Minimum Technical Specifications for BEVs

1 Introduction

1.1 Purpose of the document

This document aims to support Welsh Local Authorities with their pre-market engagement and procurement of battery electric waste, recycling, and street cleansing vehicles by providing a minimum set of requirements to ensure that battery electric vehicles are:

- fit for purpose,
- can be charged safely and reliably,
- are delivered on time and supported throughout their life,
- and can provide the highest quality data to better inform the procurement of additional vehicles.

1.2 Structure of this document

Procurement specifications for conventional diesel vehicles typically set out exactly **how** suppliers should meet the requirements by providing a detailed set of *technical specifications* for the powertrain, chassis, body, and equipment.

Taking this approach for new to market battery electric vehicles could potentially restrict competition between suppliers and prevent suppliers from developing innovative solutions by being overly prescriptive. As such, this document instead focuses on **what** the supplier should be expected to deliver (*outcome specifications*) so that they can propose the best solution to meet the functional requirements of the vehicles and share some of the risk to ensure that the vehicle can do the job required.

1.3 Audience for this document

This document is primarily aimed at fleet, waste, and procurement managers involved in acquiring new to market battery electric waste, recycling, and street cleansing vehicles, including, but not limited to:

- refuse collection vehicles (RCV),
- resource recovery vehicles (RRV),
- and truck mounted sweepers.

This document has been produced by Cenex on behalf of Welsh Government and Local Partnerships as part of ongoing expert support to the Ultra-Low Emission Waste and Recycling Vehicle Programme.

More information about the programme can be found on the project website below, alongside battery electric vehicle planning tools, infrastructure guidance documents and best practice from other Welsh Local Authorities from quarterly knowledge sharing workshops.

https://welshulev.cenex.co.uk/

2 Minimum Technical Requirements for Battery Electric Vehicles

As a minimum it is suggested that you should include the following sections in your specification for battery electric vehicles and any associated electric vehicle charging infrastructure:

1. **Battery Electric Vehicle and Charging Requirements** – what does the vehicle need to do?
2. **Telemetry Systems** – what data needs to be collected from the vehicle and chargepoints?
3. **Delivery Timescales** – when will the vehicle be delivered and what steps are involved?
4. **Training** – what training will be provided to drivers, loaders, and maintenance technicians?
5. **Aftersales Support & Account Management** – where and when will issues be dealt with?
6. **Warranty** – what are the warranty periods and conditions?

The requirements in this document should be considered as the absolute minimum, and you are encouraged to both tailor them to your needs and exceed these standards where appropriate. Consideration should also be given as to which requirements are *essential* and which can be categorised as *desirable*, thereby ensuring that any proposed solutions are not over specified or constrained.

2.1 Battery Electric Vehicle and Charging Requirements

First and foremost, it is important to specify a vehicle that will be fit for purpose both now and over the lifetime of the vehicle. To do this, you must provide suppliers with as much information as possible on the vehicle requirements, duty cycles, and round / route characteristics. This information can then be used to specify the electric powertrain and battery capacity required for the vehicle (electric motors, transmission, power take-off (PTO), batteries, and charging equipment).

Chassis Type:

Battery electric waste, recycling, and street cleansing vehicles are currently available from ***Original Equipment Manufacturers*** (OEM) or from low volume vehicle suppliers that fit an electric powertrain to a ***new glider chassis*** provided by an OEM. Several companies can also ***repower*** and refurbish end of life diesel vehicles to convert them to battery electric vehicles using the existing chassis. You should clearly state which of these options will be accepted to meet the requirements or can specify a warranty period that is acceptable for the chassis / equipment so either option can be offered by the supplier.

Vehicle Type Approval:

Battery electric waste, recycling, and street cleansing vehicles are typically type approved to one of the following standards and the minimum type approval required should be specified: ***Whole Vehicle Type Approval*** (WVTA), ***Small Series Type Approval*** (SSTA), ***Individual Vehicle Approval*** (IVA).

