The Electrification of Council Depots.

A Guide to making Local Authority depots ready for fleet electrification.

> Foreword.

The Midlands Net Zero Hub is funded by the Department for Business, Energy and Industrial Strategy as part of the government's strategy to achieve Net Zero by 2050. We are one of five local Net Zero Hubs in England. We work with our partners in the Midlands to support decarbonisation projects, from the earliest stages of feasibility through to investment readiness and delivery.

In the Transport Decarbonisation Plan, published in 2021, the government committed to building a cohesive, integrated, and affordable Net Zero transport system. The plan includes a target to end sales of new petrol cars and vans by 2030, and end the sale of all non-zero emission HGVs by 2040. Whilst decarbonisation of privately owned vehicles is key to the Net Zero transition, it is essential that publicly owned vehicles, such as refuse collection vehicles, road sweepers, light vans and ambulances also be transitioned. Local Authorities across the Midlands are at the forefront of this effort with many making commitments to eliminate emissions from their fleet operations on or around 2030.

In order to successfully transition from a fossil-fuelled fleet to an equivalent electric fleet, it will be necessary for Local Authorities to install appropriate EV charging infrastructure at the depots where their vehicles are based. Fleet operators will need to install large-scale bespoke EV charging systems to serve a large number of vehicles with differing charging requirements. Electrification projects will entail engaging with external stakeholders to upgrade connections to the electricity distribution network and an understanding of the technology and technical language used when specifying EV charging equipment.

Depot electrification projects will require significant investment and a strategic approach in order to futureproof and achieve value for money. These projects will prove challenging for many Local Authorities if they are to be completed within the next eight years in line with their stated climate change commitments.

This Guide to the Electrification of Council Depots was commissioned by the Midlands Net Zero Hub to assist Local Authorities design and procure depot scale EV charging infrastructure to support electric fleets. By targeting the specific needs of municipal fleets, it seeks to assist decision makers and project officers navigate the complexities of depot electrification projects. We believe this guide will prove invaluable to our partners, both in the Midlands and nationally, as they embark on our shared endeavour to eliminate carbon dioxide and other harmful emissions from public sector fleets.

Michael Gallagher
Head of Midlands Net Zero Hub

> Acknowledgment.

Distributor Network Operators

Vehicle Manufacturers

Electric Vehicle Charging Point Supplier

Low Emission Vehicle Research and Consultancy

Contents.

Glossary & Useful Terms

AC	Alternating Current
BEV	Battery Electric Vehicle
CAPEX	Capital Expenditure
CPO	Charge-Point operator
CT	Current Transformer
DC	Direct Current
DNO	Distribution Network Operator
EOI	Expression Of Interest
ESCo	Energy Service Company
ESG	Environmental, Social, and Governance
EV	Electric Vehicle
EVCI	Electric Vehicle Charging Infrastructure
EVCP	Electric Vehicle Charging Point
FM	Facility Management
GHG	Green House Gas
GRP	Glass Reinforced Plastic
GVW	Gross Vehicle Weight
G99	Formal application for export of power
HGV	Heavy Goods Vehicle
HV	High Voltage
ICE	Internal Combustion Engine
ICP	Independent Connections Provider
IDNO	Independent Distribution Network Operator
IP	Ingress Protection rating
ITT	Invitation To Tender
kW	Kilowatt
kVA	Kilovolt Amps

kWh	Kilowatt hour
LEV	Low Emissions Vehicle
LEVI	Local Electric Vehicle Infrastructure
LGV	Light Goods Vehicle
LV	Low Voltage
NPg	Northern Powergrid
mpg	miles per gallon
MPAN	Meter Point Administration Number
NERS	National Electricity Registration Scheme
NJUG	National Joint Utilities Group
OCPP	Open Charge Point Protocol
O&M	Operation & Maintenance
OJEU	Official Journal of the European Union
OZEV	Office for Zero Emission Vehicles
PPA	Power Purchase Agreement
PPM	Planned Preventive Maintenance
PQQ	Pre Qualification Questionnaire
REGO	Renewable Energy Guarantee of Origin
RCV	Refuse Collection Vehicle
SLA	Service Level Agreement
SPEN	Scottish Power Energy Networks
SPV	Special Purpose Vehicle
ULEV	Ultra Low Emission Vehicle
VeSeCo	Vehicle Services Company
V2G	Vehicle to Grid
V2X	Vehicle to Everything
WCS	Workplace Charging Scheme
WPD	Western Power Distribution (soon to be re-branded National Grid Distribution)

Part A - The GUIDE.

List of Explainers

> Introduction.

This Guide is intended to provide Local Authorities with an understanding of what Electric Vehicle Charging Infrastructure (EVCI) will be required within their fleet depots to support the transition to fully Battery Electric Vehicles (BEVs) and, thereby, support each Local Authority's climate emergency goals.

The Guide includes a step-by-step process for delivering this infrastructure: firstly by defining the scale of the project, spatial viability, delivery programme, and risks with basic commercial options; and secondly by describing how to develop a concept design and specification in order to procure the infrastructure itself.

This document is broken into two parts: **Part A**, the Guide, and **Part B,** the worked examples, where three case studies illustrate the methodologies and outcomes described in Part A.

Part A (the Guide) is divided into three sections:

> Scoping the Project

> Concept Design

> Commercial Considerations

A forward, glossary, list of 'explainers' and acknowledgements are provided alongside this introduction, which also contains a process map, a map of the players and the diagram describing component parts of the product.

Context & Limitations.

Transitioning to Battery Electric Vehicles

This is 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 BEVs can fulfil all daily, weekly and annual 'duty' requirements.

The Guide does not capture transitioning the vehicle fleet itself or constructing a business case for transitioning from Internal Combustion Engines (ICEs) to BEVs.

There are other Guides (including for example Energy Savings Trust and Cenex) that provide the business case for transitioning the municipal fleet wholly to BEVs, including whole life cost benefits and risks. This Guide assumes the transition to zero-emission vehicles is necessary to meet each Local Authorities' climate emergency goals, and to fully transition ahead of the forthcoming ban on the sale of new diesel and petrol cars/vans in 2030 followed by Heavy Goods Vehicles (HGVs) in 2040.

Consultation with a number of transport, fleet and depot managers, as part of this and other studies, confirms that municipal vehicle fleets have sufficient overnight parking ("dwell") time to make Electric vehicle (EV) charging relatively straightforward, and that the fleet of BEVs is almost universally available to meet the daily and seasonal needs of most Local Authorities. There are some use classes such as 4x4 pickups that are less well tested. Some Local Authority depots have partially transitioned to BEVs and have worked with vehicle manufacturers to test battery sizes against daily, weekly and annual duty cycles.

As this Guide supports the electrification of fleet depots, it does not include the provision of charging infrastructure for those vehicles that are regularly home based.

Context & Limitations.

Phasing

It is understood that a more modest phased approach may be more affordable and will give confidence to drivers and operators that BEVs fulfil their needs. Options for phasing the introduction of electricity infrastructure is included in this Guide as it is assumed that the transition from diesel to EVs will also be phased.

Behaviour

This Guide doesn’t talk about driving efficiencies and behavioural changes within depots. Guides such as Cenex and Energy Savings Trust fleet reviews do capture this.

Carbon Outcomes

This Guide promotes design efficiency from an economic perspective but does not describe [in detail] the optimisation of the system based on carbon outcomes. This Guide recognises that adding renewable generation and further electrical storage in the system and providing connectivity to local or remote low and zero-carbon energy networks through engineered connections, power purchase agreements (PPAs) and sleeved Power Purchase Agreements can significantly improve carbon outcomes, and is commented upon, but this will only modestly impact on peak electricity demands as used to develop the design of the electrical infrastructure.

This Guide allows the user to plan, design and install electrical infrastructure that will meet the needs of a partly and wholly transitioned vehicle fleet now and in the future.

The Process.

The Process for procuring EV charging infrastructure

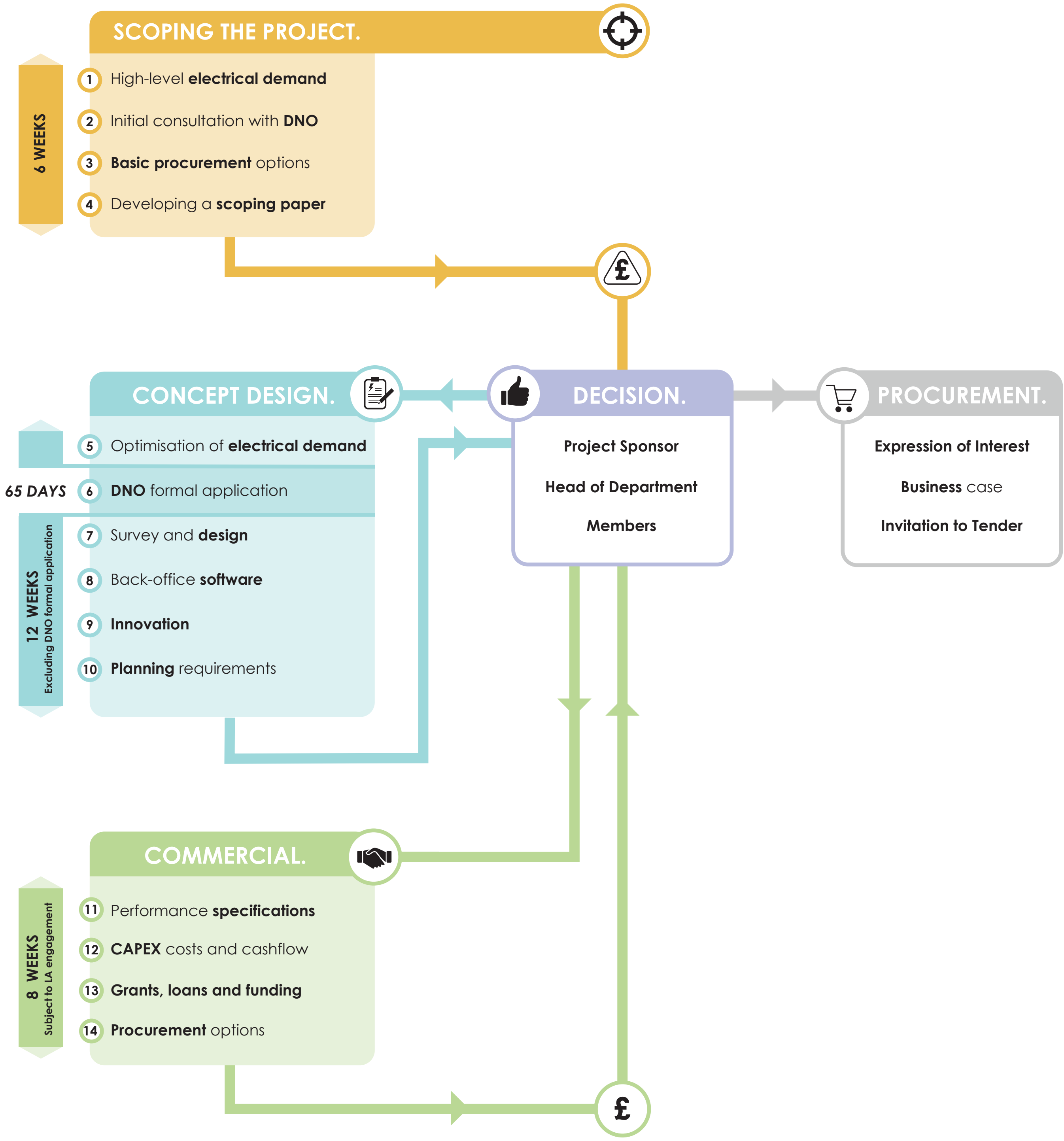
The process map below defines the process described in Part A of this Guide. It also references the chapter headings; each numbered part of the process is the chapter number within the Guide.

The process is developed around an initial scoping stage to understand the feasibility and scale of the project in Capital Expenditure (CAPEX) terms, together with any abnormal risks, and a likely delivery programme. This should be sufficient to create a project team and budget to develop a concept design and technical specification. It is also understood that should a Local Authority wish to go to the market to obtain some 'Expressions of Interest' (EOI), this might also be possible.

The second stage allows the user to optimise the electrical demand and to develop a concept design and technical specification which should be sufficient to undertake an 'Invitation to Tender' (ITT).

A third stage captures the commercial considerations; capital cost and phasing; funding and loans; and the procurement options with risks and opportunities.

The Process.


SCOPING THE PROJECT.
6 WEEKS
1 High-level electrical demand
2 Initial consultation with DNO
3 Basic procurement options
4 Developing a scoping paper
CONCEPT DESIGN.
65 DAYS
12 WEEKS
Excluding DNO formal application
5 Optimisation of electrical demand
6 DNO formal application
7 Survey and design
8 Back-office software
9 Innovation
10 Planning requirements
DECISION.
Project Sponsor
Head of Department
Members
PROCUREMENT.
Expression of Interest
Business case
Invitation to Tender
COMMERCIAL.
8 WEEKS
Subject to LA engagement
11 Performance specifications
12 CAPEX costs and cashflow
13 Grants, loans and funding
14 Procurement options
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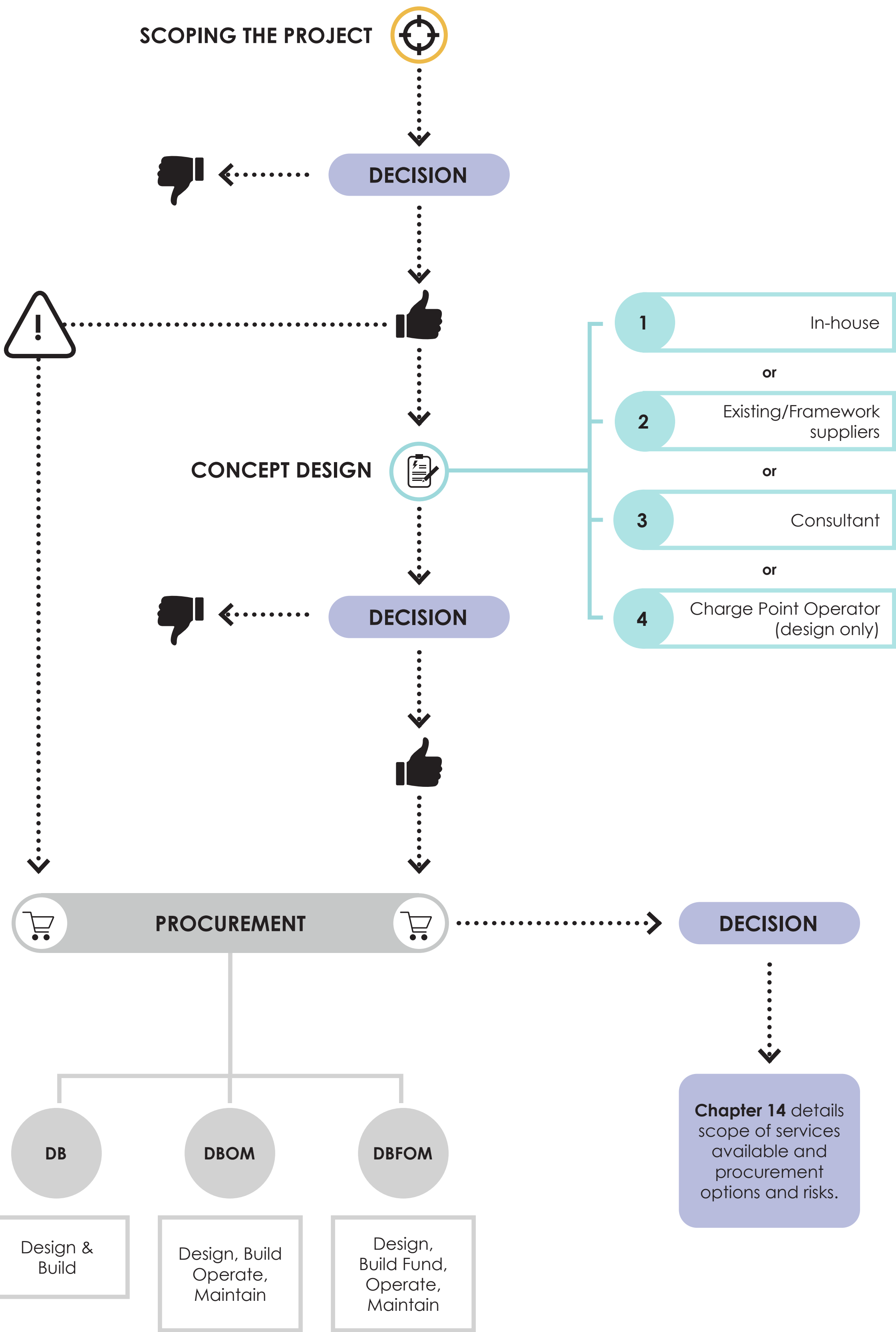
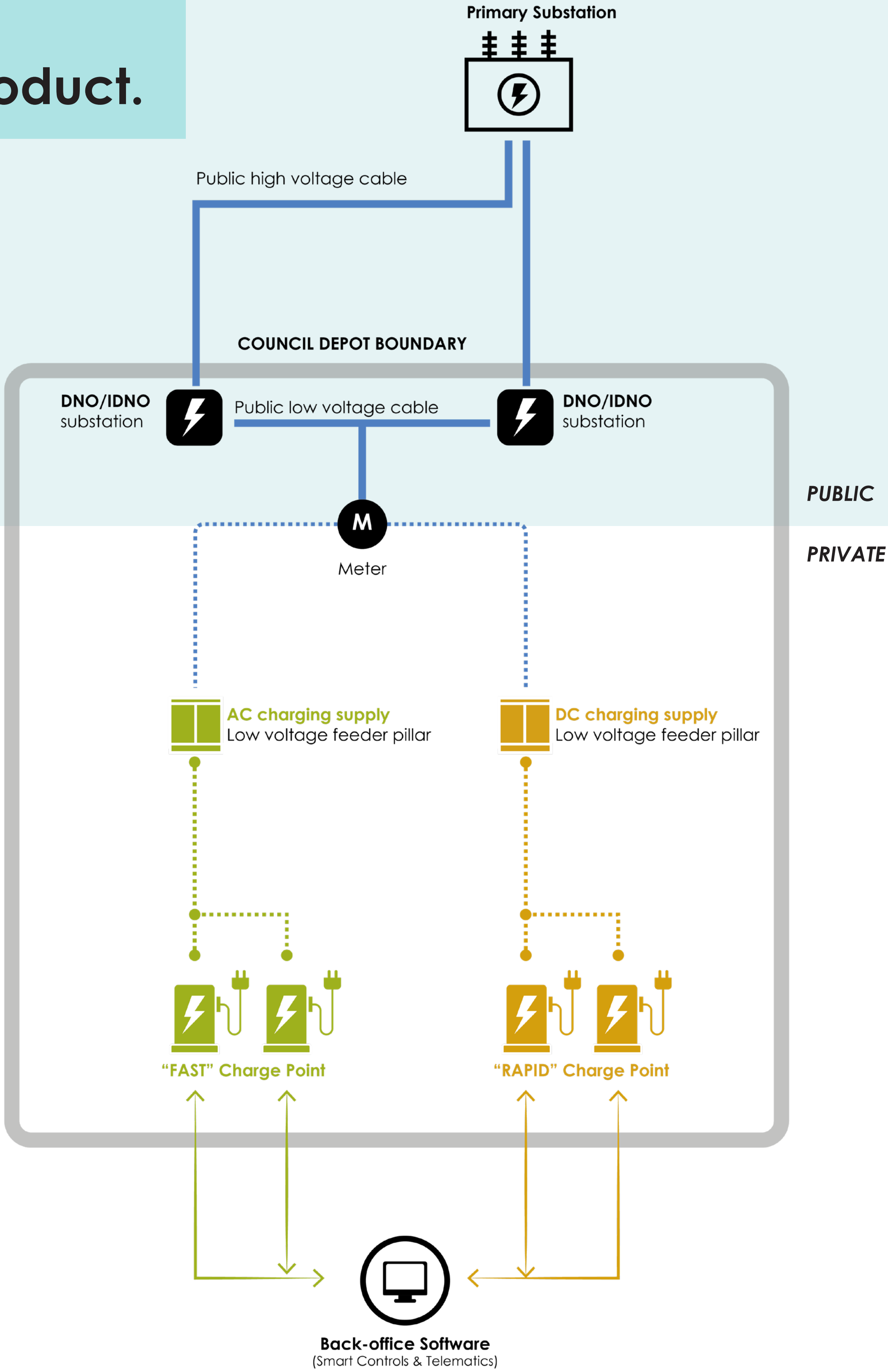
The Choice.



Market response likely to be more variable in quality if design and specifications are not well developed.

The Product.

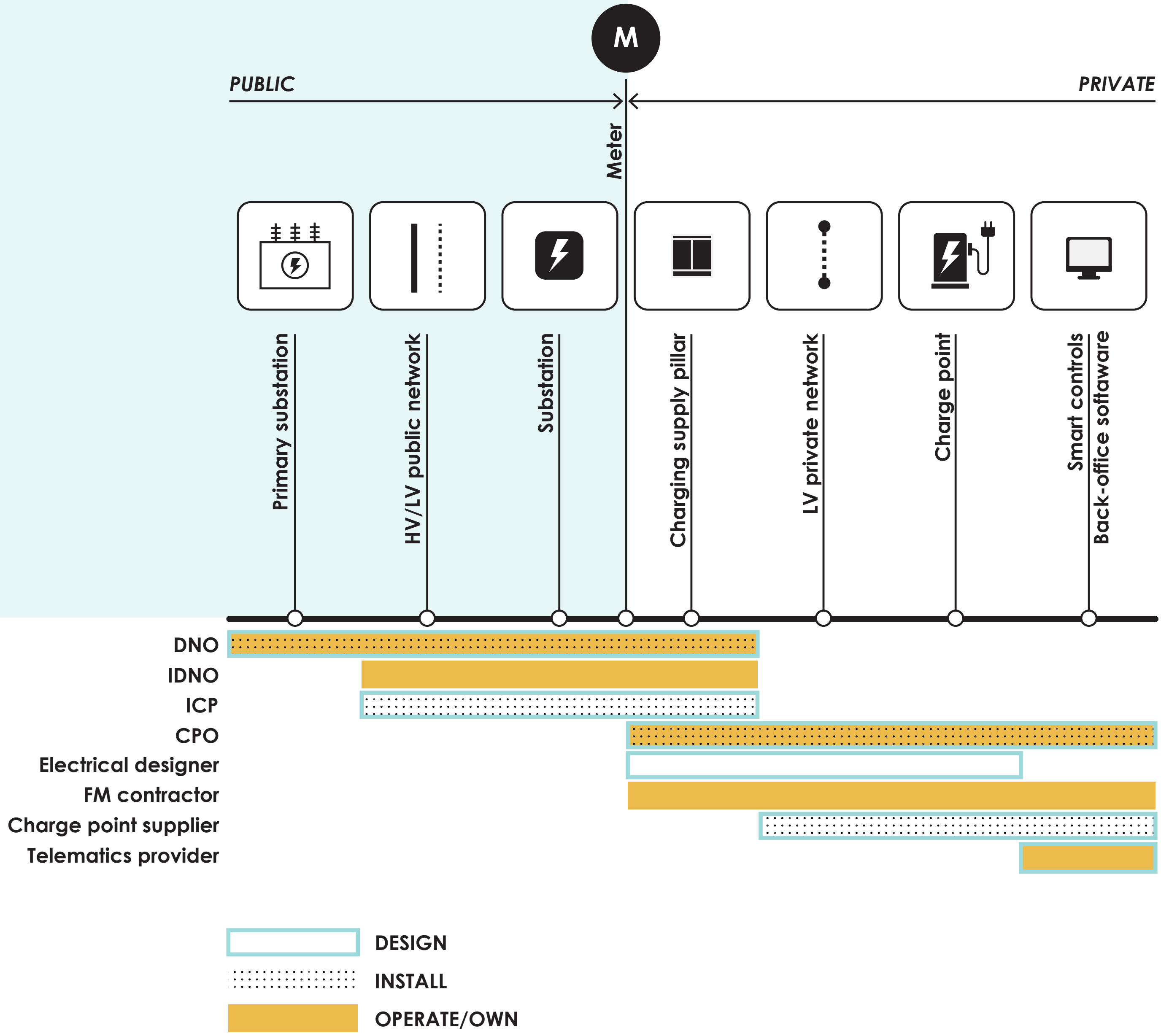


The completed product

The diagram describes the component parts of the EVCI and should be read alongside the next diagram illustrating who will design, install, fund, own and operate each component part of the system.

The Players.

The diagram below defines the 'players' and their role in the delivery, ownership and operation of the EVCI that is required to operate a fleet of BEVs with a Local Authority depot.



> Scoping the Project.

