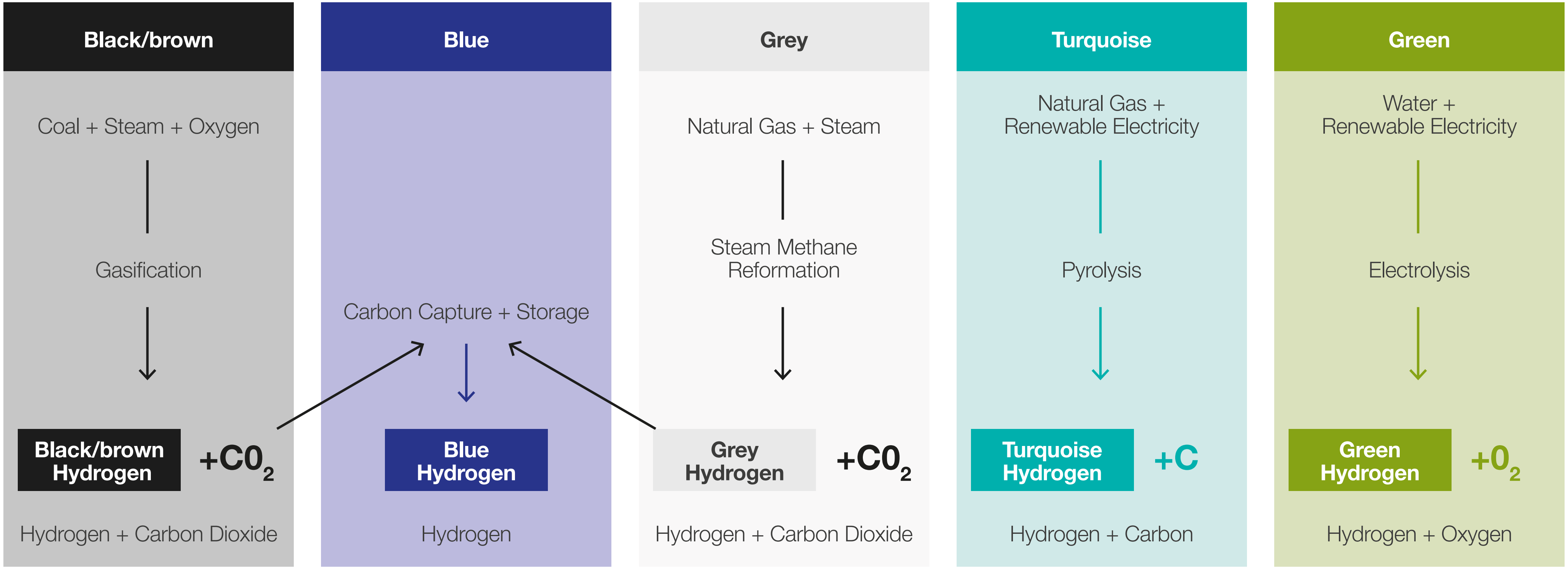






Fuel cell electric vehicles

Hydrogen production method by colour



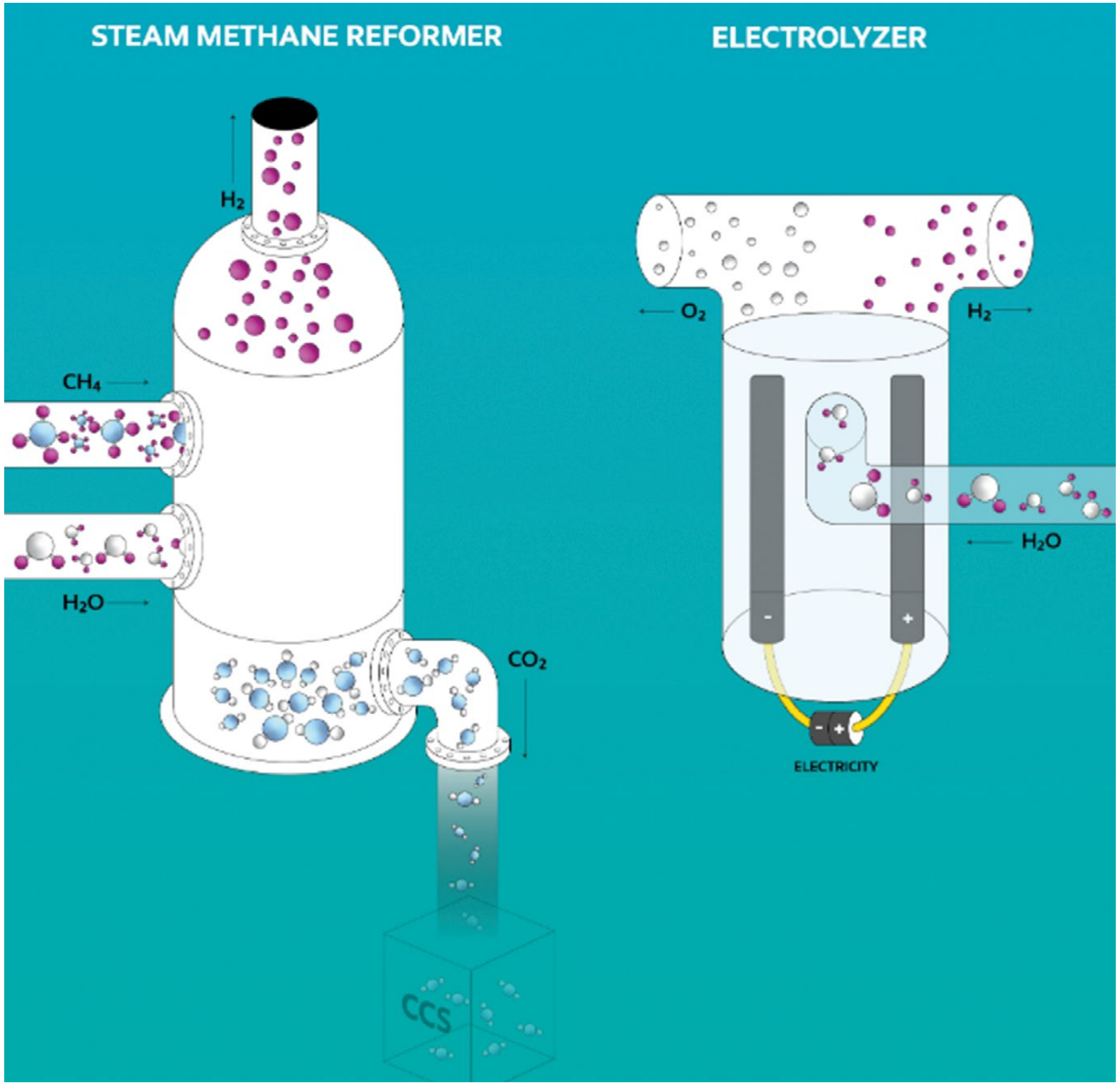
Fuel cell electric vehicles

Water electrolysis is the second most common method of hydrogen production.

Among the challenges that face water electrolysis is the high system cost for electrolysis systems which resulted in low penetrations of PEM electrolysis technology in the markets.

Three major types of electrolysers are either currently produced commercially or could be produced commercially in the near future:

- alkaline electrolysers are a demonstrated water electrolysis technology at large scale, but they tend to have lower system efficiency.
- polymer electrolyte membrane (PEM) electrolysers work at temperatures between 50°C and 95°C. PEM electrolysis is a commercial technology that could still be improved through additional R&D.
- solid oxide electrolysers are still in early commercialisation stage and still need more work to scale up into commercial systems.



Fuel cell electric vehicles

Electricity consumption

A completely efficient electrolysis system would require 39kWh of electricity to produce 1 kg of hydrogen.

However, the devices commonly found in operation for this process are less efficient. A typical operational figure is about 48kWh per kg of hydrogen.

A typical steam methane reformation with a carbon capture storage system which could produce 4,644 kilograms of hydrogen per day and would require about 30MW of electricity, that volume of hydrogen could power between 50 to 100 FCEV HGV's.