Vehicle Type and Access Requirements:

The ***axle configuration*** (4x2, 6x2, 6x4, 8x4, mid lift, mid / rear steer etc.), ***vehicle dimensions*** (length / width / wheelbase, turning circle etc.) should be specified as normal to ensure that the vehicle meets your operational needs in terms of street access and manoeuvrability.

Payload:

The unladen vehicle weight of a battery electric vehicle is likely to be higher than an equivalent diesel vehicle. ***Payload weight (kg)*** and ***payload volume (m^3)*** should be specified for each compartment on the vehicle. A maximum allowable gross vehicle weight (GVW) could also be specified for safety or operational reasons, but we do not recommend using this as the main or only requirement.

Electric Powertrain:

To specify an appropriately sized electric motor, gearbox / transmission, and power take-off it is important that the vehicle supplier understands the requirements relating to ***top speed***, ***gradeability*** (the maximum gradient that the vehicle is expected to climb), and the ***power requirements of the body and equipment***.

The table below shows which functional requirements you should specify and how they relate to battery electric vehicle powertrain specifications.

Output Requirements	Vehicle Powertrain Specifications
Maximum speed at GVW – for usability it is recommended that most vehicles are specified with a top speed of 56 mph (90 km / h). ***Minimum speed at X % gradient (e.g. 40 mph at 10%)*** – it is recommended that the minimum speed, % gradient, and % payload should all be specified.	Motor Power (kW, peak and continuous). Motor Torque (Nm, peak and continuous). Number of forward and reverse gears. Gear ratio.
Power take-off – the PTO type, location, and power should all be specified to meet the body and equipment requirements (kW, peak and continuous).	

Usable Battery Capacity and Range:

To specify an appropriately sized battery is important that the vehicle supplier understands the drive and duty cycle requirements of the vehicle. If evidence has already been provided that the vehicle is fit for purpose (e.g. through in service trials, vehicle testing, or modelling and simulation), then it may be appropriate to simply specify the battery capacity. If this is the case, then both the ***usable battery capacity (kWh)*** and ***installed battery capacity (kWh)*** should be stated or specified. Usable battery capacity is the amount of energy that can actually be used to power the vehicle, this is smaller than the total installed capacity to help protect the battery and extend its life.

If the vehicle is the first of its kind to be deployed on the fleet, then a reputable vehicle supplier should want to work with the local authority and body / equipment suppliers to undertake a feasibility study before quoting to ensure that the chassis and powertrain are fit for purpose for the application. By stating the duty cycle requirements this puts the emphasis on the supplier to demonstrate that the vehicle will be fit for purpose, you should also request that the supplier states the vehicle powertrain specifications in response so that you can sense check the options and score different solutions (for example if a supplier can provide the same range but with a smaller battery).

The table below shows an example of the duty cycle requirements that you should aim to specify and how they relate to battery electric vehicle specifications.

Output Duty Cycle Requirements	Possible Battery Specifications
Duty cycle details for most demanding day: Distance / operating hours. Payload and number of tips. Fuel economy. Power take-off use. ***Round intensity factors***: Number and type of bin / container collected. Number of compaction cycles. Sweeping time / average fan speed. Elevation gain. Route details / telematics data. Ambient temperature.	***Usable and installed battery capacity (kWh).*** ***Range (km)*** – it is suggested that a list of accepted evidence is stated or specified, this could include in-service trials, vehicle test reports from the supplier or an independent third party (for example using the Zemo Partnership Heavy Goods Vehicle (HGV) or RCV test procedure[1]), or by using simulation software tools like the Vehicle Energy Consumption Tool (VECTO) using the Municipal Utility Cycle[2]. ***Energy consumption (kWh / km or equivalent)*** – same as above but can also be calculated from usable battery capacity and range. Energy consumption determines fuel costs so vehicles with the lowest energy consumption are preferred. Battery voltage (V) and power (kW). Number and configuration of battery packs (fixed or modular). Battery chemistry e.g. NMC (Nickel Manganese Cobalt) that has a higher energy density or LFP (Lithium Iron Phosphate) that doesn't require Nickel and Cobalt, and can provide a longer life.

