Green Finance Institute

Delivering Net Zero:

Unlocking Public and Private Capital for Zero Emission Trucks

1. Foreword

The freight and logistics sector contributed £127 billion to the UK economy in 2022 and is a critical element of UK supply chains.[1] Road freight plays a key role, with around 89% of all goods in the UK being moved directly by road. Heavy Goods Vehicles (HGVs) i.e. vehicles over 7.5 tonnes, covered 19.5 billion kilometres in the UK 2022[2] and today, almost all of these vehicles are diesel powered.[3] Consequently, HGVs represent a significant proportion of the UK's road greenhouse gas (GHG) emissions and the sector must decarbonise if the UK is to meet its Net Zero targets.[4]

Adopting these new technologies poses significant challenges to HGV operators, the needs of whom must be considered and addressed if the transition is to be successful. The challenge of making these changes in an industry where operating margins are slim is not insignificant. An estimated **£100 billion** of investment will be required, delivered through collaboration between the public and private sectors.[5] There is limited time remaining, as many HGV operators in the UK have just one more cycle of replacing their fleet before the diesel truck end of sales dates, which means many are making decisions now that will impact the speed at which they are able to decarbonise in the future.

To help mobilise the capital required, the Green Finance Institute (GFI) brought together global experts from finance, freight and logistics and energy sectors, with leading thinkers from academia and non-profit organisations as well as local and central government, to focus on unlocking the barriers to financing decarbonisation of the HGV sector.

The speed at which the sector can decarbonise will vary depending on the type of vehicle, the job it performs, and the duty cycle. The UK Government has committed to end the sale of new diesel HGVS emission HGVs weighing 26 tonnes and under by 2035, with all new HGVs sold in the UK needing to be zero emission at the exhaust from 2040. This is in addition to the pledge for 30% of all heavy duty vehicles sold in the UK (including coaches and buses) to be zero emission by 2030.

The barriers facing operators are many and varied, so there is no silver bullet solution; a range of approaches will be needed. The financial solutions highlighted in this report, together with policy recommendations, have the potential to demonstrate how the required finance can be unlocked to accelerate the transition to zero emission road freight and ensure the UK meets its Net Zero ambitions.

Green Finance Institute

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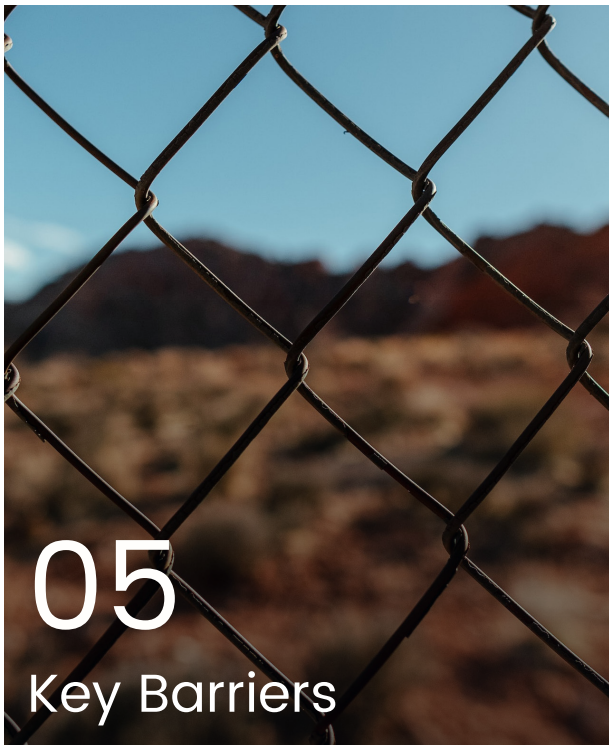

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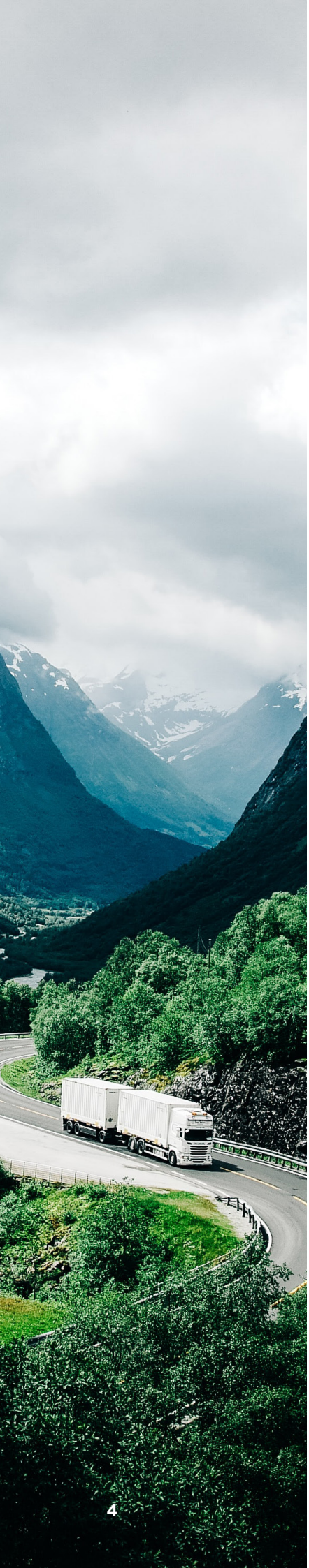
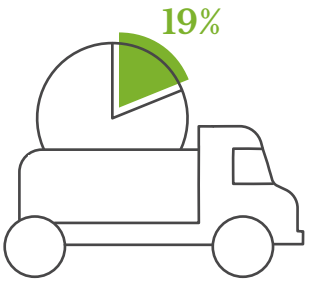


2. Executive Summary

Context

The HGV sector is a priority sector to decarbonise, representing a disproportionately large share of UK transport emissions (19%)[6] relative to the number of vehicles (1%)[7]. As part of its commitment to Net Zero, the UK Government has committed to support the shift to zero emission truck (ZET) technologies through progressive policies and regulation as well as grants and tax incentives. From 2035, original equipment manufacturers (OEMs) will not be able to sell new diesel vehicles under 26 tonnes, and from 2040 they will not be able to sell new diesel vehicles of any weight in the UK.[8] OEMs are already bringing ZETs to market and making zero emission technology central to their strategies, announcing sales targets, redirecting research and development spend and developing strategic partnerships.



of transport emissions represented by HGV sector

ZET technology is rapidly improving, and some ZETs are already capable of achieving comparable ranges to diesel.[9] All ZETs available today use one of two powertrain technologies: battery electric or hydrogen fuel cell. Battery electric trucks excel at applications with short to medium ranges and fixed routes that return to the depot at night to charge. Most models available today offer ranges between 200 - 320 km on a single charge, although some models can offer up to 600 km, which makes them compatible with long haul applications. As of November 2023 there are over 300 battery electric truck models available worldwide. Hydrogen fuel cell vehicles are typically able to offer longer ranges (450 - 700 km) and require less time to refuel, although model availability is more limited (21 models as of 2023).[10]

Despite this progress, adoption of ZETs remains low. There are just 500 (0.1%)[11] ZETs in the UK, out of a total parc of 450,000 vehicles over 7 tonnes.[12] Adoption to date has been dominated by larger companies driven by commitments to reduce their own Scope 1 emissions, and by local government fleets. There are fewer examples of SME operators adopting ZETs, despite SMEs accounting for half of the sector's turnover and truck ownership. According to analysis conducted by the GFI and KPMG, to transition the rest of the UK parc, an estimated **£100 billion** of additional investment will be required.

Barriers

There are a number of barriers to transitioning to ZETs and installing infrastructure from the perspective of vehicle operators and charging infrastructure installers:

1. **High capital cost of vehicles:** Battery electric trucks are generally at least 2-3 times more expensive than diesel equivalents, and hydrogen trucks are even more expensive. Whilst costs are expected to fall (price parity is generally expected by 2030 across the majority of use cases), this upfront price premium can be partially overcome by taking into account the lower running costs.[13] To accelerate this process, further intervention is required, particularly to support small and medium size operators to access the additional capital required.[14]
2. **Lack of infrastructure:** Infrastructure will need to be built to enable ZETs to either recharge or refuel. Operators will need to install chargepoints in depots, and some public infrastructure will also be required, particularly to facilitate long haul operations. There are also currently no hydrogen truck refuelling stations in the UK.[15] The key challenges in building this infrastructure are upgrading the distribution network, and cost: by 2050, between £11 and £24 billion will be needed for depot infrastructure, and £1 to £2 billion for public infrastructure.[16]
3. **Vehicle suitability and availability:** ZET technology is still not suitable for some operations, especially those which require ancillary equipment. Across the majority of existing OEMs, production levels are currently low and lead times can be long.
4. **Technology uncertainty:** Debate continues around whether hydrogen fuel cell or battery electric technology will "win" the race, which is delaying operators from making the switch. In reality, there is no one technology which will be suitable for all use cases and both technologies will have a role to play, depending on the vehicle use case.
5. **Impact on operations:** Adopting new technologies may require changes to day to day operations, including changes to route planning and downtime scheduling, or use of different types of vehicles.

Solutions

There are a variety of financial solutions and policy levers that could be implemented to address these barriers and unlock investment in ZETs and infrastructure. If all HGVs are to be zero tailpipe emission, it is particularly important that these solutions support smaller operators who do not have the same access to finance as larger fleet owners.

Policy

A stable and supportive policy environment will be key to supporting investment at the pace and scale required. The UK Government has laid the groundwork by setting end of sales dates for new diesel trucks, and the large scale zero emission HGV and infrastructure demonstrator (ZEHID, previously known as zero emission road freight demonstrator, or ZERFD) project will be crucial in understanding how to scale battery and hydrogen technologies for long haul transport.[17] Beyond this there are several key policy levers which could be considered to further drive investor certainty and support the sector in its transition, including the introduction of a zero emission vehicle (ZEV) mandate for trucks, a comprehensive ZET infrastructure strategy, and measures to support smaller operator access to ZETs.

Financial Solutions and Next steps

To unlock the investment required, the GFI brought together global experts from finance, freight and logistics and energy sectors, with leading thinkers from academia and non-profit organisations, as well as local and central government, to innovate the solutions required to finance ZETs and charging or refuelling infrastructure.

Ten demonstrator solutions were identified, as shown in Table 1. Many of these are applicable to smaller HGV operators which require greater support to transition. Stakeholders assessed the solutions based on scale of impact on ZET and infrastructure uptake, and ease of implementation, as shown in Figure 2. The GFI will work with interested parties to bring these to market to demonstrate how they can be used to mobilise capital at scale.