This section is intended to allow the user to define the scope of a 'depot electrification' project in terms of capital cost, programme, spatial viability, basic procurement options and risks.

The scope can then be shared with decision makers to define funding and identify next steps.

1.

What is the electrical demand?

The electrical demand is the 'maximum' amount of electrical energy that is required at a single moment in time (the simultaneous peak demand, likely during the night in a Council Depot assuming most vehicles are charging at night) to ensure that all BEVs have a sufficiently full battery in the morning.

High-Level Electrical Demand.

This chapter allows the user to understand the scale of the project in electrical infrastructure terms by estimating the additional electricity or power needed from the grid in order to fully charge the whole of the vehicle fleet within the depot.

It is understood that all the on-site electrical infrastructure may not be procured in one go but certainly the initial discussion with the electricity network operator (DNO) should be based on the off-site work needed to secure the full electrical capacity at the outset, and thereby future-proof the on-site works within the depot, which may be phased.

This chapter represents an early high-level estimation of the electrical demand for scoping purposes only. Chapter 5 describes how to optimise the electrical demand to reduce infrastructure need ahead of a formal connection application.

> High-Level Electrical Demand.

The existing vehicle fleet, anticipated future fleet needs and growth

Each Council depot will contain a varied mix of vehicles, 26-tonne Refuse Collection Vehicles (RCVs) to small vans, with large vans, minibuses and trucks between. Most of these vehicles are now available in battery electric formats, and the varieties of BEVs is increasing rapidly.

It is anticipated that all diesel vehicles will be transitioned to battery electric, with the ban on the sale of new petrol and diesel cars and vans in the UK in 2030, and HGVs in 2040. This will likely be accelerated in the municipal fleet to meet each Local Authority's individual net zero carbon emissions targets (well before these dates). For the purposes of this Guide it is assumed that all vehicles will transition to battery electric, and electrical demand is calculated on this basis.

In addition to the existing vehicle fleet, any calculation of electrical demand should be considerate of new fleet vehicle services. For example it is understood that many Local Authorities will be introducing new food-waste collection services, which will require additional vehicles. For the purposes of early estimations of electrical demand it might be assumed that these will be twin axle truck-based chassis (19-tonne Gross Vehicle Weight (GVW) – with battery sizes to suit).

For the purposes of this Guide vehicles that charge from the driver's home are not included as this Guide supports the planning, design and procurement of electrical infrastructure within a depot.

VANS		COMPACT SWEEPERS
4.25 tonnes	Kg	3.5 tonnes GVW
100-200 miles		10-hour duty cycle*
AC on-board charger	DC/AC	AC on-board charger
35-70 kWh		54.4 kWh

* Single battery cycle based on vacuum turbine system and sweeper motor, not drivetrain motor. Battery life: 3000 charge cycles.

> High-Level Electrical Demand.

HGV		RCV
19-32 tonnes	Kg	27 tonnes GVW
1 kWh/km (>175 miles)		22kW/hour – 11 hours @ 80% battery*
AC on-board charger in some models**	DC/AC	AC on-board charger in some models**
>282 kWh		~ 300 kWh

*Battery cycle based on duty cycle: combination of mileage and bin lifts, loaded vehicle weight and number of refuse ejections.

**At least two of the major medium and heavy-duty vehicle manufacturers (>16-tonne) do not have on-board chargers.

Total battery capacity and fleet mileage

Batteries store energy in the same way as a diesel tank stores energy. In order to calculate electrical demand for a depot it is necessary to know how much energy is required to fill the vehicle batteries within the depot, so they have sufficient energy to undertake their daily and weekly duty cycles.

A battery might be considered a bucket or container of energy and can be filled and emptied depending on the needs of the vehicle (in mileage terms and operational/hydraulic duty terms). However, the heavier a vehicle the more energy is required to move it.

Typical dwell time for typical vehicle

The 'dwell-time' is the duration that the vehicles are stationary so that they can be filled with electrical energy via a charging post. Basically, the longer a vehicle is able to charge the less power that is needed to fill it. Therefore, the dwell-time is very important as the longer the dwell time the less power that is required to fill it at a moment in time, which reduces the infrastructure costs.

Many Local Authority vehicle depots benefit from very substantial dwell-times, which makes municipal vehicle electrification a viable way to decarbonise the vehicle fleet.

If a RCV leaves the depot at 7.00am and returns at 4.00pm it has a dwell-time of 15 hours, which means it can be charged from a relatively inexpensive charging device and requires relatively little power from the grid – compared with a vehicle that needs to be charged in perhaps 3 hours, which would require 5 times more power.

Measure of maximum electrical demand

In this chapter a simplistic measurement has been used and there are many more sensitivities when it comes to calculating the maximum power demand as described in chapter 5 - Optimisation of Electrical Demand. This high level estimation

1.

How are EV batteries measured?

Battery sizes are measured in kilowatt hours (kWh), which is the amount of energy stored. Often larger vehicles will have larger batteries because they need more energy to undertake their daily and weekly duty cycle. For example the Dennis eCollect (RCV) has a 300kWh battery whilst the Vauxhall Corsa-E has a 50kWh battery. In theory the larger the battery the greater the range, but of course this doesn't necessarily apply to municipal vehicles because the energy required to move additional axle weight and operate hydraulic machinery will impact on range.

is to support an initial consultation with the local electricity Distribution Network Operator (DNO) in order to prepare a provisional scope of work and budget cost for early discussion with Local Authority decision makers.

Typical fleet vehicle's types	Typical battery size (kWh)
Car	45
Compact Sweeper	55
Food Waste Collection - 2 axle (7.5 tonnes)	83
Gritter - 2 axle (>15 tonnes)	282
Large Panel Van (<7.5 tonnes)	83
Mini Bus	75
RCV	300
Rigid Truck - 2 axle (>3.5 tonnes)	83
Small/Medium Van (<3.5 tonnes)	75
Telehandler (up to 7m reach)	55
Tipper - 2 axle (>15 tonnes)	282
Tractor (small units)	15

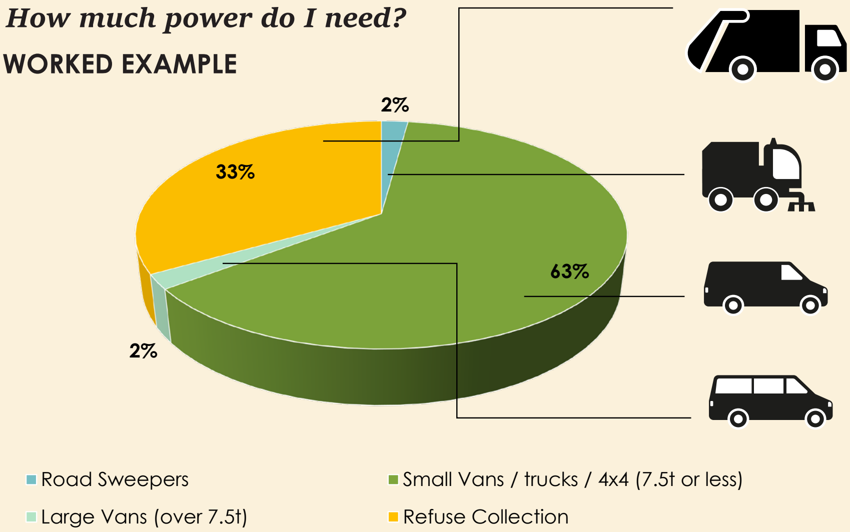
1.

Energy vs Power.

The electrical energy stored in the battery of a BEV allows the vehicle to perform work: e.g. propulsion and other municipal duties such as lifting, sucking and sweeping. Power is the rate at which energy is used and is measured in Watts. Electrical systems are never 100% efficient and therefore not all of the systems' "apparent" power is being used for useful work output. kVA is a measure of apparent power: it tells you the total amount of power in use in a system. In a 100% efficient system kW = kVA. Electricity networks and new electricity connections are typically measured in apparent power and in typical situations, the assumption is that the system is 90% efficient the conversion from kW to kVA is calculated by dividing by 90%.

How much power do I need?

WORKED EXAMPLE



Battery storage capacity ÷ **Dwell time** = **Energy Demand** ÷ **Power correction factor** = **Power demand**

Example 1 - Municipal fleet power demand estimation

Vehicle type	Number of vehicles		Vehicle battery size		Battery storage		Dwell time		Power demand		Power correction factor		Apparent Power demand
	No		kWh		kWh		hours		kW		0.9		kVA
Refuse collection	16	x	300	=	4,800		4:30pm to 6:30am						
Large/small van	20	x	75	=	1,500								
Minibus	10	x	75	=	750								
Sweeper	1	x	54.4	=	55								
Total					**7,105**	÷	**14**	=	**507.5**	÷	**0.9**	=	**563.9**

> High-Level Electrical Demand.

Summary

At the completion of this chapter the reader will be able to calculate a very approximate quantum of electricity (maximum demand) that will required from the electricity grid. This is a simplified methodology to support an initial consultation with the DNO and derive the scale and scope of the project (in budget and programme terms). A more detailed and more accurate methodology is described in the concept design section of this Guide (chapter 5).

2.

What is a DNO?

A DNO is a 'Distribution Network Operator' and is the company that owns and operates the electricity distribution network. They are regulated by Ofgem and must respond to applicants for new power connections in a very prescriptive way.

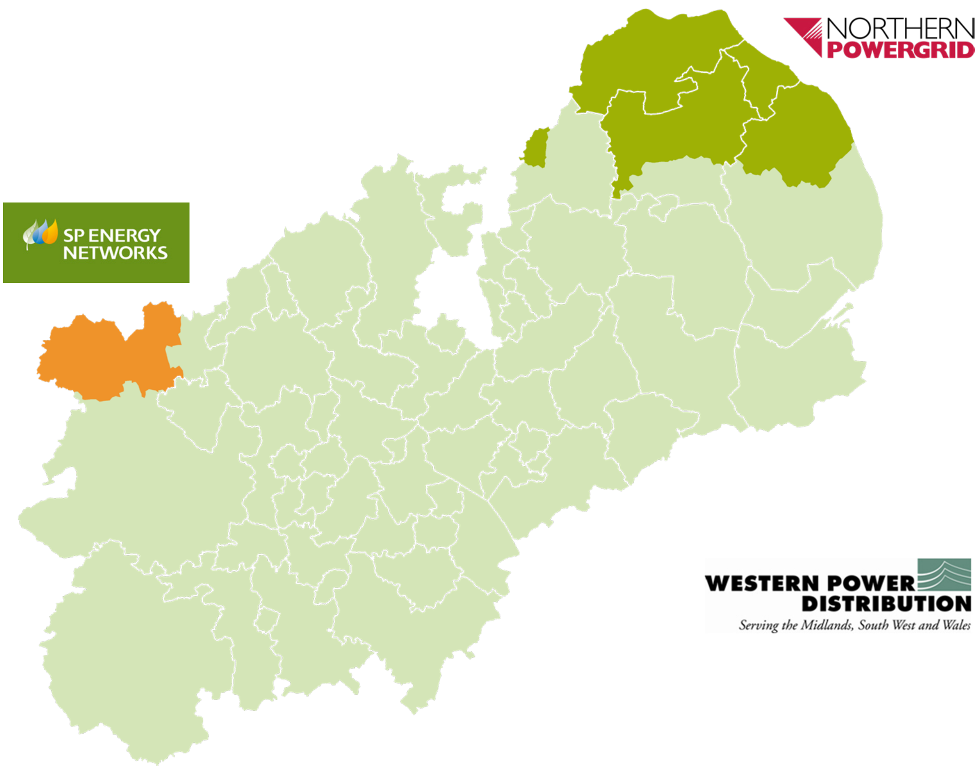
Western Power Distribution (WPD) covers most of the Midlands with Scottish Power Energy Networks (SPEN) and Northern Powergrid (NPg) covering the fringes. WPD is about ot be rebranded as National Grid Distribution.

Only they know what capacity is available on their network during daily and seasonal peak periods and only they can advise if abnormal risks and costs will likely be associated with the connection of a new electricity demand to their network.

Initial Consultation with DNO.

This chapter defines in very high-level terms what works are necessary by 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.

> Initial Consultation with DNO.



Western Power Distribution (WPD), to be re-branded as National Grid Distribution

Northern Power Grid (NPg)

Scottish Power Energy Networks (SPEN)

DNO EV charging guides, web portals and asset maps

Every existing Local Authority depot will likely have an existing metered electricity connection. It is very likely that this connection has some spare capacity but highly unlikely that there will be enough spare electricity capacity to provide more than a handful of new Electric Vehicle Charging Points (EVCPs). Certainly the 'Available Capacity' on each existing electricity meter can be ascertained from the consumer's electricity bill, and the user may wish to utilise any spare capacity before applying for a new electricity supply. The spare capacity will be the difference between the Available Capacity as stated on

DNO - Existing Reference Guides	
NORTHERN POWERGRID	[Your Guide to guide to electric vehicle charging]
WESTERN POWER DISTRIBUTION Serving the Midlands, South West and Wales	[2021 Electric Vehicle Charging for Local Authorities]
SP ENERGY NETWORKS	[Connecting your EV Fleet - A Guide for Fleet Operators]

> Initial Consultation with DNO.

the bill 'Availability Charge' is part of the standing charges and the maximum demand as recorded from metered consumption for the depot.

This Guide largely assumes that a new metered connection will be required in order to fully transition to BEVs and the detail below provides a high-level guide for understanding the capacity that is available at the Local Authority depot on the local Low Voltage (LV) and High Voltage (HV) networks.

Each DNO publishes their own EV connection guides and also has an array of web-portal based tools (including capacity maps showing 'demand' capacity on their network) that can support an initial consultation or meeting with the DNO. However, many of these interactive maps may not function for the power required to electrify a whole depot so it is strongly advised that a meeting is convened directly with the DNO whereby a future application for power can be directly discussed. All DNOs offer electronic and paper copies of their asset maps upon request, showing their apparatus in a selected area. The purchase of these maps might be rechargeable unless secured via the Local Authority Street Works Team. However, these maps do not show available capacity and are limited, unless the user has a very good understanding of utility networks, but they can be useful in showing the proximity of the local electricity network to the depot.

Budget enquiry to DNO and/or initial meeting

It is strongly advised that a meeting is convened directly with the DNO to discuss the impact of a new connection, based on the maximum electricity demand estimated in chapter 1.

This meeting can be facilitated through the Local Authority's DNO Account Manager. Each Local Authority should have a supportive Account Manager within the incumbent DNO. This is required particularly for town planning and economic development purposes – is there sufficient power to support the Local Authority growth and decarbonisation ambition

DNOs - Interactive Capacity Maps	
NORTHERN POWERGRID	Demand Heat map
WESTERN POWER DISTRIBUTION Serving the Midlands, South West and Wales	EV Capacity map
SP ENERGY NETWORKS	Connect More Interactive map

HV vs LV infrastructure.

High Voltage (HV)infrastructure carries much more electrical capacity then Low Voltage (LV) infrastructure, but to use the electricity within the depot it will have to be converted back to LV as all EV charging infrastructure requires a LV connection.

Where the DNO dictates a new HV connection is required to supply the total new power demand then a new on-site distribution substation will be required to transfer the HV supply back to a more usable LV supply.

2.

more widely, so the Planning and Economic Development Teams should have a contact.

The following questions should be considered at this initial meeting:

- ? What capacity is available at the depot Location on the LV network and on the HV network?
- ? What is the impact of connecting the estimated electrical demand (chapter 1) at this location; where will the LV/HV point of connection be located; and is there any abnormal upstream network reinforcement required?
- ? If upstream reinforcement is required what is the likely scope; what is the likely cost; and what is the likely programme for delivery?

Additionally, a 'Budget Cost' enquiry can be issued to the DNO, which will provide a reference number and a name with whom an initial consultation can be convened. This will also result in the provision of an actual budget cost (for the local on-site works) but will probably not provide sufficient information on the off-site works and any abnormal investment need, which is why a meeting or other direct consultation is preferred.

Likely off-site network extensions, reinforcement and timeline

Where the electrical demand estimated in chapter 1 is greater than 350 kVA, it is likely that a HV connection to the network will be required to provide sufficient infrastructure to electrify the whole depot.

This could mean the connection to the local network is not immediately outside the depot and there is a need to lay HV cable(s) to a suitable point of connection away from the depot. This also means that a substation will be required within the depot to transform the power back to a usable LV supply with a spatial requirement for a 5x5m Glass Reinforced Plastic (GRP) enclosed substation. This will also come with a higher capital cost for both on-site and off-site works.

DNOs - Budget and Expenses Estimates	
NORTHERN POWERGRID	Auto-Design Budget Costs
WESTERN POWER DISTRIBUTION Serving the Midlands, South West and Wales	Budget Estimate 'Assessment & Design Fee' Consultation
SP ENERGY NETWORKS	Budget Estimate

2.

The DNO might need to upgrade its HV network to ensure that sufficient capacity is delivered at the given HV point of connection and some of these costs are currently payable by the new connection applicant. However, if these network investment works create capacity for other users, then only the element attributable to the depot works should be chargeable.

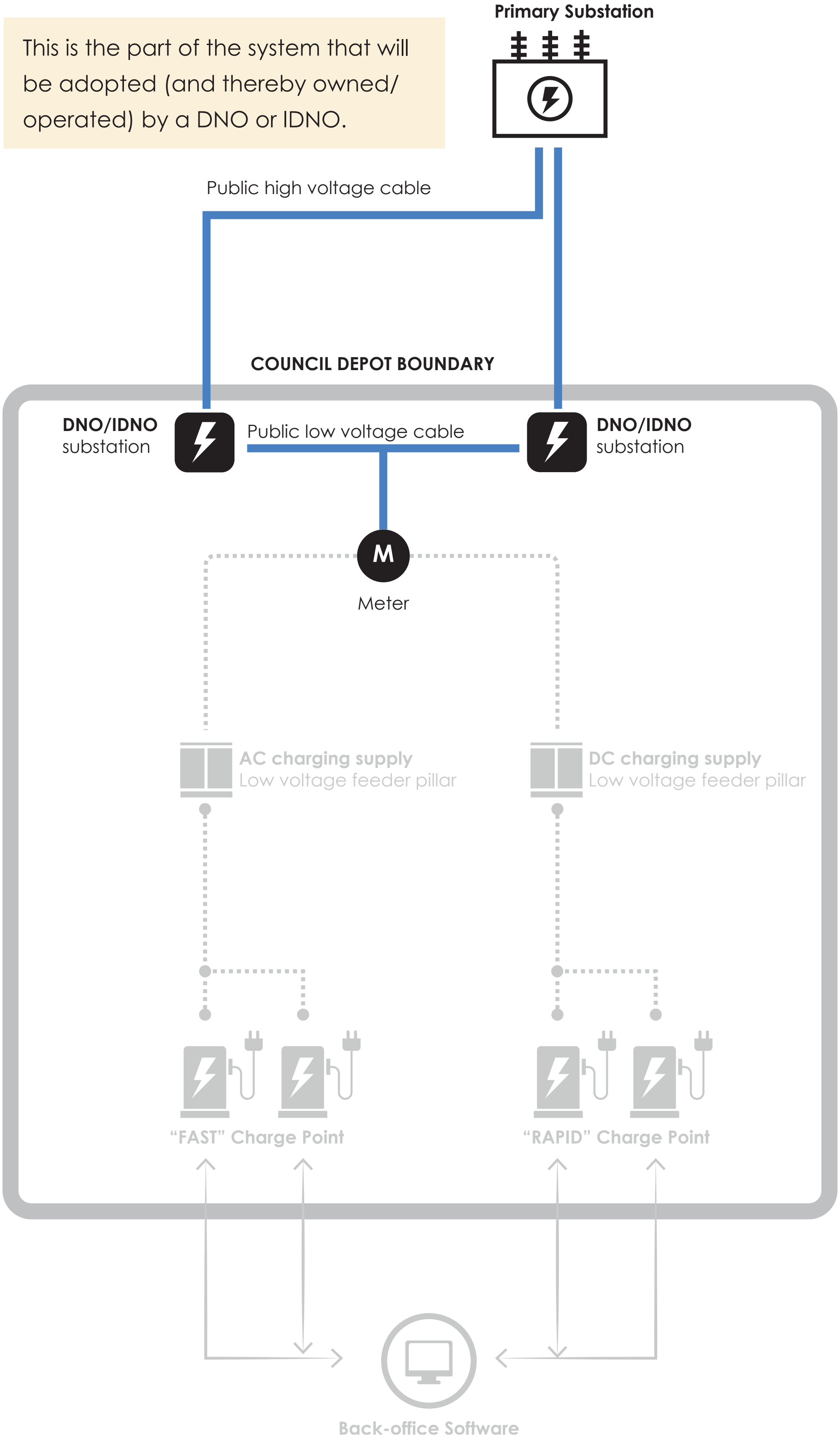
Summary

Following consultation with the DNO through web-portals, budget cost applications and preferably a meeting with the Connections Designer and/or Network Planner, it should be possible to define whether an HV or an LV connection is required and where the new infrastructure will connect to the existing network and thereby understand, in budget terms, the capital costs associated with:

- £ The on-site costs associated with the provision of **new HV and LV infrastructure**, including any new substations to convert HV to LV.
- £ The **off-site network extension** costs to connect the new on-site infrastructure with a suitable point on the DNO network to provide adequate power to meet demand.
- £ The **off-site network reinforcement** costs to improve the network to bring more power to the local area.

> Initial Consultation with DNO.

This is the part of the system that will be adopted (and thereby owned/ operated) by a DNO or IDNO.



***NOTE**: For loads above 1000kVA the DNO might insist on an HV meter with the substation being on the private-side.*

3.

Basic Procurement Options.

This chapter provides in very simplified terms the types of services that can be procured from the EVCI marketplace. E.g. Charge Point Operators (CPOs), Charge-point manufacturers or suppliers and electrical contractors. A more detailed version is provided in chapter 14.

> Basic Procurement Options.

Spectrum of Procurement and Commercial Structure Options

Detail design can be purchased as a stand alone service, but more likely will be procured as a design and build service, or perhaps a design, build, operate and maintain fully managed service. The following are the players in the market and what they might typically provide:

> CPOs - An organisation that can design, build, operate and maintain EVCI within a depot. A CPO might be contracted as single [managed] service provider and undertake the design, installation, operation and maintenance under a single turnkey contract. This could potentially include funding of the infrastructure (and possibly the vehicles). The CPO might then sub-contract the design and build of the adoptable infrastructure to an ICP.

> An ICP can be procured through the CPO or directly by the Local Authority. The ICP will design, install and then offer for adoption the part of the electrical network upstream of the metered electrical supply into the depot. The ICP will typically manage the interface with the DNO (and IDNO).

> A DNO operates the existing electricity distribution network and can be contracted directly by the Local Authority to deliver a new metered electricity supply.

> It is unlikely that an IDNO would be contracted directly.

> EVCPs themselves could be procured as supply only or more likely supply and install directly by the fleet team. This supplier could also specify and detail the depot infrastructure need. The charging infrastructure would then be operated and maintained by the Local Authority, or a separate facilities contract could be let to a CPO or a more general facilities management company on an existing framework or perhaps shared with another Local Authority.

If the charging infrastructure and electric vehicles themselves are procured through a single funded service this might be preferred to as a Vehicle Services Company (VeSeCo).

If a Local Authority has already contracted with a CPO to invest in or accelerate vehicle charging across their District or Borough this contract might be extended (likely under a variant billing mechanism) to build, fund, operate and maintain the charging services in a municipal fleet depot.

Similarly, any Local Authority that currently operates a Special Purpose Vehicle (SPV) through partnership with a CPO to provide community charging services might extend this contract to design, build, fund, operate and maintain the charging services in a depot. It is considered unlikely that an SPV would be created just to operate new depot infrastructure.

> Basic Procurement Options.

Risk rating

LOW	MEDIUM	HIGH

	ROUTE 1	ROUTE 2	ROUTE 3	ROUTE 4
	Supply only	**Design&Build**	**Design&Build Operate&Maintain**	**Design&Build Fund Operate&Maintain**
Hardware/Software	✓	✓	✓	✓
Design& Specifications		✓	✓	✓
5-7 years turnkey contract			✓	
10-15 years funded contract				✓
	LA secures the new connection, designs and installs the EVCI	Operation and Maintenance by LA or separate facility contractor	Extended warranties and system's optimisation	Funding period as long as vehicle's life

3.

4.

'Non-Contestable' vs 'Contestable' works.

DNOs are mandated under their Ofgem regulated license conditions to offer 'Competition in Connections'. This means that new electricity connection works can be designed and installed by a Lloyds accredited National Electricity Regulation Scheme (NERS) contractor. The works that are open to competition by a Lloyds accredited contractor is commonly known as 'Contestable Works'. Other works – typically reinforcement of the existing DNO network – are not open to competition and can only be undertaken by the DNO itself: these works are referred to as 'Non-Contestable Works'. A Local Authority or other Developer that requests a new electricity connection is provided with an offer that is broken into Contestable and Non-Contestable works.