Care should be taken when specifying the *usable* battery capacity to ensure that there is sufficient spare capacity to account for the most demanding day, seasonal variation, and degradation over time.

Vehicle Charging Capabilities and Equipment: The vehicle charging capabilities should be specified to ensure that the vehicle can be charged in the time available between uses in a safe and efficient manner. It is recommended to specifically state if the vehicle should have an ***onboard charger*** (to convert AC to DC when charging from an external AC chargepoint) or if it can be DC only. ***Charging time*** should be specified and is shown as both the time it takes to charge the battery and the state of charge that it applies to. For example, 12h from 0 to 100% at 22 kW AC or 1h 15 min from 20 to 80% at 160 kW DC.

The table below shows the types of charging requirements that you should specify and how they relate to the charging capabilities of the vehicle.

Charging Requirements	Vehicle Charging Capabilities
Maximum charging time of X hours (e.g. 12 hours) from 0 to 100% - typically this will determine the minimum charging power which can either be AC using a vehicle with a compatible onboard charger or low power DC. ***Minimum charging time of X minutes (e.g. 75 mins) from 20 to 80%*** - this will typically determine the maximum charging power which will usually be achieved through high power DC charging. **Cable length**.	**Vehicle charging capabilities** to meet the required charging times e.g. 22 kW AC onboard charger, 44 kW AC onboard charger, and / or 40 to 160 kW DC.

Care should be taken when stating charging requirements as over specifying the vehicle charging capabilities and electric vehicle charging infrastructure will add unnecessary costs to both the hardware, installation, and power supply required at the site. At the same time, charging times can vary significantly

[1] CVRAS-Chassis-DynamometerTest-Procedures-for-Low-Emission-Adaptations-v12-12July2023.pdf (energysavingtrust.org.uk)
[2] Vehicle Energy Consumption calculation TOol - VECTO (europa.eu)

based on several factors such as the ambient temperature and battery state of charge, so you need to make sure there is sufficient charging power to charge the vehicle in the time required under a wide range of conditions.

2.1.1 Battery Electric Vehicle Output Specification Example

For a first of a kind battery electric vehicle, **it is suggested that you develop an output specification**[3] to define 'what' output the vehicle and electric vehicle charging infrastructure is expected to deliver to meet your requirements (rather than using a typical input specification to define exactly 'how' this should be achieved).

An example output specification for a battery electric RCV is shown below, this should be specified for the most demanding day and should also factor in seasonal variation and performance over time:

Requirement	Possible Output Specification
Operating range	Up to 50 miles on a single charge with 20% battery capacity remaining
Maximum operating time	10.5 hours
Maximum payload	10 000 kg
Maximum speed	56 mph / 90 kph
Charging time	no longer than 12 hours (0 to 100%) with the capability to also charge in less than 75 minutes (from 20 to 80%) if required.
Minimum operational lifetime	5 days a week, 52 weeks a year, for 7 years (1,820 days)
Operating temperature range	-10°C to 35°C with cabin temperature set to 18°C.

Where there are specific input requirements (for example to meet a known need) then these can also be included. For example, you may wish to specify a minimum motor power equivalent to your existing diesel vehicles (e.g. 300 kW), or you may already know that you need a certain power-take off for the compaction body and lifting equipment (e.g. 30 kW).

2.1.2 Electric Vehicle Charging Infrastructure

For most battery electric HGVs, ***22 kW AC charging equipment using Type 2 socket outlets / vehicle connectors is recommended as the minimum standard***. AC charging equipment must be compliant with BS EN 61851-1 and use Type 2 socket outlets / connectors compliant to BS EN 62196.

22 KW charging equipment has the following electrical characteristics:

- Three-phase connected equipment.
- Current rating: 32 A sustained current rating.
- Power: Capable of sustained 22 kW (three-phase) / 7.4 kW (single-phase) power delivery (at 50 Hz, 400 VAC nominal).
- Able to provide charging data for each charging event to you from a back-office/Chargepoint Management System (CPMS).

