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Lowering your emissions through innovation in transport and energy infrastructure

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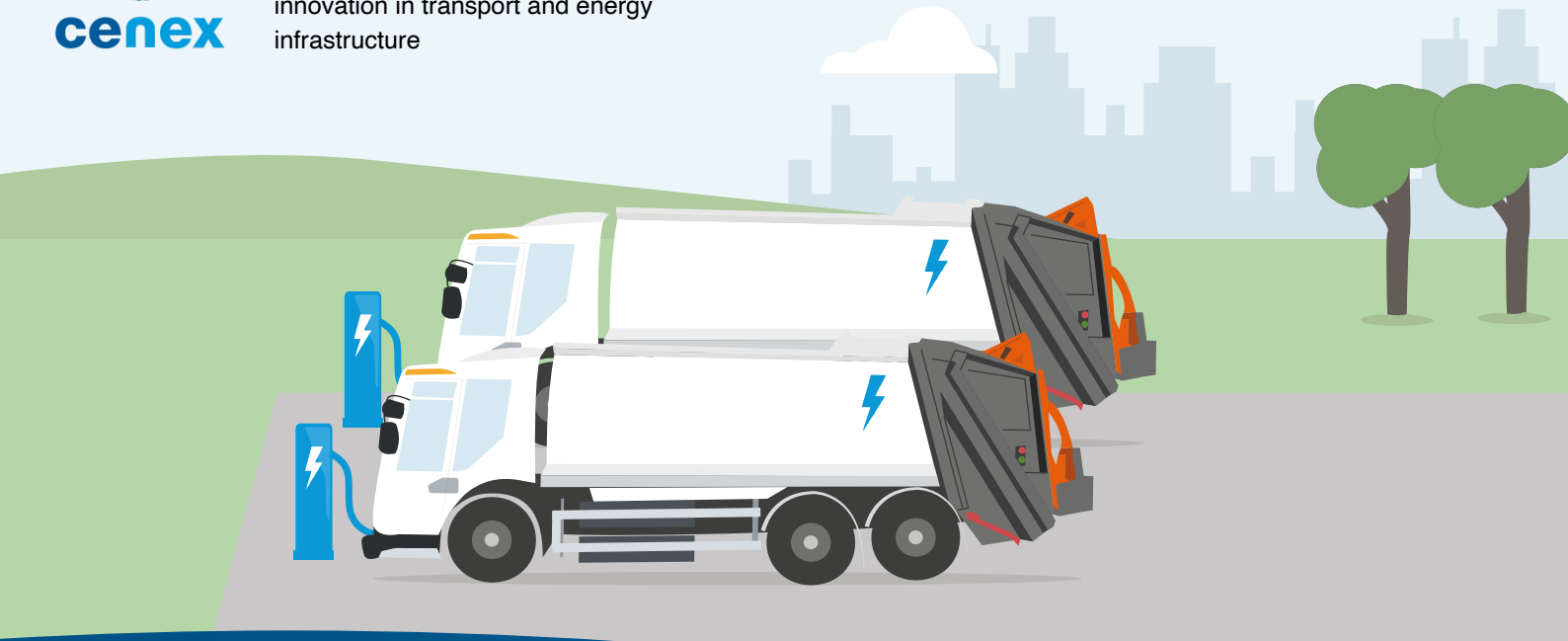


Introduction to Zero Emission Waste and Recycling Vehicles

Cenex Insight

Mercedes Benz eEconic: The eEconic waste collection vehicle is designed to efficiently cover the majority of standard waste collection routes typically managed by an Econic in a single shift, without the need for intermediate charging.

The Challenge

Local authorities and private sector waste fleet operators use refuse collection vehicles and other specialist heavy goods vehicles (HGV) to collect waste and recycling from all households and businesses in the UK. These vehicles are multi-stage builds that are designed to collect and transport recycling, food waste, garden waste, and residual waste from the point of collection to a transfer or processing facility.

In May 2022, the UK Government announced that from 2035, all new HGVs sold in the UK less than or equal to 26 tonnes must be zero emission vehicles meaning that there is now a fixed timescale by which fleet operators will need to transition from their existing diesel fleets to either battery electric or hydrogen fuel cell electric vehicles.

Waste and recycling vehicles are theoretically well suited to transitioning to zero emission vehicle technologies compared to some other more challenging applications because of:

Operations:

Most waste and recycling vehicles operate on fixed rounds and routes of 20-100 miles a day which makes daily energy expenditure easier to understand, and they normally return to the depot overnight which provides plenty of opportunity for charging or refuelling the vehicle before the next shift.