> *"Heavy goods vehicles are a big part of the puzzle when it comes to driving down transport emissions. At Connected Places Catapult, we're proud to be working with the Department for Transport and Innovate UK to help bring forward the Zero-Emission HGVs and Infrastructure Demonstration programme. But technology must go hand in hand with policy and investment as we seek to scale solutions. This report proposes mechanisms for driving widescale adoption of zero emission HGVs.* ***It is essential reading for every policymaker in this space."***
>
> **Dr Chris Jones,** Ecosystem Director - Integrated Infrastructure at innovation accelerator Connected Places Catapult

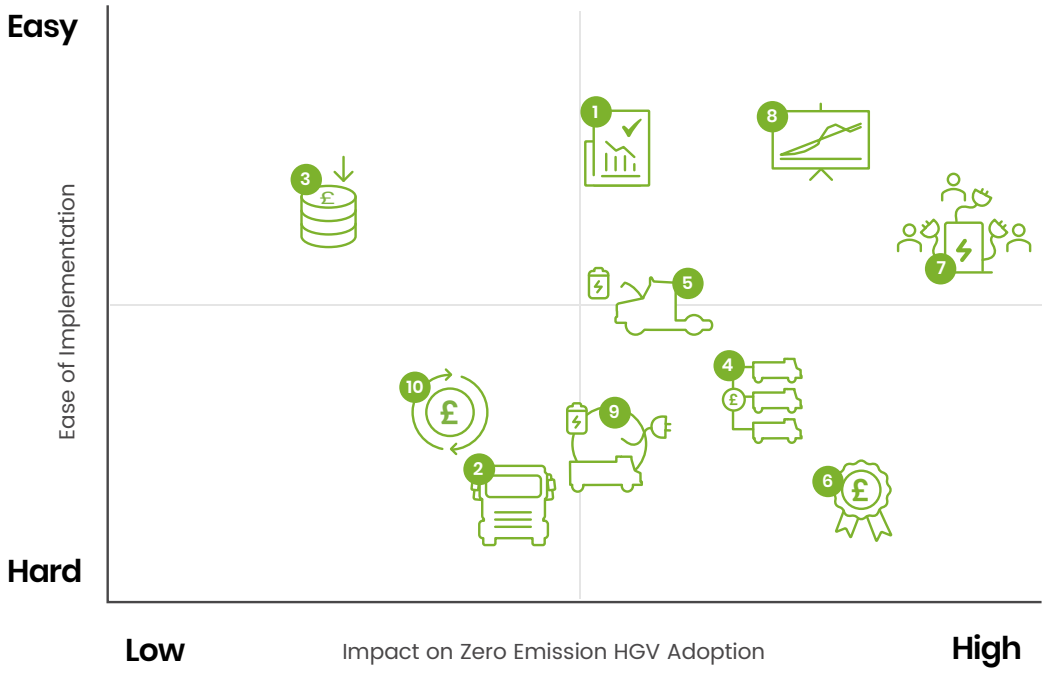
Demonstrator Solutions

Barriers Addressed:

1. High capital cost of zero emission vehicles
2. Lack of infrastructure
3. Vehicle functionality & availability
4. Technology uncertainty
5. Impact on operations

	#	Solution	Overview	Barriers Addressed
HGVs	1	Residual Value (RV) Guarantee	A government-backed RV guarantee could reduce costs for operators accessing HGVs through RV-based finance mechanisms.	1. 3. 4.
	2	Shared RV Risk Agreement	RV risk is shared by all stakeholders involved in a financial contract, i.e. the operator, OEM and finance company, to the extent they stand to benefit from any upside.	1. 3. 4.
	3	Concessional Financing	Loans with concessional terms, such as lower interest rates and/or longer repayment schedules.	1. 2. 3. 4.
	4	Demand Aggregation	A service, coupled with new financial products, that establishes a critical mass for ZETs and/or charging infrastructure, bringing down the upfront costs through economies of scale.	1. 3. 4. 5.
	5	Component Leasing	The operator buys most of the vehicle (chassis, cab, and motor) and leases other more expensive parts, such as electric batteries or hydrogen fuel cells.	1. 2. 5.
	6	Small Operator Loan Default Guarantee	A government-backed guarantee could support lenders providing loans to smaller businesses.	1. 2.
Infrastructure	7	Shared Charging Infrastructure Agreement	Co-located fleet operators and other players pool resources to acquire or invest in charging infrastructure. This could be done through the formation of a joint venture underpinned by a Special Purpose Vehicle with debt and equity leveraged by potential partners, or through a contractual agreement.	2. 5.
	8	Utilisation Linked Financing	Finance for ZETs or chargepoints with repayments linked to usage of the asset.	1. 2.
	9	Integrated End to End Financing	An integrated financing solution offering the operator a complete package of ZET and infrastructure via an "as-a-service" model, where a regular fee is paid for the availability and use of assets on a per mile basis.	1. 2. 3. 4. 5.
	10	Revolving Fund	Government or financiers utilise a revolving fund to encourage energy and utility companies to invest in charging infrastructure. The principal financier provides capital to support infrastructure development for operators. The energy supplier/utility firm repays the expenses from the additional profits made through increased energy demands.	2.

Table 1: Demonstrator Solutions



1. Residual Value Guarantee
2. Shared HGV Risk Agreement
3. Concessional Loan
4. Demand Aggregation
5. Component Leasing
6. Small Operator Loan Default Guarantee
7. Shared Charging Infrastructure Agreement
8. Utilisation Linked Financing
9. Integrated End to End Financing
10. Revolving Fund

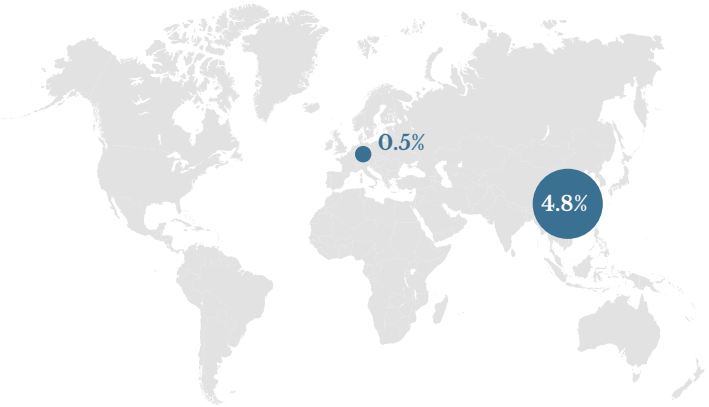
Figure 2: Demonstrator Solutions Overview - Ease vs Impact

3. Introduction

HGVs account for 19% of transport emissions in the UK despite HGVs comprising fewer than 1% of vehicles[18]. HGVs are also a primary source of roadside nitrogen oxides, a significant contributor to air pollution in urban areas.[19]

The UK Government has introduced end of sales dates for new fossil-fuelled HGVs, starting in 2035.[20] Many of the trucks used in the UK are manufactured in Europe, which means they are required by EU CO2 targets to reduce their emissions, starting with 15% in 2025.[21] Major HGV manufacturers are also making the transition to ZETs a central part of their strategies, bringing new models to market across all weight categories.[22]

Despite these ambitious targets, adoption of ZETs is low today. Globally, the strongest levels of adoption have been seen in China which reported 52,000 ZET sales in 2022 (4.8% of the country's annual truck sales).[23] By comparison, adoption of ZETs in Europe is much lower: just 3,000 ZETs were sold in Europe in 2022, equating to 0.5% of European annual sales.[24]



Fewer than 500 ZETs have been registered in the UK to date,[25] representing 0.1% of the total UK HGV parc of 450,000 vehicles.[26] Across the different categories of use cases, ZET adoption has generally been limited to those which

involve shorter distances and predictable duty cycles, such as urban refuse collection vehicles. Key barriers highlighted by operators include high upfront costs and uncertainty about the functionality of the new technologies or how they may affect operating cycles. Debate continues around whether battery electric or hydrogen fuel cell technology will be most suitable for long haul operations, and upfront costs are at least twice the diesel equivalents.[27] In addition, the cost of installing charging infrastructure at depots, and a lack of public charging infrastructure is slowing the transition. In an industry where operational efficiency is vital and profit margins are typically no more than 2-3%[28], any incremental cost presents a significant challenge where it cannot be passed on to the customer.

50% of HGVs in the UK are owned by small businesses, many of which do not have access to the additional capital needed to transition.[29]

To fully transition to ZETs, infrastructure will need to be built across the country to enable ZETs to either recharge (if powered by batteries) or refuel (if powered by hydrogen). The vast majority of ZETs will need to charge in their home depot, which means operators and landowners will need to invest in charging infrastructure. Public charging will also be needed, particularly for long haul operations which account for more than half of UK HGV emissions, despite accounting for just one quarter of HGVs.[30] Currently there are very few examples of dedicated truck charging infrastructure, and no dedicated hydrogen refuelling stations for HGVs in the UK.[31]

Making these changes will require significant capital investment. An estimated £40 to £75 billion of additional finance will need to be made available to operators between now and 2050 to enable them to switch to ZETs, and £11 to £24 billion invested in depot infrastructure. £1 to £2 billion will also be needed to install public infrastructure.[32]

A stable and supportive policy environment is key to enable this investment at the pace and scale required. The UK Government has already laid the groundwork for attracting the investment needed by setting end of sales dates for new diesel trucks, along with significant investment in large-scale demonstrations of new technologies through the ZEHID scheme.[33] These projects will help demonstrate the feasibility of these technologies to hauliers, and provide confidence to operators looking to make the switch. Beyond this, there are several key policy levers, detailed in Section 7, which the government could consider to further support the sector in its transition.

Following consultation with a wide range of expert stakeholders from across the industry, this report aims to outline the financial solutions, data, policy levers and collaboration necessary for the road freight sector to transition in time to meet net zero targets. The GFI will work with the market to demonstrate the solutions identified in this report to demonstrate their potential to mobilise capital at scale.

4. Market Context

4.1 Fleet Breakdown & Ownership for HGVs

HGV Fleet Composition

The HGV sector encompasses all vehicles weighing 7.5 tonnes and above, and vehicles are typically classified as light, medium or heavy duty (7.5 tonne – 18 tonnes, 24 – 36 tonne and 40 – 44 tonne respectively). HGVs can either be articulated or rigid. Articulated trucks consist of a separate tractor and trailer unit, are typically heavier, and are used for hauling freight over longer distances. Rigids are generally lighter, with the tractor and trailer fixed together.

Based on figures from the UK Department for Transport June 2023, there are approximately 450,000 HGVs registered above 7 tonnes in the UK, as shown in Figure 3. The average age of an HGV in the UK is currently 8 years,[34] and there is a strong market for used HGVs, many of which are sold abroad after their second or third owner.