Developing a Scoping Paper.

This chapter describes how to develop a very high-level scope of works and some very indicative budget costs to take to decision makers to agree next steps and a budget on the basis of the information presented in chapters 1 and 2. This does not include the budget for the EVs.

> Developing a Scoping Paper.

The scoping paper will describe the scale of the depot electrification project in financial and programme terms, provide some assurance that spatially the depot is suitable, and present some very high-level procurement options. This should be sufficient to engender political support and to enable key decision makers to secure funding for subsequent phases of the project - whether concept design or straight to the market in the guise of an EOI.

Infrastructure that will be adopted by a DNO or IDNO

A new metered service connection will very likely be required to supply sufficient power to a wholly electric fleet. Each depot will have an existing electricity meter, which may be able to provide some new EV charging provision, but certainly not the whole depot, as described in chapter 2.

A new metered connection will be planned, designed, and installed by the DNO (or an ICP working with an IDNO). The electricity meter is the demarcation between council owned and publicly adopted assets. Everything upstream will ultimately be adopted by the DNO (or an IDNO). The budget costs and scope of works will be as per the process described in chapter 2.

Infrastructure that will be owned and operated by the Local Authority

Infrastructure downstream of a new (or existing) electricity meter will not be adopted by the DNO/ IDNO and will very likely be owned in perpetuity by the Local Authority – it might be managed under an FM contract or through a managed service provider, but Operation and Maintenance (O&M) liabilities will rest with the Local Authority.

For the scoping paper it will be assumed that the whole fleet will transition to BEVs and each vehicle will need its own charging cable – we are not suggesting that every charging post is always charging a vehicle once the vehicle is plugged-in – but it must be assumed that drivers will not move a vehicle once it is 'parked-up' for the evening.

In many instances twin charging posts (two sockets per post) can be utilised. In some depots, and for larger vehicles, this might be harder, and some vehicles might have their own single charging post.

To calculate a budget cost for the charging infrastructure for the purposes of a scoping paper assume each RCV or medium-duty truck over 16-tonne (16.7 tonne with battery) will require a 40kW-twin AC charging post (20kW socket per truck) or similar.

For Sweepers, Minibuses, Large Panel Vans, Small/ Medium Size Vans and Cars assume each vehicle can charge from twin 7.4kW sockets i.e. a twin 14.8kW AC charging post.

EVCI spatial feasibility

A further aspect of developing a scoping paper is to understand whether there is physically enough space to deploy suitable charging infrastructure.

Of the nine depots surveyed as part of the development of this Guide one of the depots was considered unsuitable for electrification (the other eight were considered 'spatially' suitable). This unsuitability was because there was not enough parking bays or space within the depot to provide each vehicle with a charging post that could safely be connected.

Charging cables are typically no longer than 5m in length and should not be longer than 7m

> Developing a Scoping Paper.

because they become too heavy for manual handling. If vehicles are parked 'three-deep' and need to reverse park the distance from the charging post to the vehicle cab may be longer than 5 or 7m. In this case additional kerbing may be required to house the charging posts, or overhead gantries with charging boxes. There may or may not be space for this additional kerbing and overhead gantries would be very expensive.

This situation is further exacerbated and becomes more untenable if vehicles are parked in different locations each day or week, or worse if vehicles are parked in staff or other non-uniform parking places on an ad-hoc basis. Ultimately if vehicles are regularly parked outside an allocated parking bay and a considerable distance from a kerbed or otherwise protected pedestrian throughfare then a more detailed review of the parking and operational logistics of the depot must be considered before the electrification scoping process can properly be undertaken.

Eight out of nine depots surveyed during the development of this Guide would accommodate sufficient EVCI to safely transition to BEVs, but one depot was too full. Reference might be made to the worked examples provided in Part B of this Guide.

Phasing opportunities

Many Local Authorities will likely transition to wholly BEVs over a period of time of perhaps several years. Their procurement route might start with a new metered electrical connection to the boundary of the depot, with sufficient capacity to deliver all on-site electrical infrastructure, and progress with the delivery of the on-site infrastructure in phases as the vehicle fleet transitions from diesel to electric.

The first phase of the on-site charging infrastructure might be procured with all off-site infrastructure, and then each phased delivery of on-site infrastructure can easily be connected to the future-proofed metered service connection. This would mean that all major ticket items, including those that have a planning, licensing, or land transfer need such as HV substations and LV switch rooms are procured early, and the major

Off-site

Type of work	Typical budget cost		Delivery
'Non-contestable' **HV network reinforcement**	Only the DNO can provide a budget		DNO can provide costs and deliver works.
'Contestable' **HV or LV network extension**	LV connection only	£5,000	ICP or DNO can provide costs and deliver works.
	Loads <350kVA	£25,000	
	Loads >350kVA <800kVA.	£50,000	
	Loads >800kVA <2,000kVA	£100,000	
	Loads >2,000kVA	£250,000	

4.

On-site

Type of work	Typical budget cost		Delivery
On-site ‘contestable’ HV and LV infrastructure including substation and LV switch-room	LV switch room and meter HV connection (for an HV substation) and LV switch room and meter	£20,000 or £75,000 and add	ICP or DNO can provide costs, and deliver works.
	HV connection >1,500 kVA	Extra £55,000	
	HV connection >2,000 kVA	Extra £55,000	
	HV connection >3,000 kVA	Extra £55,000	
	Example 1 HV connection <1,500 kVA (incl. LV switch room and meter)	**£75,000**	
	Example 2 3,200 kVA supply	£75,000 + £55,000 + £55,000 + £55,000 = **£240,000**	
On-site Civil works: Excavation, backfill & reinstatement substation slab/builders works.	LV connection	**£40,000**	Design and install by ICP (as bolt-on to contestable works above), or Local Authority contractor or turnkey contract through CPO.
	HV connection	**£65,000**	
	Loads >1,500kVA	**£100,000**	
	Loads >3,000kVA	**£150,000**	
	Example 1 400 kVA LV supply	**£40,000**	
	Example 2 3,200 kVA HV supply	**£150,000**	

4.

project risks are dealt with only once.

Budget costs

The table below lists all the component works with an indication of anticipated budget costs. The budget costs listed vary depending on the maximum electrical demand derived from chapter 1.

These budget costs presented below are for 'scoping' only. By undertaking a concept design (and specification) as described in chapters 4-13, the budget costs can be much better defined, and at each design stage thereafter via the development of a more formal schedule of works, and the costs below should not provide a target cost for any form of contract procurement.

These costs are in accordance with DNO, ICP and CPO costs in February 2022. It is recognised that material costs, and to a lesser extend labour and plant costs are rising quickly during Q2 of 2022 and therefore inflationary factors should be considered, especially if the delivery will be phased.

On-site

Type of work	Typical budget		Delivery
LV EVCI distribution including feeder pillars.	Per vehicle	£450	Local Authority contractor or turnkey contract through CPO.
Earthing	Included in LV EVCI Distribution		Local Authority contractor or turnkey contract through CPO.
Structure cabling			
Containment and Builders Works			
DC 'Ultra Rapid' Charge Point	Per RCV without on-board charger / or RCV with short dwell time	**£17,750**	Local Authority contractor or turnkey contract through CPO.
AC 'Rapid' Charge Point	Per truck >16-tonne and RCV with on-board charger	**£3,500**	
AC 'Fast' Charge Point	For all other vehicles (e.g., minibuses, vans, sweepers, cars)	**£1,500**	

> Developing a Scoping Paper.

The following examples from Part B of this Guide show the estimation of the budget costs for actual municipal depots.

Blueprint 1 - Small Site

Extension of existing on-site HV network requiring additional substation.

No off-site works

720 kVA connection from HV network

On-site works

On-site contestable HV/LV	£75,000
Civil works	£65,000
LV EVCP distribution infrastructure (**34 vehicles**)	£15,300
EV AC Charging Points (29 RCVs)	29x £3,500
EV AC Charging Points (5 others)	6x £1,500

£265,800*

***Excluding any abnormal off-site 'non-contestable' works that the DNO must undertake - these could be greater than the on-site costs in some circumstances and care should be taken to qualify this risk.**

This estimation does not include DC chargers. If preferred BEV manufacturer does not have vehicles with on-board charger, than a DC charger is required irrespective of the need for ultra-rapid charging.

> Developing a Scoping Paper.

Medium Site

Extension of an off-site HV network to a new on-site substation.

Off-site works	
'Contestable' works - HV extension	£50,000

647kVA connection from HV network

On-site works	
On-site contestable HV/LV	£75,000
Civil works	£65,000
LV EVCP distribution infrastructure (**59 vehicles**)	£26,550
EV AC Charging Points (14 RCV+ 3 HGV)	17x £3,500
EV AC Charging Points (42 others)	42x £1,500

£339,050 *

***Excluding any abnormal off-site 'non-contestable' works that the DNO must undertake - these could be greater than the on-site costs in some circumstances and care should be taken to qualify this risk.**

This estimation does not include DC chargers. If preferred BEV manufacturer does not have vehicles with on-board charger, than a DC charger is required irrespective of the need for ultra-rapid charging.

4.

Blueprint 3 - Large Constrained Site

Extension of an off-site HV network to three on-site substations.

Off-site works

'Contestable' works - HV extension	£250,000

4,605kVA connection from HV network

On-site works

On-site contestable HV/LV	
(£75,000+ £55,000 + £55,000 + £55,000)	£185,000
Civil works	£215,000
EVCP distribution infrastructure (**380 vehicles**)	£171,000
EV AC Charging Points (50 RCV+ 77 HGV)	127x £3,500
EV AC Charging Points (253 others)	253x £1,500

£1,700,000 *

***Excluding any abnormal off-site 'non-contestable' works that the DNO must undertake - these could be greater than the on-site costs in some circumstances and care should be taken to qualify this risk.**

This estimation does not include DC chargers. If preferred BEV manufacturer does not have vehicles with on-board charger, than a DC charger is required irrespective of the need for ultra-rapid charging.

4.

Delivery Timeline

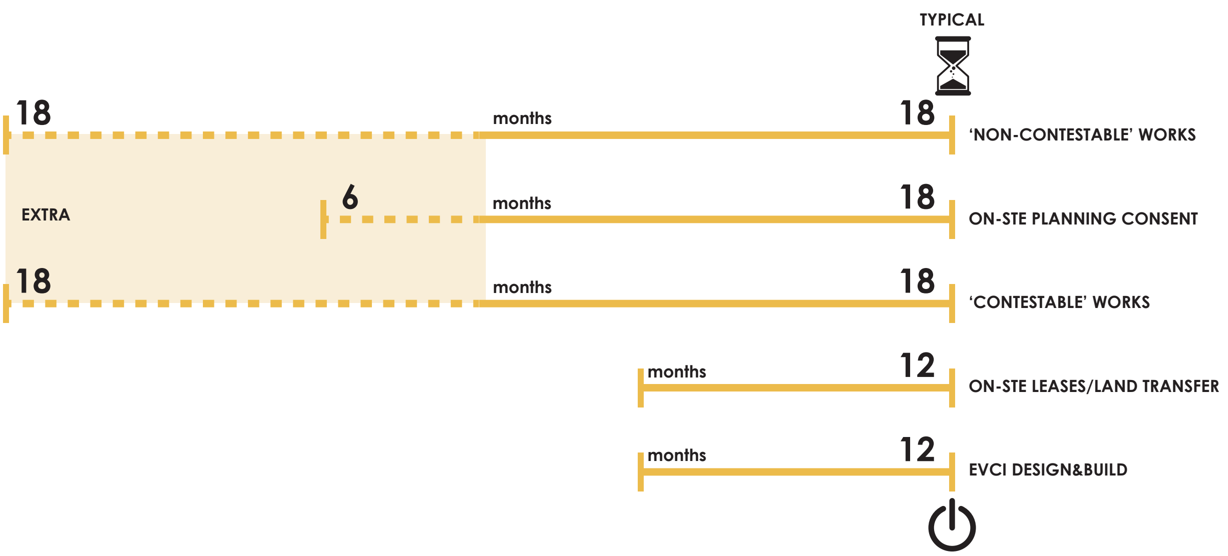
The biggest risk in terms of the delivery programme is the non-contestable DNO works. This is fully dependent on the time it will take for the DNO to deliver network investment such that the full complement of additional power can be delivered to the depot.

In the most unusual cases, it could take 3 years from payment to deliver the non-contestable works. It is more usual that should the DNO need to undertake abnormal network reinforcement it can be delivered in 12-months, but 18-months might be allowed.

When off-site network extensions are required, it may take up to 26-weeks to secure materials, including substation plant, and then 12 weeks Street Works notice, so a 9 to 12 months programme should be considered from acceptance of the DNO, or Independent Connection Provider (ICP), or CPO offer. This can usually be completed in the same window as the non-contestable works therefore in most instances the contestable and non-contestable infrastructure can be completed within 12 months, but an early programme might allow 18-months.

If a substation is required this may be subject to a land-transfer agreement, which can usually be completed within the 12-month window if all parties are willing.

If a planning consent is required, this will likely increase the window for delivering the contestable DNO (or ICP) works and a further 6-months might be added thereby increasing the 12-month window to 18-months (24-months for early programming).



> Developing a Scoping Paper.

The on-site works can more easily be controlled in design and installation; however, the on-site works has little value until the capacity is secured as above.

Summary

The scoping paper will provide a high level summary of the risks and options available. This will include:

- > Space constraints/availability.
- > 'Non-Contestable' works, time scales and costs.
- > Off-site works and costs.
- > On-site works and costs.
- > Preliminary procurement options.

The scoping paper can be presented to a Leadership Team or Committee to secure a budget for completing the next stage - concept design or otherwise.

> Concept Design.

This section is intended to allow the user to optimise the electrical demand from the network and prepare a concept design and specification for depot electrification in terms of the power requirements, general electrical plant requirements and locations, cabling routes and charger types.

The concept design can be used to engage with EV charging suppliers and operators, and electrical contractors to develop detailed specifications and firm costs.

5.

AC vs DC charging.

The UK electric grid runs on Alternating Current (AC) with a frequency of 50Hz. All electric vehicle batteries use Direct Current (DC), which is faster and more efficient for their operation. This means that in the charging process, the AC from the grid needs to be 'rectified' to DC. DC charging equipment tends to be more expensive, but most vehicles have an on-board AC to DC 'rectifier' or 'on-board charger' which allows a vehicle to accept both AC and DC charging connections. Most 'standard' and 'fast' chargers are AC, whilst most 'rapid' and 'ultra-rapid' chargers are DC.

Optimisation of Electrical Demand.

This chapter offers an overview of the process and items to be considered when calculating the maximum electrical demand capacity required to meet the charging needs of an electrical fleet.

The Electrical demand is the amount of electrical energy required from the DNO grid to charge the vehicles and is explained in chapter 1. In this chapter opportunities for reducing the maximum demand are considered.

> Optimisation of electrical demand.

Depot vehicle fleet

The first item to consider is the current depot fleet quantities and types of vehicles. The second is the expected growth of fleet vehicles due to both organic growth and/or new services needing to be delivered by the Local Authority (e.g. food waste collection).

The types of Fleet vehicles to be considered normally comprise of Refuse Collection, Rigid Trucks, Gritters, Tippers, Sweepers, Minibuses, Large Panel Vans, Small/Medium Size Vans and Cars.

Once all the vehicle types and quantities of each group of vehicles are established then the average daily mileage of each vehicle type needs to be determine by reviewing all vehicles daily average mileage in each group to determine a vehicle group average daily mileage.

1 Fleet size

2 Fleet growth

3 Vehicle types

4 Daily mileage

Typical fleet vehicle's types		
Car	Large Panel Van	Small/Medium Van
Compact Sweeper	Mini Bus	Telehandler
Food Waste Collection	Refuse Collection Vehicle	Tipper
Gritter	Rigid Truck	Tractor

Most EVs have an on-board charger. This means the DC battery can be charged from an AC charging point. However a number of medium and heavy goods vehicle manufacturers (>16-tonnes) do not offer on-board chargers and therefore these vehicles need to be charged from DC charging posts even when rapid and ultra-rapid DC charging is not necessary to fill the battery.

> Optimisation of electrical demand.

Battery capacity and fleet mileage

A review of the existing fleet diesel & petrol vehicles and their current electric equivalent must be established to provide information on the battery capacity need of each vehicle.

In the unlikely scenario where the electric equivalent of a vehicle is not available, the daily diesel usage of the current vehicle can be used to estimate the electric energy by a simplified equation that one litre of diesel would yield 10kWh of electrical energy (see example).

Once the average daily electrical energy (kWh) per vehicle type is established then the total energy usage per day can be calculated for each vehicle group by multiplying the average vehicle usage by the number of vehicles in each group.

Other factors that need to be considered when assessing the electrical energy usage per day of a vehicle is the additional weight that a vehicle maybe carrying at certain times and also items such as bin lifts and compaction by a RCV. Vehicles that are carrying heavy loads for long periods have a decrease in mileage range and may also require an additional charging period at the end (or in rare circumstances middle) of the day.

The electrical performance of vehicles requiring energy to perform additional tasks, such as bin lifts, etc., should be reviewed against their mileage autonomy and charging period with the vehicle's manufacturer as this might have an impact on the total energy usage for the depot.

Example 2 - Battery capacity

This estimation of the battery capacity can be used when the BEV equivalent of an municipal ICE vehicle is not currently available.

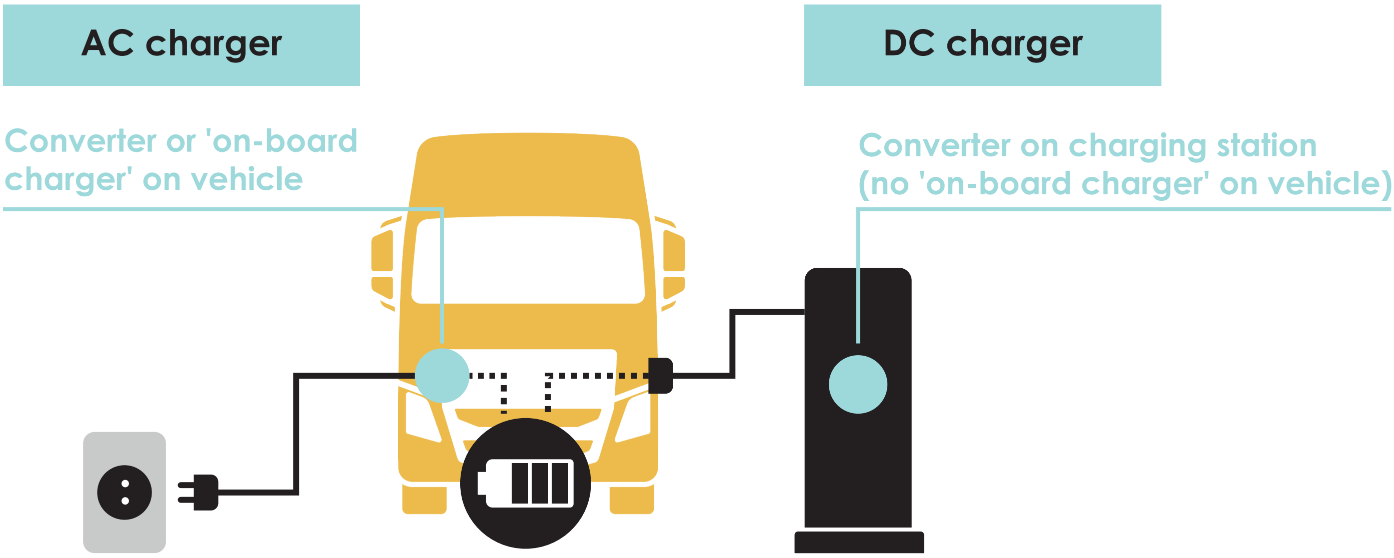
Typical RCV

25 miles	*daily mileage*
÷	
4 mpg	*fuel economy*
=	
6.25 gallons	*fuel use (diesel)*
=	
28.41 litres (1 gallon=4.456 litres)	*fuel use (diesel)*

Battery capacity

284.1 kWh

1 litre = ***10 kWh***



By adding all the different group average daily energy usages together will provide the total daily electrical energy usage for the entire fleet.

Vehicle duty cycle and energy need

The duty cycle of the vehicle is when the vehicle is in use. The dwell period is when the vehicle is not in use and is parked within the depot and available for charging. The dwell period is important when accessing the electrical demand as it limits the amount of power required from the electricity network which has cost benefits when assessing the depot's infrastructure requirements.

The dwell period allows the peak demand to be spread over the day/night.

As an example, a fleet of 12 cars would require 12 charging points (or 6 no. twin charging posts) to physically deliver power to each vehicle, because the cars will be static once parked-up for the evening. However, if each of these cars has a daily duty cycle need of 21 kWh and has a dwell-time of 14 hours, then a 7kW charger would charge each vehicle sufficiently to meet it's next-day duty need in 3 hours. Therefore 4 no. charging cycles of 3-hours duration can fully charge all 12 vehicles in 14 hours such that a maximum demand of 28kW (4 x 7kW chargers) is required and not 84kW.

In Example 3, all the vehicles are charged within the 12-hour dwell period, but when staggered charging is used, the peak demand from the grid is greatly reduced with cost benefits as the reduced peak capacity demand will reduce the rating of the substation, supply from the grid, and the on-site electrical infrastructure.

Some low daily mileage vehicles may not require charging every day because the capacity or range of the battery is greater than the daily or weekly duty of the vehicle. This should be assessed by reviewing current diesel requirements as per Example 2. Therefore, these vehicles could be

5.

Optimising charging cycles.

One of the key activities in designing EV charging infrastructure is reducing the maximum [electricity] demand from the grid. A primary tool will be the optimisation of charging cycles across multiple vehicles per night, or over a working week to reduce the number of vehicles charging simultaneously (as described in Example 3). To achieve this an accurate measure of the energy needed to meet each vehicle's duty cycle is required.

charged on a rota of charges every other, or every third day, reducing the overall maximum demand on the network. Separately it should be noted that good practise can dictate that batteries would be filled not more than 85% full and emptied not below 10% empty (assuming 75% of the total battery energy storage is sufficient to meet the vehicle's typical duty cycle) so this might also be considered as part of the optimisation of the charge cycles within a municipal fleet depot.

For larger vehicles which may not have long dwell periods or do not have regular use periods, e.g. Gritters, rapid charging may need to be considered, and these vehicles and their impact on the electrical demand will need to be assessed separately.

Example 3 - Optimising charging cycles

Fleet size: 12 vehicles

Daily energy usage: 15 kWh/vehicle

Charger power: 7 kW

	Charging options					
	1 Full fleet simultaneously charging		**2** Staggered charging		**3** Staggered charging	
	1 charging cycle (12 vehicles per cycle)		3 charging cycles (4 vehicles per cycle)		4 charging cycles (3 vehicles per cycle	
Peak capacity	12 x 7 kW	**84 kW**	4 x 7 kW	**28 kW**	3 x 7 kW	**21 kW**
Charge time per vehicle (hours)	15 kWh ÷ 7 kW	2: 08	15 kWh ÷ 7 kW	2: 08	15 kWh ÷ 7 kW	2: 08
Fleet total charge time	1 x 2:08 hours	**2:08 hours**	3 x 2:08 hours	**6:24 hours**	4 x 2:08 hours	**8:32 hours**

NOTE: As 8.32 hour dwell time is available, then maximum demand reduces from 84kW to 21kW. If 12.5 hours dwell time is available in the depot, then could have 6 charge cycles of 2 vehicles per charge with a maximum demand of 14kW. Ideally, all 12 charging points would be on the same feeder pillar where the maximum demand could be delivered through fairly simple load management in the feeder pillar.

> Optimisation of electrical demand.

Charger types

When assessing your fleets charging needs you will need to review the type and rating of chargers to be used to charge the vehicles. Typical Local Authority fleet charging requirements will range from 7kW up to 50kW chargers and also whether to use AC charging or DC charging.

DC charging is faster than AC charging, but DC charging is more costly and therefore for vehicles with long dwell periods or low charging rates, DC charging may not be necessary and should be avoided.

Generally, for smaller cars, minibuses, small/ medium vans and large panel vans 7 to 11kW AC will generally be the preferred charger size. For larger vehicles such as RCVs, gritters and HGVs Trucks then 22 to 40kW AC chargers would generally be used, however 50kW DC charging could be considered where dwell periods are short or the use patten of the vehicle is not regular and therefore rapid charge periods are required.

