cenex

Lowering your emissions
through innovation in transport
and energy infrastructure

An Introduction to Zero Emission Fire & Rescue Fleets

Cenex Insight - April 2023

The Emergency One E1 EVO, set to be trialled by London Fire Brigade and Scottish Fire & Rescue Service in 2023. Credit: Emergency One Group

The Challenge

Emergency service fleets, like all fleets, must lower their emissions in line with net zero and sustainability targets, particularly the end of new combustion engine sales in 2030.

It is important all fire & rescue vehicles transition to zero emission technology, which can be challenging for a variety of reasons, including:

> Emergency response vehicles are in use 24 hours a day, need to be available at short notice, and driven at sustained high speeds.

> Fire appliances use a power take-off from the internal combustion engine (ICE) to pump water and undertake other firefighting activities.

> Regional coverage is provided by many sites with relatively few vehicles at each. This means that infrastructure requirements must be planned and implemented on a site-by-site basis and there is a risk of overprovision of infrastructure to meet their operational requirements.

Fleets also have a wide variety of vehicles in use across multiple operational requirements which can make it difficult to identify a specific technology, or technologies, that is most appropriate.

Presently, zero emission vehicle technologies have not been deployed as front-line fire appliances in the UK but there are several vehicles in development.

It is therefore important to gain a full understanding of the fleet – including daily mileage variation, vehicle specifications, and operational constraints – before making decisions on which technology to deploy.

Cenex can provide emergency services with the knowledge and tools required to make informed decisions about zero emission vehicles and will continue to develop support for an efficient and effective transition.

Vehicles

Fire & rescue services use a wide range of vehicles in their fleet, from pool cars and community engagement vehicles to Type B Fire Appliances and specialist vehicles, each with their own operational and technological requirements.

While annual and daily mileages can be low across the fleet, Type B fire appliances, and other vehicles with significant power take off requirements, will have high energy demands.

This means that fire appliances have the highest per vehicle greenhouse gas (GHG) emissions and will account for the majority of the fleet's emissions.

Zero emission technologies for Type B fire appliances have not yet been demonstrated in real-world operations, however there are several in development, including:

> Emergency One E1 EV0, expected to be trialled with London Fire Brigade and Scottish Fire & Rescue Service in 2023, has a 280 kWh battery, up to 150 kW PTO, and ICE range extender for pumping water at prolonged incidents.

> ULEMCo, with Oxfordshire County Council and Oxfordshire Fire & Rescue Service, shared findings of a study into zero emission fire appliances, featuring a 220 kWh battery with a fuel cell range extender and 8 kg of hydrogen to meet driving and pumping requirements.

ULEMCo is developing a hydrogen fuel cell and battery electric fire engine. Credit: ULEMCo

An Introduction to Zero Emission Fire & Rescue Fleets

Vehicles

Battery electric and fuel cell electric vehicles would have sufficient range to complete most journeys however prolonged incidents could require vehicles to charge / refuel or rotate out during an incident.

Both battery electric and fuel cell electric 18 t rigid trucks are currently at least three times as expensive as a diesel vehicle over its lifetime, so it is not yet economically viable to replace an entire fleet.

Cenex therefore recommends trialling vehicles to understand the impacts and developing technologies for fire & rescue applications.

Battery electric medium cars are available today to replace pool and community engagement vehicles with sufficient range to complete the average daily mileage and journeys up to 180 miles.

They cost an additional £7,800 to purchase, which should reduce in the next five years, and they already provide total cost of ownership savings of £2,000 per vehicle (on average) and GHG emissions savings of at least 67% using the current electricity grid.

Battery electric large vans currently have sufficient range to complete average daily mileages and can complete individual journeys up to ~90 miles without needing a top up charge. They currently provide total cost of ownership savings of £5,200 on average but require significant additional capital funding.

London Fire Brigade will roll out 50 Volkswagen ID3 in 2023, with 200 miles range and boot space for PPE. Credit: London FIre Brigade LinkedIn

Chargepoints

Fire & rescue fleets will need to develop a detailed understanding of their journey patterns, dwell times and daily energy requirements to plan for, and optimise, their charging infrastructure.

Cenex recommends the lowest-power charger that can deliver the relevant energy in the available time as this has a lower cost and the least impact on the grid connection.

The number of chargepoints required is closely linked to the number of vehicles charging and the amount of downtime, for example:

- For a large number of EVs charging for longer periods of time, a greater number of chargepoints will be required but at lower speeds
- For a large number of vehicles charging for shorter periods of time, fast or rapid chargepoints become necessary to ensure adequate charge.

Infrastructure costs can be minimised by ensuring there is not an overprovision of chargepoints or power supply to a site through the following mitigation measures:

- Sharing chargepoints between vehicles and services, such as local Police
- Load management systems to prevent the electricity supply from being overloaded
- Engage with the DNO early to get accurate connection cost budget estimates
- Plan for future chargepoints.

Although using the public charging network is not ideal, it is likely that vehicles will occasionally have to use them.

Innovative Infrastructure

Wireless charging

Wireless charging technology is in the early stages of development but presents an innovative option for emergency fleets in the future.

Where vehicles are parked regularly for short periods of time, static wireless charging allows the battery to top up in short bursts.

From an operational perspective, there are time savings in not having to plug and unplug charging cables each time.

Vehicle-to-Grid (V2G)

V2G is a system whereby plugin electric vehicles, when connected to a V2G charger, can provide bi-directional flows of energy to charge, store and discharge electricity when necessary.

By controlling the timing of charging and discharging, customers can use less carbon-intensive or cheaper electricity, and reduce battery degradation.

Research by Cenex shows that vehicles with high plug-in times optimise the benefits of V2G, and would therefore suit non-response vehicles best.