Breakdown of UK HGV Fleet by Vehicle Weight

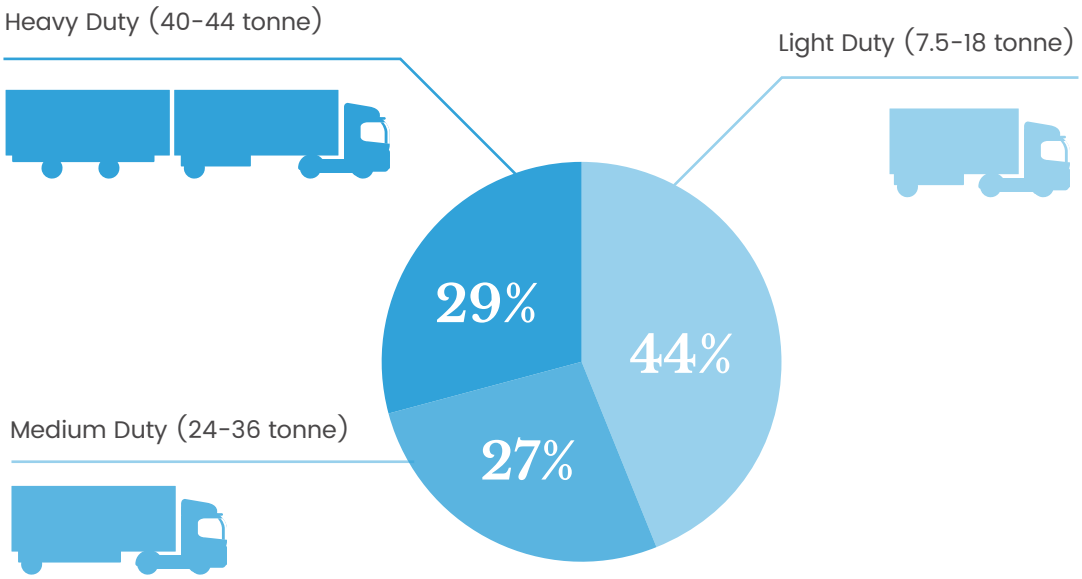


Figure 3: UK HGV Fleet Number of Vehicles by Weight Category[35]

HGV Use Cases

HGVs have a variety of different use cases, including distribution of dry goods, cold storage distribution, and transport of specialised loads such as refuse disposal. Use cases can be summarised into urban, regional and long haul operations. Larger and heavier vehicles are typically used for longer distances and heavier payloads, however to smooth maintenance costs, most fleet operators will rotate vehicles as they age which means they might be used for a variety of different operations throughout their life:[36]

- **Urban** use cases such as last mile delivery typically use rigid, light duty vehicles to travel shorter distances, often returning to the same depot each night.
- **Regional** use cases, such as distribution of refrigerated supermarket goods, usually use medium duty (large rigid or smaller articulated) vehicles and require travel across longer distances between distribution centres and the end destination.
- **Long haul** operations, typically undertaken by heavy duty articulated vehicles, travel hundreds of kilometres each day, stopping in locations along the strategic road network on route to the end destination. They also frequently travel internationally, with 76% of long haul journeys starting or ending at a port.[37]

In 2022, larger articulated trucks were responsible for carrying almost two thirds of freight on UK roads and therefore make up a higher proportion of emissions (see Figure 4).[38]

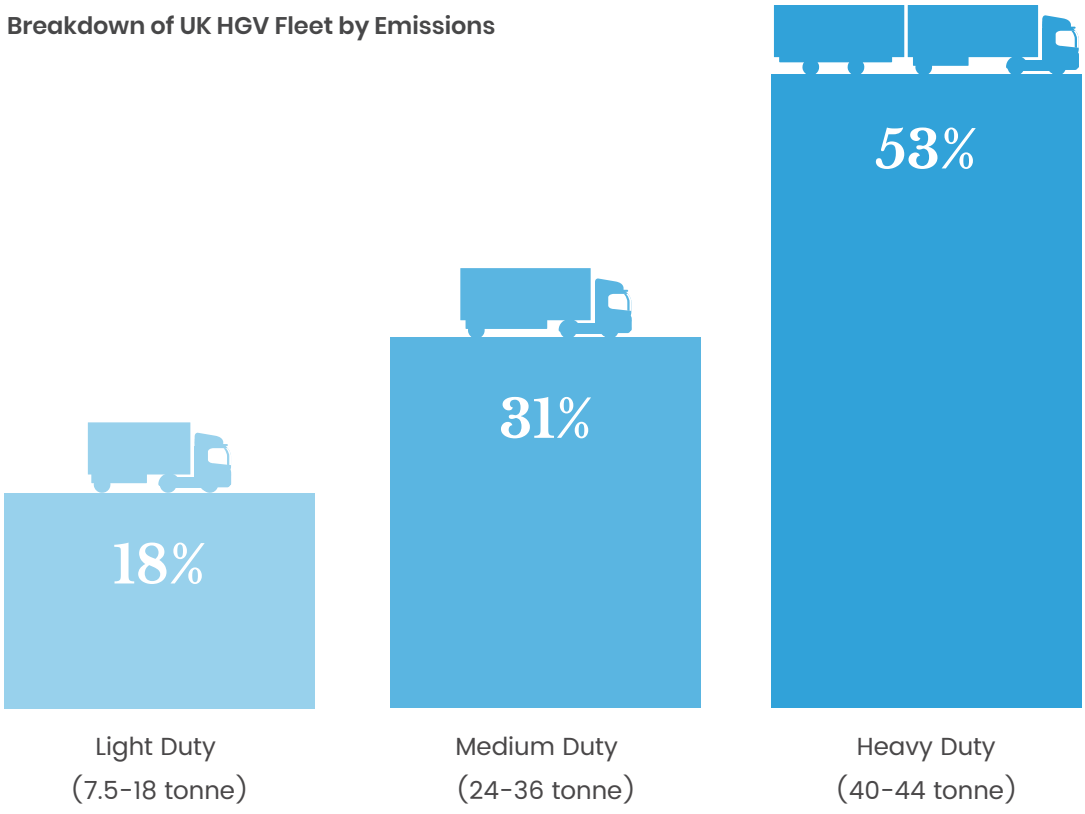


Figure 4: UK HGV Fleet Emissions by Weight Category[39]

Types of Road Freight Enterprise

In the UK, approximately two thirds of freight lifted is contracted out to specialist road hauliers and third-party logistics providers on a 'hire and reward' basis by operators contracting as carriers for specific consignments or as part of a long-term commercial relationship.[40] The remaining third is transported by vehicles operated by the owner of the goods (known as owner operators). These tend to be larger companies such as retailers, wholesalers and manufacturers.[41]

Though large logistics companies dominate certain parts of the market, logistics providers typically operate with profit margins of no more than 2-3%, and it is common for them to subcontract to smaller fleets.[42] Subcontracting, combined with vehicle leasing, allows them to reduce the liabilities on their balance sheets and respond flexibly to peaks in business demand. As a result, over half of the UK HGV parc is part of a fleet operating fewer than 10 vehicles.[43]

HGV Ownership Trends

There are three main ways operators finance the acquisition of HGVs, with the majority of HGVs in the UK being purchased outright, as shown in Table 2.

Ownership Model	Explanation	% of UK HGVs
Outright purchase	The traditional ownership model for HGVs, where the operator uses cash reserves or a business loan to buy the asset and assumes responsibility for operating and maintaining the vehicle.	46%
Contract hire/ operating lease with maintenance	Operators enter a fixed term contract (typically 5 years) to lease vehicles from a leasing company for a fixed monthly sum. Operating costs such as road taxes and maintenance can be included in the monthly payment. At the end of the contract the vehicle is returned to the leasing company. Leasing also provides access to newer and more advanced technologies without the upfront investment costs.	25%
Flexi lease/ flexi rental	Companies can rent vehicles on a short-term basis to meet the demands of peak periods. This model is ideal for companies that do not require full-time access to HGVs or do not want to own the asset.	15%
Other models	Operators can also lease vehicles but without maintenance included (9%) or have their vehicle managed by a fleet management services company (5%).	14%

Table 2: HGV ownership according to the British Vehicle Rental and Leasing Association (BVRLA) in 2020 who conducted a survey amongst their membership which represent approximately 25% of all HGVs in the UK.[44]

The method of acquisition is determined by several factors including the preferences of the end customer, the size of the operator's fleet or business, and the resources they have available. Smaller companies typically acquire vehicles outright using their own cash reserves, whereas larger companies favour finance or leasing arrangements. Reasons for this include the lower average creditworthiness of SMEs compared to larger businesses, and preferences of small business owners.[45] The shift to more expensive ZETs could increase finance penetration amongst SMEs who may find that it becomes more affordable to lease or rent than buy.

Size of fleet also impacts other aspects of ownership, including whether the business prefers to buy new or used vehicles, and how long they keep the vehicle once acquired. Small fleet owners are more likely to buy vehicles second hand and keep them for longer – 12 years on average.[46] Large fleets account for the vast majority of new vehicle sales, and keep vehicles for less time, on average 3-7 years.[47]

4.2 Zero Emission Technologies

Almost all HGVs on the road today are diesel powered.[48] Various technologies exist to decarbonise HGVs, with different technologies suited to different vehicle weights and use-cases. Table 3 below summarises the powertrains available today and under development. This report focuses primarily on the first two: BET and hydrogen fuel cell electric trucks (FCET), also known as hydrogen direct fuel injection, which through our conversations with industry experts and leading OEMs, are expected to be the dominant zero emission powertrain solutions of the future.[49]

According to a study by Element Energy, BETs are anticipated to become the primary option for most HGV use cases, particularly for urban and regional travel.[50] However, there remains debate around the feasibility of BETs for certain specialist applications and long haul use: FCETs currently offer greater range capabilities, but there is very little refuelling infrastructure. To an extent, the dominant technology for long haul trucks in the UK will be determined by decisions made across continental Europe, and the infrastructure installed.

Synthetic low carbon fuels in internal combustion engine (ICE) trucks may play a transitionary role in helping the industry to reduce its emissions. However, there remains significant uncertainty about the quantum of synthetic fuels which can be produced, which means they are likely to be prioritised for heavier transport such as aviation. Other technologies, such as battery swapping or catenary charging via overhead cables, may also feature, but with significant challenges still needing to be solved, including the cost and amount of emissions involved with constructing the infrastructure needed, they are likely to have a niche role.