Battery electric waste, recycling and street cleansing vehicles are also currently capable of charging at 40 to 160 kW DC depending on operational requirements. DC charging equipment must also be compliant with BS EN 61851 and most vehicles currently use the Combined Charging System Combo 2 (CCS2) charging standard.

[3] How to write a specification – Procurement Essentials - CCS (crowncommercial.gov.uk)

It is also suggested that the charging equipment should be:

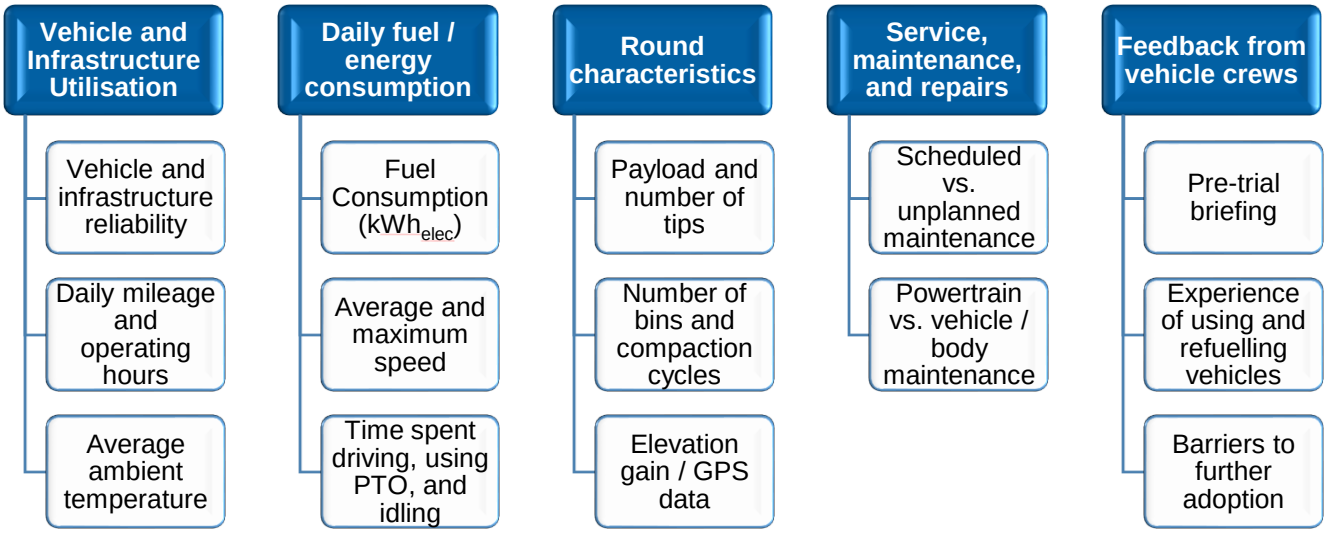
- ***Internet connected*** via wired ethernet, Wi-Fi, or mobile networks.
- ***Compliant with the Open Chargepoint Protocol (OCPP) version 1.6 or above with a supported back-office system*** / Chargepoint Management System (CPMS).
- ***Compatible with relevant hardware or software-based load management systems*** to future proof the installation (if required).
- ***Provided with a meter fitted to each outlet*** to provide energy consumption data to enable billing back to specific services or users.
- ***Fitted with two outlets if the parking layout allows*** and the chargepoint can still provide the required power to each vehicle.

There are many other considerations for procuring electric vehicle charging infrastructure and we would recommend that you read the 'Infrastructure Guidance Documents' on the Cenex website[4] and the 'Technical Schedules' on the NEVIS Procurement Forum website[5] for more information (it should be noted that the NEVIS technical schedules are designed for public charging infrastructure but many of the technical aspects also apply to charging infrastructure in a fleet depot context).

2.2 Telemetry Systems

Battery electric vehicles, waste collection systems, and electric vehicle charging infrastructure should be specified with telemetry systems and automated reporting capabilities to provide either daily or journey summary data on the vehicle usage, performance, and energy consumption (and all the variables that can impact energy consumption).

