NHS Wales Decarbonisation Strategic Delivery Plan

Initiative 17: Electric Vehicle Charge Point Best Practice Guidance

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Glossary

AC	Alternating Current – where the flow of electrons in a current reverse regularly and rapidly.
Battery Electric Vehicle (BEV)	Vehicles that are powered using a battery storing energy, with power sent to an electric motor. Vehicle is recharged externally or via regenerative braking.
Cars	Small passenger carrying vehicles with up to eight seats (excluding the driver).
CCS	Combined Charging Standard, the most common charging socket used on vehicles sold in Europe.
CHAdeMO	A legacy charging socket, often from vehicles originating in Asia, which stands for Charge de Move. Largely being phased out, with only the Nissan Leaf and e-NV200 being sold with this socket. As it is a legacy socket, support may still be required on new charging infrastructure in future until these vehicles are decommissioned.
DC	Direct Current – where the flow of electrons in a current is uni-directional.
DfT	Department for Transport at UK Government level, responsible for planning and investing in transport across the UK.
Distribution Network Operator (DNO)	A company who owns the right to distribute electricity in the UK. These companies own the cables, towers, substations and other associated infrastructure that enable this distribution.
E-bike	Cycles with an electric motor and battery used to assist cyclists, particularly up hills.
Electric Vehicle Charging Infrastructure (EVCI)	Devices for the purposes of recharging Electric Vehicles when stationary, which can be categorised by its power output into slow, fast, rapid and ultra-rapid.
GPDO	The Town and Country Planning (General Permitted Development) (Amendment) (Wales) Order 2019 outlining what kinds of development fall within permitted development, which do not require planning permission.
Grey Fleet	Vehicles owned or leased by members of staff, with the vehicle partly used for business purposes.
Heavy Goods Vehicles (HGVs)	Vehicles constructed for transporting goods and must have a gross weight over 3.5 tonnes.

Independent Distribution Network Operator (IDNO)	A company who owns the right to distribute electricity in the UK. An IDNO owns and operates a network that is directly or indirectly connected to a distribution network operator's (DNO) distribution network.
Internal Combustion Engine (ICE)	Vehicles fuelled by petrol, diesel, biofuel, etc driven by a combustion process in the engine to power the vehicle.
Light Goods Vehicles (LGVs)	Vehicles constructed for transporting goods with a gross weight of 3.5 tonnes or less.
Open Charge Point Protocol (OCPP)	The open-source software on the charging devices which is essentially a common ‘language’ for charger and vehicle to communicate with one another. This includes metrics such as battery state of charge, temperature and power requirements. Presently the most widely adopted is version 1.6, which should be the minimum version used.
Operational Vehicles	Vehicles owned or leased directly by NHS Wales supporting the day-to-day operations of the health service.
Other Vehicles	All vehicles not mentioned in other body types, including ambulances and tractors.
Passenger Carrying Vehicles (PCVs)	Vehicles constructed for passenger carrying with nine seats or more (excluding the driver).
Plug In Vehicles (PiV)	Vehicles that are solely or partly powered by electricity from an external source.
Plug-in Hybrid Vehicles (PHEV)	Vehicles that contain an internal combustion engine and a small battery with an electric motor which can be charged externally or via regenerative braking.
Range	The typical distance a vehicle can travel without refuelling or recharging.
Range Extended Electric Vehicle (REx)	Vehicles that are principally powered by an electric motor and battery but contain a backup petrol generator to top up the battery when it is low.
Self-Charging Hybrid Vehicle	Vehicles that are contain an internal combustion engine and a small battery which can only be recharged through regenerative braking and the consumption of petrol/diesel.
TAN	Technical Advice Notes which are provided by the Welsh Government which gives more detail on planning policy specifics, including topics such as transport.

Tariffs	The unit cost per kilowatt (kW) for using electric vehicle charging infrastructure.
Ultra Low Emission Vehicles (ULEV)	Vehicles that have zero or low emissions at the tailpipe. These include Electric Vehicles, Plug in Hybrid Vehicles, hybrid vehicles and Hydrogen-fuelled vehicles.
Vehicle to Everything (V2X)	As Vehicle to Grid, but the electricity stored in an Electric Vehicle battery is distributed to anything requiring electricity via a compatible charger. This can serve as a generator to a local power network, home or workplace.
Vehicle to Grid (V2G)	The use of the battery included in an Electric Vehicle to store electricity, in conjunction with a compatible charger which can then provide electricity back to the national grid as a generator.
WAST	Welsh Ambulance Service NHS Trust which operates the ambulance fleet across Wales.
Zero Emission Vehicles (ZEV)	Vehicles that are zero emission at the tail pipe. There are still emissions during the manufacturing process, from the use of brakes and tyre wear.

Executive summary

NHS Wales has set an ambitious commitment to decarbonise its operations. To meet this, NHS Wales must decarbonise its vehicle fleet, in line with the UK Government commitment to ban the sale of petrol, diesel and hybrid cars and vans by 2035, and HGVs by 2040.

This Best Practice Guidance document sets out clear guidelines and advice for the different fleets, vehicle types and sites across NHS Wales. This includes information on:

- Goals and objectives of rolling-out Electric Vehicle Charging Infrastructure (EVCI) and the wider policy context.
- Current infrastructure requirements and other resources to support the deployment.
- Fleet planning and anticipated demand by user type.
- Audience and key roles and responsibilities.
- Legislative and technical considerations.
- Safety and security considerations.
- Best practices for implementation across the various estate settings.
- Skills and knowledge requirements for upcoming delivery plans.

Aims and Objectives

The following vision outlines the approach for providing charging infrastructure for the NHS Wales vehicle fleet.

NHS Wales will continue to support the commitment of procuring zero or ultra-low emission vehicles by developing a comprehensive fleet charging network across its estates. Where possible, cross-sector opportunities will be utilised to ensure value for money and work within grid capacities.

This aim is supplemented by four objectives to support the successful delivery of the vision.

1. Prioritise deploying electric vehicle charging infrastructure where it will have the greatest impact in reducing carbon emissions in the vehicle fleet. Solutions will not comprise accessibility in rural locations, nor critical hospital services, and will improve fleet operations through cost savings and emissions reductions.
2. Maximise opportunities for quick wins and early improvements given the Welsh Government climate emergency declaration, targeting high mileage vehicles and lighter vehicles initially.
3. To deliver the greatest return on investment and avoid infrastructure duplication, expenditure should be driven by value-for-money assessments and public sector collaboration. For NHS Wales to stay abreast of EVCI developments future-proofing should lie at the heart of decision-making.
4. Where possible, integrate new charging opportunities with renewable energy generation and consider the wider impacts of climate change.

Policy Context

A review was undertaken of national, regional and NHS Wales policies surrounding the decarbonisation of transport, particularly for fleets. From these policies, the key targets for decarbonisation of vehicle fleets are as follows:

2030	2035	2040
No new petrol and diesel only cars will be sold from 2030 onwards	All new cars and vans will be fully zero emissions by 2035 Non-zero emission HGVs weighing 26 tonnes and under to be phased out	All new HGVs sold in the UK are expected to be zero emission by 2040

As a result of these national targets, NHS Wales has committed to:

- All new cars and light goods fleet vehicles procured across NHS Wales after April 2022 will be battery-electric wherever practically possible. In justifiable instances where this is not suitable, ultra-low emission vehicles should be procured
- All new medium and large freight vehicles procured across NHS Wales after April 2025 will meet the future modern standard of ultra-low emission vehicles in their class.

To support the deployment of EV across the NHS Wales fleet, the Wales National EV Charging Strategy outlines the key actions required to support the deployment of charging infrastructure:

- Improve charging provision at key public locations for all types of charger, especially fast.
- Establish Welsh quality standards to improve the customer charging experience, particularly improved accessibility and inclusivity.
- Increase public awareness and confidence in transitioning to EVs.
- Create synergies with spatial planning and other public sector bodies to share charging infrastructure.

Infrastructure Requirements

The required charging infrastructure is highly dependent on the types of vehicle, the operational purposes, vehicle downtimes and daily mileage. Broadly, the types of required charger can be summarised as follows:

- A Type 2 7kW AC socket for vehicles which can be recharged overnight, which can be shared among multiple vehicles if the average daily mileage is below the typical range of an EV.
- If overnight charging is not possible, then a minimum of 22kW AC/DC should be specified for recharging cars within a minimum of 3 hours or 5 hours for LGVs.
- At least 20kW CCS DC charger, recommended 50kW or higher, should be provided where daily mileages are high, which can be shared among multiple vehicles for rapid top ups. CHAdeMO cables may also need to be provided where legacy vehicles are used.

It is recommended that actual requirements should be worked out per organisation and use case, as these would depend on operational requirements and the above should therefore only be used as an approximate guide.

The deployment of charging infrastructure across NHS Wales for the fleet will also have competing priorities between departments for a finite electrical grid connection and public funds. Therefore, the following outlines the electrical power priorities for transportation:

1. WAST vehicles should have charging priority due to potential impact on patient critical care.
2. Operational vehicles which are vital to day to day NHS operations.
3. Any grey fleet vehicles for other operational purposes.
4. Staff or visitor vehicles should then follow with any remaining capacity.

Additional recommended requirements include setting a sustainable tariff for users of charging infrastructure, which should include the following direct and indirect costs:

Electricity Wholesale Cost	Asset Replacement	Maintenance Costs	Transaction Costs
Green infrastructure levy (if applicable)	Charge Point Operator management fee	DNO Capacity Charge	Network expansion fund

These costs should be applied to any vehicle using an NHS charge point, whether public-facing or fleet to recover the operational costs. To levy the tariff, it is recommended that users activate a charge point using Radio Frequency Identification (RFID) cards or fobs, rather than using an app or contactless reader for ease of use. In addition, a centralised Welsh Government approach to leveraging tariffs across the NHS Wales estate should be explored and encouraged to standardise costs.

Most EVCI include RFID readers by default, and so are a relatively low-cost method of controlling tariffs. To manage revenue and costs, back-office software is required to communicate with chargers. It is recommended a minimum of Open Charge Point Protocol 1.6 or newer to ensure compatibility and interoperability with back-office software.

Car Parking and Space Planning

Car parking standards for healthcare facilities vary by council area in Wales, however the below presents common guidelines for provision of general parking bays. Charging provision should be within these car parking requirements.

Hospitals	• **Operational:** Essential operational vehicle spaces as required. • **Non Operational:** 2 spaces per bed for non-operational purposes.
Health Centres and Surgeries	• **Operational:** 1 space per practitioner, e.g. doctor, nurse, etc • **Non Operational:** 1 space per 2 ancillary staff and 3 - 5 spaces per practitioner.
Blue Badge Parking	• **Up to 200 spaces:** 6% of total capacity, minimum of 3 spaces. • **Over 200 spaces:** 4% of total capacity plus 4 spaces.

As a minimum, parking bays are 2.4m x 4.8m with blue badge parking sized at 4.8m x 3.6m. Additional leeway of between 10 to 20% should be added to parking bays to allow for the positioning of charging ports. Other recommendations from the PAS1899 Accessible Charging Specification current edition include:

- Ensure the user interface is accessible for all.
- Positioning of the charge point in such a way not to restrict mobility.
- Reduced trailing cable lengths as much as possible.
- Sufficient height of charging connectors or cables, with weight reduced as much as possible.

To quantify the number of parking bays that require charging infrastructure, these are as follows:

- **Critical NHS Fleet Vehicles** – one charging socket per parking bay where daily mileages are high, or when a vehicle is required to be ready to be used at all times.
- **Rapid response vehicles** – high powered charging at relevant healthcare facilities in parking bays reserved for ambulance use.
- **Staff and visitor parking** – the Future Wales National Plan indicates that in new developments with car parking 10% of spaces should be allocated for EVCI.
- **Blue badge** – there is currently no minimum charging provision for blue badge bays, however where provided it should meet as much as PAS1899 current edition as possible.

Other considerations outlined include:

- When positioning charging infrastructure, these should be situated in locations which would not obstruct footways or create trip hazards from cables.
- Clear signage should be used where public charging infrastructure is provided, following DfT Standard P660x9. Any parking restrictions should also be presented.
- Appropriate bay markings should be provided indicating they are for recharging only, or if restricted for staff, ambulance or fleet use.
- If parking enforcement measures are used on-site, then these should be extended to cover charging bays. These can include fines for vehicles not charging or blocking bays.
- Usage monitoring to provide data to guide future decision making on site or elsewhere.

Planning Considerations

There are some permitted development rights for developments specific to car parking and EV charging, namely Class D and E of the General Permitted Development Order (Wales) 2019. This outlines specific requirements for the installation of charging infrastructure within permitted development, with limitations mostly around the size of infrastructure provided the site is already used for off-street parking.

Where planning permission is required, the following information should be provided in the application:

- Clear site plans showing the location of EVCI
- Details and dimensions of outlets and associated structures
- Description of the application site and locality
- Assessment again relevant national and local planning policy

Refer to Technical Advice Notes 12 (Design) and 18 (Transport) for detailed planning advice.

Listed Building Consent may be required if the installation of charging infrastructure would affect the character of a listed building. Where possible, chargers should be located away from listed buildings to not obstruct views or disrupt maintenance.

Electrical Infrastructure

Electrical connections for EV chargers are required from the private Low Voltage (LV) network, via a new or existing 11kV/LV substation. Chargers require a single-phase or three-phase AC power supply. For substations up to 1MVA, package substations can be deployed which contain the main required equipment while 2MVA or beyond require modular systems to ensure sufficient power can be supplied.

To determine the required grid connection capacity, the following should be considered:

What substations are nearby	Nearby transformer ratings and load on said transformers	LV cable sizes to local LV units	Feeder pillar / LV board ratings and spare ways
Upstream 11kV ring cable size(s)	Overall site Single Line Diagram (SLD)	Reserved capacity to site	Standby power arrangements (if any)

When designing the grid connection infrastructure, the following should be considered:

- New load requirements (based on type of EV chargers to be installed)
- Number of EV points and loads
- Assessment of existing electrical limits (based on new and existing load versus existing)
- Impact of additional load to upstream connections
- Collation of EV locations car park by car park and as a whole
- Earthing requirements at the point of connection
- Wiring system, including routing of all cabling
- Metering for energy management purposes, as well as tariff metering if required.

There are also possibilities to utilise Vehicle to Grid (V2G) on site, when charging infrastructure has two-way power flow enabled. This would require regulation, protection and design practices for generation and loads as charging infrastructure would be seen as energy storage.

Electrical Demand

It is understood that grid capacity is already limited across much of the NHS Wales main hospital sites, especially in rural areas. Therefore any additional load for EV charging would need to be second to any critical hospital equipment, and then balanced between other decarbonisation objectives such as heat.

To understand the likely additional load from EV charging, the load of each new device should be added together to understand the potential maximum power draw. However it is unlikely that all charge points will be used simultaneously.

The current power draw on site would also be required, involving assessments of the existing electrical infrastructure and measuring the demand. The following can be considered:

1. Gathering information about the site's electrical infrastructure, including main electrical service panel, distribution panel, transformers and electrical loads, noting the voltage and current maximum current capacity.
2. Reviewing electrical blueprints or drawings of the electrical system. These documents provide insights into the layout, capacity and distribution of electrical circuits and panels.
3. Assess existing electrical loads on site and determine power ratings and current drawn.

4. Calculate available capacity by comparing the electrical demand with the maximum current capacity of the site's electrical infrastructure. Additionally, allow room for safety margins.
5. Incorporate future thinking into planning for the installation of charge points by accounting for the future growth and potential expansion of EVs on site, as well as considering other additional loads.

For additional grid capacity to then be provided to meet the new demand, the local Distribution Network Operator (DNO) or IDNO (Independent DNO) would need to be contacted early in the process to understand the connection requirements in terms of technical constraints and planning. This would involve contacting SP Energy Networks (North Wales) or National Grid (South Wales). The DNO would assess the likely impact on the grid based on the information provided and additional load, with a quotation provided.

Load management strategies could be used to mitigate some additional load on the grid if constrained. These can include timed charging for off-peak periods, demand limiting, charger management systems and integration with renewables or energy storage.

Renewable Energy

For a wind or solar project to be developed, there are five main considerations required:

1. Available Land or Area

- The viability of solar or wind resource at the site.
- Constraints mapping to understand limitations.

2. Planning and Environmental

- Planning and environmental review to determine roadmap including surveys.

3. Energy Yield Estimation

- Subject to site specific aspects.
- Design considerations such as orientation, PV module tilt and distance to shaded areas.
- Height, blade length and distance between turbines for wind.
- Energy Yield Assessment recommended.

4. Technical and Project Considerations

- Types of solar panel used, model of wind turbine and inverter type
- Location of onsite substation or MV Switchgear.

5. Project Costs

- Once capacity to be developed then CAPEX and OPEX estimates can be made.
- Combined with yield estimate to understand Levelised Cost of Energy of project to assess viability.

Each type of renewable generation method has positives and negatives associated with them, with solar generally being flexible and quick to deploy across a range of surfaces. Wind tends to be more reliable with a higher yield due to seasonal variation in the UK, but is offset by the larger space requirements and stricter planning regulations. Each approach is explored later.

EVCI can benefit from on-site renewables to contribute towards power requirements, especially when integrated with energy storage. The three approaches can work together to mitigate limited grid capacity or further boost decarbonisation efforts onsite.

Carbon Savings Analysis

Using a recognised approach using data from the Department for Transport, the estimated carbon emission equivalent has been calculated of the current NHS Wales fleet. The analysis has been undertaken for each organisation to calculate the emissions of each.

Two scenarios have been assessed on the baseline, one assuming a 50% uptake of EV within the fleet and another with 100% uptake (excluding HGVs and assuming ambulances are hybrids). The results indicate that between a 44% to 74% reduction in emissions could be achieved by converting the existing fleet to EV.

Further reductions could be realised if these are wholly powered by renewable electricity and larger, heavier vehicles like HGVs and ambulances are also decarbonised.

Climate Change Resilience

It is evident that climate change will impact our climate through extreme weather events, such as extreme hot and cold temperatures and flooding. Therefore, it is important that any planned infrastructure moving forward has integrated resilience where possible to mitigate any hazards.

There should be three main considerations when planning for resilience:

1. Safety
   - Considering the potential for hazards caused by weather-related incidents such as flooding, snow or extreme temperatures when accessing the charging infrastructure
2. Continuity of Services
   - Locating infrastructure to reduce the risk of service interruption and considering risk assessment and mitigation for the impact of any down time
3. Protection of assets
   - Minimising risk of damage to the EV infrastructure

Site risk assessments undertaken must account for potential environmental hazards, especially those arising from climate change such as extreme heat or cold and flooding. This approach should aim to capture climate risks on existing or planned assets. For example, the suitability of canopies above chargers to offer protection from severe weather and the siting of infrastructure away from flood risk locations.

As well as climate resilience, service continuity should be a key priority. Standby power support for rapid response vehicles and other essential service vehicles should be factored into contingency and business continuity plans. These should account for extreme weather or power cuts that may impact the service provision particularly around EV charging, and offer actions should be using the public charging network.

Fire Safety

There are a range of best practice, design guidance and legislation for fire safety with EV charging, which should be wholly met when deploying infrastructure. These include relevant legislation through building regulations and fire safety orders (Regulatory Reform (Fire Safety) Order 2005 (RRO)), design guidance and fire risk guidance documents. These should be reviewed in detail to ensure compliance, with fire risk assessments undertaken.

This document outlines fire safety requirements for the following subject areas:

- Fire safety provisions
- Fire detection and alarm systems
- Impact on fire escape routes
- Fire separation requirements
- Fire suppression
- Smoke ventilation
- Fire service interventions
- Environmental protection
- Management procedures

Commercial and Procurement Models

There are a range of commercial models and procurement approaches that could be undertaken for EVCI across NHS Wales. Once potential sites for EVCI have been identified, the decision for individual or joint procurement should be taken. Charge Point Operators (CPOs) prefer larger packages of infrastructure over limited locations, meaning more interest can be gained from the market through bundling sites.

Pre-market engagement should be undertaken to develop the tender scope, specifications and key performance indicators that will meet the needs of both parties. Estates managers, decarbonisation leads, legal and procurement colleagues should consider these before engagement takes place.

A range of commercial operational models could be deployed, which provide the organisation and commercial framework which NHS Wales and CPOs will work together to deliver and manage EVCI. The most appropriate approach would depend on a range of factors including the buyer's own objectives, site context, charger types, and CPO interested in supplying the infrastructure. Common commercial models include:

- **Privately owned and operated** – with private sector investment, tariff control, ownership and operation of the network, with no risk to NHS Wales.
- **Concession model** – with a private operator and investment in the network and assets transferred to the public sector at the end of the contract. May be some revenue share depending on the amount of risk willing to be taken on. Some level of tariff control.
- **Public sector owned and operated** – requiring public sector investment and operation with all risk and revenue on the public sector. Tariffs under full control.

The Welsh Government is developing a bespoke framework for the procurement of charging infrastructure, with details pending. Other frameworks may also be relevant such as the Crown Commercial Service Vehicle Charging Infrastructure Solutions or ESPO Vehicle Charging Infrastructure.

1 Introduction

NHS Wales has set an ambitious commitment to work towards the decarbonisation of its operations. As part of this, it is necessary for NHS Wales to decarbonise its large vehicle fleet, in line with UK Government commitment to ban the sale of non-zero emissions cars and vans by 2035, and HGVs by 2040. This document is designed to support NHS Wales to move towards a decarbonised fleet, by providing best-practice guidance on Electric Vehicle Charging Infrastructure (EVCI).

1.1 Scope

This Best Practice Guidance document sets out clear guidelines and advice across different fleets types, vehicle types and site settings across NHS Wales in the context of Electric Vehicles (EV). This includes information on:

- Goals and objectives of EVCI roll-out and the wider policy context.
- Current infrastructure requirements and other resources to support the roll-out.
- Fleet planning and anticipated demand by user type.
- Audience and key roles and responsibilities.
- Legislative and technical considerations.
- Safety and security considerations.
- Best practices for implementation across the various estate settings.
- Skills and knowledge requirements for upcoming delivery plans.

This Best Practice Guidance supports asset managers to achieve the optimal roll-out of EVCI, the expected outcomes to be achieved and the steps to be taken to ensure success across the various technical considerations. It concludes with a summary and a roadmap for how to proceed with EVCI roll-out.

In conjunction with the Best Practice Guidance, a baseline report[1] was also developed which collated relevant policies and data from NHS Wales organisations. It also outlines what likely charging requirements would be needed assuming the whole fleet switched to plug-in vehicles, based on the data provided from NHS Wales organisations.

1.2 Engagement

The development of the Best Practice Guidance included extensive engagement with the NHS Wales organisations. The organisations engaged with as part of the study are listed below, grouped by Central All Wales Support Services or health board.