As stated previously, some medium and heavy goods vehicle manufacturers (>16-tonnes) only produce BEVs without on-board chargers and these vehicles will require DC charging irrespective of the need for rapid charging. This will nott effect maximum demands but will affect electrical infrastructure design.

Harmonic & fault currents

When selecting your charge points an item that needs to be considered is the Harmonic distortion which the charger could produce when charging which could have an effect on the waveform of the AC supply serving the charger.

Electrical networks have an Alternating Current (AC) waveform whereas the power configuration within an EV is Direct Current (DC), therefore a converter is required to change the waveform from AC to DC to charge the vehicle. A side effect of changing the waveform from AC to DC is the production of distortion to the waveform which is referred to as Harmonic currents.

Harmonic currents have a negative impact on electrical systems resulting in equipment and cable failures due to overheating both within the local site electrical infrastructure and also within the DNO electrical network.

When assessing an application for a new or upgraded supply to serve EV charging many DNO's will request details of the proposed charger model and manufacturer, and the quantity of charges to be installed to assess the impact that these chargers could have upon their network due to Harmonics caused by the charger.

To assist in assessing the harmonic impact manufacturers of charge points are required to declare the required fault level power rating of their chargers and a rule of thumb is that the lower the declared fault level power rating the less impact the charger will have on the electrical infrastructure.

A charger that has a higher fault level power rating declaration will have a greater impact on the electrical infrastructure that could result in the DNO having to provide a larger connection to the site which will increase the costs. Therefore, it is important that, when selecting your charging points, the manufacturers should be requested to provide their declared Fault Level Power ratings for their chargers so a comparison of different manufacturers' offers can be carried

> Optimisation of electrical demand.

an a cheaper charger with a high Fault Level Power rating may not be as cost affective as a more expensive charger with a lower Fault Level Power rating, once the additional DNO costs to overcome the harmonics are included for the cheaper chargers.

Staff & visitor car parking charging

When reviewing the fleet charging requirements, it would also be prudent to consider staff and visitor parking charging within the depot.

Generally, staff and visitor charging on-site does not affect the electrical demand capacity requirement as the charging periods differ from the fleet charging periods, as normally staff or visitor charging would be carried during the periods when the fleet vehicles are out and in use, however this should be reviewed.

Off-site or home charging

Some depots may utilise off-site parking or home parking for some of their vehicles.

Whilst this Guide does not cover off site or home charging, when calculating the on-site charging requirement's considerations should be given to off-site parking and home parking arrangement as this may impact on the final solution for the on-site charging.

Off-site parking for vehicles which do not require daily charging can be utilised to park vehicles when they do not require a charge.

Electrical capacity resilience

Consideration should be given to the resilience of the supply when reviewing the electrical maximum demand.

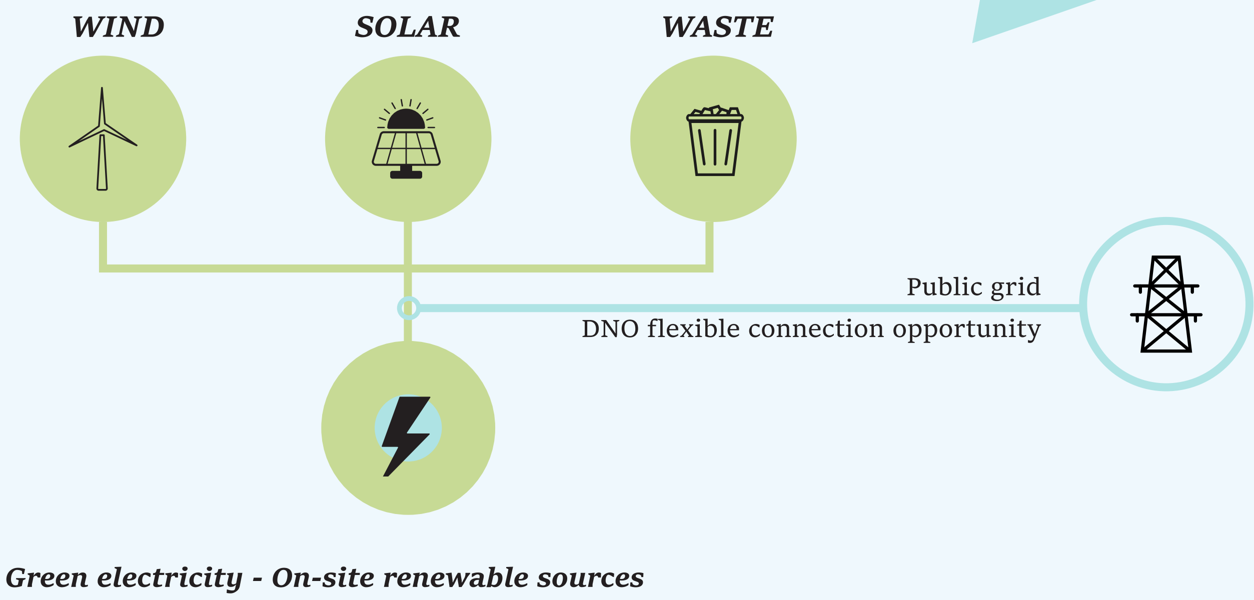
The majority of HV supplies from the DNO network will be via a ring main from a primary substation. These ring mains provide some supply resilience as in the event of one section of the ring main being lost the supply can be maintained by the other leg of the ring main. However, in the event of an issue within the DNO Primary Substation then both sides of the ring main would be lost.

DNO's can provided additional resilience within their HV network to a depot by providing HV supplies from separate Primary Substations, however there will be a cost premium to provide this level of resilience and arguably this level of resilience is not required.

On-site electrical resilience can be provided to back-up the electrical supply serving the charging system by the use of standby generation. More information on this is included in chapter 6.

Load management

Load management should be provided to control the capacity drawdown from the network and the charging of the vehicles, i.e., reduce the peak demand from the grid. This can be implemented



in various different ways.

Simple capacity control can be provided by implementing local load sharing on clusters of chargers, which effectively limits the maximum capacity a cluster of chargers can deliver simultaneously, this is known as dynamic load management. Whilst this method of control does control the capacity draw from the network it provides little control over when vehicles will be charged and therefore vehicles may not have sufficient charge the next day.

For more effective control, dynamic charging via a back-office software system is recommended as this provides more intelligent charging which can be programmed to identify vehicles and their requirements to ensure that vehicles are available for the next day at the correct time and fully charged for the day's usage. Programmable and smart dynamic load management needs to be specified in the back-office software specifications (refer to chapter 8).

Renewable energy & energy efficiency options

As the electrification of the depot fleet will require an increase in electrical capacity to the site, it is recommended that the current metered electrical supply is reviewed for available spare capacity. This is undertaken by comparing the 'Availability Charge' on the current energy bill against the maximum half-hourly meter reading. It is considered unlikely there is sufficient headroom on the current meter to supply more than a handful of new charging points. However, this exercise may indicate that when the vehicle charging is required and the load being drawn by the depot is low, spare capacity is available for vehicle charging at certain times of the day, and particularly at night when other depots electrical consumption is low. Timed connections are considered in chapter 6 but reconfiguring electrical demand profiles on existing electrical services could increase the number of chargers that might be installed before a new connection is required.

As part of the review of the existing depot capacity it is recommended that other services within the depot are reviewed for potential energy saving. Items which could be reviewed are as follows:

> Replacement of Gas or Oil Boiler Heating Systems with Electric Heat Pump Systems.

> Review of lighting and replacement of Fluorescent lamped luminaires with LED lamped luminaires.

> Solar hot water generation.

Possible renewable energy should be explored for the potential to offset some of the capacity from the mains by utilising power from renewable sources on-site. Whilst renewable energy sources can be used to offset capacity from the mains, the energy from a renewable source must be considered as not a reliable source and therefore mitigation measures must be included such as mains or standby generation back-up and battery storage, both of which can be costly. Alternatively new (or existing) renewable generation might be considered as part of a new flexible demand connection in agreement with the DNO. This is described in chapter 6.

Maximum Demand and Available Capacity

The maximum demand is the maximum quantity of power required at a single moment (simultaneous peak demand). This is critical to the efficient design of the electrical infrastructure to meet the needs of the depot. It is possible for the simultaneous demand to exceed the maximum demand, in this case the DNO can levy additional costs through the consumer's bill. However, the consumer should not over-estimate demand to avoid this situation because the consumer must also pay, through their regular bill, an 'availability charge' within the standing charge to ensure that capacity is available on the network to allow the maximum demand to be realised at any time of the day.

Any existing gap between 'available capacity' and maximum demand on an existing electricity meter should be understood by the user and could supplement the additional power required to deliver the depot electrification programme, or alternatively, this available capacity could be given back to the network operator to reduce operational costs to the Local Authority and create additional capacity for others.

> Optimisation of electrical demand.

As stated in this chapter the calculation of maximum demand is based on numerous factors including perhaps most importantly the optimisation of simultaneous BEV charging demands based on daily or weekly vehicle duty cycle and corresponding dwell-time, plus any further reduction available through load management software described in chapter 8.

Summary:

This chapter provides a methodology for calculating and optimising the maximum quantum of electricity (peak or maximum demand) that is required from the electricity grid to ensure that each vehicle is sufficiently charged in order to undertake its daily operational duties. This methodology is more refined than the methodology in chapter 3 and is cognisant of the time that each vehicle is parked in the depot and an optimised number of chargers and charging cycles. This maximum demand calculated in this chapter can be used in the formal new connection application to the local DNO.

6.

What is an ICP?

An ICP is an 'Independent Connections Provider' and is a Lloyds NERS (National Electricity Regulation Scheme) accredited contractor. It is a specialist contractor able to design, install and project manage electricity infrastructure for adoption by a DNO or an IDNO. Because an ICP can work under standard engineering contracts as a sub-contractor to a CPO, or directly for a Local Authority, they can provide significant added value to the process of installing new electrical infrastructure without having to go to a DNO for all design, installation, and project management. An ICP will usually manage all interfaces with an IDNO (or DNO).

DNO Formal Application.

This chapter describes a more detailed consultation with the DNO, including the process for securing additional electrical capacity and suitable new connection infrastructure. It also presents what the DNO provides in terms of security of supply; the options available to mitigate any abnormal costs and risks identified previously; and the process for obtaining a suitable 'new connection agreement'.

> DNO Formal Application.

The DNO, IDNO and ICP design, build, own and operate the electricity network upstream of the electricity meter. The electricity meter is usually on a LV connection within the depot. Everything downstream of the meter will be owned by the Local Authority (although might be operated and maintained by a third party).

Network resilience opportunities

The network upstream of the electricity meter is operated under regulation by the DNO or IDNO and must meet prescribed levels of service relating to power failures and faults. This means that the network operator designs their network to ensure that faults can be rectified in short periods of time. Typically, networks are designed to a N+1 level of resilience and this provides most electricity consumers with sufficient security of supply.

It is possible to secure a fully diverse connection that gives an N+N level of supply. Data Centre operators and other time critical sectors, including financial trading, would do this. This is a very expensive method of providing additional security as it involves ensuring that a depot is on two wholly separate HV networks. In the case of vehicle depots, it would likely be more prudent that additional resilience is secured on the Local Authority owned network (downstream of the electricity meter) as described elsewhere in this Guide.

Planning for new substations

Distribution substations convert HV electricity at 11kV or 6.6kV to LV (415V) electricity which can supply on-site EV charging points (AC and DC).

An existing local off-site or on-site substation with some available capacity at the LV level might already be in place (this can be confirmed on the DNO web-portal as described in chapter two), and a new on-site substation might not be required. If there is very little capacity on the LV network, or the new power demand for EV charging points is more than 350kVA it is quite likely that a connection to the HV network will be required (this will have more capacity) and therefore a new substation will be required within or immediately adjacent to the depot. This will have a 5x5m footprint.

Northern Powergrid can provide a substation with up to 1600kVA (2500A) transformer for single users if metered on the LV side (very useful for depots). Scottish Power Energy Networks are considering the introduction of a 2MVA transformer with DC and AC feeders – this is being introduced to support EV charging stations but particularly those that require rapid 'route' charging and may not be required in a depot with good daily dwell-times.

Western Power might allow a 1500kVA rated substation, but typically any maximum demand over 1,000kVA would require a 2nd substation with an additional 5x5m footprint; and a 3rd substation for a demand >2,000kVA and a 4th in the more unlikely scenario for a demand >3,000kVA.

Anticipated risks (financial and programme)

By far the biggest risk with a depot fully transitioning to BEVs is the lack of electrical capacity (lack of power) on the local HV network. This is very common because a DNO is not able to over-invest ahead of need as their investment programmes and cycles are heavily regulated by Ofgem to protect wider consumers.

> DNO Formal Application.

Therefore, early consultation with the DNO is hugely important in setting budgets, programmes, phasing and procurement strategies for these projects.

Mitigating abnormal financial and programme risks

A "lack of electrical capacity" actually means a lack of capacity when the electricity grid is operating at its peak - typically about 7.30pm. The daily and seasonal peaks can vary depending on whether the depot is in a largely industrial or commercial area where peaks might be at different times.

Ultimately there might be lots of 'spare' capacity at night when the depot requires most power!

Before alternative supply options are considered the demand must be further reviewed to understand if the peak demand can be reduced

Risks.

1 Remote connection

The nearest point of connection(s) on the DNO network where capacity is available is remote from the depot.

This means that HV cables must be extended from the remote point of connection(s) into the depot. In many cases 2 no. HV points of connection are required to ensure that the depot is on a 'ring-main' to provide the correct level of security. The worst case will be extending 2 no. HV cables from the nearest primary substation all the way to the depot, which could be more than 3,000m away.

2 Sufficient capacity

The DNO network upstream of the most suitable point of connection(s) is not robust to provide sufficient capacity or security of supply and therefore the DNO must undertake works on the HV or extra-high-voltage network to deliver more power to a particular area.

This can involve extensions to existing primary substations and upstream 33kV and 132kV network improvements. The capital cost of these works can sometimes be millions of pounds. However, these works typically create much more capacity than required by the depot and therefore the capital costs are equitably apportioned but they might take years to complete.

What is an Independent Distribution Network Operator (IDNO)?

An IDNO is almost exactly the same as a DNO in that they own and operate electricity distribution networks. They are regulated under license by Ofgem the same as a DNO. The key difference is that they can own and operate an electricity network within the host DNO's network, often referred to as an 'embedded' network. A Local Authority can go to an IDNO if the existing electricity network needs extending. Typically, an IDNO offers a capital contribution toward the capital cost of new distribution infrastructure, i.e. they will part-fund the cost of the new infrastructure. IDNOs are not always developer-facing and might be engaged via an ICP or CPO. A number of ICPs and CPOs have existing relationships with IDNOs.

(or spread/shifted) using on-site renewable generation, batteries and smart controls, but more importantly a review of vehicle duty cycles, proposed charging cycles, extending vehicle dwell time, and applying dynamic load management. These important considerations are described more fully in chapter 6.

Once the peak demand for the depot is minimised through careful consideration of maximum demand as described above (and in chapter 6) the following options can be considered:

Both mitigation options can mitigate the large capital investment needed to deliver significant network reinforcement. However there are no tick-boxes on application forms – this would need to be discussed and agreed with the DNO before submission of a formal application.

A further alternative is to apply for a 'lesser' demand at the outset of the project rather than the maximum demand required to electrify the whole depot (for example the first phase of EV charging only). The residual demand could be applied for later, perhaps when the network characteristics have improved (although if a third-party investment has created additional capacity on the network this will still be rechargeable to any future beneficiary under the '**Second Comer Rule**'.

Mitigations.

1 Flexible connection

A flexible connection allows the DNO to 'turn-down' the availability of power at peak times of the day. Ultimately this might mean having to install some rapid charging so that some of the fleet can be fully charged in fewer hours, which would increase the cost of the downstream infrastructure (but reduce off-site network costs). Flexible connections can sometimes be delivered in conjunction with local renewable generation. If the demand connection is 'timed' with the renewable generation outputs the DNO may allow the new generation to off-set some of the peak demand.

2 Timed connection

A timed connection allows the customer to elect specific charging times from the DNO network. For example a Local Authority might elect to start charging from 9.30pm to 5.30am to avoid expensive network reinforcement fees.

6.

What is the 'Second Comer Rule'?

The second comer rule is a mechanism that allows a DNO to recharge some of the capital cost for an earlier investment where a second applicant is a beneficiary of this earlier investment. The rule applies for 10-years so if Developer 1 required 2MVA and the most economic solution delivers 10MVA then Developer 1 pays 2/10 of the investment and if Developer 2 takes a further 4MVA they pay 4/10ths of the investment as a 'second comer'

A slight variation on the above is to secure the capacity that is currently [affordably] available on the DNO network – through early consultation and the use of tools as described in chapter 2 - and then apply for the residual power when the anticipated Ofgem-supported changes to new connections charging mechanisms have been implemented.

Ofgem has recently published its "minded to" response following a consultation in June 2021 on the 'Distribution Connection Charging Boundary' which favours the removal of non-contestable upstream network charging costs levied on new connection customers. It is not yet finalised, but it is widely anticipated that this change will be introduced in 2023.

New connection (or increased capacity) application

A DNO has a duty to provide a new electricity connection under Section 16 of the Electricity Act 1986. The new connection process is heavily regulated and major applications for new power have a turnaround of 65-days for the provision of the design and a formal new connection offer.

As stated previously the new connection offer must split the connection offer into 'non-contestable' and 'contestable' works. Only the DNO can undertake the non-contestable work but an ICP can design and install the non-contestable works (and offer the completed asset to the DNO or an IDNO for adoption, ideally with a further capital rebate).

DNO new connection offers are typically valid for 90-days but this could be extended to 180 days.

ICP (and IDNO) application

In addition to securing a new connection offer from the DNO the following should be considered:

Secure one or more offers for the 'contestable work' from a Lloyds NERS accredited ICP contractor.

This will benefit the user in three ways:

> The labour, plant and material costs of the 'contestable work' (including cable laying and off-site/on-site excavation, backfill and reinstatement) may be keener and more competitive than that of the DNO. This can also be tendered competitively between ICPs.

> An ICP should be able to secure a capital contribution (rebate toward the costs of the works) from an IDNO (payable to the Local Authority on adoption of the completed assets by the IDNO). This capital contribution is based on the value of the adopted asset, which is proportional to the new metered revenue. An IDNO was consulted as part of this Guide who confirmed that electrical infrastructure assets in a BEV depot is very valuable to them, and

> DNO Formal Application.

they would contribute capital to the cost of design and build.

> An ICP can work under more standard forms of contract, can respond to Official Journal of the European Union (OJEU) and may be able to provide more bespoke or tailored levels of service through competitive tender.

Allowing for export (Vehicle to Grid - V2G) or other on-site renewable generation

chapter 7 describes where bi-directional connections (from the vehicle back to the grid, or where on-site renewable generation is connected through the EVCI and back to the grid) provides additional value. If it is considered likely that power should flow back from the depot onto the grid (and not just into the BEVs for charging purposes) then any consultation with the DNO should capture this and any application for power should include a 'G99' export allowance.

Harmonics and Fault Levels

DNOs are very aware of the impact that lower quality charging infrastructure can have on the grid. Chapter 5 has a section titled "Harmonic and Fault Currents" that needs to be read ahead of any formal application to a DNO.

Summary

This chapter allows a formal new connection application to be issued to the DNO, which will ultimately result in a formal offer (detailed design and connection costs), which upon acceptance will mandate the DNO to undertake the non-contestable connection works (to provide sufficient power to a given point of connection) and perhaps also the contestable works (the installation of the HV/LV infrastructure from the given point of connection to a new metered supply within the depot).

7.

Survey and Design.

This chapter reviews the process to develop your electrical infrastructure schematic including how to cluster vehicle and charger types to optimise your charging requirements and supporting equipment requirements. This includes typical schematic information, layouts and details on cabling routes and equipment locations.

> Survey and Design.

Depot survey

It is essential to carry out a depot survey before commencing the design of the EV charging to establish main Electrical equipment locations such as DNO or IDNO substations, LV Electrical switchboard enclosures and electrical feeder pillar locations.

Spatial requirements for the typical electrical equipment are illustrated to the right.

When locating substations, LV switchboard enclosures and feeder pillars future access requirements need to be considered for future ongoing maintenance and therefore items to be considered are as follows:

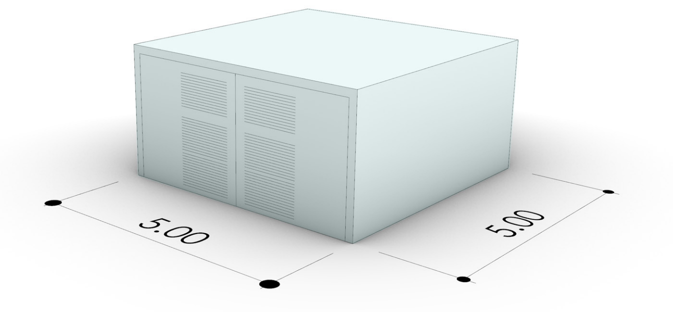
> Level solid ground to site the equipment.

> Level access to the equipment location with both pedestrian and vehicle access especially for substations & LV switchboard enclosures. IDNO or DNO require 24 hour 365 day unrestricted access to their equipment.

> Any planning or third party agreements required for the proposed equipment locations.

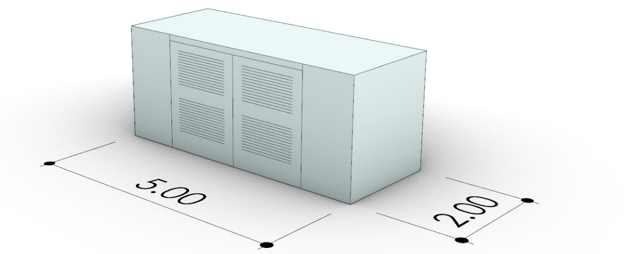
During the survey, cabling routes for both on-site IDNO or DNO HV cabling and electrical infrastructure LV cabling need to be established. Whilst establishing cable routes it is recommended that soft dig areas such as grass verge areas or small shrub areas are preferred as these areas are quicker and more cost effective for excavation to lay cables.

DNO/IDNO SUBSTATION **25 m^2**



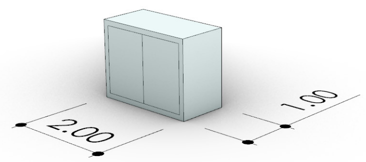
> 24/7 hour access required to the DNO/IDNO engineers

LV ELECTRICAL SWITCHBOARD & METER ENCLOSURE **10 m^2**



> Access to on-site maintenance team

ELECTRICAL FEEDER PILLAR **2 m^2**

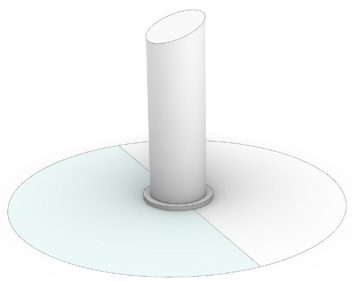


> Access to on-site maintenance team

> Survey and Design.

However, areas with large mature trees should be avoided where possible to avoid disruption to tree root areas. When reviewing existing hard surfaced areas for cable routes it is recommend assessing the current finish of the surface and the impact of cable route scarring would have on the finish. Areas with tarmac or concrete finish can generally be excavated and resurfaced to a reasonable standard, however areas with a specialist surface such as paving can be more problematic and expensive to reinstate after excavation and cable laying.

The final aspect of the Electrical Infrastructure to consider during the survey is the location of the vehicle charging points in relation to the vehicle parking bay areas.



When considering the charger location there are a number of items to consider, such as:

> Proximity of the charger to the vehicle parking bay, which should be as close as practical to minimise charging lead lengths (charging cables <5m in length).

> Location of charger to possible collision by vehicle. Review the requirement for wheel stops or bollards to protect the charger from impact damage.

> Proximity of charger to hazards such as existing electrical equipment, fuel tanks or fuel lines and other fire hazards such as waste storage.

> Safe access to charger for pedestrian.

As part of the survey for equipment locations, cabling routes and charger locations and a review of the existing installed services within the depot should be undertaking. This should include a review of existing record drawings and documents, PAS 128 equivalent Ground Penetration Radar survey of the proposed equipment locations, and cabling routes to identify and locate existing burned Electric, Gas, Communications, Water & Drainage services.

Electrical infrastructure design

The process for the electrical design of the EV charging comprises the following scope:

> Review EV types and associated battery types with the manufacturer.

> Review and agree with the IDNO or DNO the preferred location for their substation or multiple substations to serve the EV charging and also their HV cabling distribution route onto the depot from the external network infrastructure. Agree metering requirements with the IDNO or DNO.