Emissions savings potential:

Waste and recycling vehicles can account for over 75% of the greenhouse gas emissions from local authority fleets, despite typically only accounting for a third of the vehicles.

Several challenges remain that must be overcome before the mass adoption of zero emission waste and recycling vehicles:

Specialist vehicles:

Waste and recycling vehicles have specialist bodies and equipment that need to be powered by the vehicle, this additional energy also needs to be considered when sizing the battery or fuel tanks.

Infrastructure:

Many fleets will need depot based charging or refuelling infrastructure and to prevent it being prohibitively expensive it is important that this is righty sized to match the duty cycles and operating patterns of the vehicles.

Business case:

Zero-emission HGVs cost more to buy than diesel vehicles, but can save on running costs. However, fleets need to invest in infrastructure and grid upgrades, making it economically challenging to transition without extra funding.

Types of Waste and Recycling Vehicles

Refuse Collection Vehicles (RCV)

Refuse collection vehicles are typically 26 tonne rigid trucks with low-entry, walk-through cabs but can also be 12 to 32 tonnes rigid trucks with a variety of different axle configurations including mid- and rear-steer options.

Refuse collection vehicles can be configured to have a single body used to collect mixed recycling, garden waste, or residual waste from households and commercial properties. It is also possible to have two separate or 'split' bodies to collect two different waste streams at the same time and/or to have an additional pod for the collection of food waste or glass recycling.

Resource Recovery Vehicles (RRV)

Resource Recovery Vehicles have several compartments to collect and sort different recycling materials at the source/ kerbside rather than using refuse collection vehicles to collect commingled recycling.

These vehicles typically have a compaction system for plastics and cans, a separate compaction system for cardboard, a sealed stillage for food waste and other compartments for the remaining recyclables.

Terberg Kerbloader

Types of Waste and Recycling Vehicles

Dedicated Food Waste Collection Vehicles

These vehicles collect a single stream of food waste, or other organic waste, in an easy to clean leakproof body. Dedicated food waste collection vehicles are likely to become more common as weekly collections of food waste are introduced for most households across England by 2026.

Sweepers

To keep pavements and roads clean, these vehicles include a set of brushes that dislodge waste, hoses to disperse waste, and a vacuum system that extracts any particles or waste accumulation. These vehicles can be compact sweepers designed for manoeuvrability in urban environments, or truck-mounted sweepers for larger roads and dealing with incidents.

Terberg ORUS

Bucher MaxPowa V65 Sweeper

Battery Electric Vehicles (BEV)

Battery Electric Vehicles have a high voltage battery that is used to store energy and provide power to an electric motor that drives the wheels, they are typically charged from the electricity grid by plugging the vehicle into an AC or DC chargepoint.

Battery electric vehicles produce zero emissions at the tailpipe and can reduce well-to-wheel greenhouse gas emissions by 85% using the UK electricity grid (which consisted of 50% renewables in 2024) to nearly 100% if using exclusively renewable electricity.

Vehicle Availability

Battery electric waste and recycling vehicles are increasingly becoming available in the most common vehicle types and configurations, for example 26 tonne refuse collection vehicles like the Dennis Eagle eCollect and Mercedes-Benz eEconic.

Vehicle availability:

Mercedes-Benz, Dennis Eagle, Romaquip, Electra, Bucher, etc.

Configurations available:

Most common vehicle configurations initially.

Typical specifications:

140 to 420 kWh battery, 22 kW to 250 kW charging.

Operational suitability:

Suitable for many, but not necessarily all duty cycles.

Dennis Eagle eCollect

Battery Electric Vehicles (BEV)

Advantages

- **OEM product** – Battery electric rigid trucks are now offered by all major truck manufacturers, otherwise known as original equipment manufacturers (OEM). These vehicles increasingly come supplied with the power take-off options required for integration with waste and recycling bodies and equipment.
- **Fit for purpose** – Battery electric waste and recycling vehicles have been demonstrated at scale by several waste fleet operators since 2021 including Cardiff Council, Manchester City Council and Biffa, Newport City Council, Nottingham City Council, and Westminster City Council and Veolia.
- **Lower running costs** – Battery electric waste and recycling vehicles are more efficient than internal combustion engine vehicles and already have the potential to reduce fuel costs by 20-60% depending on the price of electricity/diesel and usage patterns. Maintenance costs are currently similar to a diesel waste and recycling vehicle.
- **Depot based infrastructure** – Most waste and recycling vehicle fleets refuel at or near their depot and electric vehicle charging infrastructure can be installed at the depot and scaled as the number of electric vehicles increases (if there is sufficient power supply capacity available).