- Central All Wales Support Services
  - Digital Health and Care Wales
  - NHS Wales Shared Services Partnership
  - Health Education Improvement Wales
- Local Health Boards
  - Aneurin Bevan University Health Board
  - Betsi Cadwaladr University Health Board
  - Cardiff and Vale University Health Board

[1] Mott MacDonald, 2023. NHS Wales EV Charging Best Practice – Baseline Report. 100112568 | 1 | B

  - Cwm Taf Morgannwg University Health Board
  - Hywel Dda University Health Board
  - Powys Teaching Health Board
  - Velindre University NHS Trust
  - Swansea Bay University Health Board
- Welsh Ambulance Service NHS Trust
- Public Health Wales

1.3 Report Structure

This Best Practice Guide is structured as follows:

- **Section 2 – Terminology:** detail on the specific terms used throughout the document with regards to electric vehicles and their infrastructure.
- **Section 3 - Aims and Objectives:** an overview of key aims and objectives produced in collaboration with organisations comprising NHS Wales.
- **Section 4 - Policy Context:** a summary of existing UK, Welsh, NHS Wales and local policy that is of relevance to the decarbonisation of vehicles fleets.
- **Section 5 - Overview of Infrastructure Requirements:** a summary of typologies produced as part of the baseline report, and requirements for infrastructure at sites across NHS Wales.
- **Section 6 - Car Parking and Space Planning:** an overview of considerations for space planning, with relevant accessibility standards for parking and EVCI provision.
- **Section** Error! Reference source not found. **- Planning Considerations:** a summary of p lanning permission requirements and constraints regarding the development of charging infrastructure, including permitted development rights and listed building consent.
- **Section 8 - Electrical Infrastructure:** an overview of electrical infrastructure connection requirements, standards and risks.
- **Section 9 - Electrical Demand:** an overview of understanding present and future electrical demand, the grid connection process and load management strategies.
- **Section 10 - Renewable Energy:** an overview of considerations for renewable energy use in the context of providing charging infrastructure.
- **Section 11 - Carbon Savings Analysis:** an overview of potential carbon emission savings resulting from the transition to an EV-based NHS Wales fleet.
- **Section 12 - Climate Change Resilience:** potential risks arising from climate change and their impacts on charging infrastructure, and possible mitigation measures.
- **Section 13 - Fire Safety:** an overview on key considerations to ensure compliance with fire safety standards in the context of electric vehicle charging.
- **Section 14 - Commercial and Procurement Models:** an overview of procurement and operation approaches for charging infrastructure, including the advantages and disadvantages of different models.
- **Section 15 – Summary of Recommendations:** this section provides an overview of some of the key recommendations made throughout the Best Practice Guidance, as well as providing a road map for EVCI rollout.

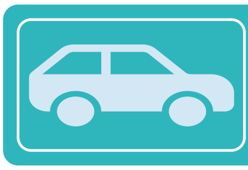
2 Definitions

The terminologies used in this Best Practice Guidance document to describe fleet vehicles and the associated charging requirements are covered in this section.

2.1 Vehicle Types

The Best Practice Guidance uses the UK Department for Transport (DfT)[2] vehicle classifications, which are shown in Figure 2.1.

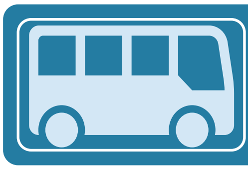
Figure 2.1: DfT Vehicle Classifications



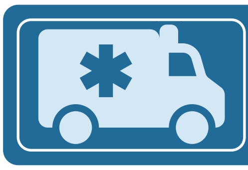
Cars
Small passenger carrying vehicles with up to eight seats (excluding the driver)

Light Goods Vehicles (LGVs)
Vehicles constructed for transporting goods with a gross weight of 3.5 tonnes or less

Heavy Goods Vehicles (HGVs)
Vehicles constructed for transporting goods and must have a gross weight over 3.5 tonnes.



Passenger Carrying Vehicles (PCVs)
Vehicles constructed for passenger carrying with nine seats or more (excluding the driver).



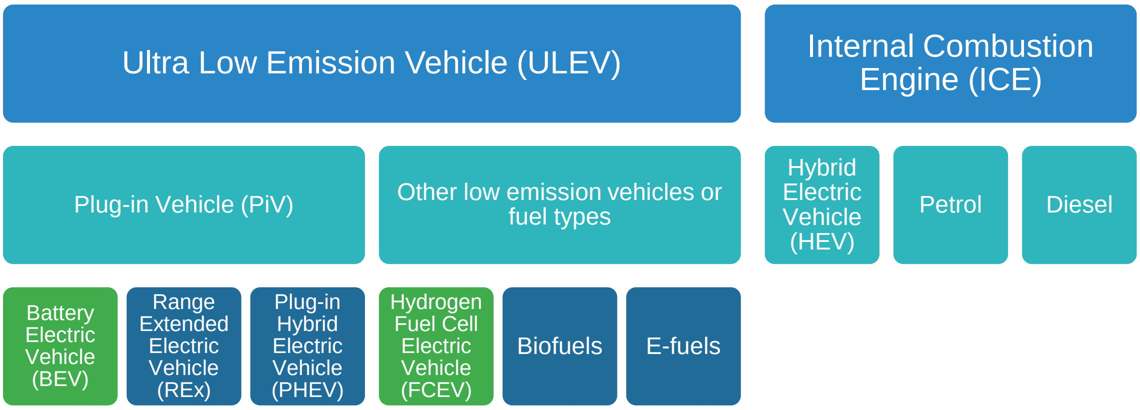
Other Vehicles
All vehicles not mentioned in other body types, including ambulances and tractors.

The DfT vehicle classifications are also split further into vehicle fuel types. Historically, the main types of fuel were petrol and diesel, burned in an Internal Combustion Engine (ICE) to provide energy to drive the vehicle wheels. However, with the need to reduce greenhouse gas emissions from transport, new cleaner vehicle fuels and propulsion methods have been developed.

Figure 2.2 shows how these new vehicle fuels are classified, especially the emerging category of Ultra Low Emission Vehicles (ULEV) compared with the historic category of ICE.

[2] Vehicle licensing statistics: notes and definitions (gov.uk)

Figure 2.2: Summary of Vehicle Propulsion Types



Within ULEV, further categories of Plug-in Vehicle (PiV) and other low emission fuel types are shown in Figure 2.2. However, not all fuel types are zero emission at the tailpipe, which do not fully meet the decarbonisation objective. Battery Electric Vehicles (BEV) and Hydrogen Fuel Cell Electric Vehicles (FCEV) are zero emission at the tailpipe and can be zero emission in the generation of electricity and hydrogen to power the vehicles, as shown in green.

Other alternative means like Range Extended EV (REx) and hybrid vehicles may offer a useful stop-gap, with petrol and diesel motors providing traditional fuel sources while the small battery pack can provide zero emission driving for a short range. Other alternative fuels like biofuel or e-fuels depend on the production methods as to whether they are zero emission. Often, these rely on carbon capture methods which are not fully commercially viable yet.

The Best Practice Guidance therefore focuses on EV due to the proven pathway in decarbonising transport and zero emissions at the point of use, with many different vehicle models available in all vehicle classifications. PHEV and REx are also included in the guide due to their reliance on charging infrastructure. These can offer a useful alternative where full BEV is not yet fully viable, such as rural areas where electricity grids are limited.

The range of PiV approaches are described in more detail in Figure 2.3.

Figure 2.3: Overview of Plug-in Vehicle Types

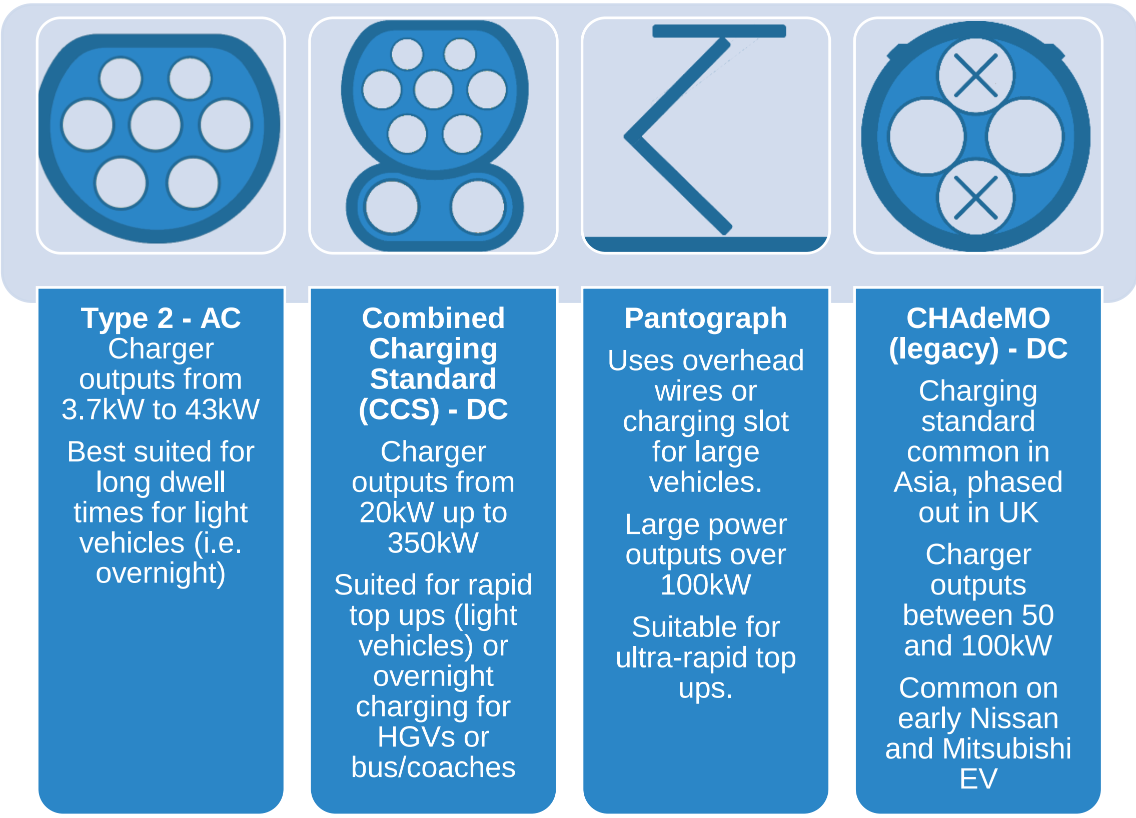
Plug-in Hybrid Vehicle (PHEV)	Battery Electric Vehicle (BEV)	Range Extended Electric Vehicle (REx)
• Contains an Internal Combustion Engine and a small battery with electric motor • Capable of regenerative braking to recharge the battery • Pure electric range of ~40 miles • Not zero-emission. • Due to be phased out by 2035	• Relies on a battery to store energy, with power sent to electric motor(s) • Capable of regenerative braking to recharge the battery • Range varies by battery size and vehicle efficiency (typically 200 to 300 miles) • Zero-emission at the tail-pipe	• Contains a battery and electric motor for primary propulsion. • Also contains a backup petrol generator to top up the battery when low. • Capable of regenerative braking to recharge the battery. • Not always zero emission at the tailpipe if battery is depleted.

2.2 Charging Infrastructure

Any PiV are capable of being recharged via a charging port on the vehicle, which require a source of electricity to power via a specialist charger.

The charging infrastructure for EVs are split into Alternating Current (AC) and Direct Current (DC) charger types. Each is suited for different applications depending on the vehicle usage pattern. Figure 2.4 presents the types of charging connector, associated speeds and typical applications for use.

Figure 2.4: Types of charging connector, associated speeds and applications



In Europe, CCS and Type 2 are the preferred charging standard going forward, with CHAdeMO gradually being phased out. However, at present, most charging infrastructure offer a range of connector types and are interoperable with most EV models. Pantograph connections are a more recent implementation of EVCI and are typically associated with HGVs and bus services. A key example of their usage is in London on an electrified bus route[3].

The charging speeds of the above charging types are shown in Table 2.1.

[3] Transport for London, 2022. New rapid, wireless bus charging technology introduced as part of the capital's journey to zero emission. https://tfl.gov.uk/info-for/media/press-releases/2022/october/new-rapid-wireless-bus-charging-technology-introduced-as-part-of-the-capital-s-journey-to-zero-emission

Table 2.1: Summary of charger types, power outputs and typical charging speeds

Charger Type	Typical Outputs (kW)	Max Charge Rate (Miles per Hour Charged)*	Examples of Location Suitability
Slow (AC)	3.5kW 6kW	12 21	Vehicles which are parked for long periods of time, like in staff car parks or for overnight recharging of light vehicles
Fast (AC)	7kW 22kW	25 77	Providing charging to operational vehicles, staff that spend 3-4 hours on site, and for hospital visitors
Rapid (DC)	50kW 100kW	175 350	Large service vehicles and fast rapid response vehicles that require significant volumes of power or require short turn arounds. Other vehicles may fall into this category, such as taxis or visitors who are picking-up/dropping-off.
Ultra-rapid (DC)	350kW	1,200	

*Assuming 3.5miles per kWh. Actual miles of range added varies depending on vehicle, battery temperature, state of charge and actual power output of charge point.

AC chargers typically have a Type 2 socket, either with a ‘tethered’ cable or requiring the vehicle user to use the cable provided with the vehicle.

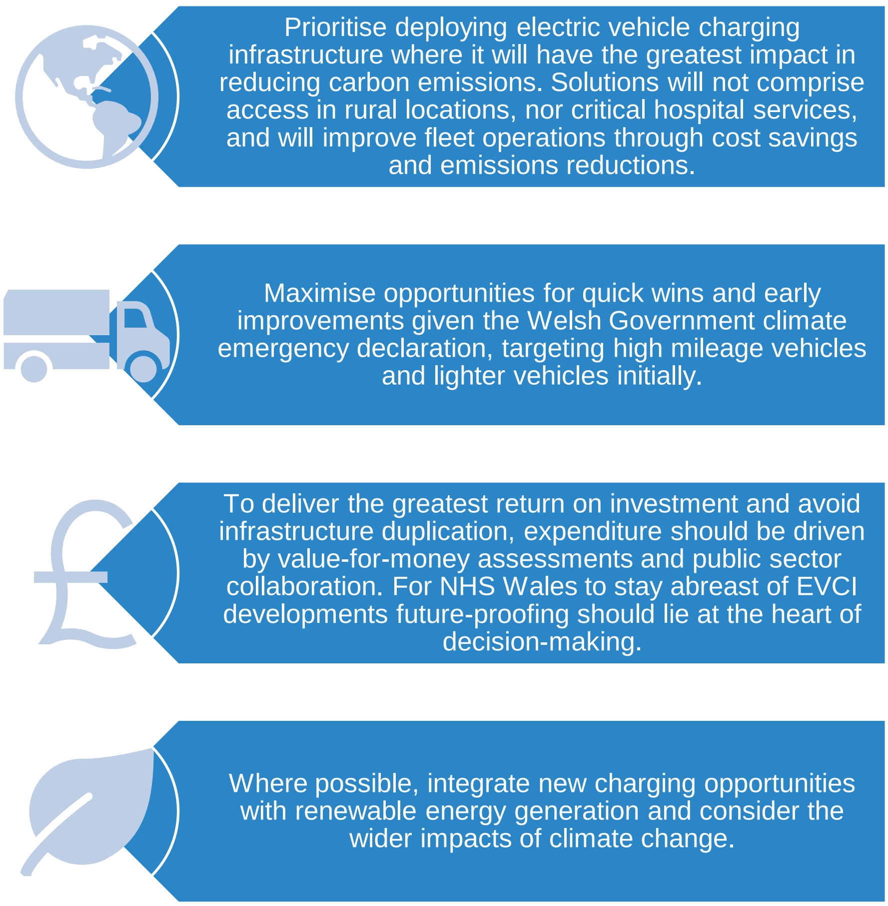
For DC rapid and ultra-rapid chargers, the cable is built in, with power delivered via the CHAdeMO or CCS connector, depending on the vehicle type.

3 Vision and Objectives

The following vision outlines the approach for providing charging infrastructure for the NHS Wales vehicle fleet.

NHS Wales will continue to support the commitment of procuring zero or low emission vehicles by developing a comprehensive fleet charging network across its estates. Where possible, cross-sector opportunities will be utilised to ensure value for money and work within grid capacities.

This vision is supplemented by four objectives to support the successful delivery of the vision.



4 Policy Context

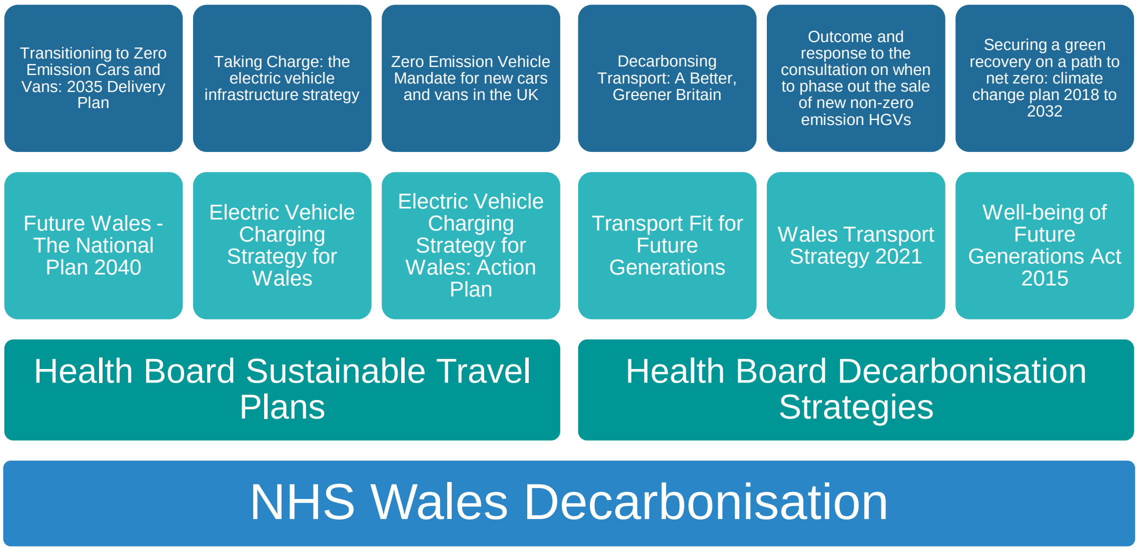
This section provides an overview of the wider policy context for the decarbonisation of the vehicle fleet in NHS Wales.

The policy background represents the current position of the Welsh Government on EVs and supporting infrastructure. In addition, other relevant mandates, policies and strategy from the UK Government, NHS Wales and local health boards are also summarised. These indicate key priorities and goals that should be considered when providing charging infrastructure.

4.1 Overview

Figure 4.1 below shows the range of relevant policies analysed.

Figure 4.1: Existing relevant policies and context



Source: Mott MacDonald

4.2 UK Government

The main UK Government policies relevant to charging infrastructure and EVs include:

- Transitioning to zero emission cars and vans: 2035 delivery plan.
- A Zero Emission Vehicle (ZEV) mandate and CO2 emissions regulation for new cars and vans in the UK.
- Outcome and response to the consultation on when to phase out the sale of new, non-zero emissions HGVs.

From these policies, the key targets for decarbonisation of vehicle fleets are:

2030

No new petrol and diesel only cars will be sold from 2030 onwards

2035

All new cars and vans will be fully zero emissions by 2035
Non-zero emission HGVs weighing 26 tonnes and under to be phased out

2040

All new HGVs sold in the UK are expected to be zero emission by 2040

In support of these milestones, there are key ZEV mandate targets where proportions of new vehicles sales from manufacturers must be ZEV. This means that:

- Minimum ZEV target for new cars sold of 22% in 2024, 80% in 2030 and 100% by 2035.
- Minimum ZEV target for new vans sold of 10% in 2024, 70% in 2030 and 100% in 2035.
- Special purpose vehicles however are excluded, along with small manufacturers until 2030.

These targets have been jointly developed with devolved administrations.

Other UK government policies are targeted towards public charging infrastructure, or wider decarbonising transport objectives. These have been referenced for completeness.

4.3 Welsh Government

The devolved administration in Wales have introduced several key policies that support the aims of decarbonisation of vehicle fleets through EVs and associated charging infrastructure:

- Future Wales – The National Plan 2040
- Electric Vehicle Charging Strategy for Wales
- Electric Vehicle Charging Strategy for Wales: Action Plan
- Transport Fit for Future Generations
- Wales Transport Strategy 2021
- Well-being of Future Generation Act 2015

These policies cover a range of topics, from the wider transport policy context, to implementing public charging infrastructure, to ensuring that developments support future generations. The key messages from Welsh Government policy can be summarised as in Figure 4.2.

Figure 4.2: Key messages from Welsh Government Policies

One of the focuses for all Welsh Government policies are the key principles from the Well-being of Future Generations Act 2015. The relevant principles related to the implementation of EVCI for fleet recharging are shown in Figure 4.3.

Figure 4.3: Relevant policies from the Well-being of Future Generations Act

A globally responsible Wales

- Improvements made to economic, social, environment and cultural well-being of Wales accounts for positive global impacts.

A prosperous Wales

- An innovative, productive and low carbon society.
- Develops a skilled population which generates wealth and employment opportunities.

A more equal Wales

- A society that enables people to fulfil their potential regardless of their background or cirumstances.

A Resilient Wales

- Maintains and enhances a biodiverse natural environment.
- Supports social, economic and ecological resilience and capacity to adapt to change.

Source: Welsh Government

The aspirations from the policy indicate the wider considerations and impacts that providing a decarbonised fleet and the associated charging infrastructure will have on Wales and beyond. Crucially, there are also wider sustainable travel considerations such as reducing the need to travel, rethinking the movement of goods across the NHS supply chain and adapting operations to reduce mileage. These approaches could reduce costs and emissions, making more efficient use of resources which align with the Wales Transport Strategy.

Focusing on the deployment of charging infrastructure, Welsh Government EV charging policies are largely focused on the public charging network. The Electric Vehicle Charging Strategy for Wales outlines the following target for the public network:

"By 2025, all users of electric cars and vans in Wales are confident that they can access electric vehicle charging infrastructure when and where they need it."

Electric Vehicle Charging Strategy for Wales

Many key strands from the policy are directly relevant to the implementation of chargers on NHS Wales estates. Although, it is recognised that scaling up deployment across the entirety of the estate will take time. Ensuring good coverage as an initial foundation as fleet begins to transition to EV are the recommended initial steps.