Hydrogen refuelling sites

With fuel cells there will be two types

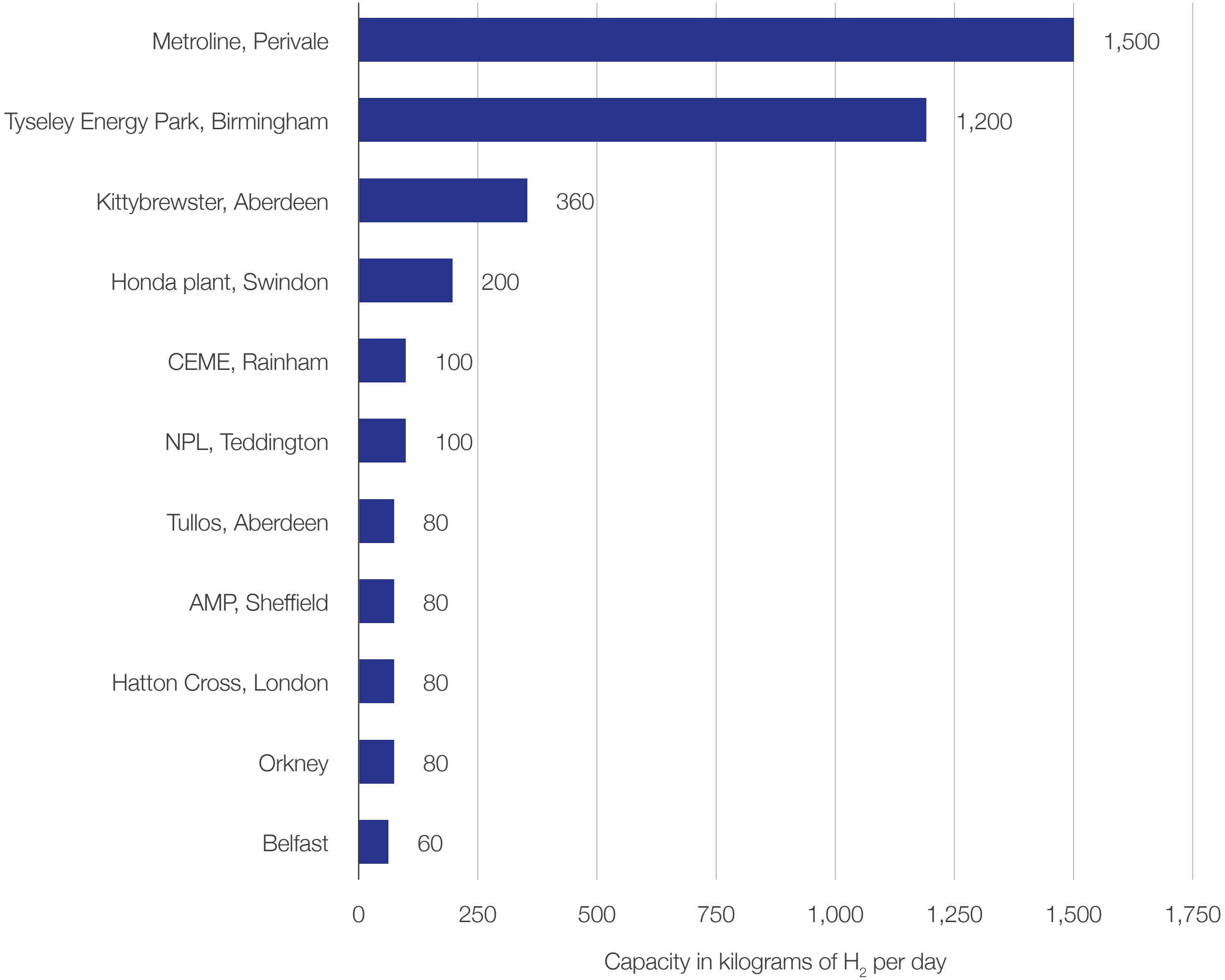
1) which works with pressurised hydrogen and the other where the hydrogen

2) hydrogen operating as a liquid.

There are currently 11 public hydrogen fuel stations in the United Kingdom, among which Metroline in Perivale is the largest. The station, which launched in 2021, has a daily capacity of 1,500 kilograms of H2.