As a minimum you should specify that suppliers provide monthly update reports or access to an online reporting dashboard that can provide the following data on a day-to-day or journey by journey basis (e.g. ignition on to ignition off):



You should aim to get the most out the vehicle(s) by testing it on several representative rounds, under a wide range of conditions, and make sure that the vehicle is well utilised (both in terms of operational days but also distance and amount of work done). This will maximise the learnings from the initial deployments and provide the best emissions savings / value for public money.

[4] Ultra-Low Emission Waste and Recycling Vehicles - Cenex
[5] Technical Schedules (LEVI)

3 Supplier Capabilities

As well as making sure that the vehicles and infrastructure are compliant with your technical requirements you should also request as much information as possible about the delivery phases and timescales, what training will be provided and when, what level of service will be provided (with a particular focus on how quickly technical issues will be resolved and what measures will be in place to ensure the fleet continues to operate), and what warranty can be provided for each subsystem (e.g. vehicle, body, battery, electric vehicle charging infrastructure).

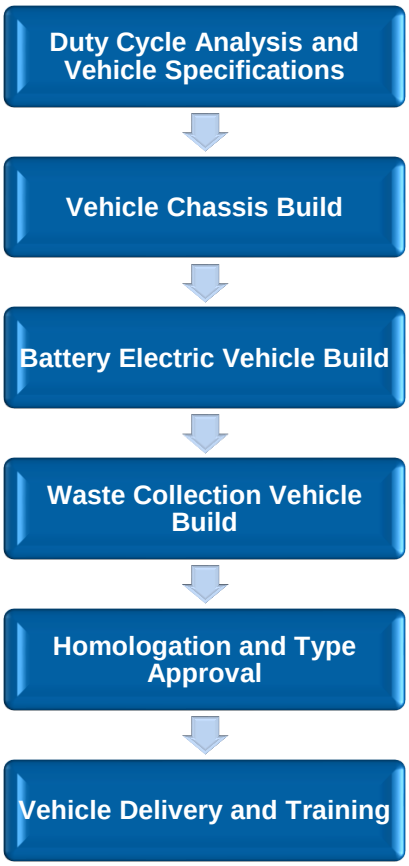
3.1 Delivery Timescales

You should request a detailed delivery plan before placing an order with a potential supplier and set a realistic deadline for the delivery of complete vehicles and infrastructure. This should identify interdependencies with any other suppliers involved in the project and show the timescales and sequence for each individual phase.

You should assess the lead times from potential suppliers to make sure that they meet your requirements and decide whether to include any conditions for late delivery such as the supplier needing to make alternatives arrangements in the event of late delivery (e.g. providing replacement vehicles or equipment, or covering any additional operational costs incurred by delays).

Some suppliers might be able to provide a complete vehicle build from start to finish, but it is also possible that up to three suppliers could be involved in the process of building and delivery a complete vehicle (a vehicle chassis supplier, a specialist electric vehicle integrator / conversion specialist, and a body / equipment supplier).

The figure below shows an indicative process for specifying, building, and delivering a battery electric waste vehicle.



For larger vehicle orders, we would recommend agreeing a stringent set of acceptance criteria with the supplier of the initial vehicle(s) before approving and releasing the orders for additional vehicles. Having a phased introduction of new vehicles is also recommended to reduce the risk of having many vehicles out of operation due to potential teething issues.

3.2 Training

As a minimum suppliers should be required to provide details of what training they will offer, including but not limited to:

- **Driver and operational staff familiarisation training** – to ensure that the drivers are aware of the different systems and driving style required to get the most out of battery electric vehicles, this is also important to prevent misuse of the vehicle during operation.
- **Electric vehicle charging infrastructure training** – to ensure that the driver can safely charge the vehicle and knows what to do if there is an issue with the vehicle or chargepoint.
- **Data collection systems training** – to ensure that fleet managers or data analysts can view and produce the reports they need to monitor the performance of the vehicles and infrastructure.
- **Training for workshop technicians** – to ensure that they can undertake routine inspections and maintenance and are aware of the additional risks associated with working on battery electric vehicles.