Key actions required to support the deployment of charging infrastructure include:

- Improve charging provision at key public locations for all types of charger, especially fast.
- Establish Welsh quality standards to improve the customer charging experience, particularly improved accessibility and inclusivity.
- Increase public awareness and confidence in transitioning to EVs.
- Create synergies with spatial planning and other public sector bodies to share charging infrastructure.

In addition, Future Wales 2040 states that local authorities should seek to provide at least 10% of car parking spaces in non-residential contexts with charging bays for new developments.

4.4 NHS Wales

The NHS Wales has introduced the following policies to support the wider aims of decarbonisation:

- NHS Wales Decarbonisation Strategic Delivery Plan
- Public Health Wales Strategic Plan (2023-2026)

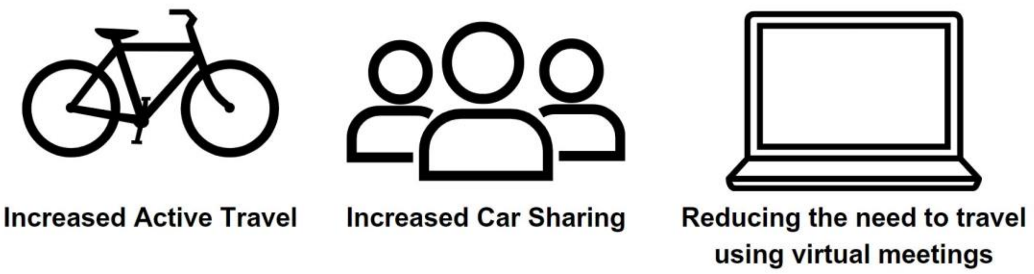
These policies aim to provide groundwork for supporting the NHS Wales Health Trusts to move towards a decarbonised future. The NHS Decarbonisation Strategy states that:

- All new cars and light goods fleet vehicles (small van / car derived van) procured across NHS Wales after April 2022 will be battery-electric wherever practically possible. In justifiable instances where this is not suitable, ultra-low emission vehicles should be procured.
- All new medium and large freight vehicles (larger vans, box body builds, 3.5T compatible and above) where available and procured across NHS Wales after April 2025 will meet the future modern standard of ultra-low emission vehicles in their class.

4.5 Local Health Boards

Figure 4.4 below introduces some of the main outcomes for policies that have been introduced by local health boards in an effort to decarbonise operations.

Figure 4.4: Key Local Health Board policies



4.6 Summary

Across each of the scales from UK Government to local health boards in Wales, there has been a significant policy shift towards the decarbonisation of vehicle fleets. This means that to reach the key dates for decarbonisation in 2030, 2035 and 2040, rapid action needs to be undertaken to transition large vehicle fleets towards a decarbonised future. This is in addition to implementing EVCI for users of hospital car parks.

5 Overview of Infrastructure Requirements

This section provides an overview of the approach to calculate the infrastructure requirements across NHS Wales, and some of the key operational requirements.

5.1 Typologies

To determine the appropriate charging infrastructure requirements, the baseline report outlines a series of key typologies for the organisations within NHS Wales. These typologies assisted in the classification of the required charging infrastructure and are described below.

5.1.1 Health Boards

The different types of health board sites are summarised below. This is used to classify the types of vehicles used by purpose and the likely charger requirements.

Major Hospital

Larger hospitals, with A&E facilities, providing acute care to a wide population within a health board.

- Typically have a large vehicle fleet.
- Fleet vehicles consist of cars, LGVs, HGVs and other specialist vehicles.
- Will require ultra-rapid charging at A&E for ambulances and rapid response vehicles.
- Likely to have large parking areas for staff, visitors and fleet, but capacity may be constrained due to high demand.
- Large electricity requirements at one site, potentially with limited spare capacity.

Community Hospital

Smaller hospitals, unlikely to have A&E facilities, providing acute care to a settlement or number of settlements.

- Smaller vehicle fleet likely including some maintenance vehicles and community support vehicles.
- Vehicle fleet consisting of cars, LGVs and some specialist vehicles.
- May require charging facilities for ambulances and rapid repsonse vehicles.
- Usually sufficient car parking provision for staff, visitors and fleet.
- Varying electricity requirements on-site, depending on the hospital facilities.

Specialist centres

These include specialist facilities and care centres, operating at a smaller scale with highly specialised care.

- Likely to have a small vehicle fleet for maintenance and community support.
- Vehicle fleet likely to consist of cars and LGVs.
- May require charging facilities for ambulances and rapid repsonse vehicles.
- Likely to have sufficient parking provision for staff, visitors and fleet.
- Varying electricity requirements on-site, depending on the hospital facilities.

Other facilities

These include aggregated sites, including Primary Care facilities, warehousing, support services and admin functions (including corporate offices).

- Vehicle fleet likely consisting of cars and LGVs.
- Usage of vehicles may be spread across a number of smaller sites, which may be leased.
- Unlikely to require charging facilities for ambulances.
- May be challenging to implement charging infrastructure, depending on site ownership.
- Likely to have sufficient parking.

These sites also interface with support services, the Welsh Ambulance Service NHS Trust and Public Health Wales.

5.1.2 Central All Wales Support Services

NHS Wales is supported by support services, which include:

- NHS Wales Shared Services Partnership
- Digital Health and Care Wales
- Health Education Improvement Wales

These organisations are grouped as typically these feature a limited number of pool vehicles, instead relying on grey fleet vehicles. As a result, the vehicles used for any fleet purposes are dependent on staff members. Digital Health and Care Wales do, however, operate a traditional fleet of LGVs. These vehicles would be considered as “Operational Vehicles” in the hierarchy presented in Figure 5.1.

- Vehicles in fleets for Digital Health and Care Wales and NHS Wales Shared Services Partnership may require additional chargers elsewhere on NHS estates in order to access Hospital Stores and Laundry Drop locations. The additional chargers may be required o provide a top up charge for supply chain and laundry HGVs should the vehicle mileage be sufficiently high. These additional chargers have not been accounted for in the analysis and would be dependent on operational requirements.
- Further charging infrastructure requirements are therefore based around the need to support staff to charge their vehicles within staff car parks for business purposes. The implementation will vary depending on the site, as some offices are on NHS Wales estates while others are leased and would be dependent on the landlord.

5.1.3 Welsh Ambulance Service NHS Trust

The Welsh Ambulance Service NHS Trust (WAST) operates from ambulance stations across Wales providing critical patient care and rapid response. Most ambulance charging is expected to be undertaken at ambulance stations when vehicles are not in use, rapidly recharging the vehicles between callouts. WAST requirements for ambulance stations are to be determined as part of a separate commission.

High powered chargers should however be made available at A&E departments to support day-to-day WAST requirements, where required. This would be the responsibility of health boards as these operate the estate and the electricity required, to support the current Welsh Government target in 2028 for new ambulance procurement to be low emission.

Engagement with the local WAST representative must be undertaken when procuring charging infrastructure to determine appropriate requirements for rapid response and ambulance operations. Ensure consultation takes place with WAST and any other third parties sharing the site to ensure compatibility of planned infrastructure with the fleet. There may be opportunities for the sharing of infrastructure if grid capacities are significantly constrained.

Ambulances have a target time of 15 minutes to be on hospital sites. Shorter dwell times at hospitals would reduce the necessity for recharging on site and would allow crews to seek recharging facilities elsewhere.

It is noted that consideration must be given to the location of charging points, particularly regards to fire safety with close proximity to A&E sites. Should a fire incident occur as a result of EV, this may have a major impact on the clinical service operated at these locations. Fire Safety requirements and standards are outlined in **Section 13: Fire Safety**.

5.1.4 Public Health Wales

Public Health Wales operate a several vehicles from sites across the entirety of NHS Wales. As a result, fleet vehicles should have a suitable range to facilitate these journeys, as well as including suitable charging infrastructure at trip destinations.

5.2 Charging Hardware

The types of charging infrastructure approaches are outlined in **Section 2.2 Charging Infrastructure**.

To maximise compatibility with newer vehicles, it is recommended that the preferred charging connector is Type 2 and CCS, as these are the most common connectors on current new vehicles. Recharge speeds must be suitable to the type of vehicle and typical operations. Common power outputs should be as follows:

- **AC:** 7kW single phase minimum, up to 22kW three phase.
- **DC:** Minimum 20kW, recommended at least 50kW.

Provided the installed infrastructure meet the needs of the fleet operation and offer the above connector types, in addition to CHAdeMO where older vehicles are used, then there is no preferred manufacturer of EVCI for procurement. Instead, the devices should meet procurement specifications as detailed in **Section 14 Procurement and Operating Models**.

Other approaches to charging aside from cable-based are also in development. Wireless charging trials are underway, but a common standard is yet to be agreed. If the installed electrical infrastructure up to the EVCI is standardised, then the location could be futureproofed if other approaches to charging becomes commonplace. A standardised electrical connection would mean the charging device could be swapped out for another if made redundant.

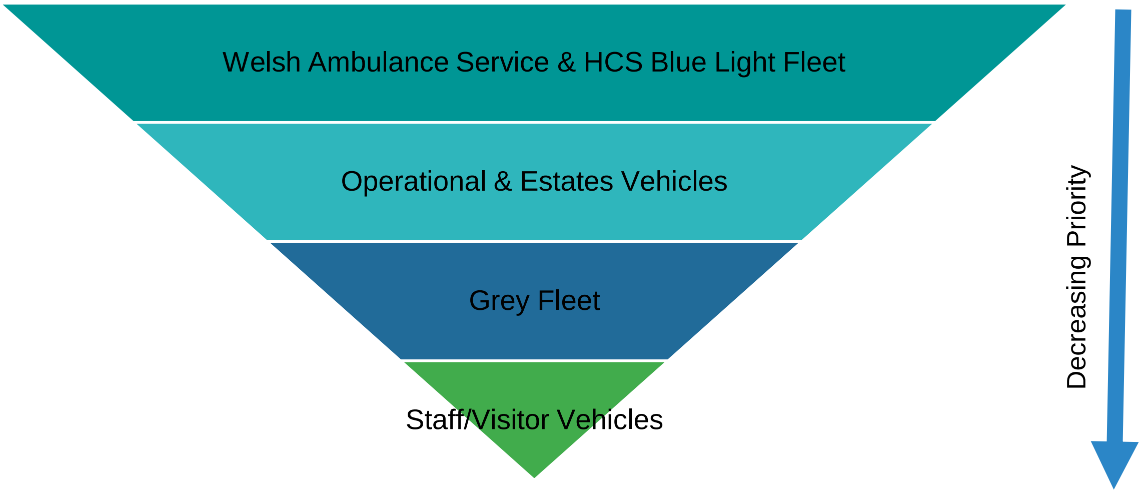
5.3 Prioritisation of Charging Infrastructure

AC chargers are typically the lowest installation cost by utilising existing power supplies, usually with minimum upgrades required. Therefore, in many instances AC chargers can be rolled out on a site with minimum intervention. However, DC rapid and ultra-rapid chargers cost more due to the electricity grid upgrades required from the charge point to the substation, meaning fewer can be deployed.

Some sites where charging infrastructure is required are likely to have limited grid capacity, especially in rural areas. Where grid capacity is limited, targeted interventions are required to maximise value for money. Load management should also be deployed in locations where grid capacity is constrained, as described in **Section 9.4 Load Management Strategies**.

Therefore, to focus investment and provide the most cost-effective solution, the following hierarchy for charge point provision is proposed as per Figure 5.1.

Figure 5.1: Hierarchy of charge point provision



The priority chart should be adhered to when deploying charging infrastructure, configuring power requirements and considering backup generation priorities that must be risk assessed.

The outcomes of this approach are as follows:

- Ensure that WAST ambulance vehicles and HCS Blue Light Fleet have power immediately when required, charging at rapid or ultra-rapid speeds.
- Power operational and estates vehicles that are plugged in and charging to ensure their duties can be fulfilled when required at fast or rapid speeds.
- If any capacity in the local network is available, share the power among grey fleet vehicles plugged in at fast or rapid speeds. Otherwise, the public network could be utilised.
- Remaining network capacity could be provided to staff or visitor charging bays (if present), at slow or fast AC speeds. Otherwise, the public network could be utilised for these vehicles.

5.4 Estimated Charging Infrastructure Requirement

The number of AC and DC sockets required for both the average and maximum mileage journeys were calculated using the typology approach outlined in the Baseline Report[1]. These were based on existing numbers of vehicles provided by organisation or were estimated. These figures represent a 100% EV fleet conversion.

A summary of the estimated charging provision required is shown in Table 5.1.

Table 5.1: Proposed EVCI requirement for vehicle fleet summary by health board

Organisation	Assumed Number of EVs Across All Vehicle Types	Proposed AC Sockets	Proposed DC Sockets	Total proposed EVCI for vehicle fleets
Aneurin Bevan University Health Board (UHB)	385	328	20	**348**
Betsi Cadwaladr UHB	160	131	44	**175**
Cardiff and Vale UHB	94	49	14	**63**
Cwm Taf Morgannwg UHB	98	55	16	**71**
Digital Health and Care Wales	21	6	2	**8**
Health Education and Improvement Wales	0	0	0	**0**
Hywel Dda UHB	133	126	2	**128**
NHS Wales Shared Services Partnership	248	89	2	**91**
Powys Teaching Health Board	106	106	0	**106**
Public Health Wales	43	17	2	**19**
Swansea Bay UHB	107	84	8	**92**
Velindre University NHS Trust	2	2	0	**2**
Welsh Ambulance Service NHS Trust	841	203	260	**463**

Source: Mott MacDonald

Health Education and Improvement Wales was not included in this analysis as there is no vehicle fleet.

To determine future infrastructure requirements, the following approach is suggested that may aid to determine the appropriate charging infrastructure required. This approach was derived for the estimated infrastructure requirements listed in Table 5.1.

- If the daily mileage with an additional 10% buffer is under 50% of the typical range of the EV, then a single 7kW AC socket could be shared with two vehicles for charging over long dwell times (e.g. overnight).
- If the daily mileage with an additional 10% buffer is within the typical range of the EV, then one 7kW AC socket would be required per vehicle for long dwell times (e.g. overnight).
- If overnight charging is not possible, then a minimum of 22kW AC/DC should be specified for recharging cars within a minimum of 3 hours or 5 hours for LGVs.
- If the daily mileages with an additional 10% buffer is beyond the typical range of EVs or the dwell times are short, then a DC charger should specified to be shared among multiple vehicles for rapid top ups.
  - This assumes that charging could also be undertaken on the public network or at the destination.
  - Additional AC charging may also be required for ensuring a full overnight charge with the DC charger only required when necessary.

It is likely the actual requirements will vary by organisation, depending on operational reviews and the pace of change when replacing ICE vehicles with EV. The above should therefore be used as an approximate guide to determine the appropriate infrastructure, with further analysis undertaken as and when new EV are deployed. Grid capacity constraints will also be a significant factor in the types of charging infrastructure installed.

5.5 Usability and Operations

A key element of the infrastructure requirements is the day-to-day usability and operational requirements by staff and visitors alike. When deploying charging infrastructure, the positioning should be a key consideration (outlined in **Section 6 Car Parking and Space Planning**), as well as the following operational factors.

5.5.1 Tariffs

The cost levied for the use of charging infrastructure is referred to as a tariff, usually measured per kWh drawn from the charger. It is critical that tariffs are enacted on charging infrastructure to ensure a level of revenue to cover operating costs and the unit cost of electricity at a rate which is comparable and aligned with other public sector rates. There should be no additional revenue cost to the organisation.

For fleet charging, the charging costs would then need to be attributed to an NHS department while any devices for public use would likely be allocated for the maintenance of charging infrastructure.

Any tariff set should be at a rate that is sustainable for users and the operator, covering the following direct and indirect operational costs:

Electricity Wholesale Cost	Asset Replacement	Maintenance Costs	Transaction Costs
Green infrastructure levy (if applicable)	Charge Point Operator management fee	DNO Capacity Charge	Network expansion fund

Tariffs should be applied for any public charging to prevent misuse and to ensure costs are adequately covered for providing the service. There must be a clear approach undertaken for calculating the cost of operating the charging infrastructure, accounting for the above costs. It is recommended the following approach is undertaken per charger type (e.g. 7kW, 22kW, etc.)

$$\frac{\text{Total Operational costs (£) associated with charger type}}{\text{Total utilisation (kWh) of that type of charging infrastructure}} = \text{Cost of providing EVCI per energy used, (£/kWh), per charger type}$$

This approach demonstrates the cost of providing the infrastructure per kWh drawn. Other costs may also need to be factored in, like contributions towards asset replacement. It is recommended the calculated cost is then compared to other public tariffs as a check.

For sites part of the NHS Wales estates, the All Wales electricity tariff may be used which could offer competitive wholesale electricity costs compared to other leased sites or properties. It is recommended that a standardised EV tariff is deployed across NHS Wales to ensure a consistent experience, particularly from a fleet perspective. For other leased sites, a price premium may need to be charged on the tariff to cover the additional wholesale electricity cost.

5.5.2 Maintenance

Any hardware installed needs to always be safe and comply with product regulations, relevant standards and operation. There should be clear responsibility for charge point maintenance (planned and reactive), replacement, and cleaning services with the designated service provider. It is recommended that this maintenance is undertaken with a suitably experienced contractor. Costs for such a service can vary significantly, with reductions on cost per EVCI likely when the supplier can scale up operations within an area.

As part of the tariff, maintenance costs should be covered including routine upkeep, replacement parts and asset replacements due to damage, misuse or faults.

These maintenance regimes should be procured through the appropriate framework, as detailed in **Section 14 Procurement and Operating Models**.

5.5.3 Access, Activation and Billing

After plugging in a vehicle to a charger, it requires some form of activation to start the charging process, even in a fleet environment. Chargers that are readily available and open to all are at risk of misuse unless in a secure compound.

A range of possible solutions are possible to limit what vehicles or users can access charging infrastructure. These can include:

- Radio Frequency Identification (RFID) cards or fobs, which could then be linked to specific users or departments using the charger management software.
- App-based activation using a specific smartphone app that users are required to download before being able to access the charger. This requires a stable internet connection and may be unreliable in a rural context.
- Auto-charging, which relies on more recent charging infrastructure and vehicles. Some vehicles can be uniquely identified by the charging infrastructure and added to an ‘allow’ list. The network would then automatically accept the charging request when the vehicle is plugged in.
- Contactless readers for credit or debit cards.

For any staff or visitor charging infrastructure, app-based, RFID or contactless readers are potential options for public charging. These approaches allow appropriate billing to take place for end users based on the tariff applied.

It is recommended that for fleet charging infrastructure RFID cards or auto-charging are used due to the convenience and the limited pool of vehicles accessing the network. These can also integrate with the national public framework for multi-supplier fuel cards.

Where app-based solutions are used, these should either be restricted to NHS Wales emails, or be an invite-only system to restrict the usage of EVCI dedicated for fleet use.

5.5.4 Open Charge Point Protocol

This is the specific software protocols that charging infrastructure and EVs use to communicate when recharging. It allows information to be conveyed from the vehicle, such as the battery state of charge and temperature, to the charger unit to ensure it provides the correct rate of electricity. This protocol communicates with the back-office, which is the management software for the network of chargers within the network.

It is recommended that at least version 1.6 of Open Charge Point Protocol (OCPP) is supported on EVCI installed across the NHS Wales estate.

Critically, any chargers with OCPP 1.6 or above are interoperable and compatible with multiple network operators. This means if the infrastructure operator contract is terminated for example, another operator would be able to use the infrastructure using their own software.

Other features of OCPP 1.6 include support for auto charging. This means if a vehicle is compatible, the charger unit can uniquely identify a vehicle and automatically start the charge with billing automatically allocated to the correct user or department. In addition, the device has the ability to dynamically manage the load, so if the grid connection is limited it can work with the other chargers in series to manage and reduce the power as required to prevent an overload.

5.6 Key Recommendations

The following key recommendations should be considered for understanding the type of charging infrastructure required:

- The required charging infrastructure depends on several factors including the vehicle type, the daily mileage, and the type of site. These factors should be weighed up and accounted for when planning charging infrastructure.
- The types of charger required depend on use case, however generic requirements have been outlined based on average daily mileage.
- WAST require specialist rapid charging facilities at or near A&E departments to facilitate the transition to EV for emergency response vehicles, in addition to infrastructure at ambulance stations.
- Between 7 to 22kW AC should be installed for fleet with average mileage, with 50kW+ recommended for large daily mileages beyond the typical range of EV.
- Following critical hospital services, the prioritisation for EV fleet recharging should be given to emergency response vehicles, followed by operational vehicles, grey fleet and staff/visitors.
- Tariffs should be implemented for all NHS Wales chargers that cover all associated costs, with no revenue cost to the organisation and at a rate comparable to other public sector organisations.
- The method of activating a charger should be hassle-free for users, with RFID cards or auto charging recommended for fleet.
- All chargers should feature at least Open Charge Point Protocol 1.6 or above.

6 Car Parking and Space Planning

This section outlines some of the main considerations for car park and space planning, in terms of implementing EV charging.

6.1 Relevant Policies and Legislation

There are a range of key legislation and car parking policies that should be initially consulted when reviewing car park requirements in conjunction with installing EV charging facilities to ensure adequate provision. EV charging bays should form part of the overall parking provision, and not in addition. The following policies and legislation are recommended to be considered.

- Relevant local authority car parking standards
- PAS 1899:2022 Accessible EV Charging
- Positioning charge points and adapting parking policies for electric vehicles
- Car park design, Institution of Structural Engineers
- Recommendations for the Inspection, Maintenance and Management of Car Park Structures, Second edition, Instituion of Civil Engineers

An overview of the above policies and legislation are provided in the following headings.

6.1.1 Local Authority Car Parking Standards

Council areas across Wales publish their own parking standards for new developments, which typically cover:

- Maximum and minimum parking requirements for a range of land uses.
- Proportion of parking bays to be allocated for blue badge parking.
- Servicing parking or loading requirements for industrial purposes.

Typical parking requirements can vary depending on the council. For example, a reviewed council in Wales specified the following requirements for healthcare estates:

Hospitals	• **Operational:** Essential operational vehicle spaces as required. • **Non Operational:** 2 spaces per bed for non-operational purposes.
Health Centres and Surgeries	• **Operational:** 1 space per practitioner, e.g. doctor, nurse, etc. • **Non Operational:** 1 space per 2 ancillary staff and 3 - 5 spaces per practitioner.
Blue Badge Parking	• **Up to 200 spaces:** 6% of total capacity, minimum of 3 spaces. • **Over 200 spaces:** 4% of total capacity plus 4 spaces.

In addition to the number of parking bays required, the size of the parking bays is also a consideration. Typically, parking bays are 2.4m x 4.8m with blue badge parking increased to 4.8m x 3.6m. Further allowance should be considered to account for the positioning of the charging ports on vehicles, allowing for 10 to 20% additional space per parking bay. This decision should be made at an NHS Wales wide level, to ensure consistency across the Health Boards

Example layouts of parking areas are also usually provided in local authority car parking guidance.