Technology	Explanation	Market readiness
Battery Electric	BETs use batteries to power electric motors. Suitable for urban and regional trips travelling fewer miles, though latest models may also be feasible for long haul. For example, the Mercedes Eactros 600 released in October 2023 has a 500km quoted range.[51]	The market is growing but investment in high power charging infrastructure is required in depots and public sites across the country.
Hydrogen Fuel Cell Electric	FCETs use chemical energy from hydrogen stored in a fuel cell. They are capable of longer distances (potentially up to 1250km per charge) making them more suitable for long haul.	The market is yet to mature, though the technology is well-understood in the UK having been applied to the bus sector.[52] With only 8 sites currently in operation in the UK, significant investment in refuelling infrastructure is required. To scale sustainably the technology also needs a mature green hydrogen market requiring significant investment and public-private sector collaboration.
Hydrogen ICE	Hydrogen ICE vehicles use similar combustion technology to traditional diesel-powered vehicles. They are also expected to operate with similar power output to diesel, making them viable for heavy loads, mining, and off-road applications.	The market is still in its early stages with no commercially available vehicles as of 2023. As with FCET, requires a mature green hydrogen supply.
Synthetic Fuel (also known as e-fuel or synthetic fuel)	Uses similar combustion technology to diesel. Synthetic fuels can achieve an 90% reduction in GHG emissions compared to diesel, but are not zero emission.[53]	E-fuel production is energy-intensive and expensive to produce. Current production capability is low and supply is likely to be prioritised for hard-to-abate sectors such as aviation.
Catenary	Overhead electric wires on roads and motorways provide power to BETs and charge them whilst travelling, similar to electric train or tram lines.	Nascent in the UK, and likely to require significant physical infrastructure investment (estimated at £19.3 billion)[54]. A significant amount of carbon is embedded in the concrete and steel used to construct the system.

Table 3: Key HGV technologies available today or under development. Only Battery Electric and Hydrogen Fuel Cell Electric are considered within the scope of the report.

4.3 Policy Direction

The UK Government has introduced a range of policies and regulations aimed at supporting the introduction of zero emission HGV technologies:

Regulation: Commitment to end the sale of ICE HGVs under 26 tonnes by 2035 (two thirds of annual HGV registrations[60]), and vehicles above that weight by 2040.[61]

Investment: £249 million investment in projects which could help to decarbonise the HGV sector specifically, as shown in Table 4.[62]

Scheme	Explanation	Amount
ZERF (ZERFT) Trial[55]	In 2021/22, the Government invested £20 million in the zero emission road freight trial (ZERFT) that supported industry to conduct feasibility studies to develop cost-effective, ZETs and infrastructure. 20 Leyland DAF-built BETs are currently in full operation on UK roads within public sector fleets.	£20 million
Freight Innovation Fund (FIF)[56]	Set up in January 2023, the FIF provides support to SMEs with solutions to challenges in the UK's freight sector. It includes a 6 month accelerator programme to provide SMEs with up to £150,000 of grant funding to trial their solutions with industry partners.	£7 million
Zero Emission HGV and Infrastructure Demonstrator (ZEHID)[57]	Announced in October 2023, the Government provided grant funding to projects to support the roll-out of 370 ZETs and 57 charging and refuelling sites across the country. The projects will explore how to overcome the operational barriers to widespread ZET deployment.	£200 million
Advanced Propulsion Centre[58]	In December 2022, grant funding was awarded to Hydrogen Vehicles Systems (HVS), a project to develop a hydrogen fuel cell tractor unit.	£15 million
Connected and Automated Mobility (CAM) programme[59]	In February 2023, grant funding was provided to Hub2Hub consortium to develop the world's first autonomous hydrogen-fuelled HGV via the UK's Centre for Connected Autonomous Vehicles (CCAV).	£7 million

Table 4: Summary of UK Government investments in ZET technology

Government Strategy: The Road to Zero Strategy introduced in 2018 set out the requirements for decarbonising the HGV sector through research projects, industry collaboration and Government investment.[69] In June 2022 the Government also published its Future of Freight Plan which set out a long-term vision for the logistics sector, including zero emission vehicles.[70] It has also issued several calls for evidence to continue exploring ways for the freight industry to decarbonise, most recently one which will inform the Government's future zero emission HGV and coach infrastructure strategy, due to be published in 2024.[71]

Grants: The UK Government currently offers a grant for low emission trucks: £16,000 for small trucks (between 4.25 and 12 tonnes gross weight) and £25,000 for large trucks (over 12 tonnes gross weight),[72] but this has had relatively little uptake to date.[73] Though there are currently no infrastructure grants tailored to electric HGVs, the workplace charging scheme can be used to support the purchase and installation of chargepoints for BETs, offering up to 75% towards the up-front costs.[74]

Tax Incentives: Zero emission vehicles benefit from reduced vehicle excise duty (VED) rates, and businesses can claim the full cost of an electric HGV in the year of purchase against their corporate tax liability.[75]

Clean Air Zones (CAZs): Charges to enter certain areas for HGVs and other types of vehicles which emit above a certain threshold in GHGs. Currently 12 cities across the UK have implemented CAZs.[76]

Governments around the world are also incentivising the uptake of ZETs. EU CO2 emission reduction targets will require OEMs to reduce tailpipe emissions, starting with 15% in 2025, and 30% by 2030. Recently Members of the European Parliament also endorsed more ambitious targets which would see this change to 45% by 2030, and 90% by 2040.[63] The European Green Deal proposed various measures including a goal of 90% emissions reduction in new trucks by 2040 and installation of fast charging stations for HGVs every 60km between key cities across Europe by 2030.[64] California leads progress in the US, with the Advanced Clean Trucks and Advanced Clean Fleets regulations establishing requirements for both ZET sales and purchases, to ensure only ZETs are manufactured starting with model year 2036.[65] China has also introduced considerable subsidies to support the supply and demand of electric trucks.[66]

Individual countries across Europe are offering grants to businesses adopting ZETs. In almost all instances, these grants are substantially larger than those offered by the UK, and some specifically provide additional support to SMEs.[67] As a result, OEMs are reporting higher sales within the EU.[68]

4.4 OEM Strategy

All of the major truck OEMs (including Mercedes-Benz, Scania, MAN, Volvo and DAF) are investing significantly in the research, development, and deployment of zero emission technologies. Many are changing their business models and forming strategic partnerships as part of the shift away from ICE. OEMs historically focused on passenger cars, such as Tesla and BYD, are beginning to transfer some of those capabilities to electric trucks, and startup companies such as Tevva are attempting to bring ZETs to market as alternatives to the incumbent OEMs.[77]

- **Sales Targets:** OEMs are announcing ambitious sales targets. Cumulatively 4 - 9 % of European HGV sales will be zero emission by 2025, rising to 41 - 47 % by 2030.[78]
- **Emissions Targets:** OEMs are committing to phase out carbon emissions, for example Scania's Electrification Roadmap has committed the company to science-based decarbonisation targets.[79]
- **Batteries:** Daimler, MAN and Volvo have all established battery-assembly plants.[80] Volvo plans to build battery-cell manufacturing capacity in Europe by 2030, while Scania is developing batteries in cooperation with Northvolt.[81]
- **Strategic Partnerships:** OEMs have recognised the value of cooperation and strategic partnerships.[82] For example Milence, the joint venture involving the Traton Group, Daimler Truck, and Volvo Group has committed to building and operating high-power charging points near motorways and logistics hubs in Europe with an initial budget of £440 million.
- **New business models:** OEMs are working with companies to deliver new service-based business models (for example as truck-as-a-service) to simplify the switch to ZETs for operators. Volvo offers a try-before-you-buy model for smaller operators to test BETs.[83]
- **Startup companies** such as Tesla, Tevva and Volta hope to gain an advantage over incumbent OEMs by redesigning trucks and not being bound by legacy designs. However, doing so requires huge amounts of capital; both Tevva and Volta reported challenges with access to cash in 2023, with the latter filing for bankruptcy in October 2023.[84]

Availability of ZETs is improving rapidly: there are over 30 vehicles up to 44 tonnes available or soon to come to the European market.[85] These vehicles will come to the UK market if the appropriate enabling conditions are in place. Currently, however, only 10 of the 20 ZETs available in the UK are eligible for the plug-in truck grant, as shown in Table 5.

Initiatives such as CALSTART's Zero Emission Technology Inventory (ZETI) and Freight Carbon Zero's Vehicle Index provide up to date information to operators about the variety of different ZET models available.

Model	Weight	Range
FUSO eCanter	Up to 8.55T	Up to 200km
Paneltex z75	Up to 26T	Up to 200km
Tevva T7 -T133	7.5T	Up to 500km
Volvo FE 6x2	Up to 27T	Up to 275km
Volvo FL 4x2	Up to 17T	Up to 450km
Electra e-Compact	Up to 32T	Up to 400km
Electra e-Star 27-350	Up to 44T	Up to 400km
DAF CF Electric Tractor Unit	37T	Up to 220km
Dennis Eagle E-Collect RCV	Up to 27T	Up to 300km
Renault Trucks D-Range	Up to 26T	Up to 400km

Table 5: HGVs available for the UK Plug In Truck Grant, October 2023[86]

4.5 Factors Driving Zero Emission HGV Adoption

There are a number of factors which are positively driving operators to switch to zero emission HGVs. The most influential are:

- **Emission Reduction Targets:** in addition to Scope 1 emissions, some larger companies are now required to report their Scope 3 (supply chain) emissions, and require emissions reporting from their contracted operators.[87] Operators with lower emissions are likely to be favoured.
- **Regulations:** as highlighted in Section 4.3, the UK Government has implemented stringent emissions regulations to curb pollution, including CAZ charges which can significantly the impact running cost of ICE vehicles and for certain use cases, strengthen the business case for ZETs.
- **Lower running costs:** while ZETs have higher upfront costs, they offer lower operational and maintenance expenses in the long run. This is explored further in Section 5.1.

- **Tax Benefits and Incentives:** as highlighted in Section 4.3, there are various tax benefits and financial incentives available for UK companies to encourage adoption of ZETs including reduced VED rates, grants and access to low-emission zones.
- **Customer demands:** customers are becoming more environmentally conscious and are more likely to choose businesses that are committed to sustainability. According to a study by McKinsey, some are willing to pay a 5-10% premium for sustainable transport.[88]
- **Early adopter advantage:** upgrading fleets now enables companies to gain knowledge of the different capabilities of trucks, and to spread the investment required over a longer time period ahead of the deadlines.

Where ZETs have been acquired, it has generally been by larger companies or local authorities as part of a commitment to reduce their own (Scope 1) emissions. Trials have been conducted for ZETs across all different weight categories. For example, Amazon recently invested £1 billion in its European fleet to acquire 1,500 ZETs,[89] and Westminster City Council recently invested £20 million to decarbonise its refuse collection fleet. There are some examples of SME adoption, including for example Welch's transport, though these tend to be multi-generational businessess that have had time to build up stronger cash reserves.[90]

4.6 Investing in Net Zero

According to analysis conducted by the GFI and KPMG LLP, transitioning the entire UK HGV fleet to ZETs by 2050 will require an additional **£50 - £100 billion** investment by HGV operators and infrastructure providers compared to replacing with diesel vehicles, as shown in Table 6. Whilst the UK Government has committed some public funding, it is clear that private finance will be needed to enable the transition, particularly to support smaller businesses.