Disadvantages

- **Operational constraints** – Battery electric vehicles may not yet be suitable for the most operationally constrained applications (e.g. double shifted vehicles, high mileage commercial waste collections, and specialist/niche vehicle configurations) as the real-world range depends on the drive cycles as well as round characteristics and other intensity factors.
- **Higher purchase costs** – Specialist battery electric HGVs typically cost 2.5x more to purchase compared to an equivalent diesel vehicle so the business case must be assessed based on total cost of ownership and on a case-by-case basis.
- **Infrastructure planning** – Fleet operators need to procure appropriate charging at each depot.

Case Study

Westminster Council and Veolia

Westminster City Council has invested £20m in 45 battery electric refuse collection vehicles as part of plans to gradually replace its entire fleet of 85 vehicles.

Westminster City Council's fleet is operated by Veolia and each electric vehicle is expected to save up to 89% in greenhouse gas emissions.

Veolia procured, designed, and operate a new all electric depot including charging infrastructure which is capable of charging up to 54 vehicles at once using smart charging to support the National Grid by charging the vehicles at non-peak times.

Hydrogen Fuel Cell Electric Vehicles (FCEV)

Fuel cell electric vehicles have high-pressure hydrogen tanks that are used to store energy and a fuel cell system that converts hydrogen and oxygen from the air into electrical energy (as well as waste heat and water) to provide power to an electric motor that drives the wheels. Hydrogen vehicles are typically refuelled from large public hydrogen refuelling stations with onsite hydrogen production or from smaller mobile hydrogen refuelling solutions that are refilled with hydrogen offsite.

Fuel cell electric vehicles are typically hybridised with a smaller battery to provide peak power requirements and to minimise transient loads. Fuel cell systems can also be used as a range extender for battery electric vehicles with a larger plug-in battery depending on the energy requirements and duty cycles.

Fuel cell electric vehicles produce zero emissions at the tailpipe and can reduce well-to-wheel greenhouse gas emissions by 12% using the UK electricity grid (which consisted of 50% renewables to 2024) to nearly 100% if using exclusively green hydrogen produced from renewable electricity.

Aberdeen City Council's Hydrogen fleet

Hydrogen Fuel Cell Electric Vehicles (FCEV)

Vehicle Availability

Fuel cell waste and recycling vehicles are currently only available from low volume suppliers such as Hyzon Motors and Faun Zoeller. All major truck OEMs have research and development programmes for hydrogen vehicles, but these are focused on heavy duty regional and long-haul applications and are likely to be limited to customer trials in the short term.

Vehicle availability:

Hyzon Motors, Faun Zoeller.

Configurations available:

Requested vehicle configurations only initially.

Typical specifications:

25 kg hydrogen storage at 350 bar.

Operational suitability:

Theoretically suitable for most duty cycles.

Advantages

- **Fewer operational constraints** – Hydrogen has a higher gravimetric energy density (energy/ weight) than batteries so you can theoretically store more energy on the vehicle for the same weight, but fuel cell electric vehicles are also less efficient than battery electric vehicles so whilst they may be more suitable for some energy intensive waste and recycling vehicle applications, it will depend on the duty cycles and vehicle specifications and should be assessed on a case by case basis.
- **Short refuelling times** – Hydrogen waste and recycling vehicles can refuel in around 15 minutes which could be a benefit for some vehicles that need short refuelling times like those that are double shifted or respond to incidents, but it is less likely to be a benefit for waste and recycling vehicles that could already potentially charge overnight instead.

Hydrogen Fuel Cell Electric Vehicles (FCEV)

Disadvantages

- **Lack of OEM product** – Fuel cell electric waste and recycling vehicles are currently not commercially available from major truck OEMs. Instead, they are purpose built one-off vehicles produced by low volume vehicle suppliers such as Faun Zoeller. So far only a handful of hydrogen fuel cell waste and recycling vehicles have been deployed in Europe and the UK.
- **Infrastructure availability** – The UK does not currently have a network of public hydrogen refuelling stations but companies like Element 2, Motive Fuels, and others have plans to expand the network in the coming years with a focus on heavy duty applications. As such, waste fleet operators looking to trial or deploy hydrogen vehicles now will either need to procure a mobile refuelling solution or work with a station supplier to build the business case for opening a new public refuelling station nearby. It is not currently economically feasible for most waste and recycling vehicle fleets to justify the investment in a new station based on their own fuelling requirements only.
- **Higher purchase costs** – Specialist fuel cell electric HGVs typically cost 3.5 times more to purchase compared to an equivalent diesel vehicle, and costs will only reduce as more options become available, fuel cell components and manufacturing methods improve, and larger numbers of vehicles are ordered.
- **Higher running costs** – Fuel costs can be twice that of diesel depending on the price of hydrogen, so fleets need access to low-cost green hydrogen at the point of use to provide fuel cost parity with diesel vehicles (approx. £15 / kg or less). Maintenance costs are likely to be similar or higher than a diesel waste and recycling vehicle.