6.1.2 PAS 1899– Electric vehicles – Accessible Charging Specification

The British Standards Institute PAS 1899[4] current edition guidance is intended to outline requirements for the inclusive design of public charging infrastructure on a voluntary basis. The audience of the policy include charge point installers, planning authorities and landowners with key roles and responsibilities outlined. However, the main responsible party is the procurer of charge points.

The document provides key guidance for ensuring the accessibility of EVCI for all users. Key recommendations include:

- Ensure the user interface is accessible for all.
- Positioning of the charge point in such a way not to restrict mobility.
- Reduced trailing cable lengths as much as possible.
- Sufficient height of charging connectors or cables, with weight reduced as much as possible.

This Best Practice Guidance is primarily aimed at **public** charge points, and not for fleet purposes, staff or visitors. It is therefore dependent on the NHS Wales organisation as to whether the standards are required to be implemented when procuring infrastructure for public charging.

6.1.3 Positioning charge points and adapting parking policies for EV

The guidance from Energy Savings Trust[5] provides information on:

- Recommended positioning of charge points within car parks.
- The use of crash barriers to protect EVCI.
- Appropriate signage in car parks for charging bays.
- Potential parking incentives for EV.
- Case studies.

Although the guidance is primarily targeted at local authorities, it does provide some useful insights on appropriate positioning to avoid conflicts with other road users and pavements. These recommendations can be taken forward when procuring charging infrastructure.

6.1.4 Car Park Design – IStructE

The Institute of Structural Engineers guidance[6] provides detailed guidance on the design, construction, maintenance, and reuse of car parks. The changes over the previous editions, which focused on underground and multi-storey car parks, now account for increases in vehicle size, weight and manoeuvrability. More detailed guidance is now included on hybrid and EV use, inclusivity and improved fire safety. Principally, this includes conducting specific structural checks to ensure when retro-fitting EVCI to existing multi-storey car parks, given the potential weight and fire considerations.

[4] British Standards Institute, 2022. PAS 1899:2022 Electric vehicles – Accessible charging - specification. Available at: https://www.bsigroup.com/en-GB/standards/pas-1899/

[5] Energy Savings Trust, 2019. Positioning charge points and adapting parking policies for electric vehicles. Available at: https://energysavingtrust.org.uk/wp-content/uploads/2020/10/Local-Authority-Guidance-Positioning-charge points.pdf

[6] The Institution of Structural Engineers, 2023. Car park design. ISBN: 978-1-906335-54-0.

6.1.5 Recommendations for the Inspection, Maintenance and Management of Car Park Structures, Second edition, Institution of Civil Engineers

The Institute of Civil Engineers guidance[7] provides guidance and good practice for car park owners and operators. The second edition encompasses new health and safety legislation to ensure that car park structures are safely maintained. Part I is of relevance to owners and operators, advising on responsibilities, actions and legal obligations.

6.2 Operational Requirements

The operational purpose of each vehicle would vary across NHS Wales organisation, department and estate. However, common approaches have been collated for the purpose of this Best Practice Guidance, with generic recommendations provided. Bespoke applications not covered within this guidance would require further analysis on a case-by-case basis.

6.2.1 Critical NHS Fleet Vehicles

Dedicated parking bays are recommended for vehicles within the NHS Wales fleet that are critical to the day-to-day operation of the service. It is assumed that estates already have appropriate provision for the parking of fleet vehicles.

- One charging socket per parking bay with high maximum daily mileages, or where the vehicle is operationally critical (i.e. ready to go at all times). Recommended for BEV only.
- Some parking bays may not need to have charging sockets if daily mileages are low. In which case, it is dependent on the operators to rotate vehicles between charging bays when required. This may also be appropriate for PHEV applications.
- Pool vehicles should have dedicated parking bays with a charging socket to ensure the vehicle is always recharged or recharging.

6.2.2 Rapid response vehicles

Emergency vehicles such as ambulances and rapid response vehicles provide critical patient care and often operate unpredictably depending on callout times. Therefore, although WAST are likely to provide appropriate charging infrastructure at ambulance stations, additional charging infrastructure is also required at Accident and Emergency departments.

Designated parking bays for ambulances and rapid response vehicles are therefore recommended at relevant healthcare facilities. These should feature at least one high-powered charger (75kW or more) reserved for ambulance use.

It may be prudent to consider wireless charging technology in future when protocols mature as a time saving measure, which could be adapted from existing installed infrastructure. However, at the time of writing this is not a viable and cost-effective option.

6.2.3 Staff and Visitor Parking

The Future Wales[8] National Plan outlines that new developments with car parking should aim to include at least 10% of spaces allocated for active EVCI provision. Any additional passive provision requirements, including the installation of ducting to enable charging infrastructure later, may be applied at a local authority level. These values will vary between local authorities,

[7] The Institution of Civil Engineers, 2018. Recommendations for the Inspection, Maintenance and Management of Car Park Structures, Second Edition ISBN: 978-0-727758-40-8.

[8] Welsh Government, 2021. Future Wales: The National Plan 2040. Available at: https://www.gov.wales/future-wales-national-plan-2040

and local planning documents should be consulted to see minimum provisions for new locations.

Based on this approach, to enable charging for grey fleet owned by staff, other staff members and visitors, a minimum 10% of parking should be applied when deploying charging infrastructure in new developments on NHS Wales estates.

6.2.4 Blue Badge

The provision of blue badge parking should follow local authority car park planning guidance. However, typical provisions are as follows:

- **Up to 200 spaces:** 6% of total capacity, minimum of 3 spaces.
- **Over 200 spaces:** 4% of total capacity plus 4 spaces.

When deploying charging infrastructure, there are no minimum required that must be accessible. However, it is recommended that EVCI is included within the provision of blue badge parking to ensure these users have access to charging. This should adhere to the PAS 1899 guidance where possible. It should be noted that EVCI provision should not reduce the ability of those with blue badges to use accessible spaces.

6.3 Positioning of Charging Infrastructure

The location of charging infrastructure relative to parking bays are a key consideration in its usability and deployment effectiveness.

EVCI must be located away from critical hospital assets. Further information is described in **Section 13 Fire Safety**.

6.3.1 Car Parks

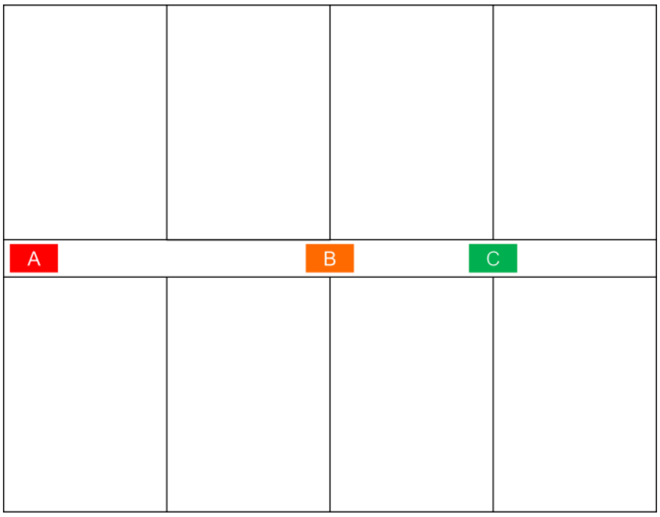
Where chargers are deployed in surface car parks, the most efficient positioning of the charger is key. The Energy Saving Trust published guidance on positioning charge points and adapting parking policies[9]. Generally, this can be summarised as follows:

- Single socket infrastructure should serve one parking bay, positioned at the ‘head’ of the space.
- Dual socket infrastructure should be positioned between parking bays, to ensure each socket is equidistant to both spaces.
- Multiple-socket deployments should be positioned appropriately to serve the number of bays that can be concurrently charged by the chosen infrastructure (i.e., some charger models have multiple cables/sockets that can be used at the same time).

Figure 6.1 presents a range of potential charge point locations in a car park where cars can park in two adjacent rows.

[9] Energy Savings Trust, 2019. Positioning charge points and adapting parking policies for electric vehicles. Available at: energysavingtrust.org.uk

Figure 6.1: Positioning of charge points



Source: Mott MacDonald

There are three potential locations to where a charge point may be located.

- Location A is not recommended as this only has the potential to serve two vehicles.
- Location B could serve all eight vehicles in this arrangement; however cables would trail along the centre which could present a trip hazard. This arrangement is therefore not recommended in locations with high footfall, but could be suitable for fleet charging where suitably risk assessed.
- Location C is suitable if only serving four vehicles. A further location would be required between A and B to serve the remaining four bays.

Any charge points positioned in car parks must be protected with a crash barrier, bollards and/or wheel stops. Charge points could also be co-located with lamp columns to reduce space requirements.

6.3.2 Parking Location

Depending on the location where fleet vehicles are stored, the following can be recommended:

- Vehicles stored in regular car parks should follow the charging infrastructure positioning guidance outlined, with fleet vehicle charging bays clearly marked to deter other vehicles blocking the bays.
- Vehicles should not be recharged within buildings, with charging infrastructure located a suitable distance away from critical infrastructure or buildings. Further standards and requirements are described in **Section 13 Fire Safety**.

6.3.3 Footways

Charging infrastructure should not be located on footways, in order to prioritise people walking, wheeling and cycling, particularly for people with disabilities. Where there is no other feasible option, then there should be an absolute minimum of 1.5m clear width on the footway. In addition, charging infrastructure should not be installed in locations where the cable could create a tripping hazard for pedestrians or barrier for wheeling (cycling, wheelchairs, etc).

6.4 Other Considerations

Signage

Clear signage must be used where public charging infrastructure is provided. The approved signage for EV charging points is DfT Standard P660x9[10]. Signage also assists on conveying any bay restrictions, such as fleet or staff only, which should be made clear where required.

Bay Marking

Appropriate bay markings should be provided for charging bays, denoting they are for charging only to reduce improper use. Additional markings must be used if bays are designated for fleet, staff or ambulance use only.

Parking Enforcement

If parking enforcement measures are used on-site, then these should be extended to cover charging bays. Typically, vehicles using charging bays **must** be plugged in and actively recharging. If not, fines should be used to deter improper parking and the blocking of charging infrastructure. Fines could also be used if private vehicles use charging bays not designated for that purpose, for example fleet charging bays.

Other enforcement measures could also include overstay fees for public recharging bays. These are typically automatically enforced by the charging device if the vehicle has been plugged in for a specified amount of time. This discourages improper use in cases where the incorrect charger has been used, for example plugged into a rapid charger for several hours instead of a slow or fast charger. This ensures the appropriate infrastructure is used by drivers.

Car Park Usage Monitoring

Specification for the provision of EV infrastructure should include for the monitoring of individual charging units to allow collection of usage data. The data should show usage by charger by time of day and power consumption to enable the monitoring of how the charging bays are used. The monitoring information is used to determine the expansion of provision of bays and what type of facility is required.

Fair Use Policy

To ensure that EVCI is used efficiently, it is recommended to include a fair use policy to prevent charging bays from being misused. This can include enacting overstay fees to ensure that once an EV is fully charged, there is an incentive to remove the charger and move the vehicle to a non EVCI bay. This could include restrictions on usage in the future, or a continuing cost for remaining connected. This would help to preserve the hierarchy shown in Figure 5.1.

[10] Regulatory Sign: Electric Vehicle Charging Point (dft.gov.uk)

6.5 Key Recommendations

The following key recommendations should be considered for car park planning:

- Local authority car parking guidelines are recommended to be reviewed in conjunction with EV charging specific requirements to ensure appropriate provision. EV charging bays should be accounted for within car parking standards, and not in addition.
- Where infrastructure available to the public is introduced, ensure that it is compliant to PAS 1899:2022 accessibility standards. This may also be introduced for fleet or staff use.
- EVCI should be positioned such that it is not a hazard to users, either from trips or falls, and should not block footways.
- EVCI must be given the appropriate spacing from critical infrastructure, as per Section 13 Fire Safety.
- Parking bays should be clearly marked for EVCI, with DfT approved signs used where chargers are available to the general public. Theses should be supported with parking enforcement, where appropriate.
- Monitoring of EV infrastructure should be included in any specification to maximise efficiency of provision and develop a timeline for installations.
- A fair usage policy should apply to charge points. This may include overstay fees to incentivise users to disconnect when fully charged.

7 Town Planning Considerations

This section provides an overview of considerations when deploying EV charging infrastructure from a planning perspective, considering permitted development rights, obtaining planning permission and any limitations arising from listed buildings.

7.1 Permitted Development Rights

The **Town and Country Planning (General Permitted Development) (Amendment) (Wales) Order 2019** ('the GPDO') grants permitted development rights – and effectively planning consent – for a range of development subject to whether they qualify and meet the relevant criteria.

Hospitals and Healthcare facilities are not afforded specific Permitted Development rights however, Class D and Class E of Part 2 Minor Operations of the GPDO 2019 enable the installation of EV Infrastructure within lawfully used off-street parking facilities.

The wording 'lawfully used' refers to the requirement that there is a lawful planning consent which regularizes the use of the site where EV infrastructure is to be located in a car park. As such, this will need to be checked on a case-by-case basis.

In the absence of formal planning consent granting the use of the site as a private car park, it is advised that a Certificate of Lawful Use (CLU) for existing use is obtained prior to installing any EV Infrastructure and exercising these rights.

7.1.1 Class D

Permitted development

D. The installation, alteration or replacement within an area lawfully used for off-street parking, of an electrical outlet mounted on a wall for recharging electric vehicles.

Development not permitted

D.1 Development is not permitted by Class D if the outlet and its casing would:

a. Exceed 0.2 cubic metres;
b. Face onto and be within two metres of a highway; or
c. Be within a site designated as a scheduled monument.

7.1.2 Class E

Permitted development

E. The installation, alteration or replacement within an area lawfully used for off-street parking, of an upstand with an electrical outlet mounted on it for recharging electric vehicles.

7.1.2.1 Development not permitted

E.1 Development is not permitted by Class E if the upstand and the outlet would—

d. Exceed 1.6 metres in height from the level of the surface used for the parking of vehicles;
e. Be within two metres of a highway;
f. Be within a site designated as a scheduled monument; or

g. Result in more than one upstand being provided for each parking space."

These Permitted Development rights are not specific to any particular authority and may be implemented by NHS Wales across their estate.

Part 12 of the GDPO 1995 (Development by Local Authorities) has been amended to include provision for the installation of EV Infrastructure specific to local authorities.

7.1.3 Limitations to Permitted Development Rights

As detailed above there are size and location limitations on the EV Infrastructure that may be installed based on whether the electrical outlet is mounted on a wall (Class D) or on an upstand (Class E).

Where electrical outlets are unable to meet the Permitted Development requirements full planning permission would be required for the installations.

7.2 Planning Permission

Should full planning permission be required, applications would need to be accompanied by:

1. Clear location/site plans showing the exact location of EV infrastructure to be installed
2. Details and dimensions of the outlets to be installed as well as any associated structures
3. A description of the application site and locality
4. An assessment against relevant national and local planning policy.

The national policies of Wales are supplemented by Technical Advice Notes (TANs) which provide detailed planning advice.

TAN 12 Design

TAN 12 highlights the importance of good design and sets out the design guidance to achieve a more holistic design response to create sustainable developments. All developments must also contribution to foster a culture of inclusion so that the development is accessible to all.

TAN 18 Transport

TAN 18 states an efficient and sustainable transport system is a requirement for a modern, prosperous and inclusive society. In this regard, the integration of land use planning and development of transport infrastructure has a key role to play in addressing the environmental aspects of sustainable development by:

- Promoting resource and travel efficient settlement patterns.
- Ensuring new development is located where there is, or will be, good access by public transport, walking and cycling thereby minimising the need for travel and fostering social inclusion.
- Managing parking provision.
- Ensuring that new development and major alterations to existing developments includes appropriate provision for pedestrians (including those with special access and mobility requirements), cycling, public transport, and traffic management and parking/servicing.
- Encouraging the location of development near other related uses to encourage multi-purpose trips.
- Ensuring that transport infrastructure or service improvements necessary to serve new development allow existing transport networks to continue to perform their identified functions.

7.3 Listed Building Consent

Although there are limitations within the Permitted Development rights in regard to Scheduled Monuments there are no such limitations in regards to Listed Buildings within the rights. Listed Building Consent may be required should it be deemed that the installation of EV infrastructure would affect the character of the Listed Building as a building of special architectural or historic interest.

In respect of high-level principles, where possible above round EV infrastructure should be located away from Listed Buildings so as not to obstruct key views or maintenance regimes. If this is not possible it is advised that pre application discussions are sought with the local planning authority to establish whether Listed Building Consent would be required. It is also advised that designers consult Cadw's Conservation Principles for the Sustainable Management of the Historic Environment Wales prior to confirming designs and locations of infrastructure.

7.4 Key Recommendations

The following key recommendations should be considered for the planning stage for EVCI implementation:

- EVCI generally has permitted development rights to be installed in lawfully used off-street parking facilities, however sites should be checked on a case-by-case basis.
- Planning permission should be sought where Class D and Class E of the GPDO cannot be satisfied, particularly if chargers are large (e.g. DC).
- When planning an installation, guidance should be sought from the local council to confirm whether planning permission is required or not, and/or seeking out published guidance notes.
- EVCI should be located away from listed buildings, however where this is not possible, consultation with the local planning authority may be required.

8 Electrical Infrastructure

This section provides an overview of the types of electrical infrastructure required for deploying EV charging, and some of the key considerations on the grid connection assessment and design to successfully integrate additional load to existing networks.

8.1 Electrical infrastructure technical requirements

To provide electricity supply to the EV chargers from the electric grid, the EV chargers would need to be connected to the private Low Voltage (LV) network, via a new or existing 11kV/LV substation on site. This substation would then be connected to the DNO (or IDNO, when applicable) substation through an 11kV network ring.

It is important to note that EV chargers are designed to be supplied from either a single-phase AC power supply or a three-phase AC power supply, depending on the type and power rating of the equipment. This aspect shall be considered when designing the electrical infrastructure.

The total demand of the EV charging equipment proposed to be installed shall not exceed the maximum demand of the existing supply. Additional considerations on understanding the additional electrical demand are included in **Section 9 Electrical Demand**.

For substation up to 1MVA, there are containerized package solutions, as shown in Figure 8.1 below. These containerized solutions include the following equipment:

- Grid connection transformer
- Switchgear
- Control and protection equipment
- Switchboard
- Metering devices

Figure 8.1: Example of a 1MVA package substation

For substation up to 2MVA or 3 MVA, a modular containerized solution including grid connection transformer, RMU (Ring Main Unit) and feeder pillar (as well as metering devices, protection and control equipment and switchboard) arrangement would be more appropriate.

8.2 Assessment of connection requirements

Connection to the electricity network could be to either the distribution or the transmission grid. The choice would depend on the required connection capacity and the location. Typically, EV chargers would connect to the local low voltage distribution network.

During the design process of the grid connection infrastructure, the following aspects should be considered:

- New load requirements (based on type and number of EV chargers to be installed).
- Assessment of existing electrical limits (based on new and existing load versus existing asset ratings).
- Impact of additional load to upstream connections and existing assets.A new discrete feed for EV charging to avoid interfering with existing equipment, loading, supply and heat degradation of existing infrastructure.Collation of EV locations car park by car park and the total number.
- Earthing requirements at the point of connection.
- Wiring system, including routing of all cabling.

A site-wide assessment on what the existing installation can provide versus what upgrades would be needed should be performed based on the information listed above, to determine whether a larger local substation transformer is required, or the 11kV cable circuits need upgrading, or the reserved capacity needs to be revised or assets such as switchgear or protection devices need reinforcements. Electrical constraints, such as breaker size or Current Transformer (CT) rating, need to be identified and addressed.The grid connection requirements and process would need to be discussed with the DNO (or IDNO, when applicable), to understand whether network upgrades will be needed, based on the results of the assessment described above. Additional details on understanding the existing network capacity, additional demand requirements and grid connection process are outlined in **Section 9 Electrical Demand**.

8.3 Footprint

Dimensions of EV chargers vary with charger type and ratings. For rapid DC chargers, charging up to four vehicles at a time and with power rating up to 360kW, dimensions would be in the following indicative range: W: 700-900 mm, D: 700-1100 mm, H:2000-2200 mm.

When designing the spatial arrangements of EV chargers, the following aspects would need to be considered:

- Space allowance between EV chargers would need to be at least 2m.
- Distance between chargers would need to be maximized to be able to reach as many parking bays as possible.
- EVs can use charge points within five meters as most charging cables are 4m-8m long.
- Space allowance for impact protection, such as protection guards and bollards.

Footprint of substation will vary with the total capacity that needs to be connected. Typical sizes of a containerized substations vary with the power rating. For substations up to 1MVA standard dimension would be equivalent to a standard 20-foot container (6.10m L x 2.44m W x 2.59m H), while for substations up to 2 to 3 MVA standard dimension would be equivalent to a standard 30-foot container (9.12m L x 2.44m W x 2.59m H).

The clearance needed around the substation varies depending on specific on location, equipment replacement requirements, surrounding area, vandalism etc. A typical allowance would be a 2m-wide footpath all around the area and 5m-wide footpath at the main point of access to allow transportation of the transformer.

8.4 Metering, control and communication devices

Metering shall be installed for energy management purposes. If billing is required, tariff metering shall also be installed. Depending on the type of EV chargers, meters could be built-in or installed in a separate feeder pillar.

The EV charging equipment should be able to provide the required control and communication features for monitoring, management, and data collection and processing.

8.5 Vehicle to Grid (V2G)

The possibility of using the EV as a storage device depends on the vehicle's functionalities enabled by the manufacturer, the state of charge of the vehicle's battery, the choices of the vehicle's user, the availability of these services at the charging location and the commercial models. When two-way power flows are enabled, the charging infrastructure can be seen as an energy storage. Thus regulation, protection and design practices for generation and loads would be applied.

The grid operator would need to be notified when a charging infrastructure is installed that can operate in parallel with the grid as a generator.

To enable V2G services, the following must be considered, as a minimum:

- Required metering configuration and types
- Data connections and instrumentation required to control, monitor and operate the equipment
- The electrical safety, wiring and protection requirements
- How the services are enabled (through the charger and/or the vehicle)
- Generation license requirements

8.6 Standards

The EV charging infrastructure shall be compliant with the following standards:

- BS EN IEC 61851
- Electromagnetic Compatibility Regulations
- Electrical Equipment (Safety) Regulations
- Electric Vehicles (Smart Charge Points) Regulations 2021
- BS 7671:2018+A2:2022
- IEC 62196-2-3
- OCPP 1.6 / 2.0, depending on site's requirements
- ISO 9001 (optional, worth considering)
- ISO 27001 (optional, worth considering)

Additionally, the EV charging equipment shall be CE (or latest equivalent) marked accordingly.