	Additional Investment
Replace entire UK HGV fleet with ZETs	£41 - £75 billion
Install depot infrastructure	£11 - £24 billion
Install public infrastructure	£1 - £2 billion
Total Additional Cost to Transition	**£50 - £100 billion**

Table 6: Summary of investment required to transition the UK's HGV fleet and build supporting infrastructure, based on GFI analysis. This is based on the assumption that all HGVs will be electric.

5. Key Barriers

There are a number of barriers to transitioning to ZETs and installing infrastructure from the perspective of vehicle operators and charging infrastructure installers. These barriers fall into five key categories:

1. High capital cost of zero emission vehicles
2. Lack of infrastructure
3. Vehicle functionality & availability
4. Technology uncertainty
5. Impact on operations

5.1 High Capital Cost of Zero Emission Vehicles

A BET costs on average 2-3 times the diesel equivalent, and a FCET 3-5 times.[91] However, it is important to consider the operating costs in order to compare the total cost of ownership (TCO). With support from KPMG LLP, GFI has analysed the TCO of different fuel types (diesel, battery electric and hydrogen fuel cell) to understand under what circumstances the financial business case for ZETs adds up for operators looking to transition.

High level assumptions:

- Cost assumptions are based on 2023 prices, and do not reflect potential future price efficiencies, or inflation.
- The TCO analysis includes costs for the vehicle, fuel, financing, maintenance, taxation, access to clean air zones, insurance as well as existing grants and subsidies.
- For hydrogen FCET, instead of including refuelling depot upgrade costs, the hydrogen price has an additional premium applied.
- The analysis was carried out for three different weight categories (light duty: 7.5 tonne – 22 tonne, medium duty: 24 – 36 tonne and heavy duty: 40 – 44 tonne) to account for the different use cases of vehicles. Lighter weight categories are assumed to travel fewer annual miles and therefore benefit less from cost differences in fuel.
- Three separate time periods have been modelled (5 years, 7 years and 10 years) to reflect the different ownership models.
- A high and low price range has been provided for each weight category and time period. The upper limit uses the price of the most expensive truck model, and higher fuel or energy costs. For battery electric, the upper limit also assumes the highest proportion of public charging vs depot charging likely to be needed for each use case/weight category, which significantly increases energy costs.

For a full list of assumptions, please see the Appendix.

Ownership Period	Costing Range	Light-duty (7.5 - 18 tonnes)					Medium-duty (24 - 36 tonnes)					Heavy-duty (40 - 44 tonnes)				
		Diesel	Electric		Hydrogen		Diesel	Electric		Hydrogen		Diesel	Electric		Hydrogen	
		£'000	£'000	% of diesel cost	£'000	% of diesel cost	£'000	£'000	% of diesel cost	£'000	% of diesel cost	£'000	£'000	% of diesel cost	£'000	% of diesel cost
5- year TCO	Average	40	57	143%	79	198%	61	63	103%	152	259%	87	107	123%	237	272%
	Low	29	36	124%	47	162%	49	48	98%	98	200%	73	69	94%	165	226%
	High	51	78	153%	111	218%	72	78	108%	207	287%	102	146	143%	310	304%
7- year TCO	Average	39	50	128%	73	187%	60	73	122%	141	235%	87	96	110%	221	254%
	Low	29	32	110%	44	152%	50	43	86%	93	186%	74	62	84%	153	207%
	High	50	68	136%	102	204%	71	102	144%	189	266%	100	129	129%	290	290%
10- year TCO	Average	38	45	118%	69	182%	58	66	114%	132	228%	84	88	105%	210	250%
	Low	28	29	104%	42	150%	48	40	83%	87	181%	71	56	79%	146	206%
	High	47	62	132%	96	204%	69	93	135%	176	255%	97	119	123%	274	282%

Table 7: Range of annual ownership costs according to fuel type, weight and TCO timeframe.

Our analysis shows that without intervention, there are limited scenarios under which the TCO of an electric truck today is less than a diesel equivalent, and none in which hydrogen HGVs cost less. This underlines the need for market intervention to accelerate uptake of ZETs.

Based on interviews with industry stakeholders, operators need to see a substantial pricing benefit to make the switch to a new technology. Currently, as shown in Table 8, this rules out hydrogen FCETs which have a higher TCO than diesel in all scenarios, and most BETs, which on average cost 4% to 36% more on a TCO basis than diesel. This is primarily driven by the high capital cost of ZETs, as shown in the first table of the Appendix.

Despite lower running costs for BETs, on average the TCO of BETs remains higher than diesel which means the majority of operators will find it challenging to make a business case to switch today. Currently, light duty electric trucks are always more expensive than diesel on a TCO basis. This assumes lighter vehicles travel shorter distances and benefit less from fuel savings. Medium and heavy duty BETs also cost more than diesel on average. However, operating costs account for a larger proportion of the TCO for longer distances, so by operating vehicles for a longer time period, the TCO differential can favour BETs.

Operators acquiring BETs for use cases where charging can be done almost exclusively at depots, and who are able to consider holding on to vehicles for longer, may be able to make a business case to switch, as the TCO is 13-21% less than diesel.

There are a number of levers which can be pulled to reduce the TCO differential:

- **Vehicle Cost** - As seen with passenger cars, vehicle prices are expected to fall as OEMs scale production, competition between OEMs to secure sales increases; price parity is forecast in the next five years.[92] Supply-side mandates such as the HDV CO2 standards in Europe and the Advanced Clean Trucks regulation in California are expected to accelerate the cost decline by ensuring production is scaled up within a given timeline. In the short term, government grants can offer a discount to qualifying trucks, but in the UK these do not close the gap at current levels.
- **Residual values (RVs)** – Unlike for diesel vehicles, there is no current used electric truck market, making it difficult for finance companies to estimate future RVs. For trucks which are leased, the setting of the RV has a significant impact on the cost of finance. A higher RV can bring down the TCO.
- **Fuel prices** – UK fuel duty has been frozen for the past seven years, and electricity prices are at an all-time high. Any rise in wholesale oil prices or fuel duty, or reduction in wholesale electricity prices will have a significant impact on the TCO equation.
- **Insurance** – Insurance policies for ZETs are often more expensive than ICE. This is partly due to the vehicles being more expensive, but is compounded by a lack of data on repair costs and additional risk of new technologies. Providing more data to insurers so they can better price this risk could reduce the cost of premiums for operators.
- **Clean air zones** – CAZ charges can significantly increase the running cost of ICE vehicles. The presence of a CAZ can strengthen the business case for ZETs operating within within urban areas.
- **Length of contract** - TCO analysis shows that over longer time horizons (7-10 years) ZETs become more cost comparable to ICE. Providing operators with access to longer term finance contracts can reduce the annual cost.

Solutions such as RV guarantees (demonstrator solution 1), shared risk arrangements (demonstrator solution 2), demand aggregation (demonstrator solution 4), and small operator loan default guarantees (demonstrator solution 6) can help to reduce the TCO for ZETs.

A robust used market is key to support the leasing market and enable smaller operators access to ZETs. The challenge of offloading the vehicle at the end of the contract could be addressed by financiers connecting their customers who purchase new vehicles with those that purchase used. There is also a need for international collaboration to ensure alignment of technologies, and prepare second hand markets for new types of vehicle.

5.2 Lack of Infrastructure

The availability of charging or refuelling infrastructure is a critical dependency that must be addressed to achieve the wide adoption of ZETs. In the UK, HGVs use around six million tonnes of diesel annually.[93] Though operators also rely on public service station refuelling, the majority (70-90%) of refuelling for EVs is expected to occur at depots or fuel bunkers.[94] These are spread across the country and often clustered around major cities and ports.

To enable ZETs to operate, charging or refuelling infrastructure will need to be installed across both depot and public sites. For hydrogen vehicles, there also needs to be a reliable supply of green hydrogen to provide at these sites. The key challenges are:

I. Cost of depot upgrades
II. Lack of public infrastructure
III. Scaling hydrogen production and distribution
IV. International interoperability

I. Cost of depot upgrades

Depot Chargepoints

All BETs will need access to depot charging. Operators will need to install infrastructure at their depots if they are to electrify their fleets, which has numerous challenges associated:

- It can be expensive, with costs ranging from around £20,000 for a single 150kW charger to over £680,000 for a 2.5MW charger.
- The location of the depot and proximity to an electricity connection with sufficient capacity can have a significant impact on the speed and cost of installation. Where a connection is not possible, or the lead time is too long, it may be necessary to invest in stationary energy storage or even move to a different site, both at significant cost.
- Currently there is no universal charger connector for HGVs which means operators risk investing in hardware which may quickly become obsolete.
- Operators often do not own the land the depot is based on, which means they need to obtain permission from landlords to install infrastructure, delaying the process.
- Some operators reported requests from insurance companies to install additional fire protection in depots to reduce the risk of damage from incorrectly installed infrastructure.

Depot Hydrogen Refuelling

There are additional challenges to installing hydrogen refuelling infrastructure in depots. Hydrogen must be cooled and compressed in order to be safely stored on site. The total cost of installation can extend to millions of pounds.

Given the high costs, the majority of hydrogen refuelling is expected to take place at public or shared locations and is likely to be limited to use by those in the long-haul freight sector where vehicles travel into Europe.

II. Lack of public infrastructure

While depot-based infrastructure will be the priority source of charging and refuelling, a public network is essential to support longer journeys and also for overseas-registered vehicles traversing the UK. The current public charging network for electric cars in the UK is not suitable for HGVs due to their differing technical specifications, higher power demand and space required to manoeuvre. The UK currently has only eight hydrogen refuelling stations.

Estimates for the number of public chargepoints required to enable the transition to ZETs vary considerably. The EU Green Deal introduced the requirement to install fast charging stations for HGVs every 60km between key cities and transport nodes across Europe and the UK by 2030.[95] In the UK, this would mean 8,200 chargepoints costing between £1 and £2 billion in total.[96]

III. Scaling hydrogen supply and distribution

An additional challenge for widespread adoption of FCETs is obtaining a green hydrogen supply because hydrogen is expensive and energy intensive to produce. The UK Government is investing significantly in developing domestic green hydrogen production, but scaling up capabilities to meet the increased demand will require significant investment and coordinated efforts from both government and private industry. The development of a distribution network to get green hydrogen to refuelling sites will also require significant infrastructure investment to establish a national network of pipelines and specialised trucks.