Ranking second is the hydrogen station at Tyseley Energy Park in Birmingham, which has a fuelling capacity of 1,200 kilograms of H2 per day.

The UK hydrogen mobility sector has been under development over the 10 previous years. Water electrolysis represents the major source of hydrogen amongst the refuelling stations in the UK, the figures shown across are in kilograms of Hydrogen.



Fuel cell electric vehicles

Hydrogen refuelling stations require volume of vehicles to be economic (e.g. 100's of cars, 10's of buses).

As a result, the careful siting of stations in parallel with growing demand for vehicles is important.

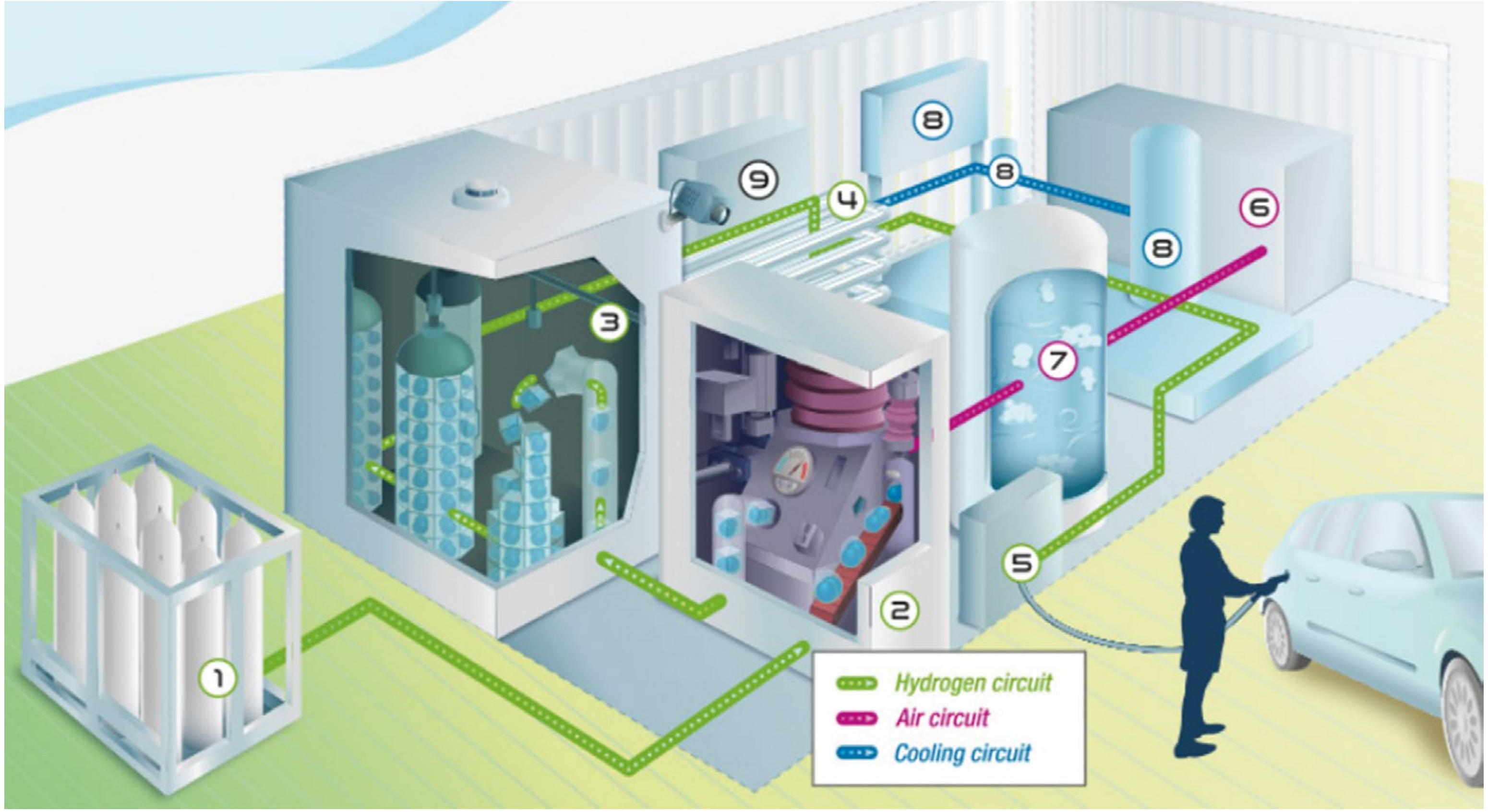
The UK H2Mobility strategy is to site stations in regional hydrogen clusters, with demand underpinned by vehicles operating within these regions for example buses, delivery trucks, local rail and fleet cars.