Comprehensive guide on necessary physical and electrical requirements during the installation can be found in the Code of Practice for Electric Vehicle Charging Equipment Installation, 4th Edition (5th edition is in draft form).

8.7 Key Recommendations

The following key recommendations should be considered for the interface between electrical infrastructure and EVCI:

- Assess the local existing electrical infrastructure to understand electrical constraints.
- Assess the connection requirements and additional load for the EV charging infrastructure to understand whether network upgrades are needed. Additional details on understanding the existing network capacity, additional demand requirements and grid connection process are outlined in **Section 9 Electrical Demand**.
- Develop an appropriate footprint plan and assess the electrical constraints of the existing infrastructure to prevent electrical issues.
- Understand metering, control and communication requirements.
- Consider potential use cases for Vehicle to Grid applications to manage grid load.
- Ensure compliance with relevant standards and planning requirements.

9 Electrical Demand

This section outlines the proposed step-by-step approach to understand existing electrical demand on sites, as well as the process for connecting additional load. Further information is also provided on DNO/IDNO engagement and working within constrained capacities.

Following engagement with health boards, it was found that there are already significant pressures on the grid capacity across the main hospital sites, which is especially acute in rural areas. Therefore, any additional load sought for these locations would be initially prioritised towards hospital equipment with the remaining capacity needs balanced between other decarbonisation objectives (such as heat) as well as EV charging.

9.1 Understanding additional electrical demand requirements

The amount of energy supplied to an EV is not always the same as the power rating on the charge point. AC-chargers are known to supply a constant power output to the car throughout most of the charging cycle. On the other hand, DC-chargers initially deliver high power output, and once the battery is around 80% charged the power supplied to the car follows a decreasing charging curve.

This relationship between power and vehicle charging time depends not only on the charger, but also on the battery management system (BMS) of the EV. The BMS dictates how much power the vehicle will accept and at what rate. The charging curve is unique to each vehicle and is dependent on factors such as age, battery chemistry, size, weather conditions and battery's state of charge.

Battery degradation is another factor influencing demand profile. Over the lifecycle of the vehicle, the battery can degrade up to 20%, leading to slower charging and slower rate of power delivered.

When quantifying the additional demand due to the connection of the proposed EV chargers, considering a worst-case scenario, the load of each charging point should be added together, and no diversity factor applied. However, it is unlikely that all charge points will be used simultaneously 24/7.

9.2 Understanding current load and installed equipment ratings

Understanding the current load of a site involves assessing the existing electrical infrastructure and measuring the electrical demand. The following key points should be considered in this process:

1. Gathering information about the site's electrical infrastructure, including main electrical service panel, distribution panel, transformers, and electrical loads, noting the voltage and current maximum current capacity.
2. Reviewing electrical blueprints or drawings of the electrical system. These documents provide insights into the layout, capacity and distribution of electrical circuits and panels.
3. Assess existing electrical loads on site and determine the power ratings and the current they draw.
4. Calculate available capacity by comparing the electrical demand with the maximum current capacity of the site's electrical infrastructure. This is important to ensure that the additional load from EV charging points can be accommodated without causing issues on the network. Additionally, allow room for safety margins.

5. Incorporate future thinking into planning for the installation of charge points by accounting for the future growth and potential expansion of EVs on site, as well as considering other additional loads.
6. The operation of existing critical loads and backup generators should not be compromised by the connection of EVCI. A risk assessment should be performed to identify those critical assets and guarantee their continuous supply and operation. An appropriate load prioritization should be considered during the EVCI design and connection process, supported by an effective EV charging load management strategy.

9.3 Grid connection process

The local DNO, or the IDNO when applicable, would need to be contacted at an early stage in the process to understand the connection requirements in terms of technical constraints and planning permissions. The correct connection application process to be followed will depend on the type of installation and requested connection capacity. For small installation involving a very limited number of EV chargers, the connection might be able to be completed without engaging with the network operator.

In Wales there are two DNOs:

- SP Energy Networks in the north
- National Grid Electricity Distribution in the south.

The process of liaising with the DNOs is comparable, however when considering a national rollout of EV chargers across Wales across the two DNOs, the programme needs to account for two different stakeholders.

We understand that some of the sites under consideration are operated by IDNOs, who are responsible for the operation, repair and maintenance of the equipment installed, up to the point where they connect to DNO's electricity network.

Based on the information provided by the DNO/IDNO for the area of interest, the available capacity at the closest DNO substation should be assessed. The indicative local networks in North and South Wales can be visualised in the network connection map on SPEN website[11] and National Grid website[12] respectively. The availability of connection depends on the EV chargers' capacity and the local grid capacity, which should be confirmed with the network operator.

Based on the assessment, the network operator would provide a report and a quote for necessary grid connection and reinforcement works. The entity of the required network upgrades and connection works will determine the relevant cost and programme implications. The site operator can ask for breakdown of contestable and non-contestable works. Contestable works can be undertaken by Independent Connection Providers (ICPs) or IDNOs, as opposed to non-contestable works which are required to be delivered by DNOs or their appointed ICPs. It is worth noting that there is guidance on what usually counts as contestable and non-contestable works, however, there is no exact same boundary, and it may differ case by case.

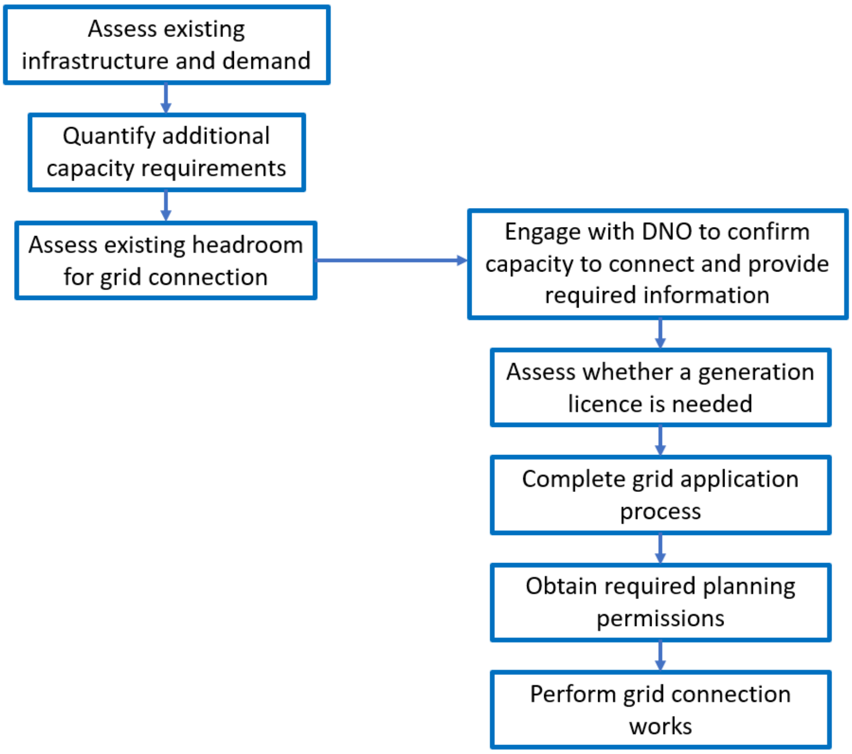
Additionally, for large installation, a generating licence might be needed. This aspect will need to be further assessed during the design and connection process.

[11] Scottish Power Energy Networks, 2023. ConnectMore Interactive Map - SP Energy Networks

[12] National Grid, 2023. National Grid – Network Capacity Map Application

A process flowchart which shows the connection assessment process to be followed for EV chargers' connection has been produced by the Energy Networks Association (ENA)[13]. This guide gives an indication of whether the connection can be completed before involving the DNO. The indicative connection process to be followed for the installation of electric charging infrastructure is shown in Figure 9.1 below.

Figure 9.1: Summary of grid connection process



Limiting the peak demand of the EV chargers could be very beneficial from a cost-benefit perspective, especially when this would result in the reduction or avoidance of costly grid connections upgrades and network reinforcements. There are ways to limit the peak demand which could be explored, such as the integration of battery storage, which enables 'peak shaving' by storing the energy during low-demand times for use during peak times. The implementation of voltage regulation could also be explored to reduce overall energy consumption, or load management strategies such as those described in the next sub-section.

9.4 Load management strategies

Load management strategies can be used to ensure EV chargers are operated efficiently and to address any potential issues related to adequacy of supply. Integrated control devices can be installed to provide control features such as:

- Timed charging, to perform charging during off-peak periods when electricity tariffs are lower, making use of Time of Use tariffs, where available.
- Demand limiting, to mitigate the risks related to capacity constraints of the existing electrical infrastructure and/or the distribution network.
- Charge management solutions can inform non-critical fleet to plug in their vehicles at favourable times and local network conditions. Such solutions evaluate grid capacity, electricity prices and vehicle owner's preferences. They can also enable charging at off-peak

[13] Energy Networks Association, 2022. Visio-Combined EV _ HP Process v5.5.vsd (energynetworks.org)

hours to balance the load and reduce peak demand. Charging during off-peak hours also often coincides with Time-of-Use pricing, where the cost of electricity varies between the different time periods, taking advantage of the associated cost savings.

- Integration with renewable generation and energy storage systems to optimise operation of the EV charging. Such integration can optimise both local generation and EV chargers.
- Load balancing across charge points: multiple platforms that manage charging offer load balancing when two vehicles are plugged into the dual charger or multiple vehicles need to charge across the network.

9.5 Risks

The following risks need to be considered when assessing and designing the connection to the electric grid of EV charging infrastructure:

- Insufficient electrical capacity: overloads, tripped circuit breakers, voltage drops, power quality issues.
- Delays in communication with the DNOs.
- Health & safety issues when assessing electrical demand.
- Inadequate grid connection for installation of charge points presents complexity and high cost for site operator.
- Lack of future planning does not allow for system scalability at moderate cost.
- Incompatibility with electrical system.
- New installation has negative impact on power quality, causing more works.
- Unanticipated high costs of site preparation and installation make project unviable.

9.6 Key Recommendations

When assessing electrical demand, it is important to accurately consider current needs for EV charging and wider site changes, as well as account for future requirements for transport electrification and energy strategy.

The site's requirements as well as the local electrical network will inform the process for grid connection and required upgrades, as well as influence the timelines and costs. The grid connection can notoriously get costly, thus several strategies are recommended to balance the electrical load on site, such as flexibility tariffs and schemes, load balancing and management, and installation of renewable energy generation and storage on site.

The following key recommendations should be considered when designing the electrical grid connection of EV charging infrastructure:

- Understand required additional capacity to be connected.
- Understand existing infrastructure ratings and constraints, as well as existing demand.
- Consult local DNO to determine grid connection requirements.
- Complete grid connection process.
- Obtain required planning permissions before performing grid connection works.
- Develop a reliable load management strategy to ensure adequate efficiency of charging network.
- Assess potential risks and impact on existing electrical grid due to the connection of the EV charging infrastructure.

10 Renewable Energy

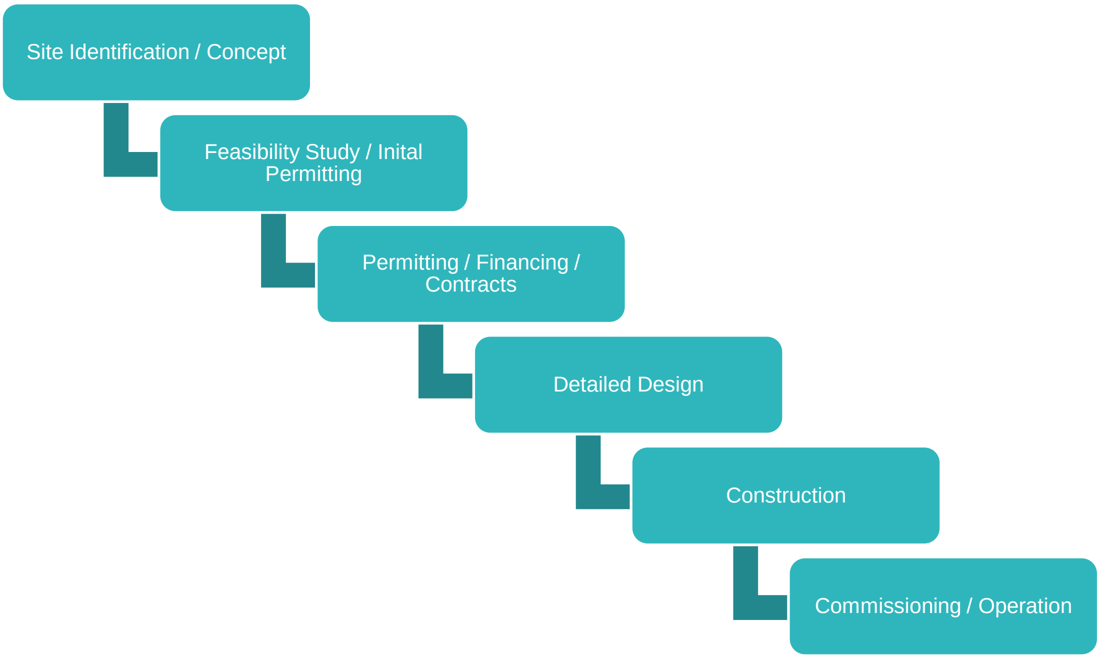
The incorporation of renewable energy sources such as solar and/or wind offers the potential to reduce exposure to rising energy costs and on-site carbon emissions, contributing to wider net-zero targets.

In addition, grid capacity across Wales is known to be limited and is particularly acute in rural areas. Some NHS sites across the country are noted to have no remaining grid capacity. As such, this section outlines key considerations to be made for the development of solar and wind at a range of typical sites which represent those owned NHS Wales (major hospitals, community hospitals, primary care etc.). Planning for EVCI with renewables in mind can help mitigate limited grid capacities and contribute towards meeting on-site electricity requirements.

10.1 General Considerations for PV and Wind development process

When developing a renewable energy project, there are multiple factors to consider at various project stages. The general process and stages to be followed are as described in Figure 10.1 below.

Figure 10.1: Development process for a Renewable (Wind or Solar) project



To develop a renewable project, a conceptual design needs to be devised to estimate installed capacity and the amount of land required to meet export expectations (as applicable). This would provide an approximation of potential investment requirements, whilst a preliminary energy yield coupled with an expected tariff and associated revenue. Further details on the main considerations are provided below. It is recommended that technical consultant should undertake the activities listed below for the areas identified by NHS.

10.1.1 Available Land/Area

The identification of a suitable site must consider many factors, one of the crucial aspect from the technical perspective is obtaining a good solar and wind resource that may vary depending on obstacles proximity, PV configuration, Wind turbine selection and site assessment including the rights of use for the site, be the land owned, for purchasing, or for long-term leasing. For any PV option, ground mounted, rooftop and carport projects, and Wind option the area available must also be assessed. This can be done via a constraints mapping exercise using Geographical Information Software (GIS) to identify constraints such us existing buildings, different infrastructures (electrical, water, gas), land designations/areas of interest, waterways hedges among others.

10.1.2 Planning and Environmental Considerations

Along with the constraints mapping exercise it is also recommended that planning and environmental reviews are undertaken for the area surrounding the site to highlight any further constraints which would impact the area available for development. This can also be used to develop a potential planning road map including identifying studies and surveys required for the planning process and to be undertaken by a discipline specialist.

10.1.3 Energy Yield Estimation

The yield that a renewable system can provide is subject to different site-specific aspects and design considerations such us orientation, PV module tilt and distance to shading objects for PV or height, blade length and distance between Wind turbines for Wind. As such it is recommended that an Energy Yield Assessment (EYA) is undertaken by a discipline specialist to assess the potential yield as this is an important metric for assessing the viability of a renewable project.

Unlike wind where it is often recommended as best practice to use 2 years of onsite measured, data solar is reasonably reliable in terms of pattern and satellite modelled data can be used to develop an EYA hence making it much quicker to ascertain the technical feasibility and potential return on investment (ROI) of the PV project.

10.1.4 Technical and Project Considerations

Technical considerations for a PV project should include but not limited to:

- Tilt angle and orientation impacts on the solar resource, different strategies can be considered for the different PV types and it needs to be assess site per site.
- PV module technology mainly bifacial or monofacial with the former predominantly associated with tracking systems and the latter with fixed structures. Bifacial modules may be slightly more expensive than monofacial modules but offer a higher yield based on the benefit from rear-side irradiance received by the back side of the PV modules.
- Inverter type central or string. String inverters have become more the norm as operation and maintenance activities are easier to undertake.

And for a Wind project mainly the selection of the Wind turbine model based on the constraints and the wind assessment to determine height, blade length and distance among the Wind turbines should be considered.

Location of onsite substation or MV switchgear should be considered for both technologies if needed.

It is recommended that a competent EPC contractor is engaged early on in the project, but certainly after initial permitting and grid application activities have commenced. The EPC contract normally outlines the scope for final design, procurement, construction, commissioning and initial operation of the renewable asset. In order to navigate this process it is recommended that an Owners Engineer is supporting the project from the inception phase.

10.1.5 Project Costs

Once the capacity which can be developed based on land and demand requirements is estimated an initial CAPEX and OPEX estimation can be made. The costs together with the yield estimate, assessment of demand to be offset with renewable generation and amount of excess generation which can be exported (as applicable) can be used to estimate the Levelized Cost of Energy (LCOE) of the project. This metric can be used to assess the economic viability of the project to compare different scenarios.

The CAPEX estimation will refine as the design progresses and the LCOE may vary accordingly.

10.2 Solar PV & Wind key differences

Solar photovoltaic (PV) technology offers a high degree of flexibility and expedited deployment compared to wind technology. PV modules can be installed in different types of surfaces, including rooftops, carports, or on the ground and can be installed in proximity to existing infrastructure, making them a suitable solution for providing on-site generation across a range of different site requirements.

A wind measurement campaign needs to be designed and developed at an early stage to assess adequately the potential of generated energy at the proposed location, which should consider roughness and terrain characteristics as well as neighbouring turbines. Once the technology is selected and wind energy yield assessment generated, the economic parameters of the Project can be used as an input on the financial model.

It is typically observed that wind projects tend to produce a higher yield which can be more easily aligned with demand profiles when compared with solar PV projects due to high levels of seasonal variation in the UK.

PV projects are often easier to develop and construct when compared to wind projects which have considerably greater spatial requirements which must be taken into consideration for siting, delivery, construction and maintenance of turbines. Wind projects may be more likely to be subject to stricter planning regulations and face opposition from local communities due to an increased potential impact to wildlife, visual landscapes and residential areas.

10.2.1 Rooftop PV Considerations

In addition to the above considerations, there are several key challenges must be addressed for rooftop PV installations. In the feasibility stage it is important to identify accessibility for installation and maintenance along with the condition and anticipated lifetime of the roof is assessed, and that structural studies and surveys are undertaken to assess whether the roof can accommodate the expected loading of the PV panels.

The roof and the surrounding area should be inspected for the presence of any features or objects which may impact the yield or capacity of PV which can be installed. Examples of this can include skylights and the presence of taller buildings or trees surrounding the roof which can cause shading. Any such features should be considered when determining the appropriate orientation and tilt of the PV modules.

The building must also be surveyed for a suitable connection point into the building distribution system, if the project is to be used to serve the demand on site. Cable routing must also be considered to ensure that cables can be routed appropriately and safely to the connection point without damaging cabling.

Rooftop projects tend to be more expensive than ground mounted PV projects as rooftop projects are generally smaller and require more complex installation and maintenance procedures.

10.2.2 Carports Considerations

Carport PV installations present their own unique challenges, though there are some similarities to the challenges associated with rooftop sites. Proper orientation of the carport structure should be assessed based on the carpark layout to ensure that the potential PV yield is maximised when possible.

As with rooftop sites, any potential objects surrounding the car park must be identified and considered. Car-port structures are larger and require a considerably larger amount of steel when compared with ground mounted or rooftop mounting structure and therefore would typically be more expensive solutions.

As with ground mounted sites, the type of foundation to be used must be designed in accordance with the expected ground conditions at the car park. A ballast foundation may be a more appropriate solution than a piled solution where the car park surface would have to be penetrated.

Specific health and safety considerations must also be made for installers and operators working in an area that is frequented by vehicles. Appropriate traffic management plans should be put into place if carparks are still to be operational during construction of the carports.

The placement of inverters and routing of cabling also should be considered to avoid damaging the cabling.

10.2.3 Ground Mounted PV and Wind Considerations

Ground-mounted PV systems entail specific challenges related to their environmental and social impact. It is essential to assess the potential consequences on the surrounding environment, considering factors such as land availability, land use compatibility, and any potential disruption to local ecosystems or communities.

Technical studies should be carried out at the site to characterise its topology, hydrology and geotechnical aspects which infer suitability or constrain potential design solutions.

Potential shading angles and nearby features that could cause additional shading (overhead lines, trees, buildings etc) should also be captured via greenfield inspection carried out by a suitably qualified consultancy for a PV project.

Key environmental and impacts can include ecological impacts, the visibility of the solar panels and the wind turbines within the wider landscape and associated impacts on landscape designations, character types and surrounding communities and aviation aspect.

In particular for a PV project, glint and glare should be a consideration in the environmental assessment process to account for potential impacts on landscape/visual and for a Wind project, noise and shadow flicker.

Additionally, particular locations in the UK can be considered less preferable to be developed or have developments near them such as areas deemed as Areas of Outstanding Natural Beauty (AONB), or heritage sites may incur additional delays.

The constraints of technical, environment, and permitting must be considered in the final layout and the boundary of optimal area identified and cross referenced with initial assumptions to validate the feasibility of the project.

While the available area plays a significant role in determining the most suitable renewable solution, cost considerations are equally important. As a general guideline for PV, based on cost, the ranking from lower to higher would typically be ground-mounted systems, followed by rooftop installations, and carport structures. However, the ultimate cost ranking is contingent upon the unique characteristics of the site and the scale of the PV project. Wind projects are typically more expensive than PV projects in the UK but the yield is also higher, and therefore is its recommended to use the Levelized Cost of Electricity (LCoE) to evaluate and compare technologies.

10.3 EVCI Considerations

Apart from the considerations discussed above, the following considerations should also be made when developing the Electric Vehicle Charging Infrastructure (EVCI).