Training should be seen as an ongoing process that is started before the vehicle is delivered (introducing the vehicle) and continues during operation either as a refresher training or as training for new starters. We would suggest that suppliers are on hand to support the initial deployment for as long as required to provide reliable and consistent operation.

Many training providers now offer Institute of the Motor Industry (IMI) qualifications in electric vehicles depending on the level of training required for different individuals to undertake their duties.

1. Level 1 – Electric / Hybrid Vehicle Awareness (e.g. for fleet managers).
2. Level 2 – Preparing Heavy Electric / Hybrid Vehicles for Repair (e.g. internal maintenance and repair technicians).
3. Level 3 – Heavy Electric / Hybrid Vehicle Systems Repair and Replacement (e.g. internal maintenance and repair technicians).
4. Manufacturer training on heavy / hybrid vehicle diagnosis and repair.

These courses are increasingly being adapted for heavy goods vehicles and the supplier should be able to recommend what level of training is required, as well as any additional product specific training that could be required as a condition of the maintenance contract or warranty.

3.3 Aftersales Support and Account Management

You should assess what level of aftersales support you are going to receive from potential suppliers including:

- How and where would servicing, maintenance, and repairs take place?
- What spare parts are kept in stock and what are the lead times for critical components?
- How quickly will the supplier respond to issues, how quickly will issues be identified and resolved?
- Will the vehicle have on-board diagnostics systems fitted for self-diagnosis or remote telephone support?
- Will there be a dedicated account manager, how will issues be escalated, and how will disputes be dealt with? Will there be regular visits and meetings to do discuss progress and key performance indicators?
- What will happen in the event of a roadside breakdown, how and where will the vehicle be recovered if needed?
- Will replacement vehicles be made available?

All this information should be captured and formalised in a Service Level Agreement with contractual obligations for both vehicle and service availability.

3.4 Warranty

You should assess the duration, conditions, and exclusions of the different warranties offered by potential suppliers and make sure that they cover the vehicle, body / lifting equipment, battery, and electric powertrain.

As an absolute minimum, we would suggest that you specify the following warranties:

- The vehicle must have a warranty of at least 3 years or 60,000 miles.
- The battery and electric drivetrain must have a warranty of at least 3 years or 60,000 miles (with the option to extend the warranty by a minimum of 2 years).
- The battery must have at least 80% of its initial or rated charge capacity for the initial 3 years or 60,000 miles and at least 70% for the initial 5 years of 100,000 miles[6].

This aligns with the UK Office for Zero Emission Vehicles eligibility criteria for zero emission HGVs to receive financial grants and conforms to the requirements of Directive 1999/44/EC[7].

You should also state the minimum number of charging cycles that will occur over the life of the vehicle. For example, a minimum of at least 1,820 charging cycles over 7 years (if charged once a day for 260 days a year).

3.5 Evaluation Criteria

For first of a kind battery electric vehicles, **you may only have a few potential suppliers to select from during the procurement process and it is therefore essential that you prioritise the quality aspects** when evaluating such responses.

As a minimum, you need to confirm whether the vehicles and infrastructure that have been proposed are compliant with the technical specifications and that you have been provided with sufficient evidence to demonstrate that the vehicles will be safe and fit for purpose.

You should also evaluate whether the supplier has the capacity to deliver the vehicle to your required timescales, but it is likely more important to understand the level of support that will be offered during the commissioning phase and the approach to dealing with issues during ongoing operation.

As an example, you could evaluate tender responses on the following criteria to emphasise the need for suppliers that will work in partnership with you to deliver the best outcomes: 70% quality (30% aftersales support and account management, 20% delivery, 20% warranty), 30% cost, and a check of overall compliance with the specification (pass / fail).

It is also suggested that as part of either the supplier engagement process or procurement process that you ask suppliers to provide evidence of their experience of delivering similar products and services, this could include relevant case studies or testimonials from other customers or project partners.

[6] Plug-in van and truck grant: how to complete the application form - GOV.UK (www.gov.uk)
[7] Plug-in van and truck grant: meeting the warranty criterion - GOV.UK (www.gov.uk)