IV. International interoperability

The extent to which public charging or refuelling infrastructure will be required in the UK will largely be determined by decisions taken within the EU. If the majority of heavy duty trucks require hydrogen, then this infrastructure will need to be built in the UK in order for trucks delivering goods from the EU to operate on UK shores. In 2022 76% (90 million tonnes) of inter-modal journeys involving HGVs began or ended at a port.[97] The existing locations of depots clustered near to ports provides an opportunity for collaboration between operators and port authorities to allow them to share grid connection costs and charging facilities where appropriate.

Solutions such as shared charging infrastructure agreements (demonstrator solution 7), utilisation-linked finance (demonstrator solution 8), integrated end-to-end solutions such as electric-trucking-as-a-service (demonstrator solution 9), and revolving funds (demonstrator solution 10) can enable fleet operators and chargepoint operators to finance the installation of charging infrastructure.

5.3 Vehicle suitability and availability

OEMs are broadening their ranges of ZETs, making them more accessible and feasible for a wider range of operators. However, they are not yet suitable for all duty cycles. Across the majority of existing truck OEMs, production levels of existing models are currently low and lead times can be long, a disincentive to those that would otherwise be ready to switch.

OEMs are adopting a variety of approaches to developing ZETs, either working with their suppliers or developing technologies in-house. The pace at which OEMs are transitioning their production lines to ZETs also varies. Some are proceeding more slowly due to the perceived uncertainty in demand for ZETs and the pace of infrastructure roll out. This lack of supply means long lead times and with the technology evolving rapidly, some fleet operators are delaying buying new vehicles as they expect better models to be available in the future.

Solutions which accelerate demand for ZETs, such as demand aggregation (demonstrator solution 4), together with a supportive policy environment, can signal to OEMs to direct sales of ZETs towards the UK market. Other solutions, such as concessional loans (demonstrator solution 3) can be used by OEMs to raise finance needed to transition production lines. OEMs offering solutions such as "truck as a service" (demonstrator solution 9) will help drive demand, but their balance sheets will be stretched if access to private capital markets cannot be secured.

There is also a need to challenge the perception that model availability is a problem for standard use cases. GFI conversations with stakeholders revealed many were not aware of the existing zero emission offerings of the OEMs. More widely publicising model availability, for example through ZETI's interactive tool, could help challenge this perception.

5.4 Technology uncertainty

Operators, and those who finance trucks, face significant uncertainty around whether hydrogen or battery electric technology will "win" the race. In reality, there is no one technology which will be suitable for all use cases. Instead, both technologies will have a role to play, and this varies by vehicle weight and duty cycle.

Latest battery technology suits light and medium-duty trucks with duty cycles that require shorter distances in urban and suburban delivery scenarios that have sufficient charging infrastructure available nearby. However, technological advancements are also making heavy-duty battery electric trucks more feasible for applications across several use case types. The UK's Climate Change Committee believes that this solution will likely be the most cost-effective option for HGV operations in the long-term.[98]

Hydrogen fuel cell trucks have longer ranges and can handle heavier payloads, making them suitable for regional and long-haul operations, as well as applications that require higher power density motors for heavy equipment. However, hydrogen FCETs are currently almost twice as expensive as BETs, and there are significant challenges remaining around the feasibility of widespread hydrogen refuelling.

In the UK, hydrogen truck trials are primarily in the feasibility stage with funding for three projects announced in 2021, and one hydrogen project announced in 2023 as part of the ZEHID scheme.[99] For this reason, adoption of hydrogen is likely to lag behind batteries.

Solutions such as RV guarantees (demonstrator solution 1) can provide certainty to finance providers against technology obsolescence.

5.5 Impact on operations

Operating BETs can have an impact on a fleet operator's daily operations. Changes may need to be made to route planning in order to optimise efficiency; payloads may be reduced; and additional downtime may need to be factored in to enable on-route charging. A lack of clarity about how BETs will fit into the existing operating cycle, or how operating cycles need to adapt, is holding back the appetite of operators to switch.

The shift to ZETs can also impact an operator's finance operations. Many SMEs prefer not to take externally provided finance, which means that they are less familiar with leasing and other products that could enable them to adopt ZETs faster. For all operators, the higher upfront vehicle cost and potential requirement for large capital investments in infrastructure means that investment decisions are more significant and have longer payback periods. This can act as a disincentive to transition.

Adjusting to new vehicle capabilities may require new operating models, for example using more vehicles. One form this could take is a 'pony express', where a vehicle's trailer continues its journey while using multiple electric tractor units at stopping points designed around the typical EV truck ranges. There are also various ways that operators can be supported to mitigate the impact of adopting ZETs on their operations:

More information and support should be provided to SMEs to help overcome barriers to accessing existing financial products. Fleet advisory services can help operators, particularly SMEs, implement decarbonisation strategies and link them to grants and financing solutions. For example, CALSTART manages the Californian and Massachusetts fleet advisors in the US.

The results of DfT funded trials of how ZETs operate in practice, and other case studies, should be widely shared to ensure operators who want to transition away from ICE vehicles have the necessary information to do this. For example, Cenex used data from the original ZERFT trial to publish a Fleet Planning Tool to help operators understand how ZETs would perform in their fleet, incorporating the results of studies on the impact of weather on vehicle efficiency.[100] Logistics UK have also published the key lessons learnt by their members who have adopted ZETs, and Amazon has created a tool called CHALET which collects data on the locations of chargepoints to help operators plan journeys. The Smart Freight Centre recently published an actionable framework to guide operators with electric truck and infrastructure implementation.

Groups such as Innovation Gateway, Climate Group's EV100+ and Sustainable Fleets encourage operators to publicly commit to decarbonisation and help develop transition plans.

> *"We saw a commercial opportunity to adopt one of the first electric HGVs in Cambridgeshire due to the location of our business and needs of our customers. There are considerable benefits to running electric trucks, in addition to the environmental benefit, including lower running costs and reduced maintenance due to fewer moving parts. We also chose to adopt an electric truck early so we could learn how the new technologies work in the real world, which will be crucial to keeping up with our larger competitors who would otherwise have a headstart."*
>
> **Chris Welch,** Operational and Commercial Director, at Welch Transport

6. Demonstrator solutions

The GFI has identified a portfolio of 10 demonstrator solutions which have the potential to scale investment in ZETs and associated infrastructure. GFI stakeholders ranked the demonstrator solutions in the order of scale of impact on HGV decarbonisation and ease of implementation. The results are shown in Figure 5 below.

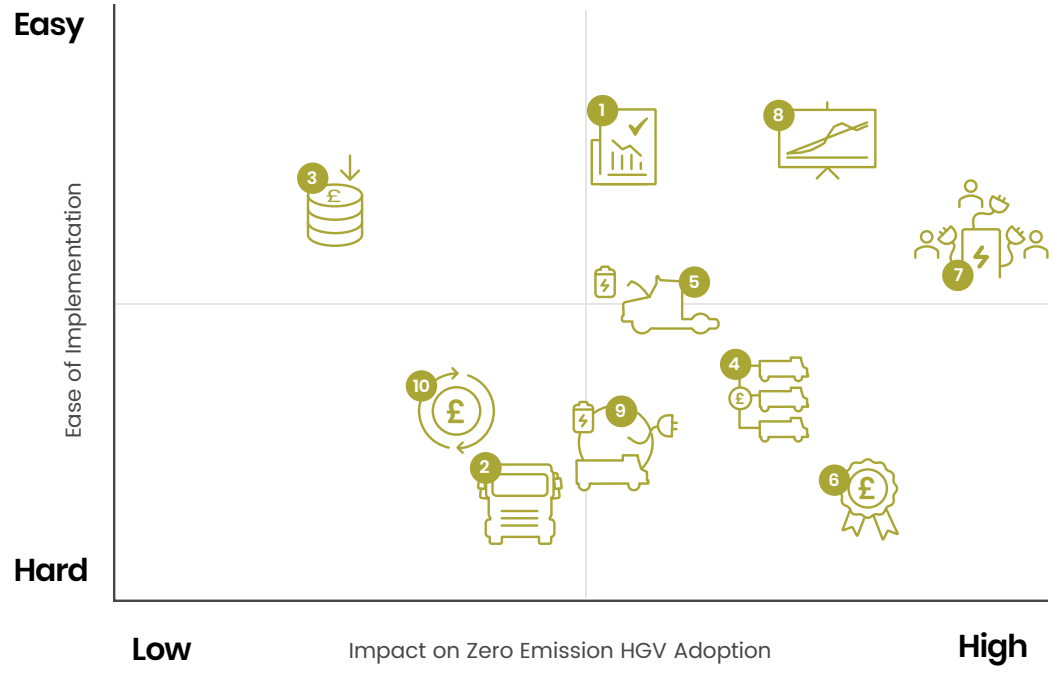


Figure 5: Impact vs Ease of Implementation

1. Residual Value Guarantee
2. Shared HGV Risk Agreement
3. Concessional Loan
4. Demand Aggregation
5. Component Leasing
6. Small Operator Loan Default Guarantee
7. Shared Charging Infrastructure Agreement
8. Utilisation Linked Financing
9. Integrated End to End Financing
10. Revolving Fund

Source: GFI Stakeholder interviews

6.1 HGVs

The following potential solutions were conceived by GFI stakeholders to address the barriers identified to financing the transition to ZETs. This section sets out the list of potential demonstrator solutions in more detail and provides further information on each. Each template includes an overview of the solution, its intended outcomes, key delivery partners and potential policy levers.

Demonstrator Solution 1

RV Guarantee

Overview: RV based finance models such as contract hire and contract purchase are routinely used by operators to finance the purchase of vehicles. The take up of these products depends on the RV set by lenders at the outset of the contract. The absence of historic data for ZETs, coupled with concerns about the pace of change of technology, means lenders are setting cautious RVs which result in less attractive lease rates. An RV guarantee, provided by a third party, such as Government or an insurance provider, could help reduce RV risk for lenders. There are likely to be financial institutions willing to acquire a portion of this kind of risk.

Outcome: Guaranteeing an RV estimate can mitigate the risk of loss for lenders, increasing the number of lenders willing to offer RV based products and reducing the cost to operators.

Delivery Partners include:
- Government body to guarantee RV losses
- Leasing companies/lenders
- FLA/BVRLA

Role:
- Provider of guarantee
- User of guarantee
- Promote guarantee to membership

Policy Levers to support demand and scale up:
- Zero emission vehicle grants available to lenders to use for RV support, potentially instead of upfront purchase discount via the plug-in truck grant.