10.3.1 On-site generation

An on-site RE solution connected to the internal electrical infrastructure, taking advantage of available roofs, carparking areas or adjacent land areas might be a preferrable option where there are no power constraints to meet the expected new demand from the grid, and the internal infrastructure can accommodate the new EVCI. This allows the RE system to contribute to the decarbonisation efforts on site, benefiting various consumers such as the EVCI, medical equipment, lighting, and more. The RE solution should be determined via a feasibility study taking into account demand profile, RE profile and the different costs for the RE and electricity tariffs. The RE solution might be collocated with BESS in case the generation and demand have significant misalignment.

10.3.2 Integration with Energy Storage

A dedicated RE solution combined with a storage system can be proposed in cases where the EVCI cannot be connected to the internal infrastructure and access to the grid is not feasible for the EVCI. This arrangement would create an off-grid system specifically designed for the EVCI, ensuring its power requirements are met independently. When grid connection is available BESS system might not be required depending on the generation and consumption alignment.

10.3.3 Power Purchase Agreements (PPAs)

A direct PPA from a private generator of renewable energy (located nearby) to cover the energy consumption on-site could be implemented if the development of renewable energy on-site is not found be feasible from a technical-economical perspective. The EVCI can be connected to the internal infrastructure if there are no constraints. If this is not the case, two PPAs may be required (one covering EVCI requirements and the other covering the site demand requirements).

If there are no opportunities for a direct PPA, other PPA structures such as the following could be considered:

- Sleeved PPA: under a sleeved PPA arrangement, the total energy generated by the project passes to the Off-taker via an intermediate arrangement using the transmission and distribution networks and back-to-back power purchase agreement managed by a third party energy supplier. The sleeved PPA provides flexibility to the Off-taker and requires less interaction among the Off-taker and the project in terms of infrastructure as it enables the consumer to buy electricity directly from the project without requiring it to be close or connected to the project. Nor does it require the project to be a licensed supplier.
- Virtual PPA: A virtual PPA is a type of contract in which the parties, Off-taker and Generator, agree a market price and strike price (strike price being the price that the Generator is willing to sell the electricity for). If the market price moves below the strike price, the Off-taker pays

to compensate the Generator up to the strike price. If the market price moves above the strike price, the excess value is transferred to the Off-taker. In this way, both the Off-taker and Generator are ensured of paying or receiving the agreed strike price for the energy produced by the project. The Off-taker is therefore insulated against price rises on the energy they consume; however, this energy is procured via a separate agreement. The generator must also manage sale of the energy it produces at the market price but has security of stable revenue.

10.4 Relevant Standards

For the design and development of PV and wind projects, relevant local and international standards developed by the following parties must be adhered to:

- Association national standards, for example:
  - BSI: British Standards Institution.
  - UBC/IBC: Universal/International Building Code.
  - ASCE: American Society of Civil Engineers.
- International standards:
  - IEC: International Electrotechnical Commission.
  - ISO: International Organisation for Standardisation.
  - IEEE: Institute of Electrical and Electronic Engineers.
- In the absence of any relevant association national standards or international standards, EN European Standards shall be used.

A non-exhaustive list of standards for each technology is provided below.

10.4.1 Solar PV

- IEC 62716, Ammonia Corrosion Testing current edition.
- IEC 61701, Salt Mist Corrosion Testing of Photovoltaic (PV) modules current edition.
- IEC 61215, Terrestrial photovoltaic (PV) modules - Design qualification and type approval current edition.
- IEC 61345, UV test for photovoltaic (PV) modules current edition.
- IEC 61730-1, Photovoltaic (PV) module safety qualification – Part1 Requirements for construction current edition.
- IEC 61730-2, Photovoltaic (PV) module safety qualification – Part2 Requirements for testing current edition.
- IEC 60068-2-68,: Environmental testing, — Part 2-68: Tests - Test L: Dust and sand current edition.
- IEC TS 62804-1: Potential Induced Degradation (PID) free tests current edition.
- IEC 62790, Junction boxes for photovoltaic modules - Safety requirements and tests current edition.
- IEC 62852, Connectors for DC-application in photovoltaic systems - Safety requirements and tests current edition.
- IEC 62759-1, Photovoltaic (PV) modules - Transportation testing - Part 1: Transportation and shipping of module package units current edition.
- IEC 60269-6, Low-voltage fuses – Part 6: Supplementary requirements for fuse-links for the protection of solar photovoltaic energy systems current edition.
- EN 50380, Marking and documentation requirements for Photovoltaic Modules current edition.

- EN 50521, Connectors for photovoltaic systems – Safety requirements and tests current edition.
- IEC 62548 Photovoltaic (PV) arrays – Design requirements current edition.
- IEC 62446 Grid connected photovoltaic systems - Minimum requirements for system documentation, commissioning tests and inspection current edition.
- IEC 60721-2-4 Classification of environmental conditions - Part 2-4: Environmental conditions appearing in nature - Solar radiation and temperature current edition.
- IEC/TS 61836 Solar photovoltaic energy systems - Terms, definitions and symbols current edition.
- IEC 62093 Balance-of-system components for photovoltaic systems - Design qualification natural environments current edition.
- IEC 61724 Photovoltaic system performance monitoring Guidelines for measurement, data exchange and analysis current edition.
- IEC 60364: Section 712 Solar photovoltaic (PV) power supply systems current edition.
- IEC 60891: Procedure for temperature and irradiance corrections to measured I-V characteristics of crystalline silicon photovoltaic devices current edition.

10.4.2 Wind

- IEC 61400 1 General Wind Turbine Design requirements current edition current edition.
- IEC 61400 2 General Wind Turbine Design requirements for small turbines current edition.
- IEC 61400 4 Design requirements for wind turbine gearboxes current edition.
- IEC 61400 5 Wind generation systems: Wind turbine blades current edition.
- IEC 61400 6 Wind generation systems: Wind turbine tower and foundation current edition.
- IEC 61400 11 Acoustic Noise measurement techniques for wind turbines current edition.
- IEC 61400 12-1 Power Performance measurement of electricity producing turbines current edition.
- IEC 61400 50-3 Use of nacelle mounted lidars for wind measurements current edition.
- IEC 61400 13 Measurement of mechanical loads of wind turbines current edition.

10.5 Key Recommendations

The following key recommendations should be considered when considering the interface between renewable energy and EVCI:

- Where grid capacity is constrained across the NHS Wales estate, investigate the possibility for the installation of renewables to complement EVCI.
- Ensure the range of renewables technology available is appropriately investigated, using the outlined process, to effectively support wider energy and cost requirements.
- If possible, integrate renewables with EVCI deployment to reduce dependency on the grid.
- Ensure any deployment of renewables does not interfere with the backup generators on-site for critical patient care infrastructure.
- Ensure that renewable energy procured is compliant with relevant standards.

11 Carbon Savings Analysis

This section outlines the potential carbon savings associated with the potential uptake of EVs within the NHS Wales fleet. It compares the carbon emissions between the existing base and future scenarios depending on the level of uptake.

11.1 Calculation Methodology

The carbon savings analysis uses UK Government emission factors from the Department for Energy Security and Net Zero (DESNZ)[14] and the Department for Transport (DfT)[15]. Current fleet composition data has also been used which includes vehicle type, fuel type and vehicle mileage.

Emission factor values are given in kilograms of carbon dioxide equivalent ($kgCO_2e$), and capture all six greenhouse gases (GHGs) defined by the Kyoto Protocol[16]. Emission factors vary by vehicle and fuel type. As such, an appropriate emission factor is applied to the vehicle type.

Emission factors for diesel, petrol, hybrid and electric vehicles categorised as Well-To-Tank[17] and Tank-To-Wheel[18]. The sum or total of these are called the Well-to-Wheel[19] emissions.

11.1.1 Scenarios Assessed

The assessment considers three scenarios which are described below. The three scenarios have been selected to provide an indication of the potential savings that could occur, depending upon the EV uptake achieved.

Baseline

The baseline scenario uses the fleet composition data as outlined in the *NHS Wales Initiative 17: Electric Vehicle Charging Point Best Practice Guidance (Baseline) Report*. The relevant emission factors have been used dependent on the fleet composition.

50% EV uptake

The 50% EV uptake scenario reflects half the total fleet transitioning to EV, whilst the other half remains as the baseline fleet composition. To achieve this, the assessment considered half the mileage using the baseline fuel type, and the other half using an EV fuel type. Heavy goods vehicles (HGVs) are excluded from this assumption and are assumed to remain as diesel.

100% EV uptake

The 100% EV uptake scenario assumes the whole fleet composition as reported in the baseline report transition to EV and as such, use EV emission factors. HGVs are excluded from this assumption and remain as diesel.

[14] https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2023 (Accessed June 2023)

[15] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/739462/transport-energy-model.pdf (Accessed June 2023)

[16] https://unfccc.int/kyoto_protocol#:~:text=In%20short%2C%20the%20Kyoto%20Protocol,accordance%20with%20agreed%20individual%20targets. (Accessed July 2023)

[17] 'Well-to-Tank' refers to the emissions from the upstream processing of the fuel. They result from the extraction, transport, refining, purification or conversion of primary fuels to fuels for direct use by end users.

[18] 'Tank-To-Wheel' refers to the emissions from fuel consumption by the vehicles

[19] 'Well-to-Wheel' refers to the sum of the Well-To-Tank and Tank-To-Wheel emissions.

11.1.2 Assumptions

The following assumptions are applicable to the calculations:

- All cars in the fleet composition are assumed to be average sized cars as defined by UK Government conversion factors.
- All light goods vehicles (LGVs) in the fleet composition are assumed to be average vans with a payload of up to 3.5 tonnes as defined by the UK Government conversion factors:
- All HGVs in the fleet composition are assumed to be classified as “All rigids” as defined the UK Government conversion factors using average laden.
- All HGVs in the fleet composition are assumed to be diesel.
- Vehicles identified as “Other” in the fleet composition are assumed to be LGV diesel vehicles, including ambulances which are more like LGVs than HGVs. As such, these vehicles will be assumed LGV plug-in hybrid vehicles in future scenarios in line with the NHS Wales Decarbonisation Strategic Delivery Plan[20].
- 2023 conversion factors have been used including the use of grid electricity emission factors.
- Where annual mileage was not given, it was calculated by multiplying the daily mileage by 365.

11.2 Results

Table 11.1 shows the annual carbon emissions from the baseline scenario, and the two EV uptake scenarios.

Table 11.1: Annual carbon emissions for each scenario per organisation

Organisation	Baseline (tCO_2e)	50% Uptake (tCO_2e)	100% Uptake (tCO_2e)
Aneurin Bevan University Health Board (UHB)	2,036	1,293	549
Betsi Cadwaladr UHB	1,016	705	393
Cardiff and Vale UHB	764	582	401
Cwm Taf Morgannwg UHB	807	623	439
Digital Health and Care Wales	78	49	20
Hywel Dda UHB	969	615	271
NHS Wales Shared Services Partnership	3,674	3,264	2,855
Public Health Wales	357	277	198
Powys Teaching Health Board	218	139	59
Swansea Bay UHB	645	439	233
Velindre University NHS Trust	11	7	3
Welsh Ambulance Service NHS Trust	9,104	7,102	5,099
TOTAL	**19,676**	**15,095**	**10,521**

It is evident that the EV transition will reduce the annual carbon emissions for the NHS Wales Fleet in both 50% uptake and 100% uptake scenarios for all the organisations.

Table 11.2 indicates the associated percentage emission savings from fleet transition to EV.

[20] NHS Wales Decarbonisation Strategic Delivery Plan (gov.wales)

Table 11.2: Percentage carbon saving relative to the baseline scenario

Organisation	50% Uptake (%)	100% Uptake (%)
Aneurin Bevan UHB	37	73
Betsi Cadwaladr UHB	31	61
Cardiff and Vale UHB	24	48
Cwm Taf Morgannwg UHB	23	46
Digital Health and Care Wales	37	74
Hywel Dda UHB	36	72
NHS Wales Shared Services Partnership	11	22
Public Health Wales	22	44
Powys Teaching Health Board	36	73
Swansea Bay UHB	32	64
Velindre University NHS Trust	37	74
Welsh Ambulance Service NHS Trust	22	44
TOTAL	**23**	**47**

At the time of writing, 2023 Conversion Factors have been used. However, it is likely that the carbon savings would increase year-on-year as the UK continues to decarbonise grid electricity. The intensity of carbon emissions from electricity generation would then decrease in line with UK Government projections[21]. A similar situation may occur for petrol, diesel and hybrid vehicles as the efficiency of such fuel production increases over time. However, the rate at which carbon emissions decrease is significantly greater for EVs.

It is important to consider the embodied carbon emissions[22] with the uptake of EVCI and EVs. Implementing new EVCI will carry embodied emissions which can often be significant. As such, measures to reduce embodied emissions through the provision of infrastructure should occur. This may include but is not limited to:

- Minimising the construction where feasible.
- Use of low carbon alternative materials or fuels.
- Local procurement of equipment.
- Supply chain optimisation.
- Maximise transport efficiency.

The age and condition of the existing fleet should be considered when planning the transition as procurement of new EV vehicles as the procurement of new vehicles, particularly EVs have larger embodied emissions. As such, transition fleet when vehicles are still within effective working life could be detrimental considering the additional embodied emissions or could extend the payback period of the EVs. For context, the lifecycle emissions associated with a large EV in 2022 are estimated at 21.5 tCO_2e compared to a large petrol car at 78.3 tCO_2e[23]. This means priority should be given to the utilisation and maintenance of the existing fleet where possible, as opposed to hastily switching to EVs.

[21]UK Government – available at: https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal (Accessed June 2023)

[22] Embodied (carbon) emissions are defined as the greenhouse gas emissions associated with the production and use of a material.

[23] Transport and Environment. T&E's analysis of electric car lifecycle CO_2 emissions 2022-03_LCA_Update-Units_corrected (transportenvironment.org) (Accessed June 2023)

11.3 Key Recommendations

The following key recommendations should be taken into account when considering the transition to EVs from a carbon saving perspective:

- Significant reductions could occur from converting the existing fleet to EVs, ranging from 44% to 74% reduction depending on the organisation.
- When planning the rollout of EVCI, the embodied emissions of the infrastructure is an important factor to consider. Design, procurement and construction should minimise emissions where possible.
- When planning the rollout of EVs, the embodied emissions associated with the EVs is an important factor to consider. It is recommended the existing fleet is assessed for age and condition and be utilised as much as possible before switching to EVs.
- In line with Section 10, explore the use to renewable energy sources as this would further reduce emissions compared to using grid electricity.

12 Climate Change Resilience

The UK has been experiencing an increase in flooding and extreme temperatures in recent years[24]. Climate change has led to an increase in heavy rainfall events and according to the UK Climate Projections, the frequency and intensity of heavy rainfall events are anticipated to increase in the future. The UK is also experiencing more frequent and intense heatwaves, and greater variability and occasional severe cold snaps during winter[25].

Therefore, when installing EVCI, consideration should be made for in relation to flooding or temperature extremes as a result of climate change in order to support:

1. Safety

- Considering the potential for hazards caused by weather-related incidents such as flooding, snow or extreme temperatures when accessing the charging infrastructure

2. Continuity of Services

- Locating infrastructure to reduce the risk of service interruption and considering risk assessment and mitigation for the impact of any down time

3. Protection of assets

- Minimising risk of damage to the EV infrastructure

By designing and implementing resilient charging infrastructure, we can create a robust and reliable EV charging network that is adaptable to meet future challenges.

The charging infrastructure should be appropriate and resilient electrically, from potential climate and environmental impacts as well ensuring that additional risks associated with where the charging infrastructure is located are considered.

12.1 Risk Assessment and Mitigation

As part of the site risk assessment for the installation of charging infrastructure, environmental impacts and the potential for flood risk or extreme temperatures should be considered. The assessment should consider physical resilience planning to address the particular needs to amenity and operational charging, where different factors will apply:

- Understand threats and opportunities in the siting of charging equipment. Reference should be made to any Flood Risk Assessments for the site to avoid unnecessary cost/interruption of service associated with predicted flooding. As far as reasonably practicable, charging infrastructure should not be located within a flood risk area, particularly for ambulances, blue light or priority service vehicles.
- Address environmental impacts, mitigate as far as practical excessive external ambient temperature and humidity, particularly for operational charging. Consideration should be given to solar shading.
- Management of access to charging infrastructure should be considered alongside existing protocols for managing car parks during extreme cold where snow or ice build up could present a hazard.

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[24] Met Office, 2023. What is Climate Change? Available at: What is climate change? - Met Office

[25] Met Office, 2022. UK Climate Projections: Heading Findings, August 2022. Available at: ukcp18_headline_findings_v4_aug22.pdf (metoffice.gov.uk)

Typically, chargers can operate across a wide temperature range, however their resilience should be assessed to extremely hot days, where blue light holding bay operation is concerned. The implications of extreme heat on the electrical infrastructure are part of the infrastructure design, however the combination of heat directly applied to chargers in conjunction with air-conditioned ambulances holding for extended periods on 'shore supplies' should be risk assessed and steps taken to mitigate.

In assessing the number of chargers required consideration should be given to the fall off in charging performance at ambient external temperatures of below -10°C and above +40°C, particularly when rotational operational fleet charging is proposed, where extended charging times may impact fleet availability.

12.2 Loss of Service

An appropriate risk assessment and mitigation plan should be developed to address flood or other environmental factors resulting in a loss of service. This should be considered in parallel to existing protocols for maintaining clinical services during a power outage.

An existing hierarchy provided by Welsh Health Technical Memorandum 00-07[26] informs designers how to address the provision of stand-by power support for equipment against power failure based on its criticality. This should be used to define a baseline load and load control for the EV charging network, together with the broader design of the electricity network.

Blue light vehicles both discharging patients and on stand-by for service duty would be considered the highest level of clinical need ('critical') and should have fully rated stand-by power support, provided by the site's embedded power generation. Generation capacity should include a full allowance for the associated load of EV's likely to be connected to it, both in in terms of available power and the impact on fuel storage requirements for meeting that load.

Other operational fleet vehicles may be considered as 'essential' rather than 'critical'. Whilst stand-by support would be a requirement, consideration should be given to the application of diversity to the anticipated connected load. A balance of capital cost for plant, equipment, fuel capacity and electricity distribution versus operational needs should be established, and it would be expected that not all chargers be supported by the embedded site generation system.

A business continuity plan should be developed, this should include an EV distribution strategy which reviews the availability of local non-NHS public charging infrastructure to 'soak-up' part of the operational charging need off site in the event of power failure to the hospital, reducing the overall capacity requirement and generator sizing. The plan should be robust in assessing the likelihood of a wider area power failure affecting the electricity supply network beyond the hospital and its impact on charging for fleet vehicles, which are potentially being stabled for charging off site.

At a concept level, stand-by power provision design should include a growth strategy to allow EV network charging stand-by power capacity to increase as the size of the electric fleet increases. The strategy is likely to be complex and should acknowledge that the need to replace or upgrade central plant is costly and disruptive, mitigation should be included through alternative methods, whether by separating EV charging network distribution to separate transformers, via high voltage generation, or by provision for distributed low voltage generation, at specific nodes supplying the EV network infrastructure.

[26] NHS Wales & Welsh Government, 2017. Welsh Health Building Note 00-07: Planning for a resilient healthcare estate. Available at: https://nwssp.nhs.wales/ourservices/specialist-estates-services/specialist-estates-services-documents/whbns-library/whbn-00-07-planning-for-a-resilient-healthcare-estate-pdf/

EVs could also be used as energy storage, as outlined in **Section 8.5 Vehicle to Grid (V2G)**. This means non critical EVs, when plugged into a compatible charger, could act as a generator during periods of power outages. This technology approach could act as a backup energy source, or be used when renewable generation is low to offset the use of the power grid. This type of system can provide some form of electrical resilience, provided the vehicles being used to provide electricity are not required to be fully charged. When power is restored, the EVs used as part of V2G can be recharged.

All of the above should be considered in conjunction with **Section 13 Fire Safety**.

12.3 Key Recommendations

The following key recommendations should be taken into account when ensuring EVCI are resilient to the effects of climate change:

- Focus on safety, continuity of services and protection of assets when positioning and planning for EVCI.
- Ensure the site risk assessments accounts for potential environmental hazards, including those arising from climate change such as extreme heat or cold and flooding.
- A fully rated stand by power support should be readily available for rapid response vehicles providing critical care, when power supplies fail to prevent a loss of service. Other essential vehicles that perform critical roles should also have access to stand-by power.
- Develop a business continuity plan to outline actions when extreme weather or power cuts interrupts service, including actions such as using the public charging network.

13 Fire Safety

This section outlines the advice and guidance on the emerging best practice standards for the introduction of EV charging. This section focuses on life-safety and space planning, but also gives considerations on property and asset protection, and on environmental protection.

The fire safety section includes general fire requirements and best practice to facilitate the installation of EV charging across hospital sites and better operational service planning.

A site-specific fire risk assessment or fire strategy should be developed to suit specific site conditions and the type of EVs (e.g. smaller electric cars/vans vs larger EVs) deployed.

13.1 Fire Engineering Objectives

13.1.1 Life Safety Objectives

The people on site, fire fighters and other members of the public who are in the vicinity of the site can potentially be put at risk in the event of a fire. The main life safety objectives in the event of a fire are:

- The people on site are able to ultimately leave the area in reasonable safety.
- Fire fighters are able to operate in reasonable safety.
- For structures, collapse does not endanger people (including fire fighters) who are likely to be near the building.
- Fire spread does not affect occupants in surrounding buildings.

13.1.2 Property Protection and Business Continuity Objectives

The design team for EV charging infrastructure should discuss with the end users to understand if additional considerations need to be incorporated. Some insurer requirements have been included to provide an increased level of property protection/business continuity, e.g. contingency planning on service interruption due to a possible EV fire on site and mitigation measures on the risk of service interruption.

13.1.3 Environmental Protection Objectives

The environment should not be adversely affected by a fire incident and potential toxic or environmentally damaging chemicals within the firefighting water should not be released into the environment.

13.2 Current Design Guidance and Best Practice

The overarching preference is for EV chargers to be located externally, where fire and smoke will ventilate naturally in the open air. External facilities also provide better access for the fire service tackling EV incidents. This contributes to mitigating the fire risk when compared to EV chargers located in a ‘similar’ indoor building.

13.2.1 Legislations

Building Regulations

For most EV charging sites which are located externally, the Building Regulations do not apply. With regards to the external parking and charging areas there are usually relaxation on fire safety requirements (compared with a 'similar' indoor building) therefore where noted best practice should be applied to these areas.

For fire safety, buildings are required to comply with the functional requirements B1 to B5 of Schedule 1 and Regulations 7 and 37A of the Building Regulations current edition (SI 2010/2214) for Wales.