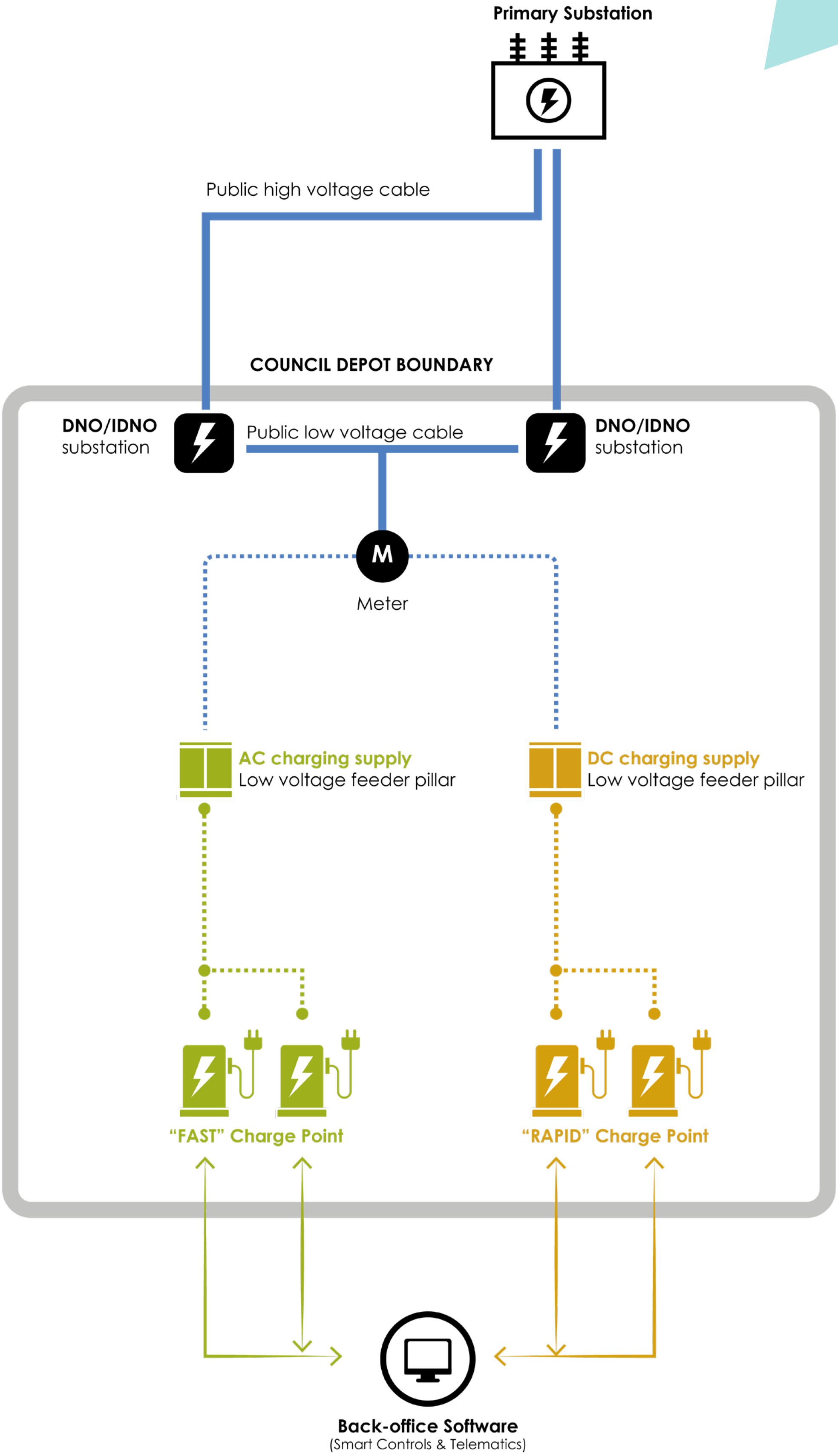
> Determine the LV switchboard requirements and locate the switchboard enclosure on the depot.

> Determine the EV cluster types and associated feeder pillar locations serving the clusters.

> Determine charging unit locations.

> Determine sub-main &sub-circuit LV cabling routes from the LV switchboard to the feeder pillars and from the feeder pillars to the charging units.

Typical Depot Infrastructure



> Determine earthing requirements for the charging units.

The Local Authority will need to employ either an electrical consultant engineer or electrical services contractor to design the electrical infrastructure to serve the EV charging. This is a guide on the general requirements.

Review electric fleet requirements

To determine the on-site Electrical Infrastructure and charging requirements the electrical fleet requirements need to be reviewed and accessed. This includes the followings:

> Vehicle types for electrification.

> Vehicle average daily mileage and duty needs.

> Vehicle battery types and sizes.

Once the vehicle types for electrification are determine then a review of the available vehicles from the manufacturer can be carried out to establish the specific vehicle charging requirements in conjunction with the specific depot daily average mileage for the vehicle types. Reference to chapter 4 is required but a vehicle with 55 kWh battery may not need to be charged to 100%. In fact, charging should ideally be between 10 to 85% at the battery's capacity.

This will determine the type, rating and number of charge points required also the locations the different charge points are required. This will enable the electrical infrastructure designer to calculate the required peak capacity and also to establish the cluster of charger types required.

IDNO or DNO substation requirements

The IDNO or DNO substation is normally located either just outside the depot or just within the depot, close to the site boundary. However, for larger depots with capacity requirements for more than one substation, multiple substations are located around the depot in suitable locations close to the charging unit clusters.

The IDNO' or DNO normally provide a single substation for a capacity up to and including 1500kVA, therefore if the depot capacity exceeds 1500kVA then multiple substations are required with the number depending upon the capacity in 1500kVA load steps.

The substation ring main unit, transformer and LV breaker equipment and enclosure are supplied and installed by the IDNO & DNO as part of their connection quotation for the depot. However, the depot is responsible for designing and constructing the substation base and earthing requirements in accordance with the IDNO's or DNO's specific requirements and details.

Where multiple substations are required the IDNO's or DNO's connection quotation will also include the on-site HV cabling installed on the

> Survey and Design.

depot as this will form part of the DNO's network. However, the depot is responsible for designing and providing the excavation and cable ducting in accordance with the IDNO's or DNO's requirements and details for the installation of the HV cabling by the IDNO or DNO. All excavation back filling and reinstatement of the surface are responsibility of the depot.

The substations and MV cabling routes are part of the DNO's infrastructure network and therefore the Local Authority and DNO need to enter into a legal lease agreement for the substations and also a wayleave agreement for access to the cabling routes. The legal process with the Local Authority is initiated by the DNO .

Metering and LV switchboard

The IDNO or DNO provide a LV supply from their substation to an LV switchboard within a dedicated enclosure located adjacent the Substation. This LV switchboard and enclosure is supplied and installed by the Local Authority, and it is at this point that the supply is metered for billing.

The DNO provides the Meter Point Administration Number (MPAN) for the LV supply to enable the meter installation to be arranged. The Local Authority needs to nominate their energy supplier and meter provider to arrange for the supply and installation of the meter. The installation of the meter is essential as the IDNO or DNO will not energise the supply until the meter installation is complete. The Local Authority LV switchboard is the point where the single LV supply is taken from the Substation and split to multiple LV outgoing circuit breaker supplies to serve the feeder pillars which serve the cluster of charging units within a specific area.

The LV switchboard and Meter will be located within a common enclosure normally either brick or GRP depending upon its location.

Sub-main cabling

From the LV switchboard, sub-main cabling is installed within below ground ducts to serve the feeder pillars.

Excavations and ducting should be constructed and provided in accordance with Street Works UK *Guidelines for positioning and Colour Coding of Underground Utilities Apparatus – Volume 1* [1] and National Joint Utilities Group (NJUG) colour identification system.

Prior to commencing any excavations works, reference should be made to HSE Guidance *Avoiding danger from Underground Services.* [2]

Sub-main cabling shall be sized in accordance with the IEE Wiring Regulations BS 7671 [3] and shall be of a steel wired armoured type for mechanical protection.

Feeder Pillars

> Survey and Design.

Feeder pillars are provided for each cluster of charging points to provide local distribution, protection and control.

Feeder pillars generally comprise of an IP67 (Ingress Protection) enclosure with front access and house the Distribution Board, MCB/RCD circuit protection and O-PEN monitoring technology for loss of the circuit protection conductor to comply with the requirements of BS 7671 (3) and also the 'Voltage Surge Protection' to protect the charging units from potential voltage surge on the electrical infrastructure from lightning strikes or network switching of large loads.

Feeder pillars should be located as close to the charging cluster it serves to minimise the sub-circuit cabling lengths from the feeder pillar to the charging posts. When locating the feeder pillar future access to the components within the feeder pillar must also be considered for future ongoing maintenance.

Sub-circuit cabling

From the feeder pillar, sub-circuit cabling is installed within below ground ducts to serve the charging posts.

Excavations and ducting should be constructed and provided in accordance with Street works UK Guidelines for positioning and Colour Coding of Underground Utilities Apparatus and NJUG colour identification system (1).

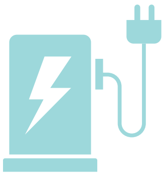
Prior to commencing any excavations works, reference should be made to HSE Guidance Leaflet HSG47 - Avoiding danger from Underground Services (2).

Sub-circuit cabling shall be sized in accordance with the IEE Wiring Regulations BS 7671 (3) and shall be of a Steel Wired Armoured type for mechanical protection.

Compliance Reference Summary	
(1) Excavation and ducting	Street Works UK, 2018. Street Works UK Guidelines on the Positioning and Colour Coding of Underground Utilities' Apparatus – Volume 1 (Issue 9). London: NJUG Publication
(2) Excavation works	Health and Safety Executive, 2014. Avoiding danger from Underground Services. Merseyside: HSG47
(3) Cable sizing and electrical installation	British Standard Institute, 2018. BS 7671:2018 Requirements for Electrical Installations. IET Wiring Regulation. London: British Standard Institute
(4) Fire safety	RISC Authority, 2021. RC59: Fire Safety when Charging Electric Vehicles. Moreton-in-Marsh: Fire Protection Association

7.

Charging units



When positioning charging units, the following items should be considered:

> Position of charger relative to the vehicle or vehicles parking bays to minimise the length of charging lead for manual handling purposes, and also to prevent trip hazards and possible damage to the lead.

> Type of charging unit i.e., floor standing post, wall mounted or soffit hanging bracket, including base and fixing requirements.

> Check for existing depot hazards such as fossil fuel storage, buried services, waste storage, etc.

> Review of possible impact damage to the charging unit once installed from parking vehicles or vehicles navigating around the depot.

> Impact of charging unit upon existing access routes or pedestrian walkways.

> Location of charger relative to the feeder pillar serving the charger.

The most cost effective charging unit is generally a dual socket charger which can serve two parking bays simultaneously, with the charger located centrally between the bays at the rear of the parking bays. With this arrangement the charging leads from the unit to the vehicle socket can be optimised to a standard length which is beneficial from both a cost and health & safety perspective. Longer leads can be supplied and used if required, but these are more costly and can be problematic to store and also used as they can be a trip hazard when in use and also more likely to be subject to possible damage from impact by other vehicles.

The selection of charging unit depends upon the area and type of installation, with the majority of charging units being post mounted. Other types of charging units, such as wall mounted, can be used where parking bays are either adjacent solid wall structures or are located internally. Also, the use of soffit mounted chargers can be used within internal areas where parking bays are located centrally away from perimeter walls.

Post mounted charging units require a concrete base and must be constructed to the charger manufacturers specific requirements for mass, size, depth and cable entry requirements, with fixed post bolt positions cast within the base. Wall & soffit mounted charging units must be fixed to structures in accordance with the manufacturer's recommendations depending upon the type of construction.

When reviewing the location of a charging unit, existing depot hazards need to be considered such as the proximity of any existing fossil fuel storage facilities, fuel lines, buried services and waste storage areas. Document RC59: Fire Safety when Charging Electric Vehicles [4] should be referred to as this provides guidance on the risks to be considered and also the mitigation works to be implemented to mitigate the risks.

Charging units should be provided with protection from impact damage from either parking or manoeuvring vehicles. Protection can be provided by the installation of wheel stops, bollards or halos around the charging units.

When positioning charging units, consideration should be given to existing access or pedestrian routes to ensure the charging unit, or the charging lead do not obstruct or cause a trip hazard when being used.

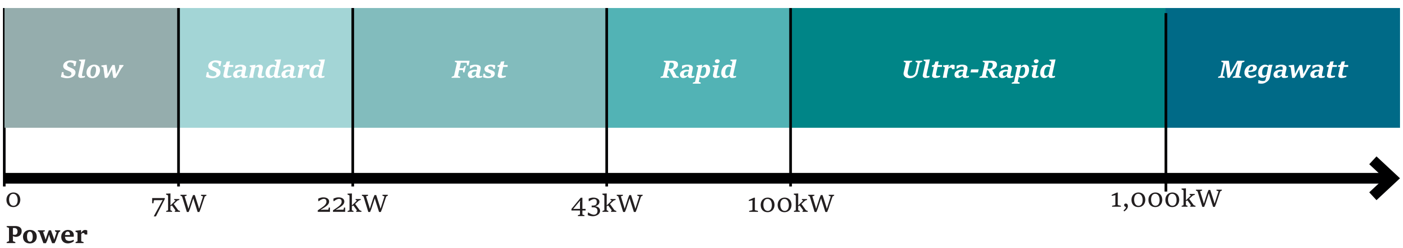
Finally, for cost efficiency the proximity of the charging units in relation to the feeder pillar serving them should be maintain as near as possible to minimise the sub-circuit cable lengths and subsequent cabling excavations.

The diagram above describes the types of chargers based on power rating, i.e. the charge point's ability to change the rate of energy within a battery.

This is a new classification system whereby chargers <7kW are "Slow"; chargers between 7kW and 22kW are "Standard"; the fastest AC chargers (22kW to 43kW) are "fast"; and all DC charging points (above 43kW) are "Rapid" or "Ultra-Rapid"; with the very fastest chargers, which are very new to the marketplace now having "Megawatt" charging capabilities (i.e. 1,000kW of power, which could fully charge 25 x 40kWh batteries in one hour).

As stated consistently in this Guide, the long 'dwell-time' in municipal vehicle fleet depots will allow "Standard" chargers to meet most vehicle charging needs, which will keep the electrical peak demand (maximum demand) to a minimum and reduce on and off-site infrastructure costs. AC chargers are also significantly cheaper (as described in the 'Scoping' chapter budget costs) and AC charging should generally be used where this can meet the each depot's charging need.

Charge Type Classification



> Survey and Design.

Some DC charging might be added for additional flexibility if a quick turnaround is required for operational reasons, or perhaps for gritters.

On-site resilience

When designing the on-site electrical infrastructure, the resilience of the infrastructure and supply should be considered to prepare for events such as local circuit failures or external network serving the site failures which can result in a partial or full failure of the site charging system infrastructure.

On-site electrical infrastructure should be broken down into a number of feeder pillars serving a group charge points with each charge point served via a dedicated radial sub-circuit, thereby ensuring that a fault on an individual sub-circuit will only affect a single post. Radial sub-circuits serving multiple charging posts should be avoided as fault would affect number of chargers.

Feeder pillars should be limited to the number of chargers they serve so that a fault on a feeder pillar will only affect a small number of chargers. The number of chargers served from a feeder pillar should be assessed during the calculation stage to establish how many chargers could be lost due to a failure without affecting the normal fleet operation the next day.

To provide resilience from an incoming supply failure on-site standby diesel generation could be considered to provide an alternative electrical supply during a mains failure from the external DNO network.

Standby generation can comprise of either an installed standby generator on-site connected to the on-site electrical infrastructure at the Main LV switchboard with an automatic start up and changeover system which would monitor the mains supply for failure and upon failure of the mains would start the generator and connect into to the charging electrical infrastructure. An alternative option is to provide a plug-in connection for a mobile standby generator at the main LV switchboard location which can enable a mobile standby generator to be brought on-site and connected to the charging electrical infrastructure as and when it is required.

Other options for supply resilience is on-site battery storage, which can provide a back-up supply from the battery storage when the mains supply is lost. However, battery storage can be cost prohibited due to the size of capacity battery storage required, ongoing charging of the batteries, ongoing technical maintenance and control of the system.

Design documentation

The design documentation for the on-site EV charging infrastructure from the DNO/IDNO substation to the charging posts should include the followings:

The Local Authority must engage with an electrical consultant or contractor to prepare the design documentation which will enable the Local Authority to competitive tender the works for costings.

To facility the Local Authorities phased decarbonisation of their fleet, the on-site electrical design should be modular in design so that whilst the design will include for the entire fleet electrification the works can be installed in phases to meet the phased electrification of the depots fleet. However, it is recommended that when

> Survey and Design.

considering the phasing of works the requirement for buried ducts for cabling should be carried out as part of the first phase so as to have the infrastructure in place to install cabling at a later detail without having to carry out excavation works at a later date causing disruption on-site.

DESIGN DOCUMENTATION

✓ **Layout drawings**	Locations of the substations, LV switchboard enclosures, feeder pillar and charging post locations, proposed resilience equipment.
✓ **Layout drawings**	Cable routes for both HV and LV cables, including trench details, duct quantities, containment routes if cables are fixed to walls or soffits and details of any protection measures for mechanical damage or fire stopping.
✓ **Electrical Infrastructure Schematic diagrams**	Substation to LV switchboard connection, LV switchboard connections to feeder pillars and feeder pillars to charging units. Details of cable types and sizes, protection device types and ratings within the LV switchboard.
✓ **Electrical Performance Specification**	Electrical infrastructure scope of works, standard of workmanship and materials, and schedules of equipment and plant.
✓ **Civil Performance Specification**	Civil scope of works, standard of workmanship and materials, details of any builders work requirements (e.g., bases for LV switchboard enclosures, feeder pillars and charging posts).

8.

What is a back-office software?

An electric vehicle charging point is often referred to as 'hardware' and is typically sold with supporting software. This software allows a Local Authority, or their FM contractor, or a CPO to monitor and manage system faults across a charging network, retrieve data for payment and billing, undertake smart energy management and optimisation, and integrate the charging points and vehicle data with telematic software.

Back-office Software.

This chapter provides information on how charging infrastructure and vehicles communicate with each other and the wider depot. A properly communicating system can help with additional reporting of information and monitoring of the equipment in addition to managing how the vehicles are charged.

8.

Communication Protocols (OCPP and ISO15118).

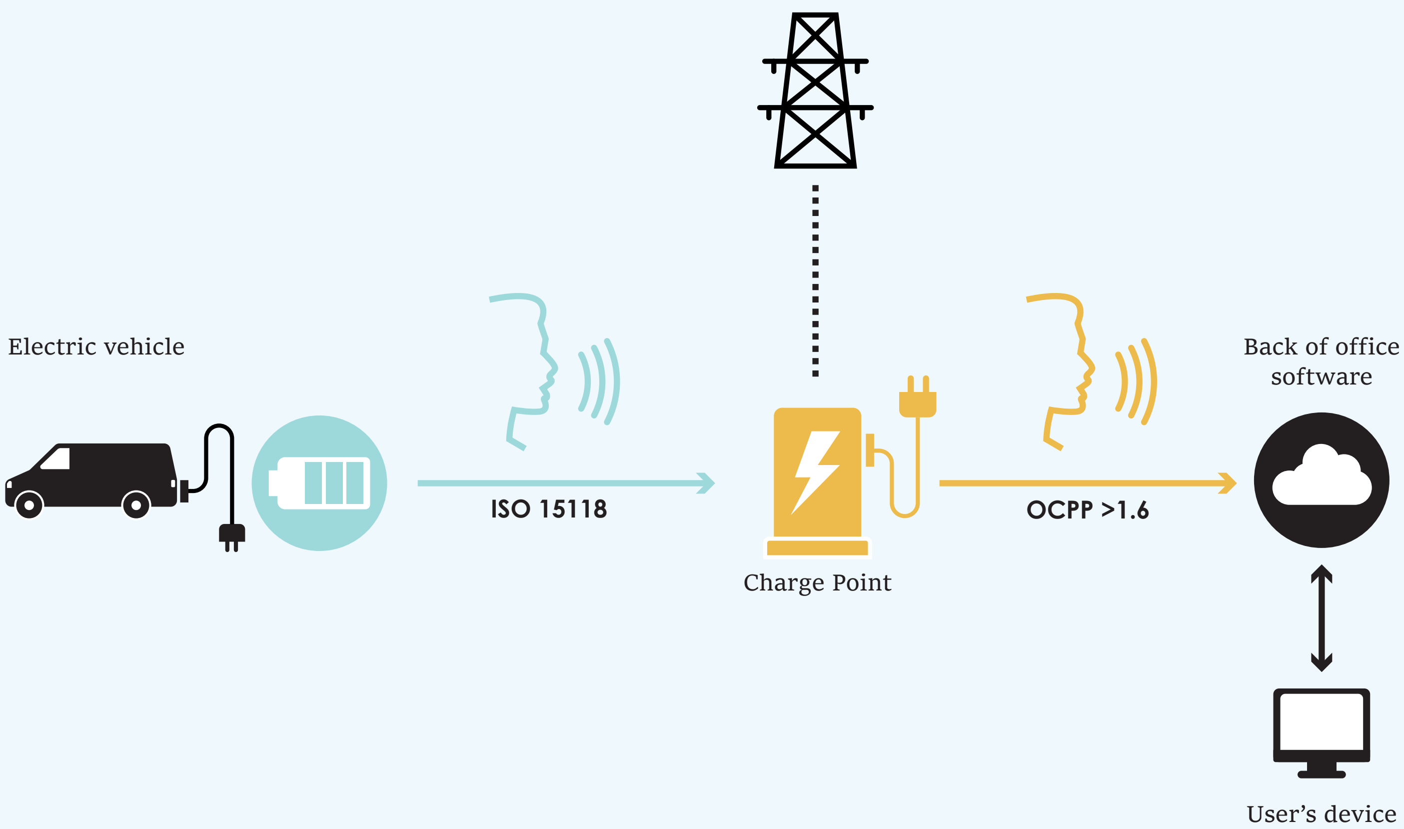
Open Charge Point Protocol (OCPP) and ISO15118 are standards that allow charging points to talk and share data between vehicles and the grid, and ensure hardware to software compatibility. Basically ISO15118 will ensures compatibility and interoperability between vehicles and charging points and will ensure future Vehicle to Grid compatibility; and OCPP ensures compatibility between hardware and software. While OCPP (OCPP 1.6 and OCPP 2.0) and ISO 15118 have been used to help facilitate the interoperability of EV charging, IEC 63110 is still in development.

Connectivity & back-office Software

The main purpose of the Guide is to enable the electrification of depots however this process also provides additional benefits due to vehicles being connected and builds on the benefits similar to the 'Internet of Things'.

While undertaking the transition to new EVs and physical depot infrastructure the software / reporting which comes with the hardware can also allow for better understanding and reporting of site operations.

The software allows for communication between vehicles, charge points and also wider infrastructure including back in the office. This can enable reporting to both fleet management and other parties on the operational aspects of vehicles (mileage / charge available) as well as charge point and overall operations of the depot.



> Back-office Software.

This enables remote monitoring, reporting and recording of information, for example this could highlight when a charge point fails or starts to show signs of failure enabling a repair prior to the unit failing.