A Hydrogen Refuelling Station (HRS) refills FCEVs with pressurised hydrogen.

A simple HRS consists of hydrogen storage tanks, hydrogen gas compressors, a pre-cooling system, and a hydrogen dispenser, which dispenses hydrogen to pressures of 350 or 700 bars depending on the type of vehicle.

There are two filling pressures in common use H70 or 700 bar, and the older standard H35 or 350 bar. A typical hydrogen car will be refuelled in three minutes and a bus in seven minutes.

The majority of fuel cell vehicles that are operational at this time run on 700bar pressure of hydrogen.



Fuel cell electric vehicles

There are currently very few HGV or LCV FCEV vehicles available, those that do exist will use the module approach to fuel cell/s i.e. take a 150kW fuel cell and stack a second to provide 300kW.

It should be noted that fuel cells work best with a steady load that is why FCEV's have a battery as the battery is the buffer to the peaks and troughs of normal driving.

The cut image across is a schematic of a fuel cell vehicle. Hydrogen fuel cell cars are powered by an electric motor and are therefore classified as zero emission.

The common abbreviation is FCEV, short for "Fuel Cell Electric Vehicle," in contrast to a BEV or "Battery Electric Vehicle."

In the fuel cell of an FCEV, hydrogen and oxygen generate electrical energy. This energy is directed into the electric motor and/or the battery, as needed.

There is one crucial difference between hydrogen fuel cell cars and other electric vehicles – hydrogen cars produce the electricity themselves.

So, unlike in fully electric or plug-in hybrid vehicles, the vehicle doesn't get its power from a built-in battery that can be charged from an external power source. Instead, hydrogen cars effectively have their own efficient power plant on board: the fuel cell.

In fuel cell technology, a process known as reverse electrolysis takes place, in which hydrogen reacts with oxygen in the fuel cell.

The most common type of fuel cell for vehicle applications is the polymer electrolyte membrane (PEM) fuel cell. In a PEM fuel cell, an electrolyte membrane is sandwiched between a positive electrode (cathode) and a negative electrode (anode).

Hydrogen is introduced to the anode, and oxygen (from air) is introduced to the cathode. The hydrogen molecules break apart into protons and electrons due to an electrochemical reaction in the fuel cell catalyst.

Protons then travel through the membrane to the cathode. The electrons are forced to travel through an external circuit to perform work (providing power to the electric car) then recombine with the protons on the cathode side where the protons, electrons, and oxygen molecules combine to form water.

The hydrogen comes from one or more tanks built into the FCEV, while the oxygen comes from the ambient air. The only results of this reaction are electrical energy, heat and water, which is emitted through the exhaust as water vapour.

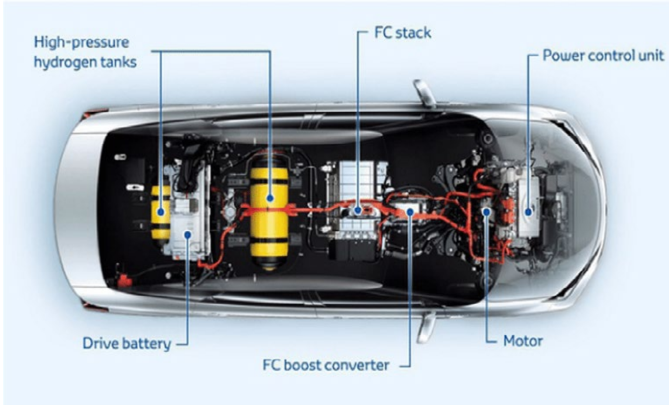
The electricity generated in the fuel cell of a hydrogen engine can take two routes, depending on the demands of the specific driving situation.