The functional requirements of Part B of the Building Regulations are:

B1	To ensure satisfactory provision of means of warning and escape for persons in the event of fire in a building.
B2	To ensure the spread of fire over the internal linings of buildings is inhibited.
B3	To ensure the stability of buildings in the event of fire; to ensure that there is a sufficient degree of fire separation within buildings and between adjoining buildings; and to inhibit the unseen spread of fire and smoke in concealed spaces in buildings.
B4	To ensure external walls and roofs have adequate resistance to the spread of fire over the external envelope and that spread of fire from one building to another is restricted.
B5	To ensure satisfactory access for fire appliances to buildings and the provision of facilities in buildings to assist fire fighters in the saving of life of people in and around buildings.

Fire Safety Order

Once a building is in use, the management regime should be maintained and any variation in that regime should be the subject of a suitable risk assessment. Failure to take proper management responsibility may result in the prosecution of an employer, building owner or occupier under legislation such as the Regulatory Reform (Fire Safety) Order 2005 (RRO).

Once the area is in use or when EVCI or EV parking is newly located adjacent to an existing facility, a fire risk assessment (FRA) should be completed for the buildings/areas that could potentially be affected by the external parking and charging area.

13.2.2 Design Guide and Guidance Documents

For NHS Wales hospital sites, *WHTM (Welsh Health Technical Memorandum) 05-02: Firecode – Fire safety in the design of healthcare premises* is typically adopted in Wales to achieve compliance with the Building Regulations. ADB (Approved Document B Volume 2 Wales) or BS 9999 is a widely adopted supplementary guidance document on these buildings.

However, there is limitation when applying WHTM 05-02 or ADB/BS 9999 to indoor and external EV charging, which covers 'general' fire safety requirements for a range of building types, but not specifically for EV charging. The most relevant sections in WHTM 05-02 or ADB/BS 9999 cover fire requirements for internal or enclosed car parks. It should be noted that, however, there is a lag between these requirements and parking/charging for more modern vehicle design (such as EVs). Further, those requirements for car parks in WHTM 05-02 or ADB/BS 9999 primarily focus on light vehicles, for which the fire hazards may be different from some of the electrical vehicles at the hospital sites.

The relevant documents for this Best Practice Guidance are summarised as below.

- WHTM (Welsh Health Technical Memorandum) 05-02: Firecode – Fire safety in the design of healthcare premises.
- Approved Document B (ADB), Fire Safety, Volume 2 – Buildings other than dwellinghouses (2006 Edition incorporating 2010, 2013, 2016, 2017, 2020 and potential future amendments – For use in Wales). This is referred as 'ADB' or 'ADB (Wales)' in this report.
- BS 9999: Fire safety in the design, management, and use of buildings – Code of practice current edition
- Risk Control – Fire safety when charging electric vehicles (RC59, current edition)
- BS 7974: Application of fire safety engineering principles to the design of buildings. Code of practice (current edition)
- Office for Zero Emission Vehicles Interim Guidance - Covered car parks: fire safety guidance for electric vehicles, published in Jul 2023.

Other key supporting guidance documents and articles are listed below.

- Fire Safety of Lithium-Ion Batteries in Road Vehicles, RISE Research Institutes of Sweden (current edition).
- Fire detection & fire alarm systems in heavy duty vehicles, Final Report, SP Technical Research Institute of Sweden (current edition).
- NFCC's response to the Department for Transport's consultation on Electric Vehicle Charging in Residential and Non-Residential Buildings (2019).
- Full scale fire-test of an electric hybrid bus, SP Technical Research Institute of Sweden (2016).
- Best Practices for Emergency Response to Incidents Involving Electric Vehicles Battery Hazards: A Report on Full-Scale Testing Results (current edition), the Fire Protection Research Foundation.
- Comparison of the fire consequences of an electric vehicle and an internal combustion engine vehicle. 2. International Conference on Fires in Vehicles - FIVE 2012, Sep 2012.
- Design Fires for Use in Fire Safety Engineering, FB 29 (current edition).

13.3 Fire Safety Requirements

Based on the review of the current design guide and best practices noted, the general fire safety requirements for EV charging areas/buildings are outlined below. It should be noted that this chapter focuses on EV's and does not contain all fire safety requirements for a building, which should be captured in a fire strategy report.

13.3.1 General Fire Risk Guidance Documents

To achieve the compliance with the Building Regulations with respect to fire, the following design guidance will be used for NHS Wales hospital sites:

- WHTM 05-02: Firecode – Fire safety in the design of healthcare premises; supplemented by:
- Approved Document B (ADB), Fire Safety, Volume 2 – Buildings other than dwellinghouses (2006 Edition incorporating 2010, 2013, 2016, 2017, 2020 and future amendments – For use in Wales); or
- BS 9999: Fire safety in the design, management and use of buildings – Code of practice (current edition).

Some sections of these design guide should be considered for the application to the external EV charging/parking areas. There is usually relaxation on fire safety requirements for outdoor areas (compared with an 'similar' indoor building), where people can move freely away from a fire event. This is due to the standards and codes of practices focusing on life safety within buildings.

Fire Risk Assessment

A fire risk assessment (FRA) should be carried out to identify the fire hazards of EV charging/parking areas and mitigation measures. RC 59 (*Risk Control – Fire safety when charging electric vehicles*) is a useful design guidance on the FRA for EV charging/parking and includes recommendations on separation/compartmentation, risks and mitigation measures on e-bikes/mobility scooters which has a growing concern, example checklist on FRA questions.

It is expected that most EV charging projects at outdoor locations are covered by RRO and hence a site-specific FRA should be adequate to address the fire risks and mitigation measures. More detailed fire strategy may be required for new building projects (e.g. a new covered carpark) where building regulations apply.

Fire Safety Engineering

As an alternative to the prescriptive approach, fire safety engineering may be suitable for solving a specific problem with a design that otherwise could not be achieved by following the provisions in WHTM 05-02 or ADB/BS 9999.

BS 7974 and supporting published documents (PDs) provide a framework for and guidance on the application of fire safety engineering principles to the design of buildings.

13.3.2 General Fire Safety Provisions

Application of this fire risk guidance

This document has outlined the guidance specific to the fire hazards of an EV charging/parking area. The recommended fire safety provisions in this chapter could form part of a full site-specific FRA/fire strategy report.

a. It is imperative that the designer consults the Organisation's Fire Safety Manager/Fire Safety Team at the earliest stage of any proposals, as well as the Authorised Engineer, care of NHS Wales Shared Services Partnership – Special Estates Services (NWSSP-SES) and the fire service where necessary. If the facility does not have NHS self-insured status, then the designer should also consult with the insurers for any additional fire requirements on property protection and business continuity.
b. For outdoor EV charging, the designer should consider the following minimum fire requirements. RC 59 should be followed to assess the fire risks and mitigation measures.
    i. Fire protection measures, e.g. battery monitoring system, EV charging isolation switch.
    ii. Impact of an EV fire on means of escape provisions, including but not limited to, separating distance to external escape routes.
    iii. External fire spread control assessment to identify the separation distance to assets/buildings. This includes but not limited to, fire classifications of the building envelope, calculation for the allowed unprotected areas on the building envelope with regard to building height and separating distances, fire barriers.
    iv. Vehicle-to-vehicle separation distance needs to be considered on a site by site basis. This is more of an asset protection consideration.
    v. Access and facilities for the fire service, e.g. nearby fire hydrants.
    vi. Operational response, e.g. recovery of an fire incident EV and potential disruption to operations.

vii. The designer may consider the application of BS 7974 to justify a suitable level of EV fire risks on property protection/asset protection.

viii. Management procedures to reduce combustibles and mitigate the risk of ignition.

c. Indoor EV charging within or adjacent to inpatient or sleeping risk premises is prohibited until such times as the fire service develop suitable EV fire extinguishment techniques.

Where there may be other exceptional reasons or requirements for indoor EV charging (such as FM maintenance garages), they should consider risk to life and services, making sure these are not located in or adjacent to inpatient or sleeping risk premises. They will be subject to FRA and approval. As a minimum, the designer should outline the fire safety provisions in accordance with WHTM 05-02 or ADB/ BS 9999 requirements to comply with Building Regulations (in addition to the fire risk considerations in item (b) above). This should be documented in a fire strategy report and agreed with the approving authority. The following minimum fire requirements should be considered:

i. Means of escape provisions, including but not limited to, exit widths, travel distances, exit signs, emergency lighting.

ii. Internal fire spread (linings and structures), e.g. fire separation/compartmentation;

iii. Fire suppression system, e.g. sprinklers.

iv. Smoke ventilation system.

v. External fire spread control.

vi. Fire service interventions, e.g. ‘let burn’ or actively tackling an indoor EV fire.

vii. Contingency planning, e.g. relocation of the fire incident EV(s) outside the building to a place of relative safety, away from the buildings/structures.

viii. Any other site-specific fire risks and associated fire protection systems/mitigation measures.

13.3.3 Fire Detection and Alarm System

Battery Monitoring System and Fire Detection

The site-specific FRA/fire strategy should outline the fire protection measures of the proposed EV charging system, e.g. monitoring of the status and temperature of the EV charging system (particularly night-time charging), any on-board battery monitoring and detection system, automatic/manual isolation switch to cut off the charging in fire emergency.

Fixed Fire Detection and Alarm System

For outdoor EV charging, there are currently no reliable and cost effective fixed fire detection means in outdoor weather conditions. CCTV monitoring of the EV charging locations is an option, but this relies on continuous 24/7 management which can be resources demanding.

EV charging in a building is not preferred until such times as the fire service develop suitable fire extinguishment techniques. Automatic fire detection and alarm system should be provided in accordance with BS 5839 for indoor EV charging. The type of fire detection and alarm system should be considered in a fire strategy report (e.g. Linear Heat Detection which is a reliable detection of fire or overheating, and suitable for use in most environments such as for use in carparks. However, it should be noted this may be too slow to react to the sudden nature of an EV related incident).

13.3.4 Impact on Fire Escape Routes

The EV charging locations should not impact on escape routes. Occupants should have alternative safe escape routes away from the EV charging bays, without passing by fire incident EVs.

Sensitive occupants and critical areas of the buildings should be considered in a fire strategy, e.g. EV charging bays should be remote from patient areas, A&E entrances, Air Handling Unit (AHU) intakes (especially AHU intakes for critical care and theatre areas). This is to mitigate the risk of fire and smoke affecting sensitive occupants.

13.3.5 Fire Separation Requirements

The EV charging bays should be located at a minimum safe distance away from adjacent buildings/assets.

Prescriptive separation distances are not provided in WHTM/ADB/BS 9999/RC 59 yet, therefore the recommended separation distance is mainly driven by insurance guidance documents. *Zurich guidance - Risk Insight: Electric Vehicle Charging* has recommended the following:

> *'Ideally, electric vehicle charging, and parking should be located at least 10 m from combustible walls or at least 7.5 m from unprotected openings/extensive glazing in non-combustible walls.'*

Similarly, *RSA Risk Control Guide: Electric Vehicle Charging and Enclosed Car Parks* has recommended the following:

> *'Vehicle Charging Separation Maximise the separation distance between vehicle charging bays, with 5 m minimum separation distance ideal. When 5 m is impractical, then provide a minimum addition of 1 m separation above standard vehicle parking bays sizes for vehicle charging bays.*
>
> *Ensure that combustible or flammable materials, such as storage, waste materials, etc., are not kept near (within 10 m) of chargers and vehicles on charge.'*

a. Prescriptive approach on separation distances

As a prescriptive approach, it is recommended that a 10m separation distance is maintained from EV charging bays to adjacent building/critical assets. Such distance can be relaxed to 7.5m from unprotected openings/extensive glazing in non-combustible walls.

There is currently no prescriptive separation distances from AHU intakes in hospitals. It is recommended this is addressed through risk-based fire engineering analysis (considering AHU intakes as sensitive receivers from EVs), with the general 10m separation distance (based on recommendations in the current insurance industry) for a minimum spacing as good practice.

b. Alternative risk-based approach on separation distances

An alternative risk-based approach is necessary where the type/size of vehicles should be considered to confirm the separation distance is appropriate, for example when locating adjacent to sensitive receivers and therefore additional risks should be considered, or where larger EVs (rather than smaller EV cars/vans) are proposed.

With a risk-based approach, a more detailed FRA (as detailed in section 13.3.1) should be carried out to suit site specific conditions and type of EVs, e.g. undertaking an external fire spread calculation to assess the safe distance to mitigate the risk of pilot ignition on adjacent vehicles/ buildings/ sensitive receivers. There are also some sensitivity scenarios (e.g. jet fires or potential projectiles and secondary fires) which are more suitable to be addressed in detailed site-specific FRAs, as currently there is limited fire testing data on these fire risks (therefore it is difficult to form design inputs for current EV charging proposals).

Fire Barriers

Fire barriers may be required to enhance fire life safety and property protection or as an alternative to providing separation distances. E.g. if fire barriers are provided to subdivide the

EVs on site into smaller groups/sets, the potential asset loss can be limited to the group/set where an EV fire is originated (rather than entire EV fleets being damaged). The provision of fire barriers should be considered in a site-specific FRA or a fire strategy.

13.3.6 Fire Suppression

Fire suppression system (e.g. sprinklers) is recommended for indoor EV charging bays. Note, these are not expected to extinguish and EV fire but can be effective in reducing the potential of fire spread to other EVs. For outdoor EV charging locations, a fixed fire suppression system is generally less effective.

- Sprinkler systems should be provided in accordance with BS EN 12845 (current edition) recommendations.
- Insurers may require additional LPC rules to apply (and therefore the hazard category under LPC Technical Bulletins).

Some EVs may contain on-board fire suppression systems which could contribute to delaying fire growth and facilitate life escape in the early phase of a fire. These are currently more common for larger EVs (e.g buses) but it is worth noting emerging UNECE regulations[27] do set out requirements for on-board detection system and fire resistance performance for EVs.

13.3.7 Smoke Ventilation

For outdoor EV charging, smoke will ventilate by natural means in the open air.

For indoor EV charging, smoke ventilation system should be considered in a fire strategy to provide tenable conditions in a building.

13.3.8 Fire Service Interventions

It is recommended to coordinate with the fire service on firefighting strategies on EV fires, such as ‘let burn’ strategy or actively tackling an EV fire. It should be noted that a ‘let it burn’ strategy has the potential for considerable impact on service interruption.

It is noted that Lithium-Ion Batteries have re-ignition risk after an initial fire. The recovery plan of fire damaged EV(s) and the service interruption risk to the vehicle fleet should be discussed with the fire service and documented in management procedures.

13.3.9 Environmental Protection

A significant amount of water is required to extinguish and cool the batteries (when compared to traditional ICE vehicles), as outlined in guidance “*Fire safety in e-bus depots - Risk, prevention and handling*” (by eBussed Interreg Europe, published in Apr 2022) and “*Best Practices for Emergency Response to Incidents Involving Electric Vehicles Battery Hazards: A Report on Full-Scale Testing Results*” (in 2013, by the Fire Protection Research Foundation).

Any water used to fight an EV fire should be appropriately managed to prevent harm to the environment. This is due to Lithium-ion batteries containing materials (especially metals and fluoride-containing compounds) which could lead to toxic fire extinguishing water. Fire water must not be discharged to the drainage system unless advised by the Fire Service to do so and permission has been given by the Natural Resources Wales and/or the sewerage undertaken.

[27] UNECE Regulation 100 (known as ‘R200’) - https://unece.org/sites/default/files/2022-07/R100r3e.pdf

13.3.10 Management Procedures

The guidance in '*Risk Control – Fire safety when charging electric vehicles (RC59, current edition)'* should be followed as part of the FRAs. This is in accordance with the RRO requirements.

- It is required that potential sources of combustible materials and waste, possible causes of fires and mitigation measures are identified to reduce a fire from starting, and to reduce the adverse impact on environment.
- All sites should identify the drainage on site, e.g. which drains are surface water (colour code blue) and which ones are foul drainage (colour code red).
- Good housekeeping on site is key to preventing fires. Know how to store materials and waste appropriately and safely.
- Fire drills – training on staff and other occupants to familiarise evacuation procedure in case of an EV fire.
- Emergency recovery – relocation of the fire damaged EV(s) to a safe outdoor location or a remote site to mitigate the re-ignition risk. A safe separation distance should be maintained between the fire damaged EV(s) and other vehicles/buildings.
- Planning/Management of NHS Wales vehicles fleet – any standby vehicles to take up the duty of the fire damaged EV(s) as a contingency plan.

13.4 Key Recommendations

The following key recommendations should be considered for fire safety:

- Ensure compliance with relevant fire legislations
- Continue to monitor changing legislations to ensure ongoing compliance
- Provide high quality prevention and warning systems are installed in areas where EVCI is implemented that are integrated with the wider site
- Carry out fire risk assessments (FRAs) as per RC 59 guidance on fire risks and document mitigation measures.
- Mitigate the risk of potential fires by ensuring 'good housekeeping', use of fire drills as well as awareness raising
- The majority of EVCPs will be retro-fit to the existing NHS estate; therefore, the existing FRAs must be updated to reflect the potential risks associated with EV charging and parking.
- Outdoor EV charging is preferred. Indoor EV charging within or adjacent to inpatient or sleeping risk premises is prohibited until such times as the fire service develop suitable EV fire extinguishment techniques
- It is important to consider mitigating service interruption risks.

14 Procurement and Operating Models

The following section outlines current best practice approaches to the procurement of Electric Vehicle Charging Infrastructure (EVCI). The Welsh Government has granted NHS Wales stakeholders with significant discretion over their chosen approach to EVCI procurement, thereby stakeholders have flexibility to tailor their procurement approach to meet their diverse requirements.

The following guidance sets out core procurement activities and considerations stakeholders are likely to face irrespective of the procurement strategy selected.

In line with the order procurement activities are likely to occur, this Best Practice Guidance reviews:

- The strengths and weaknesses of individual and joint procurement.
- How buyers can make the most out of pre-market engagement.
- The advantages and disadvantages of the principal operating models used to structure relationships between EVCI buyers and Charge point Operators (CPOs).
- Routes to procurement.

14.1 Joint Procurement

Once NHS Wales stakeholders have identified potential sites and EVCI requirements, stakeholders should consider whether to procure charging infrastructure separately or as joint buyers.

Through joint procurement, buying parties put forward the sites they wish to make available for EVCI, as well as the charger specifications required at those sites. A nominated lead buyer then manages the procurement exercise on behalf of those involved, reducing the individual administrative and financial burden of procurement.

Through this arrangement, the role and responsibilities of the lead buyer are usually defined and monitored by a steering group comprised of representatives from the cooperating parties. Importantly, the approach can facilitate greater coordination in EVCI rollout, helping to avoid the duplication of infrastructure and promote a more consistent end-user experience.

NHS Wales stakeholders may find benefit in collaborating if sites are within close geographic proximity, or if they have similar technical requirements, for instance, major hospitals with A&E facilities and significant ambulance throughput.

To fully optimise the benefits of joint procurement and develop more extensive network coverage NHS Wales stakeholders may look to engage other non-health public sector partners such as, local authorities and blue light emergency services. Indeed, local Public Service Boards (PSBs) or city region and growth deals may be useful routes to engaging other public sector partners when considering joint procurement. Strategic cooperation at this level enables greater knowledge sharing, the sustainable expansion of the EVCI network through site prioritisation, and help to prevent the creation of island networks.

Table 14.1 summarises the joint procurement points to consider in the process.

Table 14.1: Joint Procurement Points to Consider

Advantages of Joint Procurement	Disadvantages of Joint Procurement
Joint procurement can facilitate knowledge and resource sharing.	Collective agreement on contract terms and infrastructure specifications may become harder to reach as the number of cooperating buyers increases.
Greater coordination in EVCI roll-out means high priority sites can be developed faster. Helping to manage CPO resources and network capacity more efficiently.	Demand currently exceeds the supply of EVCI installation and management services. Therefore, suppliers are at risk of becoming overstretched. Buyers should use the procurement exercise to gauge whether a supplier has the capacity and experience to deliver and manage infrastructure development at the scale required.
Reduced need for duplicate procurement activities, saving time and money.	Risk that site specific challenges are not fully considered in the procurement exercise. Similarly, risk that the strengths of some stakeholders may not be fully utilised.
Joint procurement may unlock economies of scale benefits. For instance, the cost of a 24/7 Customer Helpline to support EVCI users, is shared between buyers.	
Consistent user experience across the network.	
Through joint procurement, buying partners broaden the scope and number of chargers delivered through a single contract, potentially making their collective offer more attractive to the market. This may increase market competition for the tender and deliver more competitive bids.	

14.2 Pre-market engagement

Pre-procurement market engagement is a particularly valuable exercise to undertake during the EVCI procurement process, as the technology and service offerings of CPOs continues to develop rapidly. Engagements should aim to provide the buyer(s) with knowledge of the different technical options, service offerings and costs given the buyers requirements.

To make the most out of early market engagement, those involved in the procurement process such as, Estates Managers, Decarbonisation Leads, Legal and Procurement colleagues should consider the **Scope, EVCI Specifications, Key Performance Indicators** and **Operating model(s)** of preference. Then, the viability of these preferences can be tested and refined through market engagement exercises.

14.2.1 Scope

Considerations should cover sites of charger installation, number of chargers required and charger type. Notably, charger type should consider the charging requirements of fleet vehicles and, their compatibility with EVCI hardware.

14.2.2 Specifications

Well-developed EVCI specifications are vital in ensuring a supplier develops a network that meets the needs of end users. Specifications should be informed by Welsh Government national standards[28], NHS Wales strategic priorities and cost.

[28] Welsh Government, 2023. Electric vehicle charging infrastructure: national standards | GOV.WALES

Listed below are EVCI specifications typically considered:

- Objectives
- Infrastructure Requirements
- Adoption of Legacy Assets
- Healthy and Safety
- EVCI Hardware Requirements
- Design and Placement (within Streetscape)
- Installation
- Accessibility (including language requirements)
- Energy Supply
- Customer Experience
- Maintenance
- Charge Point Management System
- Software and hardware upgrades
- Exit Plan

14.2.3 Key Performance Indicators (KPI)

KPIs are vital in supporting a resilient and effective EVCI network. Monitoring performance against KPIs provides both the CPO and buyer with important information on the network performance and areas of potential improvement. Below are examples of KPIs:

- Charge point Uptime
- Fault Resolution Service
- Fault Response Times
- Inspection and maintenance Frequency
- Charge point Management System (CMS): Remote Monitoring and Data Sharing
- Charge point Application Uptime
- Customer Helpline and complaints handling
- CMS Disaster Recovery
- CMS Server Capacity
- Exit Management
- Site Availability
- Number of Charge point Faults
- Revenue Share Payments
- Renewable energy usage
- Social Value
- Health and Safety
- Continuous Improvement
- Data protection and GDPR

14.2.4 Operating Model

The operating model through which EVCI is delivered and managed determines the party responsible for operating, maintaining and financing infrastructure.