Aberdeen City Council

As part of the Interreg North-West Europe HECTOR project (Hydrogen Waste Collection Vehicles in North West Europe), Aberdeen City Council has deployed one of the first hydrogen fuel cell refuse collection vehicles in the UK.

The new vehicle uses the same chassis, body, and bin lifts as the existing diesel vehicles but has been fitted with a hydrogen fuel cell system, hydrogen storage tanks, and battery by Hyzon Motors.

Journeys will not only result in estimated emissions savings of over 2.5kg CO2e/litre, based on a diesel truck on similar routes, but will also collect data which will allow further rollouts of hydrogen-fuelled waste trucks in the future.

Aberdeen City Council refuel the vehicle from their existing hydrogen refuelling stations where hydrogen is produced onsite via electrolysis using a green electricity tariff.

Aberdeen City Council adds UK's first hydrogen fuel cell waste truck to their fleet

[Aberdeen City Council adds UK's first hydrogen fuel cell waste truck to the fleet | Aberdeen City Council]

[Hydrogen FAQ | Aberdeen City Council]

St Helens Borough Council

St Helens Borough Council has recently introduced 34 new battery electric vehicles, including two resource recovery vehicles and one of the first hydrogen fuel cell refuse collection vehicles in the UK.

Faun Zoeller developed the custom-made vehicle which St Helens believe will help them towards achieving its target of net zero carbon by 2040.

The procurement of vehicles is part of an ongoing plan to replace ageing council vehicles with electric and low-emission alternatives. This initiative aims to save money and cut carbon emissions by hundreds of tonnes every year.

To support the charging of the new electric vehicles, St Helens Borough Council has installed 25 EV charging points in its Hardshaw Brook Depot as the first phase of its EV charging infrastructure. In addition to reducing emissions, the modernisation of the fleet is helping to increase service resilience and efficiency, resulting in less downtime for repairs and reduced maintenance costs.

St Helens Borough Council's growing green fleet, from small vans to recycling collection vehicles.

[UK's first custom-built hydrogen waste collection vehicle arrives in St Helens Borough - St Helens Borough Council]

[Council charges towards net zero with electric fleet upgrade - St Helens Borough Council]

Welsh Government ULEV Waste and Recycling Vehicles Programme

Since 2021, Cenex has been commissioned by Local Partnerships to provide specialist technical support to the Welsh Government funded Ultra-Low Emission Waste and Recycling Vehicles Programme which aims to accelerate and de-risk the transition to zero and ultra-low emission vehicles by 2030.

In the first three years of the programme, Welsh Government, Local Partnerships, and Cenex have helped 11 out of the 22 local authorities in Wales to procure and deploy 38 battery electric vehicles with more to follow. This includes refuse collection vehicles, resource recovery vehicles, and truck mounted sweepers in both urban and rural environments.

The real-world performance data from these vehicles has been used to develop energy models that local authorities can use to understand the potential range of battery electric waste and recycling vehicles before they trial or deploy them based on their specific round characteristics and duty cycles.

The programme also uses this data to provide tools for assessing the total cost of ownership and emissions savings potential of the different vehicle types to enable local authorities to make better informed decisions about which vehicles are already suitable for transitioning to battery electric vehicles.

Welsh Government ULEV Waste and Recycling Vehicles Programme

Performance reports are updated quarterly and presented to local authorities in workshops where they can also share their own experiences of specifying, procuring, and deploying battery electric vehicles and charging infrastructure.

This knowledge is used to develop best practice guidance documents and processes that all local authorities can use to understand how to specify the right charging infrastructure, how to assess the power supply capacity at depots, what data requirements to specify, and how to development minimum technical requirements for procurement specification documents.