It either flows to the electric motor and powers the FCEV directly or it charges a battery, which stores the energy until it's needed for the engine.

This battery, known as a Peak Power Battery, is significantly smaller and therefore lighter than the battery of a fully electric car, as it's being constantly recharged by the fuel cell.

Like other electric vehicles, hydrogen vehicles can also recover or "recuperate" braking energy. The electric motor converts the car's kinetic energy back into electrical energy and feeds it into the back-up battery.

Currently, as of August 22, the only UK manufacturer of FCEV is Tevva who have produced various sizes of LCV.



In the fuel cell of an FCEV, hydrogen and oxygen create electrical energy. This energy is directed into the electric motor and/or the battery, as needed.

EV charger installation journey

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.

This document sets out how National Grid Electricity Distribution can help to ensure the network exists so that Businesses within the NGED area are able to install EVSE for their proposed fleet of BEV's 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 the name of your electricity Distribution Network Operator, and also your gas network operator.

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 an 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:

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 EV and HP connection form has been downloaded and completed it then needs to be sent to the local DNO.

If your local DNO is National Grid Electricity Distribution, you can forward your completed form to the following email address:

newsupplies@nationalgrid.co.uk

Interoperability (authentication/payment/billing) CPOs must connect themselves to EU wide aggregators/roaming platforms no one will use Apps /cards which work with only one CPO brand PnC (plug and charge) will most likely be part of this solution.

EV charger installation journey

How can DNOs help?

The LA's need to engage with their host DNO as early as possible on the de-carbonisation journey their respective LA's will take. NGED are happy to carry out one on one Connection Surgeries with the LA's where discussions can be at whatever level as necessary with the DNO.

This will include the location for any new point of connection to their network, i.e. where the new on-site depot infrastructure needs to be connected into the existing DNO's network (the amount of off-site cable laying) and if any network reinforcement is required to reinforce the DNO's network upstream of the point of connection to ensure the full electricity/power capacity is available to the depot.

The cables, overhead lines and substations that make up an electricity network are assets with a typical life of fifty years.

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 of 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 39.**

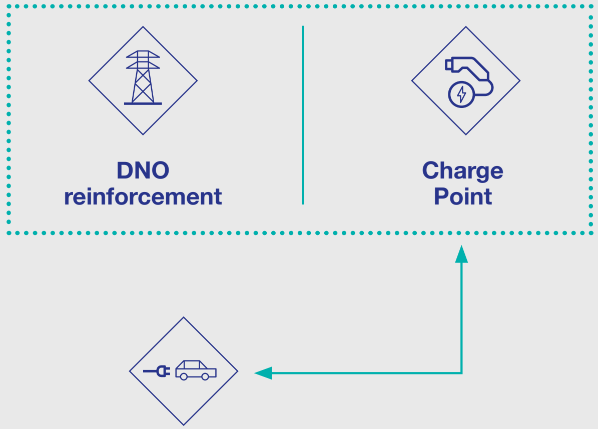
When thinking about planning to get charge points installed and operational, it is important to think of the process from the energy system perspective – with the DNO providing the critical link to an electrical power supply.

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.

Information the DNO needs to know is, the number of chargers, the power rating of chargers, the make of charger, and type of EV chargers. This data allows the DNO 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 like flicker and power quality issues for other local electricity users.

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 of 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 charger installation journey

Getting power to your site

If your EV charger requirement is such that you need to increase your capacity of your agreed connection, you will need to speak to your DNO to provide more power to your site before your EV chargers are installed.

Your DNO will be happy to discuss your power requirements prior to you making an application, you can request a one-to-one surgery to help facilitate the connection.

Once submitted your DNO project designer will produce an electrical design which will tell you how they will get power directly your site. NGED 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 dependant on the land owner.

Any LA can request a one on one engagement with NGED by clicking on the this link

connections.nationalgrid.co.uk/engage-with-us

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.
- **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.
- **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.

