BETT
BATTERY ELECTRIC TRUCK TRIAL

cenex
DAF A PACCAR COMPANY
UK Research and Innovation
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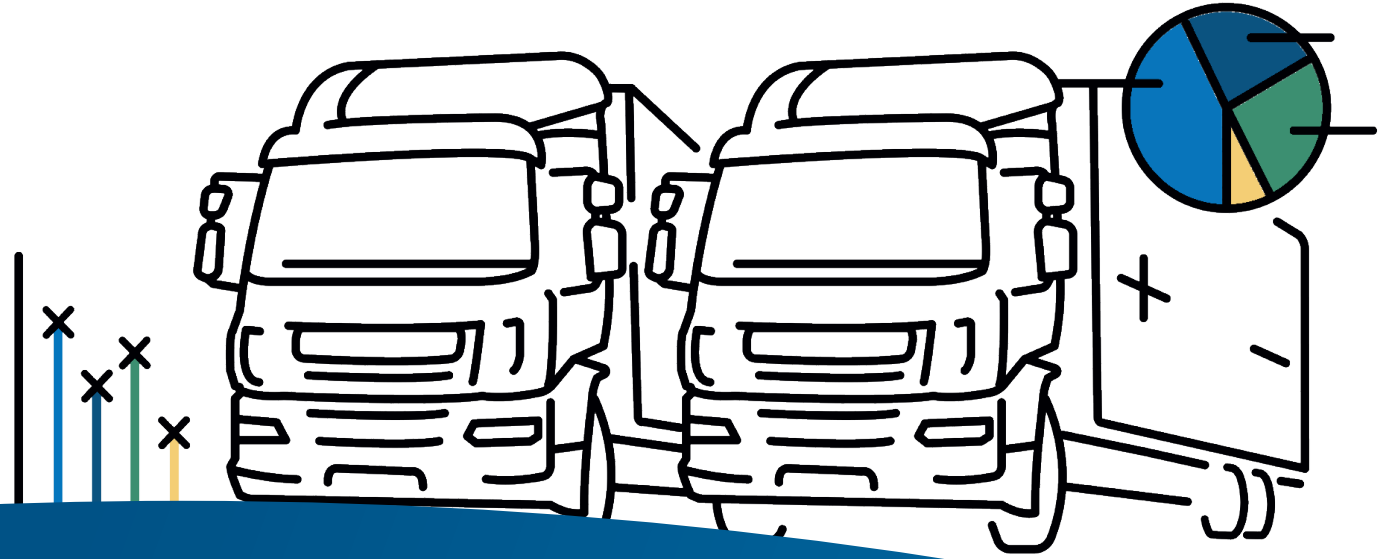


An Introduction to Deploying Battery Electric Trucks

Cenex Insight - July 2022

The Battery Electric Truck Trial (BETT) is using the DAF LF Electric:

- **Vehicle Type:** Rigid Truck, 2 axles (19t GVW)
- **Powertrain:** Electric motor with 282 kWh battery
- **Motor Power:** 250 kW
- **Motor Torque:** 1,200 Nm
- **Operating Range:** 175 miles (claimed)
- **Payload:** 11,700 kg
- **GVW/GCW:** 19,000 kg

The Need to Decarbonise

All vehicles in the UK must switch to zero tailpipe emission alternatives to reach 'net zero' targets by 2050.

Decarbonising heavy goods vehicles (HGVs) will be challenging for several reasons:

- Although HGVs are a small proportion of the UK vehicle parc, they make a relatively high contribution to CO_2 emissions because of their high mileages and low fuel economy.
- The size and weight of HGVs mean they need large batteries to provide sufficient power to move the vehicle.
- HGVs often cover high mileages so they need large batteries and access to chargepoints.

While HGVs are efficient in terms of tonnes of goods moved, the current diesel fleet must be replaced by low emission alternatives to meet UK targets. Low emission vehicles must also meet fleets' operational requirements and be viable in terms of capital, operating, and whole life costs.