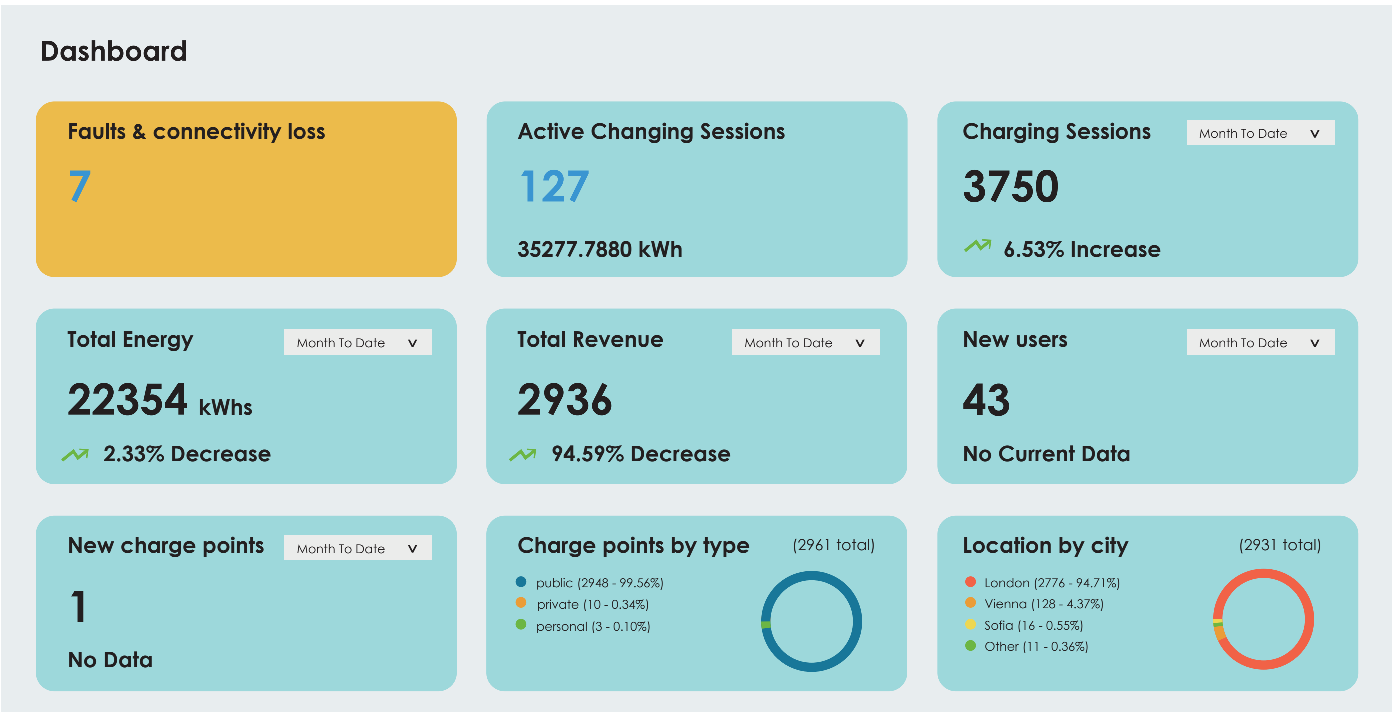
At a vehicle level this could provide information on mileage, vehicle utilisation and other key metrics automatically.

The commutation system from vehicle to charge point, and charge point to back of office has been developed in recent years with the emerging standard protocols which enable a fully connected / communicating network and common protocols.

It should be noted that while there is an emerging common language / protocol between vehicles and charging infrastructure, conversations with vehicle's manufactures, and charge point's providers highlight that there are instances of compatibility issues which results in slight miscommunicates between vehicles. This has resulted in vehicle supplier working with key charge point providers and in turn developed an 'approved supplier list', but as the technology and protocols develop these miscommunications should reduce.

The current emerging common standards and protocols are ISO 15118 and OCCP with the current version of OCCP being version 2.0.1. It is envisaged that both will continue to evolve over the next few years and therefore when obtaining charging infrastructure consideration should be given to the protocols supported by the equipment to ensure that the infrastructure can suitably communicate with each other including equipment from different suppliers.

Evidence that the EV charging point has



> Back-office Software.

been tested with each vehicle (inter-operability test) should be provided by the charge point supplier.

Many vehicle's manufactures and charge point providers also supply their own proprietary software to enable easy monitoring and open or controlled access to this data to allow operators / depots to customise / build their down systems and allow better reporting of information.

Proprietary / closed systems are more typically off the shelf and harder to adapt, however are often included as 'standard' with the infrastructure. Using the same protocol and open systems, enables different vehicles and charging points to be integrated into one customised system.

Developing one system can enable multiple charge point provides and different vehicle types to be collaged within one system enabling both easier reporting and also an overall holistic approach.

The benefits from a fully communicating system also allow for better site-wide management based on the requirements of the depot rather than the individual charging requirements of the vehicle.

A fully communicating system can lead to an optimised approach where charging is based on power constraints, i.e., the system will pull power based on the capacity of the network, by enabling a true 'smart charging'.

Summary

While the Back-office software is unlikely to affect the route to fleet electrification consideration on the complimentary software can potentially enable a smarter system which is fully integrated and allows for better management of the fleet, reporting of possible issues and even reduced draw of peak power from the network.

9.

Innovation.

This chapter describes innovation in BEVs, and the associated charging infrastructure. This detail might be utilised for future proofing purposes or to understand where the phased delivery of electric vehicles and charging infrastructure might provide additional value.

9.

Battery innovations in energy density

Currently there is a trend of increasing battery size to increase 'range'. To support this many vehicle manufacturers are commenting that the 'energy density' of [Lithium-Ion] batteries is improving quickly and in 5 years' the same weight of battery will store 50% more energy, which means that a 1-tonne battery having 300kWh of storage could soon have 450kWh of storage.

As battery sizes in EVs are constrained by weight, it is likely that storage capacity will continue to grow and electrical demand calculations should consider this. However, if a 300kWh RCV battery can meet current and future waste collection duty cycles then batteries within a depot should not have to be filled beyond their need and a 300kWh 'fill' should still suffice and increased power may not be required unless charging times (dwell-time) reduces.

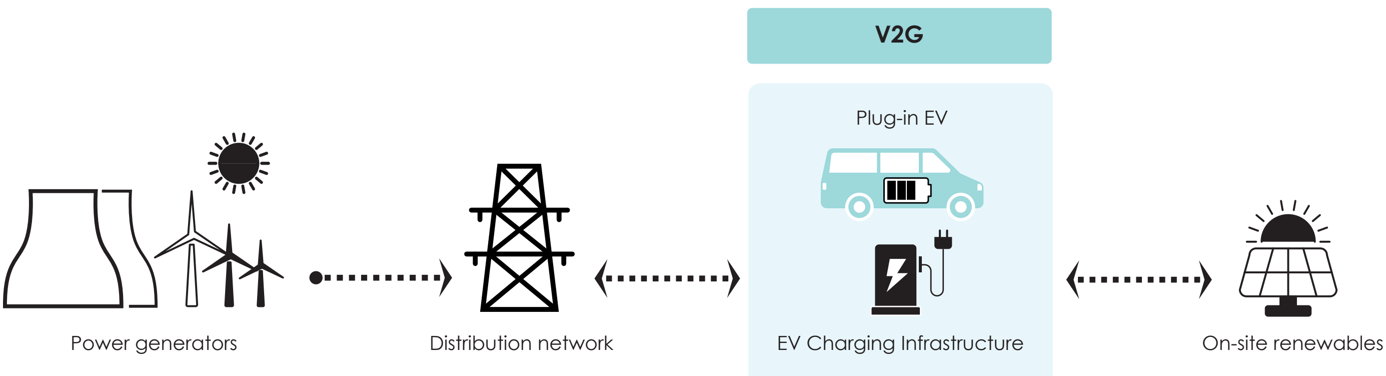
Vehicle to Grid (V2G)

V2G allow vehicles to provide energy services in addition to providing mobility and municipal services such as waste collection. V2G is a bi-directional connection between the vehicle battery and the electricity grid so energy (electricity) can go in both directions.

This should provide a significant step-forward in energy services. If 250 BEVs are parked in a Council depot overnight or over a weekend, then the depot operator has energy storage equivalent to 250 large batteries (perhaps c. 20MW).

The cumulative battery storage would be sufficient to provide additional – and potentially revenue making – services to the Local Authority (to harvest renewable energy for storage/sale to local communities); to the Grid (to provide frequency response and other grid balancing services); and to 3rd parties (a third party may lease the energy storage for use in providing renewable or low-tariff energy for sale to local or remote residents and businesses).

The issue of V2G in a vehicle depot is that if power is required for transport and energy services more power will be required from the grid in the same period of time, which would require more rapid charging infrastructure, unless energy services



were just contracted at weekends (although this is when grid services are least desirable). There might however be an opportunity to harvest energy from local renewable generation within or adjacent to the depot (or virtually).

Vehicle manufacturers are currently undertaking most of their research and development in battery and transport, mobility, range improvements, and end of life battery repurposing opportunities. Therefore, V2G is not widely available in commercial formats and limited support is provided for V2G by manufactures and V2G may impact on the warranties provided for vehicle batteries."

Where bi-directional connections are proposed the new connection application to the DNO will need to include for export (a G99 applications) and/or G100 application to restrict export onto grid.

V2X (vehicle-to-everything) is the bi-direction communication between a vehicle and any entity that may affect, or may be affected by, the vehicle. It is a vehicle communication system that incorporates other more specific types of communication as V2I (vehicle-to-infrastructure), V2N (vehicle-to-network), V2V (vehicle-to-vehicle), V2P (vehicle-to-pedestrian), V2D (vehicle-to-device). V2X is not covered under the scope of this Guide as is not related to vehicle charging specifically.

Smart grids, batteries and renewable generation

The V2G and V2X idea can be utilised to allow batteries in vehicles to harvest renewable energy within a depot (from solar PV or similar within or local to a depot), which might be utilised to drive heat pumps, might be put through an electrolyser to create green hydrogen but more generally will allow harvested energy stored in a battery to be easily shared between different energy vectors depending on which has greatest value at a point in time, which is known as arbitrage.

Induction charging

This will allow EVs to charge without a wired connection. A vehicle battery can charge from a charging plate located beneath the highway, usually in an area designated for parking. The vehicle must be manoeuvred so that it is 'parked' directly over the charging plate otherwise charging efficiencies are less. The charging plate must be connected to an adjacent power-unit.

The manufacturers of municipal EVs that were consulted for this Guide did not indicate that induction charging was on the near horizon for medium and heavy-duty vehicles.

Megawatt charging systems and battery swapping

Where charging time is the most critical factor Megawatt charging systems are now becoming available, which can charge a vehicle faster than anything currently on the market (1MW chargers). This would potentially have limited value in a Local Authority depot which is in the enviable position of having a very routine dwell-time with vehicles having longer to charge and requiring less power.

Beyond the next generation of 1MW ultra-rapid charging systems some countries have adopted the idea of a mechanised system that replaces an empty battery with a full battery. This could work in a depot where identical vehicles with identical batteries are under a single ownership. But again, the value of this is limited when charging times are typically sufficient to charge vehicles using AC fast charging systems rather than DC rapid charging systems. Arguably this could apply to a gritter where there is limited time to charge, and replacement batteries might be available.

Future battery and charging needs (solid-state batteries)

There is much speculation about the advent of solid state batteries (still Lithium-Ion but with a different electrolyte). Solid state batteries are like those in our phones and laptops. This would provide a very significant increase in energy density and provide much more energy from a smaller and much lighter battery. It is understood that there are also improvements in fire safety. None of the vehicle manufacturers consulted for this Guide (municipal vehicle manufacturers) has a solid-state battery product that is marketable in the near future, but some higher-performance car battery manufactures are suggested the first could come to the market by 2025.

Summary

This chapter should allow the reader to understand likely technology changes and step-changes in the short, medium and longer-terms, which might then be captured within the scope and/or specification for the procurement of the on-site or off-site charging infrastructure or depot modifications, or to support future fleet behavioural changes or project budgets. It might also be used to support phasing considerations and future phases should be timed to deliver a specific new innovation.

10.

Planning, Licensing, and Rights of Access.

The user should be aware that some of the new infrastructure that might be required in an all-battery electric vehicle depot may require permission from a third party. This chapter presents risks that would require further investigation in respect of planning applications; land transfer or leases; and access to operate and maintain third party infrastructure assets within depot land.

This chapter outlines risks that will need to be investigated during the concept design stage as these risks may vary depending on the location of a specific depot.

10.

Town planning risks

Substations other than small pole-mounted substations are regulated by the Town and Country Planning Act 1990 and there are cases where a planning permission from the local planning authority might be required. This might vary depending on whether the substation is housed in a brick structure; GRP enclosure; or [less likely] a fenced enclosure.

Some forms of development can be completed without a planning permission because they can be undertaken under "permitted development rights". These permitted development rights can be more restrictive in certain locations and verification via the Local Planning Authority is advised.

Land transfer, leases, wayleave consents and deeds of easement

A DNO (or IDNO) will typically insist that the land on which a new substation is located must be transferred or leased to the DNO so it can be operated in perpetuity irrespective of the longevity of the fleet depot itself because the substation may serve premises beyond the depot boundary.

Usually a DNO (or IDNO) will not energise a new substation until this is completed.

HV or LV or any other cables that are owned and operated by a DNO (or IDNO) and located in private land may also be subject to a Wayleave consent, or more likely a Deed of Easement.

A Deed of Easement is offered in perpetuity. A Wayleave Consent provides similar protection to the DNO but a Wayleave Consent can more easily be terminated.

All these requirements are commonplace and do not typically carry a financial burden (other than the time of legal professionals) but adequate time needs to be allowed for these legal agreements to be completed before energisation of the new electrical infrastructure will be permitted.

Access for third parties

Where apparatus is owned by a third party (such as an electrical substation that is adopted by a DNO or IDNO) they will likely insist on having 24-hour unrestricted access to operate and maintain this plant throughout the year. They may also require a clearly defined parking space.

Larger apparatus – again including electricity substations – will need to be accessed to undertake maintenance which could include the removal or replacement of an oil filled transformer and would therefore require immediately adjacent access to a vehicle with lifting and haulage capabilities.

Fire risks

When surveying and reviewing the depot to position the electric vehicle charging equipment, it is important to take into account potential fire risks associated with the proximity of electric vehicle charging equipment and other hazards equipment, processes and areas within the depot, as noted in chapter 7 - Survey and Design of this guide.

Document RC59: Fire Safety when charging electric vehicles should be referred to and also the depot insurers and Local Building Control officer should be consulted to establish their input on specific fire safety requirements for the depot.

Summary

As part of the earlier concept design stage, it is important to consult with the Local Planning Authority and Local Building Control officer to establish any consent requirements or licences which could affect the implementation of the electric vehicle charging installation.

It is important to discuss and agree with a DNO or IDNO their lease and easement requirements to progress the legal agreements so as to not delay any installation works or energising of supplies.

The potential fire risks and mitigation works should also be considered early in the concept design stage and reviewed as the design and installation progresses to provide a safe electric vehicle charging installation within the depot.

> Commercial Considerations.

This Guide is divided into three parts: Scoping the Project, Concept Design and Commercial Considerations. The Commercial Considerations section includes four chapters: Performance Specifications; CAPEX Costs and Cashflow; Grants, Loans and Funding; and Procurement Options. These chapters provide the Local Authority project sponsor and their procurement team with options on what to buy, how to buy it, and from whom. Once a project has been scoped it might go straight to the market to secure interest, or a formal offer, or it might be further developed into a concept design to better inform the market what is required, but ultimately a Local Authority will need to engage with the marketplace and this part of the Guide provides support.

11.

Performance Specifications.

This chapter reviews the need to develop both Electrical & Civil Performance Specifications, the process to produce the performance specifications and also the associated documents which should be referred to as part of the process.

> Performance Specifications.

The need for a specification

Performance specifications for both the electrical works and civil works are needed to obtain a competitive price for the required on-site electrical infrastructure works and also ensure that the depot charging requirements, the standard of workmanship, the materials used, and any other added value services meet the requirements of the Depot and wider Local Authority Environmental Social governance (ESG) needs.

The performance specifications and associated drawings and schematics detail the Local Authority's requirements and also set out the standard of workmanship and materials to be used.

The Local Authority needs to engage with an electrical consultant or contractor to prepare the performance design documentation to enable the procurement of works via a competitive tendering process.

Performance design documentation

The performance design documentation for the on-site EVCI from the DNO/IDNO substation to the charging posts should include the followings:

- Layout drawings indicating the locations of the Substations, LV switchboard enclosures, feeder pillar and charging post locations. The layout should also include any details of proposed resilience equipment.

- Layout drawings detailing cable routes for both HV and LV cables including trench details, duct quantities, containment routes if cables are fixed to walls or soffits details of any protection measures for mechanical damage or fire stopping.

- Schematic diagrams of the electrical Infrastructure detailing substation to LV Switchboard connection, LV switchboard connections to feeder pillars and feeder pillars to charging units. Schematics should also provide details on cable types and sizes also protection device types and ratings within the LV switchboard.

- Electrical Performance Specification detailing the electrical infrastructure scope of works standard of workmanship and materials also schedules of equipment and plant.

- Civil performance specification detailing the associated civil scope of works standard of workmanship and materials also details of any builders work requirements such as bases for LV Switchboard enclosures, feeder pillars and charging posts.

The electrical layouts and schematic drawings shall be prepared to detail the location of various electrical plant and also cable routes. The layout drawings should be prepared to scale to provide information on cable lengths.

NOTE

A Performance Specification Scope is provided in support of the Worked Examples in Part B of this Guide. The Performance Specification Scope is relevant to each of the three worked examples but is provided once on page 142.

12.

CAPEX Costs and Cashflow.

This chapter suggests where further refinement to those budget costs derived in chapter 3 can be achieved, and how the delivery of these projects can be made more affordable through a phased delivery. However, this chapter (and this Guide) does not cover whole life costs, simple payback, internal rates or return or a similar economics-based business cases.

Other Guides (such as [Energy Saving Trust]) provide a Business Case for the transition from ICE vehicles to BEVs. This Guide is developed on a given assumption that the ban on ICE vehicles will mandate the transition to zero-emission vehicles, accelerated by each Local Authorities' own commitment to a climate and biodiversity emergency.

There is also an assumption by the sponsor that BEVs are available now. Electricity infrastructure is available now. And the 'dwell-time' in a municipal vehicle fleet depot is very supportive of the transition to battery electric because most of the vehicles can be charged using [lower-cost] fast-charging and not [higher-cost] rapid-charging infrastructure.

> CAPEX Costs and Cash Flow.

Capital cost considerations

Using chapter 3 an indicative budget cost can be derived. In chapters 4-6 and 11, the concept design and technical specification process is described, including opportunities to significantly reduce peak electrical demand by optimising charging cycles and providing only the quantum of power which is required to meet specific duty-cycle reads. The development of the concept design and specification will allow a quantity surveyor to create a schedule of works, and with receipt of a formal offer from a DNO or ICP (chapter 5) they can derive a much-improved budget.

The key risks are those that relate to the adoptable DNO (or ICP/IDNO) infrastructure and are fully described in chapter 5, alongside opportunities for mitigating these risks. Ideally a new connection offer from the DNO (and an ICP) is required ahead of going to the design and build or ChargePoint Operator markets via an Expression of Interest or Invitation to Tender.

The capital costs for the infrastructure only are formed from the following:

> DNO (non-contestable works) – DNO delivery only – get offer

> DNO (contestable works) – ICP or DNO delivery – get offer

> IDNO capital contribution - via ICP or IDNO directly

> LV EV charging distribution infrastructure – CPO or ICP

> AC/DC charging infrastructure (hardware/ software) – CPO or EVCP supplier

Capital cash flow – phasing of delivery

The capital costs derived from chapter 3 indicative that the range of capital costs across the vehicle depots ranges from £260,000 to £1,530,000 depending on size of depot. This does not include the off-site non-contestable DNO works, which has very many caveats in-built, and also the need for the procurement of more expensive DC charging points, which might be required depending on the type of medium and heavy good vehicles being purchased.

In chapter 5 there is also reference to Ofgem being "minded to" vary the 'Distribution Connection Charging Boundary' which favours the removal of non-contestable upstream network charging costs levied on new connection customers. This would have a significant impact by reducing capital cost (but not programme risk – it will still take at least as long to secure the additional power to a local area).

This hints at applying for whatever power is currently available on the local DNO network and securing this and applying for the residual power when the 'charging methodology' changes.

A variation of the approach described above would be to consider electrifying only part of the fleet at an early stage and complete the remainder as future phases. However, this would require undertaking each process identified in this Guide several times.

Perhaps the most suitable solution might be developing a design for the electrification of the whole depot, with appropriate budgets, and then break this into manageable (or affordable) elements. It might be prudent that all DNO/ IDNO infrastructure is secured in the 1st phase of works such that the new metered connection into the depot is suitable for the whole depot electrification and fully future-proofed so that each subsequent phase can be relatively easily 'plugged-in'.

This option would allow the Local Authority to procure the infrastructure once and instruct a single contract but phase the contract to improve cashflow to a more manageable level.

A phased approach will not only be more affordable but could give confidence to drivers and operators that BEVs fulfil their needs. However, there is an understanding that most depots need to fully transition within 8 years and therefore the costs, risks and procurement options for a complete transition need to be understood now, even if the delivery is phased.

Operation and maintenance cost considerations – risks/opportunities rather than costs

Guides such as the Energy Saving Trust's fleet electrification Guide discuss the Business Case for transitioning to wholly EVs, i.e. the vehicles rather than the infrastructure.

The 'Commercial' addendum to this Guide considers options for operation and maintenance as part of a design, install, [fund,] operate and maintain contract.

Procurement options are considered in summary terms in chapter 13.

Carbon and environmental benefits

Again, Guides such as the Energy Saving Trust's fleet electrification Guide discuss the Business Case for transitioning to wholly EVs, which includes the cost of carbon based on the decarbonisation of the BEV fleet as the grid decarbonises. It is anticipated that the full decarbonisation of the GB electricity grid will be achieved near to 2035.

13.

Grants, Loans and Funding.

This chapter provides information on possible help with the costs associated with transitioning to an all-electric fleet including the charging infrastructure.

> Grants, Loans and Funding.

Grants

Central Government have provided grant funding in recent years to enable and facilitate the transition to a more sustainable network. The electrification of the fleet also provides benefits to the local area in regard to air quality and also towards a wider target of net zero.

The provision of grants could help facilitate Local Authorities in funding and fast tracking the electrification of the fleet. This is an area which is subject to change and the latest grants should be reviewed and the key grant programmes have been summarised below.

Depending on funding requirements and scale of the roll-out (for example if undertaking in a modular approach and upgrading assets once at the end of their useful life), the funding available at the time could also support with the purchase of EVs, and / or charging infrastructure.

Air quality grant programme

This programme helps Local Authorities to make air quality improvements and supports their duties under the Environmental Act 1995. DEFRA has supported with grant funding to support air quality improvements with £81million of grants provided since 1997. The scheme provides wider support than just EVs, but recent grants include £578,000 towards the electrification of 10-26 tonne RCVs. This funding also covered the telematic systems and five years of parts for the vehicles.

Local EV infrastructure (LEVI) fund

Following the initial £10 million pilot this scheme will look to provide access to up to £450 million to help local authorities leverage private sector investment into their local charging networks. The full scheme is expected to be launched following the pilot projects, and could include funding required for site adaptations with the eligible costs covering both the purchase of the equipment and installation costs.

OZEV grant scheme

The Office for Zero Emission Vehicles (OZEV) grant scheme helps with the installation of EVCI. This includes both workplace and residential home owner charging schemes.

The Workplace Charging Scheme (WCS) is a voucher-based scheme that provides support towards the up-front costs of the purchase and installation of EV charge-points.

Depending on funding requirements / and scale of the role out (for example if undertaking in a modular approach and upgrading assets once at the end of their useful life), the funding available at the time could also support with the purchase of EVs, and / or charging infrastructure.

UK Government Grant Schemes	
Summary of Government Grant Schemes (including LEVI)	Electric vehicle charging infrastructure: help for local authorities
Air Quality grant programme	https://www.gov.uk/government/collections/air-quality-grant-programme
OZEV Grant schemes	https://www.gov.uk/government/collections/government-grants-for-low-emission-vehicles

13.

14.

Procurement Options.

This chapter allows Local Authority decision makers, project sponsors and procurement teams to understand the 'services' that can be procured from the CPO market so that the design and installation of the EV charging infrastructure can be supplemented with operate and maintain services (as a fully managed service) or with capital funding so that a design, build, fund, operate and maintain service can be procured.

The chapter explores the 'services' available to support the EV charging infrastructure and the potential opportunities and risks of procuring 'services' rather than just the charging infrastructure.

This is a 'Guide' and not a definitive or exhaustive list of services available and will be subject to market testing, competitive tender, OJEU requirement, and local need.

> Procurement options.

A 'Product' or a 'Service'?

Throughout this Guide EVCI is referred to primarily as a product – hardware (charging points and associated electrical infrastructure) that can be designed and installed by a suitably qualified contractor. Invariably this hardware comes with back-office software, but increasingly this product can be purchased as part of a wider turnkey service offered by CPOs.

In a municipal vehicle depot it would be relatively easy for the Local Authority to operate and maintain this infrastructure themselves but what are the benefits and risks? The risks and opportunities are captured later in this chapter.

SPVs and partnering

A SPV could be created with the purpose of funding charging infrastructure, battery electric vehicles, and selling charging services back to the Local Authority. This could be a brand-new autonomous entity or could be a commercial restructuring of an existing SPV – perhaps an Energy Services Company (ESCo).

The Local Authority would have a significant stake in the SPV. This could be an equity stake (up to 49%, based on consultation with the CPO market), but very likely would include a level of governance or control such that the Local Authority can set the affordability, equitable access, and carbon outcomes for the SPV.

If the purpose of the SPV were to fund infrastructure and sell charging services just to a single municipal vehicle depot this could be a very convoluted and overly complex mechanism and would likely offer little value to a Local Authority (unless combined with other energy services or shared with multiple Local Authorities cross a multiple depots).