Demonstrator Solution 2

Shared RV Risk Agreement

Overview: An arrangement involving the acquisition of ZETs whereby the parties involved agree to redistribute the residual risk amongst each other. Each party would take on a portion of risk to the extent they feel is proportionate to what they stand to benefit. For example, OEMs could provide confidence around the chassis RV by providing a buyback option to the operator at the end of the lease term, and battery manufacturers could support battery RV through extended battery warranties or component leasing.

Outcome: Sharing the risk premium of transitioning to ZETs across the value chain, enabling operators access to RV based finance products for ZETs. It could also provide a mechanism for monitoring the asset, and incentivise the operator to keep it in good condition.

Delivery Partners include:
- Fleet operators
- OEMs
- Leasing companies/ lenders
- Shippers
- Battery manufacturer
- FLA/BVRLA

Role:
- Buyer of the ZET
- Take on a portion of the risk, for example through a buy-back guarantee
- Provider of finance for truck acquisition
- Demand for zero-carbon services
- Provide extended battery warranty
- Promote mechanism to membership

Policy Levers to support demand and scale up:
- N/A

Demonstrator Solution 3

Concessional Finance

Overview: Loans or investments with concessional terms, such as lower interest rates and/or longer repayment schedules to acquire ZETs and finance related infrastructure. These can be used as part of blended finance arrangements to de-risk investment and provide confidence to investors. For example, the South Korean Government provided blended concessional financing for hydrogen trucks and installation of refuelling stations. Finance can be made available to a variety of borrowers, including OEMs, automotive finance companies and fleet operators. Funds can also be made available by investors to insurance companies to reduce insurance premiums of ZETs.

Outcome: Incentivise production or acquisition of ZETs by enabling lenders to provide more favourable finance arrangements to operators for ZETs and manufacturers to invest in ZET production with a lower cost of capital. Concessional finance could also enable operators to decarbonise their supply chains, for example through trade finance arrangements to provide early payments to subcontractors adopting ZETs.

Delivery Partners include:

- OEM, Fleet Operators
- Financiers & investors
- FLA/BVRLA
- Government bodies including Innovate UK, British Business Bank, UKIB in the UK. For Eastern-European operators which run trucks in the UK other multilateral development banks (MLDBs) such as EIB could be considered.

Role:

- Receiver of concessional loan
- Provide concessional capital to OEM/ operator
- Promote blended finance facility to membership
- Provider of blended finance facility

Policy Levers to support demand and scale up:

- Government funding may be required to enable funders to offer concessional finance rates.

Demonstrator Solution 4

Demand Aggregation

Overview: Demand for ZETs is aggregated from across different operators and presented to OEMs and financiers. By reaching a minimum threshold of demand, individual operators have increased bargaining power. Local or combined authorities can also introduce these schemes to negotiate lower prices of new technologies for groups of buyers in their local areas. Traditionally this would have been done through local enterprise partnerships (LEPs) in the UK, though Government sponsorship of these networks is due to cease in 2024.[101] Schemes like this are already being trialled, for example the Smart Freight Centre and Calstart's FEC Demand Aggregation project, which signalled demand for 60,000 BETs across the US and Europe.

Outcome: Reduced cost of finance for ZETs for operators and OEMs benefit from improved economies of scale in production.

Delivery Partners include:

- OEM
- Lender/lease companies
- Operators
- Aggregation platform
- FLA/ BVRLA

Role:

- Supplier of ZETs
- Provider of finance to operators
- Buyers of ZETs
- Managing operational aspect of aggregating orders for trucks from different operators
- To raise awareness of demand aggregation schemes amongst member operators

Policy Levers to support demand and scale up:

- Clean air zones within a city or region would act as a further lever to drive demand from operators in that area.

Demonstrator Solution 5

Component Leasing

Overview: The operator buys most of the vehicle (chassis, cab, and motor) and leases the more costly parts, such as electric batteries, hydrogen fuel cells, or charging infrastructure. Asset owners can introduce contract terms to preserve the RV of assets, for example imposing mileage limits to reduce degradation of the battery.

Outcome: Operators are shielded from battery depreciation, and are required to provide less upfront capital, improving access to ZETs. OEMs are able to retain ownership of potentially valuable assets, allowing for opportunity to extract further value, for example through second life battery schemes.

Delivery Partners include:

- Manufacturer of leased equipment, including truck and battery OEMs.
- Lender or lease company
- Offtaker, for example battery recycling plant or company willing to acquire battery
- Government body

Role:

- Supplier of equipment
- Lessor of equipment to operator
- Offtaker of equipment at end of finance contract
- To provide a guarantee of RV losses

Policy Levers to support demand and scale up:

- N/A

Demonstrator Solution 6

Small Operator Loan Default Guarantee

Overview: The higher upfront purchase price of ZETs will increase the finance costs which could put smaller companies at greater risk of defaulting. Many lenders may be unwilling to take on this additional risk. A loan default guarantee, provided by a third party, such as Government or an insurance provider, could help reassure lenders. Schemes like this have been implemented before, for example by the State Government in California.

Outcome: Guaranteeing default loan repayments can mitigate the risk of loss for lenders, increasing the number of lenders willing to offer smaller operators finance for expensive ZETs. SMEs make up a large proportion of the UK HGV parc; providing wider access to finance can facilitate uptake.

Delivery Partners include:

- Government body to underwrite SME lending
- Leasing companies/lenders
- FLA/BVRLA

Role:

- Provider of guarantee
- User of guarantee
- Promote guarantee to membership

Policy Levers to support demand and scale up:

- Zero emission vehicle grants available to lenders to use for support when lending to smaller operators, potentially instead of upfront purchase discount via the plug-in truck grant

6.2 Charging/refuelling infrastructure

The following potential solutions were highlighted by stakeholders as presenting an opportunity for operators to overcome the barriers to financing installation of charging infrastructure needed for electric trucks.

Demonstrator Solution 7

Shared Charging Infrastructure Agreement

Overview: Multiple truck operators collaborate to acquire or invest in recharging/refuelling sites. This could be done through the formation of a JV underpinned by an SPV, with debt and equity leveraged by potential partners, or through a contractual agreement to provide near-term cost share and future profit share. These types of arrangement could benefit from offtake structures with operators intending to use the infrastructure, providing some revenue certainty for financiers.

Outcome: Reduces the capital investment required by each party and shares the ongoing burden of maintaining the charging infrastructure. Allows for pooling of expertise and aligns the usage of the asset to the operating cycle of vehicles. Creates opportunity for local authorities or private operators to create additional revenue by sharing their infrastructure with small HGV operators. Arrangements of this nature could also facilitate collaboration around ports to enable decarbonisation.

Delivery Partners include:

- Fleet operators
- Energy suppliers
- DNOs (Distribution network operator)
- Infrastructure investors
- Charge point operators
- Local authorities
- Landowners

Role:

- User of the infrastructure and able to agree to energy offtakes
- Agree to Power Purchase Agreement (PPAs) of any electricity generated by on-site renewables
- Provide grid connection/private wire
- Provide finance for private wire if grid connection is not possible
- Provide technical expertise to manage infrastructure
- Offtake agreements from public fleets to incentivise deployment
- Allow operator access to charging infrastructure

Policy Levers to support demand and scale up:

- Simplification/standardisation of grid connection processes.
- Risk guarantees could also be provided by Government to make investments more palatable, for example through a policy bond to de-risk changes in Government mandates/timelines.

Demonstrator Solution 8

Utilisation Linked Financing

Overview: Finance for chargepoint operators or installers (such as operators or local authorities) that is repaid based on utilisation. This can offset the risk of repayment liabilities not matching revenues. The finance provider takes the utilisation risk, however, this can be mitigated by flexibility of repayment tenor.

Outcome: Utilisation Linked Financing eliminates the need for upfront capital investment in chargepoints by fleet operators, real estate owners or local authorities. Utilisation risk is transferred to the lender, allowing operators to link payments to usage, and likely cashflows.

Delivery Partners include:	Role:
• Asset Finance Providers	• Provide finance for chargepoints
• Chargepoint Installer	• Installs chargepoints and provides data feed to finance house for payments
• Fleet operators	• End user of finance
• Local Authorities	• End user of finance
• Real Estate Owners	• End user of finance
• Telematics Providers	• Support payment assumptions through providing anticipated usage data

Policy Levers to support demand and scale up:

- N/A

Demonstrator Solution 9

Integrated Financing as a Service

Overview: An integrated financing solution offers the operator a complete package of necessary assets via a "as-a-service" model where a regular fee is paid for the availability and use of assets on a per mile basis, offering more flexibility and inclusive services than traditional leasing. This could include vehicle costs, managed charging, costs of accessing clean air zones, tax, insurance, and maintenance. For example, HVS recently announced its partnership with Zeti to provide truck-as-a-service for its hydrogen powered HGV.[102]

Outcome: Operators have a simplified process of switching to a new technology, and financiers have lower risk of non-payment as operators pay per service use instead of standard fixed payment schedules.

Delivery Partners include:	Role:
• OEM	• Supplier of zero emission trucks
• Lender or lease company, or captive finance provider	• Lessor of equipment to operator
• Telematics Providers	• Provide usage data for cost calculations and usage fees
• Chargepoint installer and operator	• Install and manage network of chargepoints
• Fleet operators	• End user of finance

Policy Levers to support demand and scale up:

- N/A

Demonstrator Solution 10

Revolving Fund

Overview: Government or financiers provide a revolving fund to encourage energy and utility companies to invest in charging infrastructure. The principal financier provides capital to support charging infrastructure development for operators. The energy supplier/utility firm repays the loan repayments from the additional profits made through increased energy demands. A part of the increased profit margin goes to the principal financier as a repayment until the agreement ends or the financier is fully repaid. For example, the UK SALIX revolving fund invested £339 million in over 12,000 energy efficiency and renewable energy projects in the public sector with estimated fuel cost savings of £1.2 billion.

Outcome: Minimises upfront costs, reduces risk, and enhances operator convenience. Empowers energy companies to play a larger role in infrastructure development and scalability.

Delivery Partners include:

- Government/ financiers
- Energy companies
- Fleet operators
- Land owners

Role:

- Provider of finance
- End user of finance
- Agree to offtake energy
- Provide a site for infrastructure installation

Policy Levers to support demand and scale up:

- If Government were to provide the fund this would require a national scheme to be set up. Alternatively, if provided by private finance, government could help give confidence to lenders for example through a minimum revenue guarantee.