Battery electric (BEV) HGVs are classified by Cenex as a medium maturity technology, as manufacturers already offer products for sale in the UK but they are deployed in small numbers, or trials and demonstrations only. Ongoing improvements in battery technology and investment by manufacturers mean that the viability of BEVs is increasing, even for the heaviest vehicles.

While early BEV trucks were low volume retrofit solutions, products are now available from mainstream manufacturers, and product lines are growing. Many manufacturers now have medium duty pure BEVs, with a roadmap for developing heavier articulated vehicles.

There are three main drivers for fleets to consider switching to electric trucks:

1. To reduce emissions
2. To comply with policy and regulation
3. To save money.

Market Trends: Technology

Vehicle manufacturers are developing both BEV and hydrogen fuel cell technology as potential replacements for diesel HGVs. There is ongoing debate about the future role of both technologies for HGVs:

- The Committee on Climate Change forecasts that hydrogen will replace most HGV diesel consumption.
- InnovateUK forecast that BEV and hydrogen fuel trucks will be 50/50 by 2050.

Currently there are no hydrogen HGVs available commercially in the UK from mainstream manufacturers. However, manufacturers are starting to trial and deploy battery electric HGVs – with availability set to double as manufacturers bring new BEV rigid trucks and tractor units to market.

Cenex has developed a series of roadmaps which illustrate the expected introduction of low emission technologies.

The key points from the roadmap are:

Rigid electric trucks:

Up to 2025, medium rigid trucks will appear in low production volumes and demonstration activity. Volumes are expected to gradually increase with the first large-scale national deployment towards the end of the decade, driven by the UK's 2035 and 2040 deadlines for phasing out sales of diesel HGVs.

Artic electric trucks:

Articulated electric trucks will continue to develop and be demonstrated throughout the decade and are likely to be deployed in short haul applications.

Hydrogen:

Articulated fuel cells trucks will be deployed in large scale demonstration trials as we move to 2025, with OEM product availability growing. The transition to mainstream technology is expected to start towards the end of the decade with deployment increasing in line with the availability of hydrogen refuelling stations.

Market Trends: Policy

The main UK policy areas to be aware of are:

- EU targets require HGV manufacturers to reduce fleet-wide average CO_2 emissions by 15% by 2025 and 30% by 2030. Also, at least 2% of new trucks sold must be low or zero emission by 2025. While the UK is no longer in the EU, UK government guidance indicates that these standards and targets will be adopted here .
- The UK will phase out new, non-zero emission HGVs weighing 26 tonnes and under by 2035, with all new HGVs sold in the UK to be zero emission by 2040.

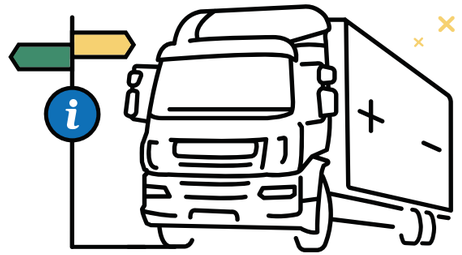
The UK government is helping industry comply with these policies. The UK Government's *Net Zero Strategy: Build Back Greener* committed to expanding the £20 million zero emission road freight trials to trial three zero emission HGVs technologies at scale on UK roads to determine their operational benefits and infrastructure needs. The BETT project is one of these demonstrators.

Cities

Over the last few years cities have played an increasing role in reducing road transport emissions.

- Clean air zones (CAZ) are in place in several UK cities (including London's Ultra Low Emission Zone) with more being introduced. BEVs are exempt from all CAZ charges.
- Scotland is currently introducing low emission zones (LEZ) in several cities , and again electric HGVs will be exempt from charges.

Fleets should prepare for future policy changes by trialling zero emission vehicles.



Assessing Fleet Suitability

An assessment of the suitability of BEVs for your fleet should, as a minimum, consider the following:

Operational:

Vehicles must be practical to meet your needs:

- Range - Vehicle range requirements will depend on the intended duty cycle, access to charging infrastructure, and dwell time.
- Charging infrastructure - Some vehicles and duty cycles work best with depot-located charging. Others will need public infrastructure.
- Payload - Electric HGVs benefit from a derogation which means payload is not reduced by battery weight until very large battery packs are specified.