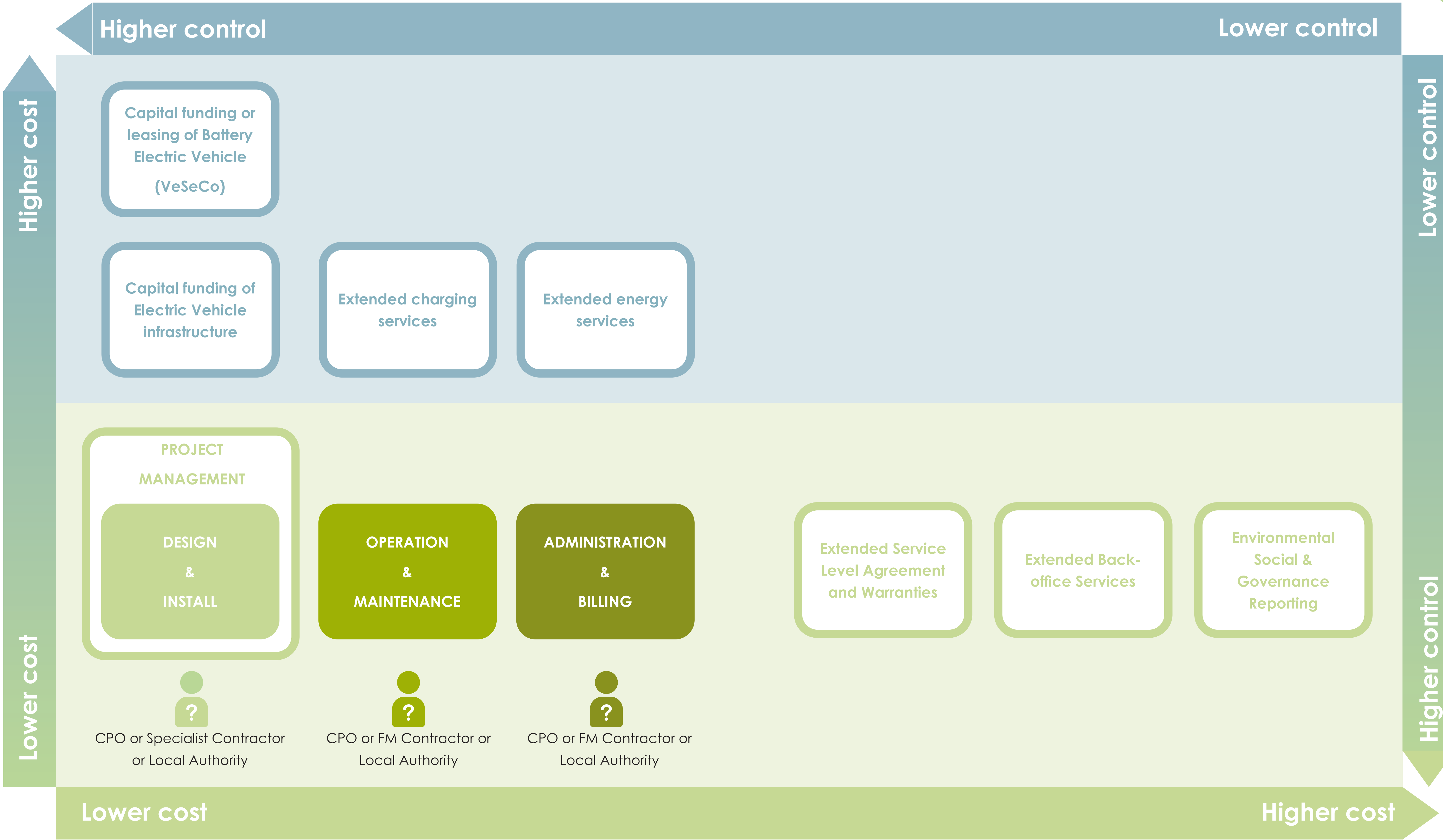
If the delivery of charging infrastructure was to support municipal depots, fleet home-charging needs community charging or public vehicle charging needs where billing and administration might be complex and require private sector know how, and/or the provision of charging points in locations that might not ordinarily be economically advantageous, or there is a necessary hook-up to a Local Authority renewable energy supply, then there may be considerable value in creating an SPV.

Useful reference

HM Treasury. Joint Ventures: a guidance note for public sector bodies forming joint ventures with the private sector

> Procurement options.

FUNDED SERVICES



MANAGED SERVICES

14. Shopping List for Services.

This is a breakdown of the required design, install and operate services into each element's component parts, including the ancillary or added value services which might be added.

The individual goods and services can be added or omitted from the 'Performance Specification Scope' appended to this Guide.

MANAGED SERVICES

PROJECT MANAGEMENT

> Interface with DNO and energy supplier
> Planning submissions and all necessary consents
> Interoperability testing between vehicle/EVCP manufacturers
> User training and development

DESIGN & INSTALL

> **Duty cycle need, dwell time, load management and maximum demand optimisation**
> **Detail design development and specification**
> **Phasing/sequencing and costs**
> **Contract and programme**
> **Installation, testing and commissioning**

OPERATION & MAINTENANCE

> Planned Preventive Maintenance (PPM)

> Emergency field operative call-outs and time to repair

> Electrical safety inspections

> Spare charge points / Spare parts

> Vandalism cover

> Penalties for inoperable plant

> Remote fault diagnosis (back-office software)

> Remote fault protection (back-office software)

> Static/Dynamic load management and optimisation

ADMINISTRATION & BILLING

> Billing for on-site charging

> Management reports (Telematics, Energy/Carbon and Costs)

> Billing for off-site charging (if applicable)

> Billing for remote charging (if applicable)

> Procurement options.

Extended Operation & Maintenance Services

> Bespoke services may be required in addition to the core O&M services provided under a PPM depending on the additional requirements of the depot.

Back-office Services

> Energy efficiency and vehicle charging analysis

> Static and dynamic load management optimisation

> Fault diagnosis (and remote fixing)

> Fault protection

> Software maintenance

> Telematics and driver behaviour

MANAGED SERVICES

Shopping List for Services.

14.

Environmental, Social & Corporate Governance Reporting

- > Operational and whole-life carbon
- > Low and zero-carbon energy (electricity) supply
  - Use of Power Purchase Agreements or
  - Renewable Energy Guarantees of Origin or
  - Green energy tariffs
  - Utilisation of Local Authority preferred supplier
- > Recovery and re-use of materials
- > Monthly and annual carbon/Green House Gas (GHG) reporting
- > Driver training and development
- > Continuous system and load management optimisation
- > Wider community engagement and employment opportunities

MANAGED SERVICES

14. Shopping List for Services.

Extended Vehicle Charging Services

> Off-site fleet vehicle charging provision (home-charging of existing fleet)
> On-site staff charging provision and/or staff home-charging provision
> Staff route-charging benefits
> On-site visitor charging provision

Extended Energy Services

> Depot energy efficiency services
> PPPA and Renewable Energy Guarantees of Origin (REGOs)
> V2G

> Procurement options.

EV Charging Infrastructure Funding

> Concession Agreement
- Duration of term
- Heads of Terms
- End of term asset value/transfer mechanism
- Borrowing and interest on loans
- Capital replacement funds
- Termination, breaches and liquidation
- Force Majeure

> Consumer Agreement
- Fuel/energy cost benchmarking
- Inflation and index linking
- Point of sale and transaction mechanism
- Fixed and variable charges
- Bumps in the road

> Land leases and rights of access

> Future proofing and innovation

> Charging as a Service versus Energy as a Service

> Procurement options.

BEV Funding

> Concession Agreement
  - Duration of term
  - Heads of Terms
  - End of term asset value/transfer mechanism
  - Borrowing and interest on loans
  - Capital replacement funds
  - Termination, breaches and liquidation
  - Force Majeure

> Consumer Agreement
  - Fuel/energy cost benchmarking
  - Inflation and index linking
  - Point of sale and transaction mechanism
  - Fixed and variable charges
  - Bumps in the road

> Land leases and rights of access

> Purchase versus leasing

> Right to buy/lease transfer/sale

> Extending vehicle asset life (technical and behavioural)

> Extending battery asset life (technical and behavioural)

> Re-purposing and re-use of assets

> Future proofing and innovation

> Point of Sale and Transaction Mechanism. It is unclear how this might work beyond a basic transaction price for a fully charged vehicle on a daily basis.

Risks & Opportunities.

14.

Warranties

1

A warranty for charging points are typically 2 years. These warranties would likely support the repair or replacement of specific products and possibly the repair of system faults. After this period an extended warranty would have to be purchased.

A Service Level Agreement (SLA) with a facilities provider (whether FM provider or CPO) should negate the need for extended warranties.
The value of the warranty would have to be measured against the value of an operation and maintenance contract, which would likely provide a Service Level Agreement containing a Planned Preventative Maintenance (PPM) programme.

Back-office software should specify fault protection and fault identification, partly negating the value of a PPM/SLA contract. However, urgent call-outs and regular electrical safety inspections would still be required - possibly a shared service across multiple Local Authorities could provide this?

System Optimisation and Energy Efficiency

2

The maximum electrical demand needs to be reduced to avoid costly 'Availability Charges'.

Back office software should be specified which incorporates system optimisation including static and dynamic load management and telematics software. Back-office software can be operated by Local Authority personal with training.

14. Risks & Opportunities.

High-voltage Infrastructure

3

The operation and maintenance of HV infrastructure is more specialist and expensive than operating LV infrastructure.

The maximum demand associated with an all-electric depot may require a HV infrastructure. A HV metered connection may provide the best value solution from a DNO/IDNO/ICP perspective but this means that the downstream HV network and distribution substations are privately owned and operated by the depot. One or more LV metered connections might be considered so that the HV distribution and substations are DNO/IDNO owned and operated and should certainly be considered as an alternative.

Extended charging services

4

While providing EV charging points at depots will enable charging of the municipal fleet parked at the depot there could be fleet vehicles which are home-parked and require charging.

If a CPO is already providing charging at other council sites, or public charging programmes then a design and install service, a managed service, or a funded service can be added to this existing contract.

Equally the depot charging infrastructure could trigger the procurement of charging infrastructure (or services) to vehicle operator homes, staff car parking and/or visitor parking spaces.

> Procurement options.

Extended energy services

5

A CPO is effectively selling energy to the Council. If the Local Authority is already selling [renewable] energy services (district heat or energy from waste etc.) via a Special Purpose Vehicle, council operated ESCo or privately sector ESCo then procuring a new service provider may not be optimal in the utilisation of existing renewable energy resources.

A CPO might be mandated to purchase energy from an existing ESCo via Renewable Energy Guarantees of Origin; via a Power Purchase Agreement (PPA); or via a direct engineered connection (and supporting grid connection).

Alternatively an existing ESCo might be asked to tender for vehicle charging services (and perhaps add energy efficiency and energy generation and storage services), although a specialist partner may have to provide the PPM/FM support.

Duration of Term (Contract term) and Capital Replacement

6

EV charging infrastructure, Municipal Vehicles and Batteries may have different asset lives. Any managed service must allow for capital replacement activities. Any funded service must allow for the cost of replacing assets during the term of the contract.

FM service terms may typically be equivalent or extendible to the asset life of a vehicle, or likely a battery, but battery and vehicle life should be extended where possible to improve economic and environmental outcomes.

Perhaps reward can be increased if asset life can be extended for charging infrastructure, vehicles and batteries and/or assets can be re-purposed or recovered. It is widely understood that battery life can be extended based on how the charge cycle for the battery is managed.

> Procurement options.

Funding EV Charging Infrastructure

7

The worked examples in the Guide suggest that the capital cost of fully electrifying a municipal fleet depot is between £265,000 and £1,700,000 (excluding non-contestable costs). Some grants and other 3rd party funding may be available, and the project can be phased to improve cash-flow and limit capital outlay. However capital expenditure for infrastructure will be significant even when the capital cost of the battery electric vehicles themselves are excluded.

The Local Authority can generally borrow at preferential rates compared with the private sector and ultimately funding from the private-sector will likely have a greater whole-life cost.

Many CPOs are part of large infrastructure or energy companies with good access to capital and a willingness to fund projects where the return on investment is guaranteed (but this return may include recovering interest on any loan to fund the infrastructure, annual operation/maintenance costs, and sinking funds to cover capital replacement). To ensure payback the private sector might be looking for concession terms up to 15-years (longer than BEV life) and these come with increased risk because of the complexity of the agreements and perhaps a loss of control. However as part of extended vehicle charging service with multiple layers (depot charging, home-charging and public/community charging), this might be a mechanism where value is added.

Risks & Opportunities.

14.

Funding vehicles and infrastructure

8

The capital cost of a BEV compared with the equivalent diesel model is very high; Battery Electric Refuse Collection Vehicles may be up to twice that of the ICE equivalent.

The CPO market may consider purchasing or leasing vehicles for Local Authority municipal use with the cost recoverable through energy or daily/annual vehicle charging services. This is sometimes known as VeSeCo.

The purchase/leasing costs would be recoverable at the point of sale likely through a charged vehicle per day transaction.

In addition to the significantly increased point of sale [energy/charging] cost there is the issue of vehicle/battery asset life being 7-10 years which is possibly too short a duration to ensure a margin for the CPO – the type of service is still largely untested and the market position is very immature, so additional market testing perhaps via a formal EOI might be required.

The business case for this type of investment is not included in this Guide, but is included the EST and other Guides.

Useful reference

[Energy Saving Trust. A step-by-step guide to electric vehicles for fleets]

14.

Risks & Opportunities.

Funded service transactions and point of sale

9

If a CPO is contracted to provide a funded vehicle charging service and charges the Local Authority based on energy used (metered electricity) then the CPO has no incentive to ensure the fleet is operated efficiently, conversely it is more profitable to the CPO if driver behaviour and fleet logistics are such that energy use increases.

Ensure that the transaction for the CPO point of sale is per vehicle duty-cycle and therefore CPO profitability increases the less energy that a vehicle uses and the CPO should proactively undertake driver and fleet operator training.

> Procurement options.

The Players: Supply Chain Skill Sets and Accreditations.

This section describes the high level scope that might be provided by each part of the supply chain and what accreditation and skill sets they might require to undertake and to complete these activities.

This section should be read in conjunction with the 'performance specification scope' provided in the Worked Examples (Part B) as well as the services that can be purchased as described in detail within this chapter. A summary of 'The Players' is also provided on Page 17.

Design/Engineering consultant
(Electrical engineers with similar experience)

> Concept design.

> Detail design (adoptable HV/LV power distribution) - via DNO/ICP (Lloyds NERS Accreditation).

> Detail design (private LV cabling, feeder pillars and charge points) - for purpose of warranties might be better undertaken by proposed operator, unless to be Council operated and maintained.

Charge point supplier/Manufacturer
(Supplier/retailer of EV Charging Infrastructure)

> Detail design (adoptable HV/LV power distribution) - via DNO/ICP (Lloyds NERS Accreditation).

> Detail design (private LV cabling/feeder pillars and charge points).

> Installation (private EV charging hardware and software and connection to DNO network).

> Project management of design, install and adoption of off-site DNO/ICP works.

> Commissioning of charging infrastructure.

ICP (Independent Connection Provider)
(Lloyds NERS Accreditation)

> Detail design of adoptable HV/LV power distribution and metered connection.

> Installation of adoptable HV/LV power distribution and metered connection.

> Project Management and adoption of DNO/IDNO infrastructure.

Charge point installer
(Electrical and civil engineering contractor with similar experience)

> Detail design (private LV cabling/feeder pillars and charge points).

> Procurement options.

- Installation (private EV charging hardware and software and connection to DNO network).
- Project management of design, install and adoption of off-site DNO/ICP works.
- Commissioning of charging infrastructure.

CPO (Charge Point Operator)
(Established operator of EV charging infrastructure with back-office staff supporting EV users needs at a local or national level with good service record. Often part of a well capitalised group of companies with electrical engineering, survey, contracting, facilities management and billing capabilities as well as account management personnel)

- Concept design.
- Detail design (adoptable HV/LV power distribution) - via DNO/ICP (Lloyds NERS Accreditation).
- Detail design (private LV cabling/feeder pillars and charge points).
- Installation (private EV charging hardware and software and connection to DNO network).
- Project management of design, install and adoption of off-site DNO/ICP works.
- Funding (of charging infrastructure - funding of vehicle infrastructure untested).
- Operation and Maintenance.
- Billing & Administration.
- Ancillary fleet or energy services.

Part B - INDICATIVE BLUEPRINTS.

1.

Indicative Blueprint 1 - Small Site.

Extension of existing on-site High Voltage network requiring additional substation.

> Scoping the Project.

Electrical demand estimation

Vehicle type	Number of vehicles		Vehicle battery size		Battery storage		Dwell time		Power demand		Power correction factor		Apparent power demand
	No		kWh		kWh		hours		kW		n/a		kVA
RCV	29	x	300	=	8,700		4:30pm to 6:30am						
Large/small van	5	x	75	=	375								
Total					**9,075**	**÷**	**14**	**=**	**648**	**÷**	**0.9**	**=**	**720**

Budget cost estimation

No off-site works

720 kVA connection from HV network

On-site works

On-site contestable HV/LV	£75,000
Civil works	£65,000
LV EVCP distribution infrastructure (**34 vehicles**)	£15,300
EV AC Charging Points (29 RCVs)	29 x £3,500
EV AC Charging Points (5 others)	6 x £1,500

£265,800*

***Excluding any abnormal off-site 'non-contestable' works that the DNO must undertake - these could be greater than the on-site costs in some circumstances and care should be taken to qualify this risk.**

This estimation does not include DC chargers. If preferred BEV manufacturer does not have vehicles with on-board charger, than a DC charger is required irrespective of the need for ultra-rapid charging.

> Concept Design.

Electrical demand calculation

Indicative Blueprint 1 - Small Site												
Vehicle type	**Number of vehicles**	**Number of chargers**	**Charger Type**		**Number of vehicles charging per day**		**Number of charging period (24 hours)**	**Peak**		**Power correction factor**		**Power demand**
	No	**No**	**kW**		**No**		**No**	**kW**		**n/a**		**kVA**
RCV	29	27	22	x	27	÷	1	594	÷	0.90	=	660
Large/small van	5	5	7	x	3	÷	2	10.5	÷	0.90	=	12
RCV/General	n/a	2	50	x	2	÷	2	50	÷	0.90		56
Total								**654.5**	÷	**0.9**	=	**727**

Headline Scope & Risk Items

> Determining the Maximum Electrical Demand and Engaging with the DNO for an Electrical Supply.

> Planning and surveying new Substation, meter/switchroom, feeder pillar and Charge Point locations during the concept design.

> Planning and surveying cabling routes including carrying out ground penetration radar survey and reviewing existing record documentation to establish existing buried services.

> Review RC59 'Fire Safety when Charging Electric Vehicles' and assess any fire risks relating to the proposed concept design and consider any necessary mitigation works.

> Review any Health and Safety issues with the concept design and consider any necessary mitigation works.

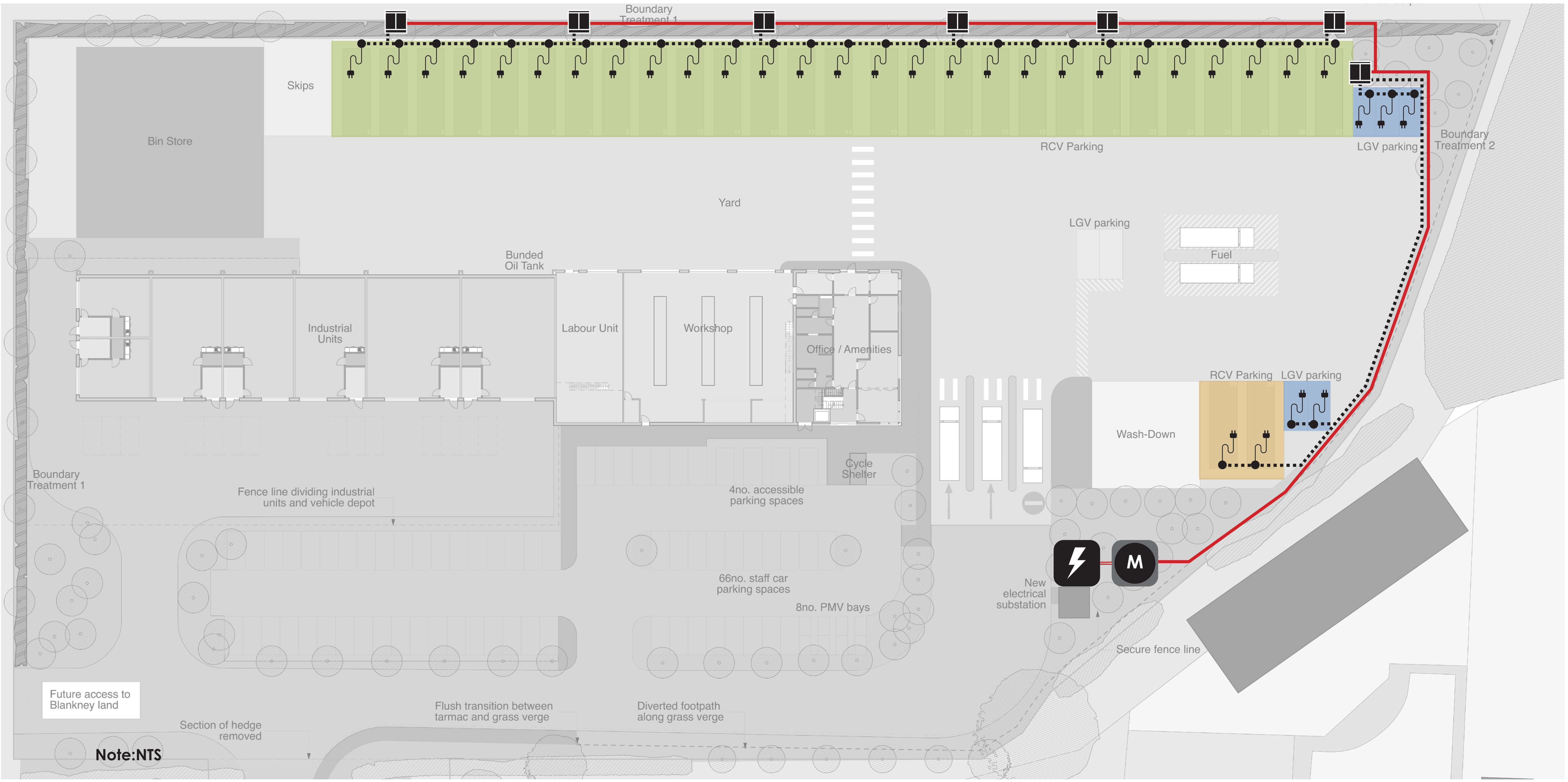
> Establishing any local Planning requirements for new substation and meter/switchroom enclosures

> Establish any third party agreements required for the proposed concept design.

> Establish any legal lease and easement agreements with the DNO for the proposed concept design Substations and HV cabling routes .

> Concept Design.

Electrical layout



DNO or IDNO HV to LV substation

GRP enclosure for Low Voltage switchboard serving EVCI and utility meter

LV feeder pillar serving group of charging posts

LV supply from DNO or IDNO substation serving Low Voltage switchboard

Primary LV Sub-Main buried ducted cable routes serving feeder pillars

LV Buried Sub-Circuit cabling serving charge posts from feeder pillar

50 kW DC charger

22 kW AC charger

7 kW AC charger

Charger

NOTE 1: 2 no. 50kW DC charging points are added to the worked example in place of 2 no. 22kW AC charging points for illustrative purposes only. These might be used to charge RCVs overnight but produce flexible rapid charging services during the day for other fleet vehicles.

NOTE 2: DC charging posts are significantly larger than AC charging posts because they have an in-built rectifier converting AC to DC (sometimes this is within a separate power unit feeding multiple posts).

> Commercial.

Performance specifications

The same scope for the performance specification is used for all three worked examples and can be found on page 142.

Example of possible preferred procurement options

> Project scoping undertaken by Local Authority depot manager or energy/sustainability team.

> Concept design and performance specification is completed by Local Authority engineering team. Including application to DNO.

> Detail design, installation, commissioning, O&M manual (hardware and software) record drawings, and training for Local Authority staff and maintenance contractors by an EVCP supplier/retailer – through competitive tender directly for Local Authority. Perhaps via ESPO vehicle charging framework.

> Local Authority issues cash-backed order for DNO works – unless major off-site works in which case EVCP supplier is asked to secure services of an ICP (as sub-contractor or directly with Local Authority).

> Local Authority manages any town planning, leases, wayleaves or easement needs.

> Operation and maintenance by Local Authority (or perhaps using existing Local Authority or 'Shared Service' FM framework contractor).