Hydrogen

A fixed hydrogen refuelling station (HRS) with onsite hydrogen production offers an economic solution for large scale fleets and is the business model for most public refuelling stations but requires high capital expenditure and is a complex long-term project.

A whole fire & rescue fleet could generate reasonable demand for a typical public hydrogen refuelling station at a single location. However the demand at each individual location is much lower and the majority of demand would come from vehicles that can reasonably transition to electric.

Collaborating with other public service fleets, such as council vehicles or ambulance and police services, could generate the demand from specialist vehicles required to justify the business case for a HRS.

Low Emission Technologies

Hybrid Electric Vehicles

Hybrid vehicles require two energy sources, a plug-in battery and an internal combustion engine.

Cenex suggests hybrids should only be used where a suitable zero emission vehicle does not exist, or where operational constraints make it the only suitable option and are best deployed where typical days can be completed in electric only mode, but flexibility is required on an infrequent basis.

Fire & rescue services could consider trialling a low number of hybrid vehicles as a stepping stone to zero emission technologies for more operationally constrained vehicles.

Hydrotreated Vegetable Oil (HVO)

HVO, or renewable diesel, is chemically similar to standard diesel, therefore is considered a direct replacement or 'drop-in fuel'.

It could be used to fuel Euro VI Type B Fire Appliances, and other specialist heavy vehicles, as an interim solution to reduce emission while fully zero emission vehicles are developed.

This would increase revenue costs but is considered a low risk and reasonably cost effective method of reducing emissions from applications that are operationally challenging.

Hydrogen Diesel Dual Fuel (H2 DF)

H2 DF vehicles use a modified diesel compression ignition engine to burn a mixture of hydrogen and diesel, with emissions saving of 30-40%.

Fuel cost increase as the engine has a similar efficiency when operating in dual fuel or diesel only mode, and hydrogen is more expensive.

It could be considered as an option for seeding demand for hydrogen refuelling stations and green hydrogen as part of a hydrogen strategy.

Essex Fire & Rescue Fleet and Infrastructure Strategy

Essex Police and Essex County Fire & Rescue Service commissioned Cenex to develop a Zero Emission Vehicle Fleet and Infrastructure Strategy.

Cenex took a baseline of the current fleet composition and emissions and used this to assess the suitability of battery electric and fuel cell electric vehicles, then calculated the number and type of charging infrastructure required and the potential demand for renewable hydrogen by location.

The results summarised the capital costs, running costs, and emissions impacts of different replacement scenarios, as well as a detailed fleet transition roadmap and action plan.

They show that 55% of the fire & rescue fleet could be replaced by battery electric vehicles that have sufficient range to complete their average daily mileages and already provide total cost of ownership savings, as well as reduce GHG emissions by 16% based on the current UK electricity grid.

Type B Fire Appliances, and other 18 t rigid trucks, account for 64% of the fire & rescue fleet GHG emissions.

Cenex recommends Essex Fire & Rescue evaluate their duty cycles and develop options for trialling battery electric and fuel cell electric heavy vehicles to see what role they can fulfil in the fleet and what operational changes may be required to accommodate them.

Cenex and Emergency Service Fleets

Zero Emission Fleet Vehicles for European Rollout

As part of the pan-European ZEFER Project, the Metropolitan Police Service (MPS) operates 10 FCEV Toyota Mirais as general purpose police vehicles, joining 11 Mirais already in its fleet.

To date they have completed around 207,700 km using 2,391 kg of hydrogen dispensed from three HRS, predominantlyTeddington in central London.

Cenex lead on the vehicle and HRS monitoring and provide independent assessments of the commercial, operational and environmental performance.

Low Emission Vehicles for Police Fleets Workshop

Cenex ran low emission vehicle and infrastructure masterclasses to support staff across a Constabulary.

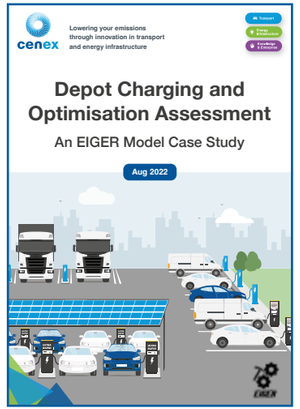
The programme covered an introduction to the different technologies, operational performance, maintenance requirements and charging equipment as well as policy, finance, and future innovations.

NHS England and NHS Improvement (NHSEI)

Cenex is working with NHSEI on a transport and travel project to support the transition of the NHS ambulance and non-ambulance fleets to zero emissions as cost-effectively, efficiently, and rapidly as possible.

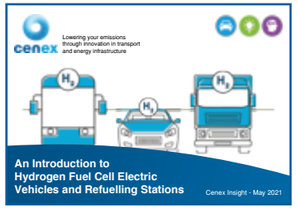
The recommendations will prioritise a safe, patient-centred service and encourage cleaner modes of transport for hospital staff and visitors.

Further Reading



Depot Charging and Optimisation Assessment

An Introduction to Battery Electric Vehicles



An Introduction to Hydrogen Vehicles and Refuelling Infrastructure

NVN: First Response Hybrid Motorcycle

Case Study: Essex Police and Fire & Rescue Fleet & Infrastructure Strategy

An Introduction to Zero Emission Police Fleets

Transport

Energy Infrastructure

Knowledge & Enterprise

cenex

Lowering your emissions through innovation in transport and energy infrastructure

Find more free-to-access resources and reports at www.cenex.co.uk/resources

Cenex

Tel: 01509 642 500
Email: info@cenex.co.uk
Website: www.cenex.co.uk
Twitter: @CenexLCFC
LinkedIn: Cenex