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

EV charger installation journey

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	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.

NGED 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 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.

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

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

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.

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 a 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.

NGED'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 NGED 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

National Grid Electricity Distribution provides a free online mapping service which you can register to use here:

dataportal2.nationalgrid.co.uk

Which will help identify the location of National Grid Electricity Distribution's assets and assist with the positioning of electric vehicle charging equipment – for consideration of the above technical aspects or the availability of space.

Charge point placement

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 NGED'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 NGED assets only, in addition NGED must retain 24/7 unhindered access to company owned apparatus.

	Demand or connection size required			
	< 18 kVA	**< 54 kVA**	**< 276 kVA**	**< 1000 kVA**
Suitable for	up to two Fast Chargers	up to six Fast Chargers or one Rapid Charger	up to 37 Fast Chargers or five 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]	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).

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 do you want to charge at any one time?
- Are all the vehicles requiring charging BEVs?
- How quickly do you want them to charge?
- How much spare capacity is available in the business premises?
- How much is the spare capacity of the existing electricity network?
- What is the cost of possible network reinforcement?

Cost of installation and commissioning

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).
- 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 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	
Type 2 - 3kW AC 	Fast (up to 22kVA)	CCS 50kW DC 	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 is identified prior to making your engagement with the host DNO because there can be a large discrepancy between EVSE appliances and some makes/models will require stronger connection characteristics, the lowest purchase price for EVSE equipment might not mean the lowest TCO for the total installation.

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.

Using your EV chargers to generate revenue

Especially with HGV battery electric vehicles with their large battery size and the fact the vehicles will be parked up for some ten hours, 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.

It is expected that 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 the grid at peak load times. This flexibility will help make best use of the electricity 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.

Common misconceptions about electric vehicles

One of the common myths that are floating around is that battery electric vehicles have higher life cycle costs than internal combustion engine vehicles the below picture has been produced by OZEV & the DfT, it is for cars because they are more numerous, but the logic will be the same for LCV's and BEV HGVs.

A battery electric car now produces only a third of the life cycle emissions of an equivalent petrol car

	$gC0_2e/vkm$
Battery	**97**
Plug-in hybrid	**128**
Hydrogen fuel cell	**169**
Petrol	**275**

A new battery-electric car has just a third of the lifetime greenhouse gas emissions of an equivalent new petrol car, even when taking into account battery production and disposal. EVs are getting progressively cleaner as electricity generation decarbonises.

The battery will need replacing after five years.

Reality: - There are well over 10 million EVs on the world's roads already. There is no evidence to suggest their lifespans are any different from a petrol or diesel vehicle. Most EV batteries have warranties of around 8 years (or 100,000 miles) but are expected to last much longer, and their lifespan continues to improve.

Batteries cannot be recycled and will all end up in landfill.

Reality: - Existing regulations ban the disposal of EV batteries to landfill and incineration. Car manufacturers are obligated to take back EV batteries free of charge and ensure they are treated at permitted facilities that meet the required recycling efficiency standards.

Hydro battery recycling joint venture Hydrovolt has commenced commercial recycling operations in Fredrikstad, in southern Norway. Hydrovolt is Europe's largest electric vehicle battery recycling plant, capable of processing approximately 12,000 tons of battery packs per year (around 25,000 EV batteries).

With the plant now online, a sustainable solution for handling Norway's entire volume of electric vehicle batteries being retired from the market, or reaching end-of-life, is now available.

Integrated with a novel process design, Hydrovolt can recover and isolate some 95% of the materials in a battery including, plastics, copper, aluminium and black mass (a compound containing nickel, manganese, cobalt and lithium).

Several novel concepts designed to maximise recovery of materials are found within the plant, including a dust collection system which ensures valuable material typically lost through mechanical recycling steps is captured.

Hydrovolt is exploring an expansion of recycling capacity within Europe, with a long-term target to recycle approximately 70,000 tons of battery packs by 2025 and 300,000 tons of battery packs by 2030, equivalent to approximately 150,000 EV batteries in 2025 and 500,000 in 2030.

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December 2022. BLU27024/JA