Financial:

Vehicles should be assessed on a whole life cost basis:

- Upfront cost - Electric HGVs have an upfront price premium which may put additional pressure on budgets. Leasing can help offset this.
- Running cost - Electric HGVs will save money in running costs (energy and maintenance), compared to diesel, as well as on congestion or emissions zone fees.
- Whole life costs - Financial assessment should be based on the total cost of ownership. Typically, savings will be achieved if the lower running costs offset the initial investment.

Environmental:

Vehicles should have clear environmental benefits and be compliant with any local regulations:

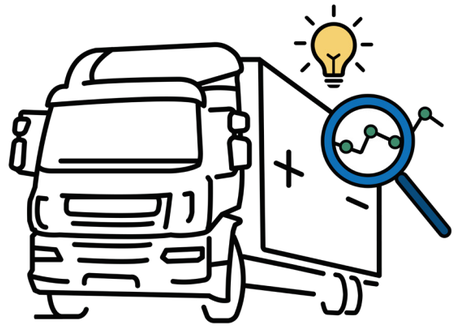
- Pollutant emissions - Electric HGVs have zero pollutant emissions at the point of use.
- CO_2 emissions - Electric HGVs have significantly lower CO_2 emissions than diesel, even on a well-to-wheel (WTW) basis and using standard UK grid electricity.
- Noise and vibration - Electric HGVs are quieter at low speeds, and have less vibration.

Assessing Depot Infrastructure

A depot site assessment is essential to understand how much charging infrastructure is needed, and the site capacity for installation.

The steps below will help you understand the process for a depot site assessment, then assess how much charging infrastructure is needed and estimate hardware and installation costs.

- Review electricity supply. An energy or facilities manager should know the site's size (in kVA or even MVA) of all supplies, or you can inspect the incoming supply to understand its rating and whether it is a single or three-phase connection.
- Identify the location(s) of the supply and distribution equipment to prioritise locations for charging infrastructure. Installing chargers near the power source will help reduce costs.
- Understand the current loads from electrical equipment on site, including any BEVs; ideally one year's worth of half-hourly metering data for each supply.
- Understand the charging capabilities and daily energy requirements of each BEV under typical operating conditions.
- Evaluate the current network connection(s) to determine the energy required and the available charging time.
- Consider future proofing when planning charging needs. If you plan to transition all vehicles to BEV in the next few years, ensure the site has sufficient power available to support this demand.



Fleet and Driver Management

BEVs need to be managed slightly differently to diesel vehicles, particularly around route planning, driving styles and charging strategies.

Route planning is more critical for BEVs due to their lower range on a single charge. This means routes need more careful planning to ensure they can be completed or opportunity rapid charging is available when necessary.

Route planning should incorporate feedback on 'real-world' range from vehicles rather than relying on official range and consumption figures. Telematics systems should be used which track vehicle movements and energy consumption.

For charging during operational use, fleets should consider how charging and dwell time can be related to drivers' hours legislation. Building in charging sessions during driver breaks is an ideal solution.

Driver Training

Providing driver training and feedback on driving style is vital to get the best performance from a BEV.

The real-world range of BEVs is highly sensitive to driving cycle, increased payload, aggressive driving style and use of climate control. Of these, driving style has the greatest impact on range; research by Cenex and Zemo Partnership found an aggressive driving style reduced range by up to 51%.

The reduction in range was greatest in city-centre and urban environments where more braking and acceleration events occur.

This is relatively easy to control with the correct processes and technology and is a 'win-win' on operational benefits, safety, cost and emissions.

Specific BEV driver training should be provided to increase range, supported by use of telematics to enable feedback on driving style and efficiency.

Charging Electric Trucks

Charging is a complex, but important, area to understand to ensure successful BEV deployment.

Charging at the depot will typically be done via fast charging which, despite the name, is a relatively slow rate of charge when considering HGVs' battery capacities. HGVs which are double or triple shifted – without long period of downtime for charging – will rely on charging at higher rates of power.