2.

Indicative Blueprint 2 - Medium Site.

Extension of an off-site High Voltage network to a new on-site substation.

> Scoping the Project.

Electrical demand estimation

Vehicle type	Number of vehicles		Vehicle battery size		Battery storage		Dwell time		Power demand		Power correction factor		Apparent power demand
	No		kWh		kWh		hours		kW		n/a		kVA
RCV	14	x	300	=	4,200		4:30pm to 6:30am						
Large/small van	40	x	75	=	3,000								
Sweeper	2	x	55	=	110								
Other HGV (>15 tonnes)	3	x	282	=	846								
Total					**8,156**	÷	**14**	=	**582.6**	÷	**0.9**	=	**647.3**

Budget cost estimation

Off-site works

‘Contestable’ works - HV extension	£50,000

647kVA connection from HV network

On-site works

On-site contestable HV/LV	£75,000
Civil works	£65,000
LV EVCP distribution infrastructure (**59 vehicles**)	£26,550
EV AC Charging Points (14 RCV+ 3 HGV)	17 x £3,500
EV AC Charging Points (42 others)	42 x £1,500

£339,050 *

***Excluding any abnormal off-site ‘non-contestable’ works that the DNO must undertake - these could be greater than the on-site costs in some circumstances and care should be taken to qualify this risk.**

This estimation does not include DC chargers. If preferred BEV manufacturer does not have vehicles with on-board charger, than a DC charger is required irrespective of the need for ultra-rapid charging.

> Concept Design.

Electrical demand calculation

Indicative Blueprint 2 - Medium Site											
Vehicle type	Number of vehicles	Number of chargers	Charger Type		Number of vehicles charging per day		Number of charging period (24 hours)	Peak		Power correction factor		Power demand
	No	No	kW		No		No	kW		n/a		kVA
RCV	14	11	22	x	11	÷	1	242	÷	0.90		269
Large/small van	40	40	7	x	20	÷	2	70	÷	0.90		78
Sweeper	2	7	7	x	4	÷	2	14	÷	0.90		16
Other HGV (>15 tonnes)	3	3	22	x	3	÷	1	66	÷	0.90		73
RCV/General	n/a	3	50	x	3	÷	1	75	÷	0.90		83
Total								**467**	÷	**0.9**	=	**519**

Headline Scope & Risk Items

> Determining the maximum electrical demand and engaging with the DNO for an electrical supply.

> Planning and surveying new Substation, meter/switchroom, feeder pillar and charge point locations during the concept design.

> Planning and surveying cabling routes including carrying out ground penetration radar survey and reviewing existing record documentation to establish existing buried services.

> Review RC59 ‘Fire Safety when charging electric vehicles’ and assess any fire risks relating to the proposed concept design and consider any necessary mitigation works.

> Review any Health and Safety issues with the concept design and consider any necessary mitigation works.

> Establishing any local planning requirements for new substation and meter/switchroom enclosures.

> Establish any third party agreements required for the proposed concept design.

> Establish any legal lease and easement agreements with the DNO for the proposed concept design Substations and HV cabling routes .

> Concept Design.

Electrical layout

Note:NTS

DNO or IDNO HV to LV substation	LV supply from DNO or IDNO substation serving Low Voltage switchboard	50 kW DC charger	
GRP enclosure for Low Voltage switchboard serving EVCI and utility meter	Primary LV Sub-Main buried ducted cable routes serving feeder pillars	22 kW AC charger	
LV feeder pillar serving group of charging posts	LV Buried Sub-Circuit cabling serving charge posts from feeder pillar	7 kW AC charger	
		Charger	

NOTE 1: 3 no. 50kW DC charging points are added to the worked example in place of 3 no. 22kW AC charging points for illustrative purposes only. These might be used to charge RCVs overnight but produce flexible rapid charging services during the day for other fleet vehicles.

NOTE 2: DC charging posts are significantly larger than AC charging posts because they have an in-built rectifier converting AC to DC (sometimes this is within a separate power unit feeding multiple posts).

> Commercial.

Performance specifications

The same scope for the performance specification is used for all three worked examples and can be found on page 142.

Example of possible preferred procurement options

> Project scoping undertaken by Local Authority depot manager or energy/sustainability team. Budget secured for concept design by electrical engineering consultant.

> Concept design and performance specification is completed by electrical engineering consultant in order to improve outcome of competitive tendering for next stage (including application to DNO). Perhaps engineering consultant secured via ESPO vehicle charging framework.

> Detail design, installation, commissioning, O&M manual (hardware and software) record drawings, and training for Local Authority staff/maintenance contractor by an EVCP supplier/retailer – through competitive tender directly for Local Authority. Perhaps via ESPO vehicle charging framework.

> EVCP supplier/retailer issues cash-backed order for DNO works – unless major works (as defined by Engineering Consultant) in which case EVCP supplier is asked to secure services of an ICP (as sub-contractor or directly with Local Authority).

> Local Authority manages any town planning, leases, wayleaves or easement needs.

> Operation and maintenance contract secured on a 5-year framework extendable to 7-years secured under competitive tender, which may or may not include Local Authority owned charging points located outside the depot. This contract may be won by a specialist CPO (who may or may not have also won the design and install works above and can therefore offer added value) or a more generalist FM contractor.

3.

Indicative Blueprint 3 - Large Constrained Site.

Extension of an off-site High Voltage network to three on-site substations.

> Scoping the Project.

Electrical demand estimation

Vehicle type	Number of vehicles		Vehicle battery size		Battery storage		Dwell time		Power demand		Power correction factor		Apparent power demand
	No		kWh		kWh		hours		kW		n/a		kVA
RCV	50	x	300	=	15,000								
Large/small van	139	x	75	=	10,425								
Minibus	95		75		7125		4:30pm to 6:30am						
Sweeper	7		55		385								
Gritter	12		282		3384								
Other HGV (>15 tonnes)	77	x	282	=	21,714								
Total					**58,033**	÷	**14**	=	**4,145**	÷	**0.9**	=	**4,605**

Budget cost estimation

Off-site works

'Contestable' works - HV extension	£250,000

4,605kVA connection from HV network

On-site works

On-site contestable HV/LV (£75,000 + £55,000 + £55,000 + £55,000)	£185,000
Civil works	£215,000
EVCP distribution infrastructure (**380 vehicles**)	£171,000
EV AC Charging Points (50 RCV+ 77 HGV)	127 x £3,500
EV AC Charging Points (253 others)	253 x £1,500

£1,700,000 *

***Excluding any abnormal off-site 'non-contestable' works that the DNO must undertake - these could be greater than the on-site costs in some circumstances and care should be taken to qualify this risk.**

This estimation does not include DC chargers.

Replacement of 4 no. 22kW with 4 no. 50kW chargers extra cost £62,000

Electrical demand calculation

Indicative Blueprint 3 - Large Constrained Site												
Vehicle type	Number of vehicles	Number of chargers	Charger Type		Number of vehicles charging per day		Number of charging period (24 hours)	Peak		Power correction factor		Power demand
	No	No	kW		No		No	kW		n/a		kVA
RCV	50	46	22	x	46	÷	1	1,012	÷	0.90		1124
Large/small van	139	139	7	x	70	÷	2	245	÷	0.90		272
Minibus	95	95	7	x	48	÷	2	168	÷	0.90		187
Sweeper	7	7	7	x	4	÷	2	14	÷	0.90		16
Gritter	12	12	22	x	12	÷	2	264	÷	0.90		293
Other HGV (>15 tonnes)	77	77	22	x	77	÷	1	1,694	÷	0.90		1,882
RCV/General	n/a	4	50	x	4	÷	2	100	÷	0.90		111
Total								**3,497**	÷	**0.9**	=	**3,886**

Headline Scope & Risk Items

This indicative large constrained site has high-level risks associated with a full electrification programme. This is because there are insufficient parking bays for each vehicle; there is some inconsistency between allocation of bays for different types of vehicle; many vehicle parking areas have vehicles double, treble or more in a stacked parking arrangement and therefore long charging leads (manual handling risk), cable damage, and safe and protected routes of man-access is a concern or perhaps gantries could be considered (very expensive). A partial electrification may be possible but other sites many need to be considered with vehicle parking density re-evaluated.

> Determining the Maximum Electrical Demand and Engaging with the DNO for an Electrical Supply.

> Planning and surveying new substation, meter/switchroom, feeder pillar and charge point locations during the concept design.

> Planning and surveying cabling routes including carrying out ground penetration radar survey and reviewing existing record documentation to establish existing buried services.

> Review RC59 'Fire Safety when Charging Electric Vehicles' and assess any fire risks relating to the proposed concept design and consider any necessary mitigation works.

> Review any Health and Safety issues with the concept design and consider any necessary mitigation works.

> Establishing any local Planning requirements for new Substation and meter/switchroom enclosures.

> Establish any third party agreements required for the proposed concept design.

> Establish any legal lease and easement agreements with the DNO for the proposed concept design Substations and HV cabling routes.

> Not all vehicles can have direct access to an Electric Charge Point without vehicles being moved around during the dwell time for the vehicles which requires consideration as part of the electric vehicle charging operation.

> Many vehicle parking areas have vehicles double, treble or more in a stacked parking arrangement and therefore long charging leads or gantries will need to be considered which have Health and Safety risks which need to be considered.

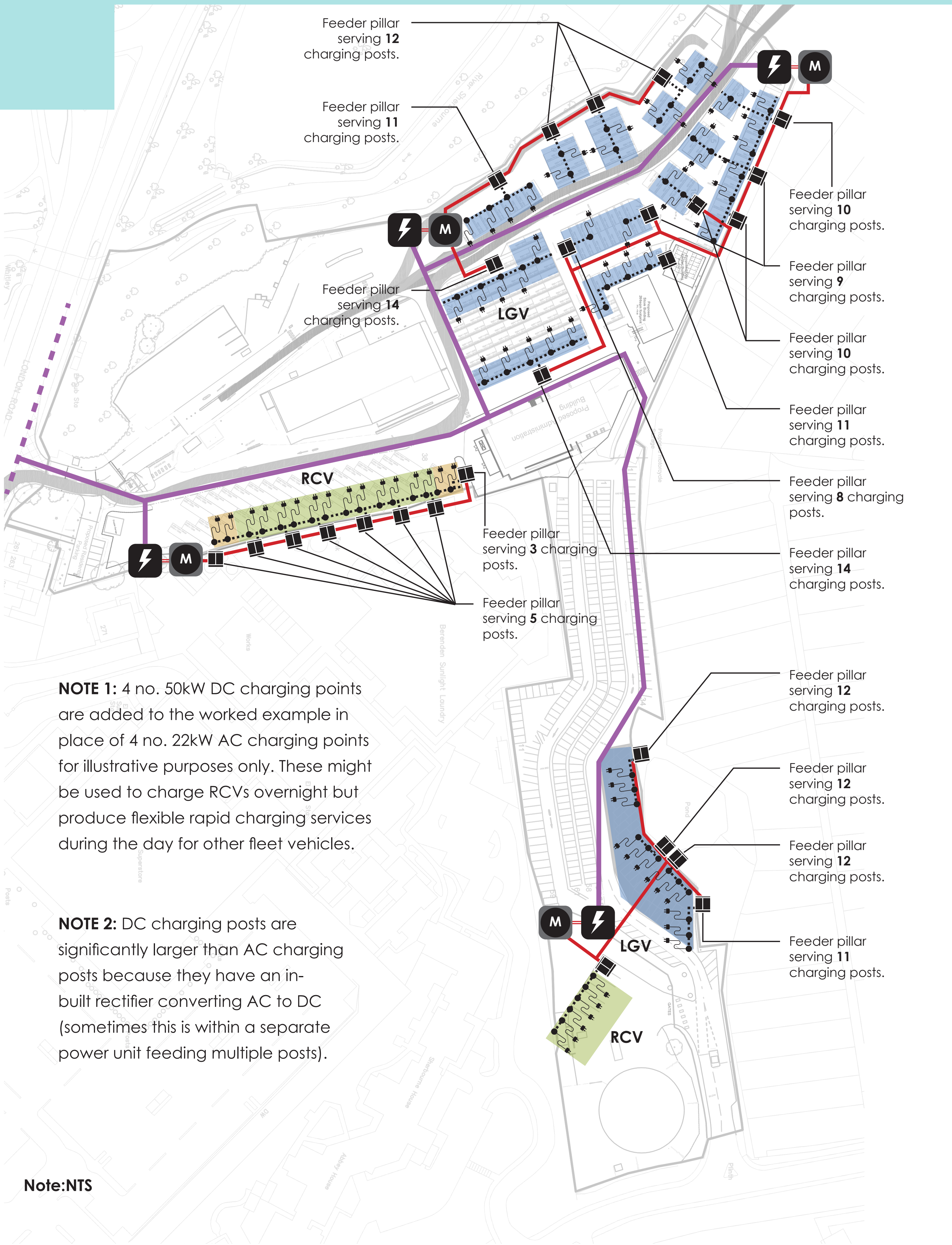
> Concept Design.

Electrical layout

This indicative large constrained site has high-level risks associated with a full electrification programme. Of the 9 depots surveyed during the development of this Guide this depot was the one that is believed will not work in its current format. This is because there are insufficient parking bays for each vehicle; there is some inconsistency between allocation of bays for different types of vehicle; many vehicle parking areas have vehicles double, treble or more in a stacked parking arrangement and therefore long charging leads (manual handling risk), cable damage, and safe and protected routes of man-access is a concern or perhaps gantries could be considered (very expensive). A partial electrification may be possible but other sites many need to be considered with vehicle parking density re-evaluated.

- DNO or IDNO HV to LV substation
- GRP enclosure for Low Voltage switchboard serving EVCI and utility meter
- LV feeder pillar serving group of charging posts
- DNO or IDNO HV ring main network
- DNO or IDNO HV ring main buried ducted cable routes
- LV supply from DNO or IDNO substation serving Low Voltage Switchboard
- Primary LV Sub-Main buried ducted cable routes serving feeder pillars
- LV buried Sub-Circuit cabling serving charge posts from feeder pillar

- 50 kW DC charger
- 22 kW AC charger
- 7 kW AC charger
- Charger



NOTE 1: 4 no. 50kW DC charging points are added to the worked example in place of 4 no. 22kW AC charging points for illustrative purposes only. These might be used to charge RCVs overnight but produce flexible rapid charging services during the day for other fleet vehicles.

NOTE 2: DC charging posts are significantly larger than AC charging posts because they have an in-built rectifier converting AC to DC (sometimes this is within a separate power unit feeding multiple posts).

Note:NTS

> Commercial.

Performance specifications

The same scope for the performance specification is used for all three worked examples and can be found on page 142.

Example of possible preferred procurement options*

> Project scoping undertaken by Local Authority depot manager or energy/sustainability team. Budget secured for concept design by electrical engineering consultant.

> Concept design and performance specification is completed by electrical engineering consultant in order to improve outcome of competitive tendering for next stage (including application to DNO). Perhaps engineering consultant secured via ESPO vehicle charging framework.

> Detail design, installation, commissioning, training and operation and maintenance secured on an extendable 5-year [turnkey] contract by specialist CPO. Perhaps CPO secured via ESPO vehicle charging framework.

> CPO issues cash-backed order for non-contestable DNO works.

> CPO procures ICP to design, build and seek adoption by IDNO of contestable works.

> CPO manages and delivers any town planning, leases, wayleaves or easement needs.

> Operation and maintenance by specialist CPO as procured as part of turnkey design, build, operate and maintain contract.

**Partial depot electrification as complete electrification not feasible!*

4.

Performance Specifications.

Introduction

This is an outline performance specification that might be included as the scope within an Employers Requirement to seek market interest - or an appointment - through an EOI, Pre-Qualification Questionnaire (PQQ), ITT or similar.

This scope is intended to allow a Local Authority to procure electric vehicle charging points, supporting back-office software, and the requisite electrical infrastructure sufficient to charge a fleet of depot-based BEVs.

This scoping document can be used to engage with a consultant, contractor or electric vehicle CPO or supplier to develop the performance specification into a full design and technical specification, or the procurement of a managed or turnkey service.

The fleet electrification shall comprise the design, procurement, supply, install and commissioning of the EVCPs and associated civil and electrical infrastructure within the depot.

The associated services shall comprise of the negotiation with the DNO for the electrical supply, new LV Switchgear, sub-main cabling distribution, local feeder pillars and sub-circuit wiring to serve the new EVCPs. The services shall also include the necessary earthing of the EVCPs and hardwired data services to support, control and provide data logging and reporting of the EVCPs.

Services to be provided

The following services shall be provided by a suitable qualified Consultant, suitably accredited contractor or EVCP or supplier as part of their design for the depot's electric vehicle charging infrastructure installation.

The works shall comprise the contractor design, supply, delivery, positioning, installation, setting to work, testing and commission of the electric vehicle charging engineering services systems for the following:

> Review of fleet vehicle types and quantities; daily/weekly mileage and duty cycles estimated growth to duty cycles or municipal services; typical daily/weekly vehicle dwell times; and the estimation of the minimum maximum demand that is required to deliver daily charging for the following day fleet

operation.

- EVCP selection to support the fleet vehicle charging requirements including charging type, ratings, quantities and location in relation to existing and future depot parking and logistics strategy and existing services and land ownership constraints.
- Incoming electric vehicle capacity assessment and submission of formal quotation application to the DNO for the incoming supply requirements.
- Review leases (substations), Wayleaves, Deeds of Easement or other rights of access as may be required by a DNO, IDNO and identification of town planning related risks.
- Securing of MPAN detail from network operator.
- LV switchboard associated metering, services and equipment.
- LV distribution including main and sub-main cabling.
- LV feeder pillar including distribution equipment, surge arrestor protection and sub-circuit cabling serving EVCPs.
- Earthing and bonding requirements for the electrical distribution and EVCPs.
- Ancillary services to provide back-office control, monitoring, data logging and reporting of the electric vehicle charging system.
- Civil works comprising of sub-base design for substations, LV switchrooms, feeder pillars and charge points. Soft and hard surface trenching, ducting and back filling including temporary and permanent surface reinstatement for cabling installations.
- Managing the adoption of any DNO or IDNO adoptable electrical infrastructure.
- Commissioning and setting to Work of the electric vehicle charging system.
- Operating and Maintenance Manuals and record drawings.
- Training for Local Authority staff and maintenance contractors.

Standards

The design and installation shall comply with the requirements of the following standards:

- *British Standard BS 7671 – Requirements for Electrical Installations. IET Wiring Regulations.*
- *Energy Networks Association Recommendations G5.*
- *Energy Networks Association Recommendations P28.*
- Building Regulations.
- *The Energy Related Product Directive (ErP) as set out in the European Commission regulations EU/327/2011.*
- *The Energy Related Product Directive (CPR) as set out in the European Commission regulations EU/305/2011.*
- *EMC Directive 2014/30/EU and associated UK*

statutory regulations.

> *BS EN 61851 – Electric Vehicle Conductive Charging Systems and Standards.*

> *OCPP 2.0 and ISO15118 – V2G to EVCP Software Interoperability.*

Design calculations

The contractor shall provide design calculations for the following:

> Fleet electric vehicle charging requirements. Following the review of the depot fleet vehicle types, quantities, daily/weekly mileage and typical daily/weekly dwell times, including an estimation of growth due to organic and additional services (e.g. food waste collection) an EVCP deployment strategy (number, type, location and power rating) is to be determined to deliver daily charging sufficient to allow the normal next-day operation of the fleet operation, including an agreed level of contingency and resilience.

> Estimation of the incoming supply from the DNO to meet the charging requirements.

> Sub-main & sub-circuit cable sizing.

> Distribution and circuiting, etc..

> Prospective short circuit current, including disconnection and withstand time.

> Full protection and selectivity study for the low voltage networks.

> Earth fault level and circuit protection conductor sizing including disconnection times.

> Surge arrestor protection calculations.

> Design and development of earthing systems within the DNO substations.

> Ancillary services calculations.

Design information

The contractor shall provide design information for the depot fleet electrification for the following:

> The continuity of existing depot electrical services (and daily vehicle movements) which should not be affected by the installation of the new electrical infrastructure (or associated civil works) during and following the installation of the fleet EVCI. The existing depot electrical services (and vehicle movements) shall be maintained at all times without affecting the normal day to day running of the depot.

> A survey of the existing depot electrical services shall be carried out to establish the current electrical installation details, condition and cabling routes, so as to coordinate the design of the electric vehicle charging electrical installation with the existing

installation.

- A review of the existing depot record drawings and a ground penetration radar survey shall be carried out to determine the location of all existing below ground services to coordinate the design of the electric vehicle charging electrical installation with the existing buried services.

- Capacity requirement for the electric vehicle charging based upon the criteria set out in the employers requirements. This shall also include an impact assessment on the current depot incoming capacity to the site.

- Survey and design for locations of DNO substations, LV switchrooms, feeder pillars and electric vehicle charging units and cable routes.

- Production of layout drawings to detail the locations of substations, LV switchrooms, feeder pillars, EVCPs and cabling routes. Schematic drawings to detail the electric vehicle distribution infrastructure design, equipment details, cable sizes and protection devices.

- Production of civil layout and detail drawings to identify plant base locations and details also cabling trenching details, ducting requirements and back filling and surface reinstatement requirements.

- Production of equipment schedules to provide details of LV switchboards, protection devices for both overload, residual current and earthing, surge arrestor protection devices, metering, distribution boards, cabling, electric vehicle charge points and back-office equipment.

- Details of proposed back-office control, monitoring, data logging and reporting system including operation, load management and output reporting facilities.

Installation scope

The contractor shall provide the following installation scope as follows:

- The DNO shall supply, install and commission the new supply substation including all HV/LV switchgear, transformer, HV cabling and enclosure. The contractor shall design, supply and install the substation base in accordance with the DNO's requirements and also provide attendance for the DNO to install the substation.

- The contractor shall supply, install and test the LV main cable from the substation to the LV switchroom including the civil trenching and ducting.

- The contractor shall supply, install and commission the main LV switchboard including incoming protection and outgoing way protection, overvoltage surge protection and Current Transformer (CT) chamber for the utility metering of the supply. The LV switchboard shall be located within a suitability IP rated enclosure.

- The contractor shall supply, install and test all sub-main cabling from the LV switchroom to the feeder pillar's including all trenching, ducting, back filling and reinstatement of the surface finish.
- The contractor shall supply, install, commission and set to work suitability IP rated feeder pillars and associated distribution boards, overload protection devices, residual current devices, over voltage surge arrestor protection devices and earthing requirements to serve the EVCPs.
- The contractor shall supply, install and test all sub-circuit cabling from the feeder pillars to the EVCPs including all trenching, ducting, back filling and reinstatement of the surface finish.
- The contractor shall supply, install, terminate and commission the EVCPs including the installation of the sub- base to support the charge point and earthing requirements.
- The contractor shall design, supply, install and commission the back-office control, monitoring, data logging and report system for the EVCPs. The contractor shall also provide training for the local depot staff and maintenance contractors.

Commissioning and training

Commissioning and training is an essential part of the installation requirements as the commissioning of system ensures that the full installation is safe to use and is operating and reporting correctly in accordance with the performance specification requirements.

Training is to be provided for all depot staff and visiting staff such as turn maintenance contractors who have responsibility in operating, maintaining, accessing information for reporting and fault finding trouble shooting.

Commissioning and training will include all EVCP hardware and software and vehicle interface, including manual handling of charging cables.

The contractor shall carry out a complete testing and commissioning exercise for the entire installation comprise of the following:

- LV Switchgear and distribution board testing and commissioning.
- LV cabling electrical testing.
- Commissioning of electric vehicle charging units.
- Commissioning of back-office control system.

Commissioning and electrical test certificates shall be issued for all equipment and cabling and shall be signed and dated.

Training shall be provided for all local depot staff and maintenance contractors on the system operations, control and basic trouble shooting.

Record documentation

The contractor shall provide an operating and maintenance manual and record drawing information which shall comprise of the following.

Operating and maintenance manuals shall include the following sections:

> Index.

> Description of the electric vehicle charging design.

> Description of the electric vehicle operation routine.

> Planned electric vehicle charging maintenance.

> Electric vehicle charging maintenance schedules.

> Electric vehicle charging and switchgear equipment schedules.

> Back-office control, monitoring, data logging & reporting system details.

> Emergency measures.

> Commissioning and testing certificates.

Record drawings shall include the following:

> The location and layout of all installed substations, switchboards, feeder pillars and charging points.

> The location, routes and levels of all buried services.

> The layout of cabling.

> Schematics of the infrastructure network equipment ratings, cable types and sizes, protection settings, etc..

> Layout of back-office control system including equipment locations and cable routes.

> Schematics of the back-office control system including cable types and sizes.

MIDLANDS NET ZERO HUB

Hilson Moran