For the next stage of the programme, Welsh Government and its partners are aiming to provide even more direct support to local authorities by developing a full process that can be followed all the way from baselining their current fleet operations, through to planning their fleet and infrastructure strategy, and implementing zero emission waste and recycling vehicles and infrastructure at scale across the fleets

Cenex and Waste Fleets

Surrey Environment Partnership

The Surrey waste fleet project helped the district and borough councils as waste collection authorities in Surrey to plan the transition of recycling, waste, and street cleansing fleets to zero emission vehicle technologies and renewable fuels.

Using experience in emissions modelling, transport and infrastructure, Cenex delivered baselining and modelling of the local authority recycling and waste collection and street cleansing services across Surrey. Cenex produced a baselining model of current costs and emissions and another model to estimate the costs and emissions of transitioning to different low and zero emission scenarios for the same fleets.

Surrey Waste Fleet - Cenex

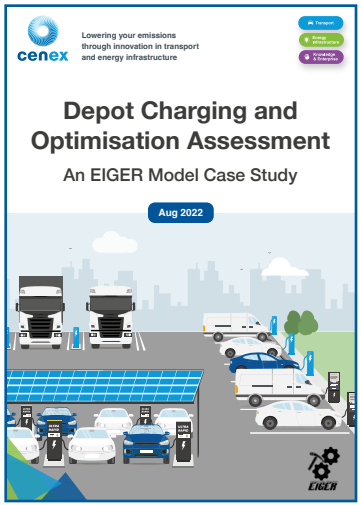
Rushcliffe Borough Council

Rushcliffe Borough Council commissioned Cenex to develop a Zero Emission Vehicle and Infrastructure Strategy for their waste, grounds maintenance and street cleansing services.

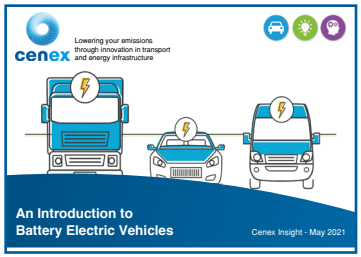
Despite only accounting for 30% of the fleet, 32-tonne rigid trucks, including refuse collection vehicles, produce 65% of the fleets well-to-wheel greenhouse gas emissions. Given the specialist requirements of these vehicles, Cenex engaged with vehicle suppliers to understand the likely availability and maturity of zero emission vehicle options.

Following a detailed assessment of the operational suitability, infrastructure requirements, site power supply capacity, total cost of ownership, and emissions savings potential it was found that 45% of the fleet (mostly light commercial vehicles) could already be transitioned to battery electric vehicles but Rushcliffe would have to consider using hydrotreated vegetable oil or consider making operational changes to better accommodate zero emission vehicles for their 32-tonne rigid trucks.

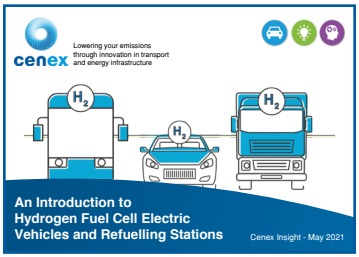
Further Reading



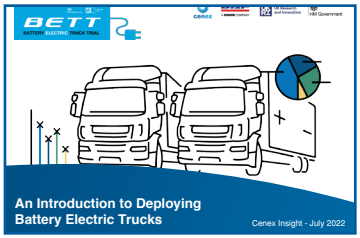
Depot Charging and Optimisation Assessment



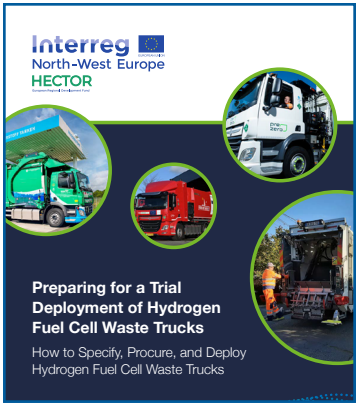
An Introduction to Battery Electric Vehicles



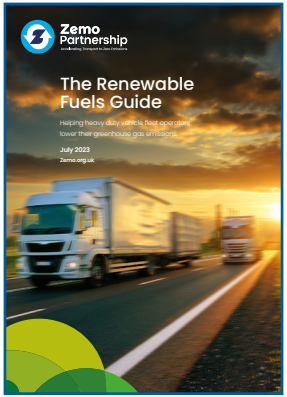
An Introduction to Hydrogen Vehicles and Refuelling Infrastructure



An Introduction to deploying Battery Electric Trucks



Preparing for a Trial Deployment of Hydrogen Fuel Cell Waste Trucks



Renewable Fuels Guide

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