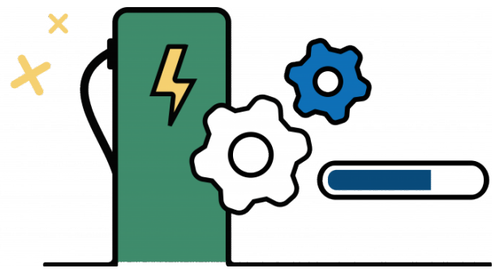
Hardware and installation costs increase with speed of charging, so it is important to match the chargepoint power to each vehicle and application.

Depot-based charging is more convenient and cost-effective than using a public network. This will be the preferred location for charging, where permitted by space and electricity network capacity.

For short haul operations, electric HGVs may be able to complete their duty cycle on a single charge, provided overnight at the depot.

Where depot-based charging is not possible or sufficient, electric HGVs will need access to public chargepoints with high rates of power for opportunity charging during shifts

However, there are few sites currently available which are suitable for larger vehicles due to site access and bay size not accommodating HGVs, the risk of a larger vehicle blocking more than one chargepoint, and cables not being sufficiently long.



About BETT (Battery Electric Truck Trial)

In June 2021, DAF trucks were awarded funding from InnovateUK under the SBRI ZE Road Freight Competition to commence deployment, and undertake research on the performance, of 20 electric trucks in public sector fleets across the Northwest of England.

The trucks on trial are DAF Electric LFs, a 19-tonne battery electric truck. The truck has a range of up to 175 miles on each charge and can be rapid charged at 150 kW for quick turn-around between shifts.

Cenex partnered with DAF trucks to lead the study aspects of the research.

Fleets are keen to shift to zero emission alternatives but there is little information available on the real-world performance of electric trucks. This trial will help understand the best way to implement the vehicles and charging into fleets and inform on any barriers to adoption.

The trucks are being trialled across different types of public sector operations, from logistics to waste management. The trial vehicles include different types of ancillary systems that will operate from the battery, such as tail-lifts and refrigeration units. Nine organisations are using the 20 vehicles.

A key focus of the research is to develop a website and a tool to promote and educate fleet owners on electric truck adoption. The BETT Portal is designed to help remove barriers to adoption of electric trucks.

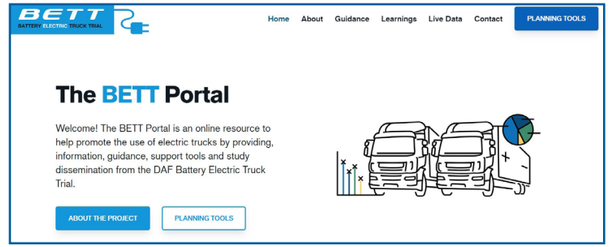
BETT Portal

The BETT Portal is an online resource to help promote the use of electric trucks by providing information, guidance, support tools and research from the Battery Electric Truck Trial.

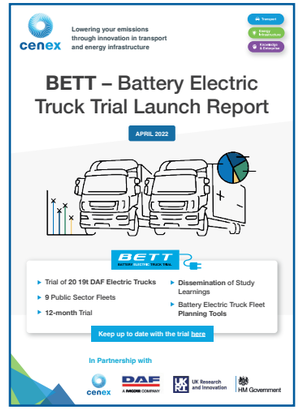
The Live Data Dashboard provides daily information from the trial so you can see top level trial statistics, such as total miles travelled, energy consumption, and vehicle range.

The Fleet Planning Tool will allow you to calculate the expected range and charging times from an electric truck when considering your own duty cycles. An advanced version of the Fleet Planning Tool also allows you to estimate the number of different chargers required, depot power requirements and potential costs.

Research from the trial will be published on a quarterly basis, including insights on attitudes and perceptions, performance, charging, and environmental impacts.



Battery Electric Truck Trial Portal
www.bett.cenex.co.uk



BETT Launch Report
https://bett.cenex.co.uk/assets/reports/BETT-Trial-Launch-Report.pdf

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