Models range from agreements where private sector Charge Point Operators (CPOs) have full ownership and operational control of the network, to arrangements where these responsibilities rest with the public sector. Between these models, concession agreements see the public and private sector share investment and operational risk. Operating models are explored in greater detail in **Section 14.3**.

14.2.5 Conducting Market Engagement

Reaching out to CPOs or DNOs for survey or interviews is an informal method of market engagement. While it does not need to be conducted through a procurement framework appropriate advice should be sought to ensure the clear separation of the market engagement exercise from the procurement process.

Following these initial discussions NHS Wales stakeholders, may be able to launch a Prior Information Notice (PIN) questionnaire. PINs are a more formal means of conducting market research, buyers publish PINs through the Welsh Procurement portal, Sell2Wales.

PINs give sight of the buyer's potential opportunity to a broad range of suppliers. Consequently, responses should indicate the CPOs that are interested in delivering future service requirements. Again, for the PIN to effectively guide any subsequent procurement exercise survey questions should cover **Scope, EVCI Specifications, Key Performance Indicators and Operating model(s)**, as well as, the buyer objectives and national or regional policy context.

14.3 Operating Models

Operating models provide the organisational and commercial framework through which NHS Wales and CPOs will work together to deliver and manage EVCI.

This section introduces the following core operating models, **private own and operate, concession agreements, and public own and operate,** see Table 14.2**.**

As this guidance focuses primarily on the procurement of EVCI for fleet vehicles, the private own and operate model, and the public own and operate model will be discussed from a fleet perspective. Discussion on the concession model presents an arrangement where charge points are available to fleet vehicles, staff, and the public.

The most appropriate operating model will vary from buyer to buyer and may be influenced by a buyer's own objectives, site context, charger type and the CPOs interested in supplying EVCI and the availability of national or regional funding to support EVCI roll-out.

Given the range of variables influencing operating model selection, in addition to pre-market engagement, (discussed in Section 14.2) stakeholders such as Health Boards, should seek internal and if required external procurement support to evaluate the best approach.

Importantly, the operating models discussed below only consider the financing and management of charge points. The models do not influence ownership and management of parking sites or bays.

Table 14.2: EVCI Operating Model Overview

	A – Privately owned and operated	B – Concession Privately operated with risk share	C – Public sector owned and operated
Approach	Private sector ownership and operation of network	Public sector ownership of EVCI assets with private sector shared-risk/revenue operation.	Public sector ownership and operation of network
Existing and new EVCI asset ownership	Private	Public (concession model)	Public
Operator	Private	Private	Public
Risk to NHS Wales	No	Yes	Yes
Revenue stream to NHS Wales	NA	Yes	NA
Tariff setting	Private	Private / Public	Public

14.3.1 Private Own and Operate

The private own and operate model describes a fully market-led solution. The private sector would ultimately own charge point hardware and would be entirely responsible for funding, operating and maintaining existing and new EVCI assets. Therefore, the CPO shoulders all risk associated with the instillation and utilisation of assets.

The commercial risk in private own and operate models rests with the private sector therefore they are typically associated with long contracts and private sector control over tariffs. However, given that fleet utilisation of charge points is within NHS Wales power to control and can be confidently forecast, when tendering for CPO services NHS Wales could offer a minimum level of utilisation. Providing such a guarantee would reduce a CPOs concern over the utilisation of charge points and assist them in calculating break-even and profit-making points. Given the reduced commercial risk CPOs may be able to agree shorter contracts, or lower charging tariffs.

Through private own and operate models, CPOs recoups the cost of their investment through one of the following approaches:

A £/kWh tariff where users pay for energy consumed during each charging session.
A regular recurring availability payment or equivalent structure from NHS Wales to the CPO.

The advantages and disadvantages of a privately owned and operated approach are summarised in Table 14.3.

Table 14.3: Advantages and Disadvantages of Privately Owned and Operate

Advantages	Disadvantages
No capital risk to NHS	CPO control over tariffs
CPO heavily incentivised to provide good end-user experience by maintaining and upgrading charge points to encourage utilisation.	NHS unlikely to retain ownership of the grid connection point, reducing control over the quality of the service. In addition, this could hinder switching to a different CPO.
Given the level of control this operating model, offers the private sector, it is usually preferable to potential suppliers	Challenges in exit planning and re-tendering if NHS becomes over-reliant on incumbent supplier
	Likely to involve very long agreement periods

Key Points of consideration

- Requirement to manage and monitor tariff charged by CPO.
- Who will own below ground infrastructure?
- Is the private sector willing and able to take on full control?
- Length of contract duration.

14.3.2 Concession Models

There is limited precedent in the UK for the use of concession models to provide EVCI in healthcare settings. However, given the speed of technical and commercial development in the market consideration of their application has been made here.

Concession models may be used where NHS Wales invest in charge points that are available to both fleet vehicles and the public, which may include non-fleet staff vehicles. Through a concession both NHS Wales and a CPO would contribute to the initial EVCI capital expenditure. Typically, the public sector entity owns and constructs the groundworks and the CPO installs and maintains the EVCI network for a given contract period, the buyer retains the ultimate ownership of assets, if desired.

The length of the concession and service level provided by the CPO is determined through a contract with the buyer. Costs for both parties are recovered through a £/kWh tariff, paid by staff and visitors. The share of revenue is distributed to parties based on the financial and commercial risk share agreed through the contract. As the CPO is reliant on charger usage to recoup investment and eventually return a profit, they are incentivised to minimise charge point ‘down-time’ and upgrade both hardware and software during the concession term.

Given that staff and public usage of car parks can be confidently forecast when tendering for CPO services NHS Wales could offer a minimum level of charge point utilisation. Providing utilisation information allows CPOs to estimate break-even and profit-making points, alleviating demand uncertainty. With this information a CPO may be able to agree shorter contracts, or lower charging tariffs. Table 14.4 summarises the advantages and disadvantages of concession models.

Overstay fees

Overstay fees can be applied where there is concern staff or public EV drivers may remain connected to charge points for extended periods thereby, blocking the access of fleet vehicles.

Table 14.4: Advantages and Disadvantages of concession models – private and public sector funded

Advantages	Disadvantages
Greater NHS Wales control over network development and maintenance decisions, CPO is likely to want some influence in these decisions.	Likely less control by NHS Wales lessor than Model C
Limited capital or revenue risk to NHS.	
Low NHS resource commitment.	
Likely viability to the private sector	

Key Points of consideration

- Are there CPOs willing to be concessionaires in a healthcare setting?
- Can and agreeable revenue share be reached?
- Plan to manage a revenue loss or a revenue surplus depending on revenue share?
- Implications for existing EV charging infrastructure?

- Are there charge point operators willing to be concessionaires?

14.3.3 Public Own and Operate

Public own and operate models describe a situation where NHS Wales would fully fund the installation, operation, and maintenance of charge points. Grant funding from local or national government may be available to subsidise costs.

NHS Wales may elect to provide charge point installation, operation, and maintenance services internally. However, if a CPO was sought, the initial contract under a 'public own and operate' model would include charge point installation, operation, and maintenance. Assuming further expansion of the network was not required subsequent contracts, may only cover operation and maintenance. This approach provides clear demarcation of responsibility, and ensures NHS control over setting tariffs, which could be set to encourage uptake by EV drivers.

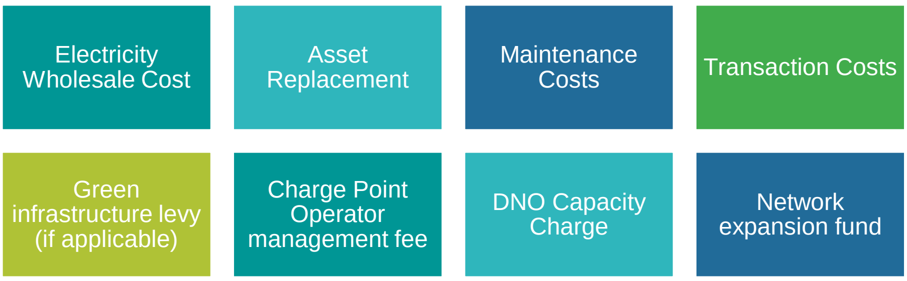
Operation and maintenance contracts typically cover, maintenance, fault resolution, back-office management, and soft and hard-ware updates and 24/7 customer support. Notably, the ultimate responsibility for network functionality rests with NHS Wales. This approach requires the buyer to have some level of internal expertise and resources available to manage the EVCI network. Energy usage from charge points would contribute to the overall energy consumption of the NHS Site, the cost of electricity used would be billed directly to the NHS.

Table 14.5: Advantages and Disadvantages of public 'Own and Operate' models

Advantages	Disadvantages
NHS retains full ownership of the charging network	Network development requires significant capital expenditure
NHS has significant control over the speed of EVCI deployment.	Requirement for NHS to cover costs for ongoing operation, maintenance, and upgrades.
This operating model may be more familiar with NHS Stakeholders and therefore, procurement route may be less resource intensive.	NHS may become the owners of redundant equipment as the charging infrastructure market and technology is developing rapidly (10-year lifespan).
Procurement frameworks could streamline the process and ensure greater confidence in suppliers.	NHS carries the risks of unexpected costs such as, electricity price increases.
Flexibility over back office management	Although a service level agreement (SLA) should be in place, the charge point operator is less incentivised to repair faults.
NHS retains control over charge point tariffs.	Operational and reputational risk if the network is unreliable

14.4 Managing Charge Point Tariffs

If the charge points are owned and operated by the private sector the CPO will have some level of control over the £/kWh tariff charged. As noted in Section 5.5.1, charge point tariffs should be set at a level that allows a CPO, assuming the network is not managed by NHS Wales, to cover operating costs. To reiterate, tariffs must cover the following direct and indirect costs:



Having said this, action can be taken during the procurement process and service delivery to mitigate the risk of CPOs significantly elevating tariffs.

1. During the procurement stage, NHS Wales could use current energy costs to establish a maximum tariff that a CPO would be allowed to charge. Bidders then respond illustrating how they would deliver and maintain infrastructure while charging at the prescribed rate. Notably, this mandated price is typically review at least annually to accommodate for any underlying energy price fluctuations. Where energy prices fluctuate significantly, NHS Wales may stipulate that they will review tariffs sooner than anticipated.
2. During procurement NHS Wales may also request data on a CPOs current and historic network costs. This gives insight into how the CPO has responded to past energy price fluctuations. Typically, CPOs charge a relatively consistent rate across their network so reviewing and comparing their data will provide useful insight in their relative rates.
3. While there is risk that long contracts bind buyers into relationships with CPO who have influence of tariff rates. Conversely, longer contracts may also insulate CPOs from energy price fluctuations and the subsequent need to pass some of this cost onto charge point users, if the CPO believes it is possible for them to still break even over the contract's lifetime.
4. NHS Wales stakeholders may also consider setting up a tariff review process to be conducted during both scheduled (annual or bi-annual) tariff reviews and during unexpected change requests from a CPO, in response to significant energy price increases. Such review processes usually require a CPO to conduct a benchmarking exercise to assess tariffs of comparable networks regionally or nationally. This review provides a benchmark against which to compare the CPOs proposed new tariff against. During the review the buyer may ask the CPO to present up-to-date data on electricity usage and costs, back-office and customer service cost, distribution network charges, profits and utilisation current and forecast. Once all this data has been considered NHS Wales may then agree to a tariff increase in line with or below the benchmark tariff or any national standard information available at the time.

14.5 Routes to Procurement

The Welsh Government is developing a bespoke framework for the procurement of charging infrastructure, aimed to be available form late 2023. As noted in the Electric Vehicle Charging Strategy for Wales, investing in EVCI can bring material economic and employment benefits to Welsh communities, a framework developed specifically for Wales furthers the realisation of these benefits.

Additional, benefits of the Welsh Government's procurement framework are listed in Table 14.6.

Table 14.6: Benefits to Welsh Government's procurement framework

Benefit categorisation	Benefit
Control	Retaining full control over supplier evaluation criteria and award to ensure buyers are confident in approved suppliers.
Control	Retaining control over the framework structure to more adequately support local Welsh suppliers
Control (future proof)	Ensuring that a new and future facing procurement route for EVCI is available to Welsh buyers and suppliers for the next few years to assist with Welsh transport decarbonisation ambitions.
Consistency	Allowing for complete inclusion of Welsh specific requirements across the procurement process e.g. Welsh signage or accessibility
Consistency	Ensuring a clear, one stop shop for Welsh public sector organisations to procure EVCI and a route for Welsh-specific technical support.
Consistency (funding)	Facilitating the creation of Welsh specific EVCI funding arrangements, and, if desired, a more consistent funding approach across Wales.
Accessibility	Providing instructions on how to use the framework in the Welsh language.
Policy alignment	Aligning the procurement process with Welsh procurement strategy and wider EVCI related policy initiatives.

Source: Welsh Government

Proposed framework lot structure

The Welsh Government's procurement framework will be comprised of four lots to ensure buyers can efficiently target the suppliers most suitable to providing solutions to their EVCI service requirements.

- Lot 1 – Electric vehicle Charge Points
- Lot 2 – Emerging charging technologies
- Lot 3 – Advisory Services
- Lot 4 – End-to-end service

Lots are expanded upon in Figure 14.1.

Figure 14.1: Welsh Government framework lot structure

Lot	*Lot 1* **Electric Vehicle Charge Points**	*Lot 2* **Emerging Charging Technologies**	*Lot 3* **Advisory Services**	*Lot 4* ***End-to-end service***
Services	1a. Planning and Design 1b. Supply, Installation, Construction, Commissioning 1c. Network Operation, Back-office Solutions 1d. Service and Maintenance 1e. End-to-end Service	2a. Renewable Energy Generation 2b. Energy Storage Solutions 2c. Pantograph and Megawatt Charging[3] 2d. Wireless Charging 2e. Mobile Charging 2f. Bi-directional Charging and Services	N/A	N/A
Scope	Covers the procurement of EV charge points through purchase, lease and concession. Customers can select individual services or an end-to-end service via the lot structure. All relevant mature charging types are covered in this lot i.e., Type 1, 2, CCS 1, 2, AC and DC etc. This lot will service: • Cars, vans, mopeds and motorcycles • Large vehicles e.g., HGVs and PSVs • Personal Light EVs (PLEVs) e.g., e-scooters • Electrically Assisted Pedal Cycles (EAPCs) • Specialist vehicles e.g., Blue Light Vehicles	Covers the procurement of new, developing or collaborative technologies in the service areas listed. It is no longer limited to only HGVs or PSVs. This lot also covers bi-directional charging services from back-office providers and aggregators. This lot assumes end-to-end service provision for each service area covered.	Covers the procurement of expertise/services to support EV charging projects and initiatives including: • Strategic partnering guidance • Site planning and feasibility • Energy capacity assessment and demand forecasting/research • Grant funding support • Specification guidance • Power network assistance	Covers the procurement aspects of the goods, works and services required to provide and operate a smart EV charging network from Lot 1 to Lot 3. *Note: the appointment mechanism for Lot 4 will be determined.*

14.6 Key Recommendations

The following key recommendations should be considered for the procurement and operation of EVCI:

- Strategic cooperation between organisations is advised to facilitate, knowledge share and ensure the sustainable expansion of the supporting charging infrastructure for fleet and users alike.
- Develop a high-quality EVCI specification to ensure that a CPO develops and maintains the network as appropriate, so the network meets the needs of its users.
- Develop KPIs in conjunction with the network operator to ensure a resilient and effective EVCI network.
- Fleet EVCI operating models should prioritise only NHS Wales stakeholders.
- Mitigations can be taken during the procurement phase and service delivery to mitigate NHS Wales's exposure to significant tariff increases. However, a collaborative approach to tariff setting should be sought to allow CPOs to generate sufficient revenue to maintain EVCI.

15 Summary of Recommendations

This Best Practice Guidance Documentation is intended to support the organisations within NHS Wales to transition to an electric fleet by discussing key considerations in deploying EV charging.

NHS Wales is currently undertaking an ambitious programme of decarbonisation, making the switch to electric vehicles from traditional internal combustion engine vehicles a key element of the programme. The key recommendations from this report are outlined below.

15.1 Overview of Infrastructure Requirements

1. The required charging infrastructure depends on several factors including the vehicle type, the daily mileage, and the type of site. These factors should be weighed up and accounted for when planning charging infrastructure.
2. The types of charger required depend on use case, however generic requirements have been outlined based on average daily mileage. These use cases should be considered depending upon operational requirement and daily mileage.
3. WAST require specialist rapid charging facilities at or near A&E departments to facilitate the transition to EV for emergency response vehicles, in addition to infrastructure at ambulance stations.
4. Between 7 to 22kW AC should be installed for fleet with average mileage, with 50kW+ recommended for large daily mileages beyond the typical range of EV.
5. Following critical hospital services, the prioritisation for EV fleet recharging should be given to emergency response vehicles, followed by operational vehicles, grey fleet and staff/visitors.
6. Tariffs should be implemented for all NHS Wales chargers that cover all associated costs, with no revenue cost to the organisation and at a rate comparable to other public sector organisations.
7. The method of activating a charger should be hassle-free for users, with RFID cards or auto charging recommended for fleet.
8. All chargers should feature at least Open Charge Point Protocol 1.6 or above.

15.2 Car Parking and Space Planning

1. It is recommended that local authority car parking guidelines are reviewed in conjunction with EV charging specific requirements to understand the impacts.
2. Where infrastructure available to the public is introduced, ensure that it is compliant to PAS 1899:2022 accessibility standards. This may also be introduced for fleet or staff use.
3. EVCI should be positioned such that it is not a hazard to users, either from trips or falls, and should not block footways.
4. EVCI must be given the appropriate spacing from critical infrastructure, as per Section 13 Fire Safety.
5. Parking bays should be clearly marked for EVCI, with DfT approved signs used where chargers are available to the general public. Theses should be supported with parking enforcement, where appropriate.
6. Monitoring of EV infrastructure should be included in any specification to maximise efficiency of provision and develop a timeline for installations.

7. A fair usage policy should apply to charge points. This may include overstay fees to incentivise users to disconnect when fully charged.

15.3 Planning Constraints

1. EVCI generally has permitted development rights to be installed in lawfully used off-street parking facilities, however sites should be checked on a case-by-case basis.
2. Planning permission should be sought where Class D and Class E of the GPDO cannot be satisfied, particularly if chargers are large (e.g. DC).
3. When planning an installation, guidance should be sought from the local council to confirm whether planning permission is required or not, and/or seeking out published guidance notes.
4. EVCI should be located away from listed buildings, however where this is not possible, consultation with the local planning authority may be required.

15.4 Electrical Infrastructure

1. The local existing electrical infrastructure should be assessed to understand electrical constraints.
2. The connection requirements and additional load for the EV charging infrastructure should be assessed to understand whether network upgrades are needed. Additional details on understanding the existing network capacity, additional demand requirements and grid connection process are outlined in **Section 9 Electrical Demand**.
3. An appropriate footprint plan should be developed and the electrical constraints of the existing infrastructure assessed to prevent electrical issues.
4. Metering, control and communication requirements should be understood.
5. Consider potential use cases for Vehicle to Grid applications to manage grid load.
6. Ensure compliance with relevant standards and planning requirements.

15.5 Electrical Demand

1. Understand required additional capacity to be connected.
2. Understand the existing infrastructure ratings and constraints, as well as existing demand.
3. Consult local DNO to determine grid connection requirements.
4. Complete grid connection process.
5. Obtain required planning permissions before performing grid connection works.
6. Develop a reliable load management strategy to ensure adequate efficiency of charging network.
7. Assess potential risks and impact on existing electrical grid due to the connection of the EV charging infrastructure.

15.6 Renewable Energy

1. Where grid capacity is constrained across the NHS Wales estate, investigate the potential for the installation of renewables to complement EVCI.
2. Ensure the range of renewables technology available is appropriately investigated, using the outlined process, to effectively support wider energy and cost requirements.
3. If possible, integrate renewables with EVCI deployment to reduce dependency on the grid.
4. Ensure any deployment of renewables does not interfere with the backup generators on-site for critical patient care infrastructure.
5. Ensure that renewable energy procured is compliant with relevant standards.

15.7 Carbon Savings Analysis

1. Significant reductions could occur from converting the existing fleet to EVs, ranging from 44% to 74% reduction depending on the organisation. Opportunities to maximise carbon reductions should be considered as a priority.
2. When planning the rollout of EVCI, the embodied emissions of the infrastructure is an important factor to consider. Design, procurement and construction should minimise emissions where possible.
3. When planning the rollout of EVs, the embodied emissions associated with the Evs is an important factor to consider. It is recommended the existing fleet is assessed for age and condition and be utilised as much as possible before switching to Evs.
4. In line with **Section 10 Renewable Energy**, explore the use to renewable energy sources as this would further reduce emissions compared to using grid electricity.

15.8 Climate Change Resilience

1. Focus on safety, continuity of services and protection of assets when positioning and planning for EVCI.
2. Ensure the site risk assessments accounts for potential environmental hazards, including those arising from climate change such as extreme heat or cold and flooding.
3. The suitability of the charging location for canopies for protection against severe weather should be assessed, located away from locations of potential flooding.
4. Ensure stand by power support is readily available for rapid response vehicles providing critical care, when power supplies fail to prevent a loss of service. Other essential vehicles should also have access to power that perform critical roles.
5. Develop a business continuity plan to outline actions when extreme weather or power cuts interrupts service, including actions such as using the public charging network.

15.9 Fire Safety

1. Ensure compliance with relevant fire legislation
2. Continue to monitor changing legislation to ensure ongoing compliance
3. Provide high quality prevention and warning systems are installed in areas where EVCI is implemented that are integrated with the wider site
4. Mitigate the risk of potential fires by ensuring ‘good housekeeping’, use of fire drills as well as awareness raising

15.10 Procurement and Operating Models

1. Strategic cooperation between organisations is advised to facilitate, knowledge share and ensure the sustainable expansion of the supporting charging infrastructure for fleet and users alike.
2. Develop a high-quality EVCI specification to ensure that a CPO develops and maintains the network as appropriate, so the network meets the needs of its users.
3. Develop KPIs in conjunction with the network operator to ensure a resilient and effective EVCI network.
4. When selecting operating models for fleet vehicle charge points only NHS Wales stakeholders should prioritise Public own and operate and Private own and operate arrangements. Buyers should seek internal or external procurement advice in making this decision.

5. NHS Wales buyers should use Welsh Procurement portal, Sell2Wales, and when available the Welsh Government bespoke framework for the procurement of EV charging infrastructure.
6. Mitigations can be taken during the procurement phase and service delivery to mitigate NHS Wales's exposure to significant tariff increases. However, a collaborative approach to tariff setting should be sought to allow CPOs to generate sufficient revenue to maintain EVCI.