7. Policy Recommendations

In addition to the market-led initiatives set out above, the UK Government can introduce policy and regulatory measures to accelerate the transition to ZETs. The ZEHID programme could serve as a testbed for many of these measures. Our work proposed the following measures to enable more investment in the sector:

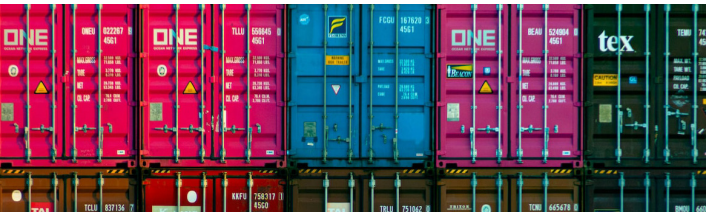
Support supply chain development for ZETs through a regulatory pathway or a ZEV mandate: Zero emission mandates for OEMs setting out the proportion of vehicle sales which need to be zero emission by each year to 2040 would provide a clear signal to industry of the direction of travel. This could be supported with a pathway to phasing out diesel HGVs, by type or weight of vehicle, for example through increased fuel duty or carbon pricing mechanisms where freight buyers either directly or indirectly pay for the carbon emitted. A carbon pricing mechanism could be implemented by adding HGVs to the UK's Emissions Trading Scheme. Any mechanism adopted would need to be sufficiently simple for operators to implement and also make sure that SMEs are not at a competitive disadvantage.

Amend grant and tax incentives to support ZETs: Currently, the plug-in grant available in the UK is significantly lower than in other European jurisdictions: Germany for example provides up to £473,000 for a BET compared to a maximum of £25,000 in the UK.[103] Increasing the grant, shortening the application process, or widening its eligibility criteria could increase its effectiveness. For example, the grant scheme could be extended to include funding of grid connections and charging infrastructure (which often need to be done ahead of truck acquisition) or made available to lenders to support RV setting which could help leverage multiples of private capital and develop a secondary market, crucial to supporting small businesses transition. Additionally, amendment of the qualifying criteria for the 100% tax deductible annual investment allowance for capital spending to include vehicles acquired via leasing or hiring, and clarification of the usage of the allowance to include investments in charging infrastructure and grid upgrades, would reduce costs for operators.

Develop a ZET Infrastructure Strategy: A detailed roadmap outlining energy requirements, infrastructure needs, and required use cases for a zero-emission road freight sector would help address technology uncertainty and increase confidence in investment decisions. The Government should **set targets for charging infrastructure deployment** to support adoption of long haul ZETs. This roadmap would need to be designed in collaboration with private businesses and backed with clear guidance and incentives for local authorities, as well as ensuring interoperability with the EU. An Infrastructure Strategy should also form part of a wider Government strategy supporting wider decarbonisation of the HGV industry that covers skills and updates to regulation.

Simplify and create nationally consistent processes for grid connections and installing charging/ refuelling infrastructure at depots: This would be helped by more transparency on available grid capacity and a common service agreement amongst DNOs for connections. Support for leaseholders including a '**right to plug**' to ensure that freehold property owners cannot block the installation of charging infrastructure, particularly when the leaseholder is prepared to bear the cost, should be provided.

Address energy price volatility to help operators make a business case to switch: Though ZETs are starting to reach TCO parity with diesel in certain use cases, volatile electricity prices are making it difficult to calculate the TCO for BETs. Providing a guaranteed price of electricity for operators, similar to the red diesel scheme in farming markets, could help strengthen the business case.[104] Local authorities can also introduce new tariffs designed specifically for HGV charging to make them more cost-effective.



Government should support intermodal opportunities for decarbonisation of transport, including road, rail and shipping. Further research should continue to explore opportunities for decarbonisation at ports to help identify investment synergies across different transport modes.

8. Conclusion

The government's vision of ending sales of fossil fuel powered HGVs by 2040 is a key component of its commitment to Net Zero. Achieving this outcome will, according to our forecasts, create a £100 billion investment opportunity in the UK. However, failure to overcome the barriers identified puts the transition to a zero emission road freight and logistics sector at risk.

There is an urgent need to create the right conditions to facilitate an orderly transition. The barriers to investment – and solutions needed to address them – are granular in nature. Alignment, coordination and collaboration between the public and private sector, and between the finance, transport, and energy sectors, will be key to ensuring the necessary solutions are effective in unlocking the private capital needed.

The roundtable and numerous stakeholder interviews conducted for this report have highlighted where the most pressing barriers lie – and what the most promising solutions are. Our demonstrator solutions have identified how to tackle these barriers and this is where our efforts are now focused. In the short term, focus should be given to deployment of depot infrastructure to support urban use cases, whilst allowing for time to establish the public charging infrastructure needed for long-haul. Solutions that address the financing challenge for the upfront cost differential for SME carriers in particular are also key.

There is limited time remaining, as many HGV operators in the UK have just one more cycle of replacing their fleet before the end of sales dates for new non zero emission trucks, which means many are making decisions now that will impact the speed they are able to decarbonise in future. We invite finance and industry organisations to work with us to co-design and pilot these demonstrator solutions. Collectively we can shape the future decarbonisation of road transport and catalyse investment opportunities working from the ground up.

We look forward to you joining us on this journey.

9. Glossary & Abbreviations

Articulated	A type of HGV where the trailer is separate to the chassis of the tractor.
CO2e	Carbon dioxide equivalent.
DNO	Distribution network operator.
FCET	(Hydrogen) fuel cell electric truck, also known as hydrogen direct injection.
Green Hydrogen	Hydrogen made using electricity from renewable energy sources to electrolyse water. Due to the high cost of producing green hydrogen, it currently makes up a small percentage of overall hydrogen production.[105]
Hire and reward	Contractual basis for work conducted primarily by specialist road hauliers and third-party logistics companies acting as carriers either for specific consignments or as a part of a long-term commercial relationship.
Owner Operator	Fleet operators that use their vehicles primarily to transport goods they own.
Rigid	A type of HGV where the trailer is part of the same chassis as the tractor.
Scope 1, 2 & 3 Emissions	The different types of GHG emissions as defined by the Greenhouse Gas Protocol, the world's most widely used GHG accounting standards. Scope 1 emissions are those a company makes directly, Scope 2 are those it makes indirectly (for example through the energy it buys) and Scope 3 are those produced by its supply chain.
TAAS	Trucking-as-a-service.
Tractor	The towing vehicle unit of the HGV which provides power from its engine.
Urban (Use Case)	Short distance HGV operations. Typically requires vehicle to travel shorter distances such as last mile delivery and use rigid, light duty vehicles to travel shorter distances, often returning to the same depot each night
VED	Vehicle excise duty
ZEHID	Zero emission HGV and infrastructure demonstrator (ZEHID). Previously known as Zero emission road freight demonstrator, or ZERFD. ZEHID is a £200m UK government project announced in October 2023.
ZERFT	Zero emission road freight trial; a £20m UK Government feasibility trial of ZETs in 2020/21.
ZETI	Zero emission truck inventory – a tool designed by CALSTART to provide up to date information to operators about different zero emission truck models available
ZEV Mandate	Zero emission vehicle mandate; government legislation which determines the percentage of sales which have to be zero emission per year.

10. Appendix

TCO Assumptions

- The following tables provide the cost assumptions made for the TCO analysis across different weight categories of vehicle, light duty (7.5-18 tonnes), medium duty (24-36 tonnes) and heavy duty (40-44 tonnes).
- For some costs, such as finance costs, the value varies depending on the length of the TCO (5, 7 or 10 years). In these instances, an average has been given.
- Where ranges have been given, these represent the highest and lowest values based on research and assumptions.
- Data for each of the tables have been obtained from multiple sources. Please contact tom.parke@gfi.green if you would like further information about data sources.

Cost assumptions summary (£'000)

TCO component	Light Duty			Medium Duty			Heavy Duty		
	Diesel	BEV	FCEV	Diesel	BEV	FCEV	Diesel	BEV	FCEV
Cost of vehicle	45 – 83	125 – 200	140 – 330	84 – 91	150 – 320	250 – 613	85 – 120	225 – 340	320 – 650
Subsidy for vehicle purchase	0	16 – 25	16 -25	0	25	25	0	25	25
Depot Upgrade Costs	0	26	0	0	26	0	0	26	0
Service Maintenance & Repair (per annum)	5.1 – 5.8	3.6 – 4.6	5.1 – 5.8	6.0 – 7.6	3.6 – 6.0	6.0 – 7.6	7. 6 -8.0	3.5 -14.0	7.0 -14.0
Road tax (per annum)	0.08 -0.21	0	0	0.63 -1.16	0	0	1.43 -1.60	0	0
Clean air zone charges (per annum)	0.85	0	0	0.85	0	0	0.85	0	0
Average Finance Costs (per annum)	6 – 52	16 -125	17 – 210	11 – 49	29 – 135	36 – 235	11 – 75	28 – 211	40 – 405
Insurance (per annum)	1.5 – 4.0	5.5 – 8.0	5.5 – 8.0	1.5 – 5.5	5.5 – 8.0	5.5 - 8.0	2.5 – 8.0	5.5 – 8.0	5.5 – 8.0
Tax benefit on interest payments (per annum)	0.15 – 1.41	0.43 -3.40	0.48 – 5.72	0.29 – 1.55	0.51 -5.44	0.86 -10.41	0.29 – 2.04	0.77 -5.76	1.09 -11.05
Fuel Costs (per annum)	16.6 – 22.8	9.2 – 19.5	21.6 – 32.4	24.5 – 30.7	19.1 – 25.8	49.0 – 55.8	30.7 – 35.0	22.5 – 34.6	72.0 – 100.8

Fuel cost assumptions breakdown

Component	Assumptions
km per year (light duty)	60,000 km
km per year (medium duty)	75,000 km
km per year (heavy duty)	100,000 km
Diesel cost (per litre)	£ 1.46
Electricity cost (depot) (per kWh)	£ 0.19
Electricity cost (OTG) (per kWh)	£ 0.39
Hydrogen cost (per kg)	£ 10.40

Fuel usage assumptions breakdown

Component	Light Duty Low	Light Duty High	Medium Duty Low	Medium Duty High	Heavy Duty Low	Heavy Duty High
Charging split: Depot to Public (%)	90%	75%	85%	60%	85%	60%
Electricity consumption (kWh/100km)	46	90	93	110	110	140
Diesel fuel consumption (litre/100km)	19	26	28	35	35	40
Hydrogen fuel consumption (kg/100km)	3	5	7	8	10	14

Depot Upgrade Cost Assumptions

1. A 1.5MW grid connection costing from £20,000 to £300,000, depreciated over 20 years facilitating 10 chargers and servicing 10 HGVs
2. The chargers are expected to be 150kWh chargers, an overarching assumption, however applied as a middle ground for the power capabilities of chargers installed at depot sites

Source: KPMG LLP

Finance Cost Assumptions

1. A vehicle down payment percentage of 15%
2. An interest rate for loan financing with a range of 2% (low-cost range) - 10% (high-cost range)

Source: Truck1.EU

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