

ZERO EMISSION HDVS - MARKET PENETRATION AND IMPACT OF LEGISLATION ON ADOPTION

By Richard Shrubbs, Ti



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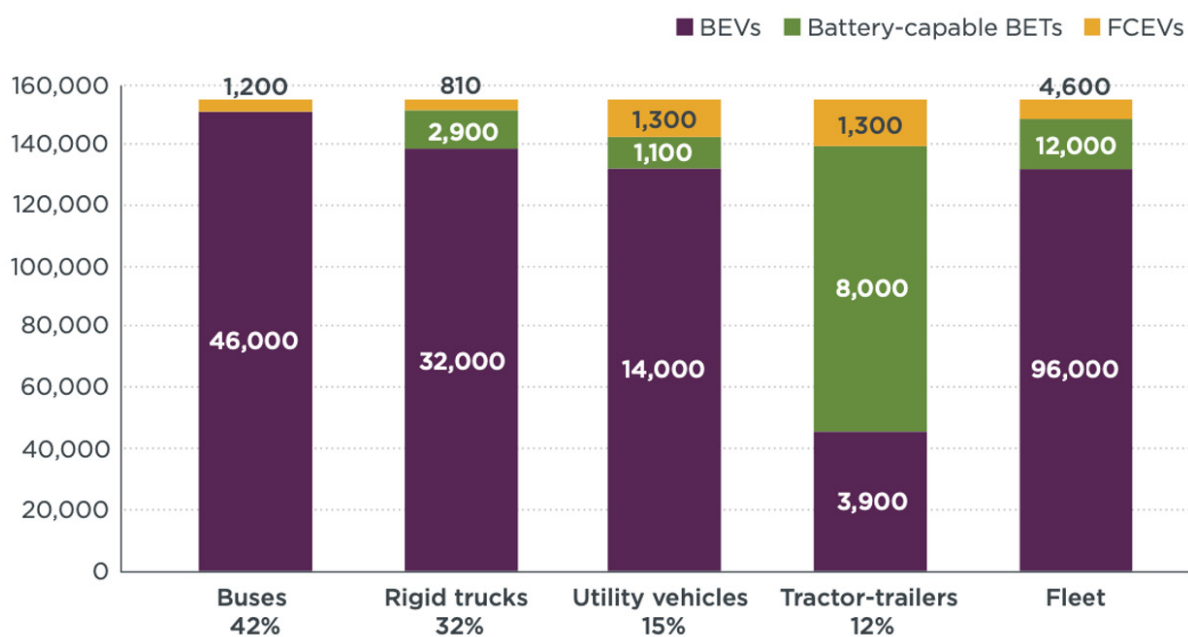
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1. INTRODUCTION

Global zero emission heavy duty vehicle (ZE HDV) market penetration has been asymmetric in recent years with China far ahead of western economies. In the next three sections we will look at China, the EU and US, showing how consumer economies lag far behind China.

China

Figure 1. 2022 China ZE HDV Sales by technology



Source: ICCT

In 2022, China accounted for over 81% of global ZE HDV sales with 113,000 units sold. This was actually a 12% y-o-y decrease over 2021, but given overall HDV sales fell 51.8% y-o-y in that period, market penetration grew to 9% as a result.

BEVs and battery-swap capable vehicles accounted for 11,900 tractor trailer units, that still amounted to almost 7.5 times the amount of battery electric trucks sold in Europe in the same period.

Fuel cell electric truck/trailer units (FCETs) sold in far greater numbers in China than the rest of the world, with almost as many FCETs sold as ZE HDVs of all types across the whole of Europe.

China has been running government financial incentives for businesses to switch to ZE HDVs. These gradually tapered off since 2017 and where there is still some subsidy available for the purchase of such vehicles, TCO in the country is such that many businesses are going over to BETs on economics alone. According to [Transport Environment](#), the Chinese government has recently announced internal combustion engine tailpipe emission reduction standards that will further improve the TCO for BETs.

Europe

Figure 2 shows the overall makeup of low emission HDV sales in 2020-23. The two diesel data points, from the ACEA, show the relative size of ZEV sales to that of conventional truck sales. In 2022 if the numbers were directly comparable, the amount of BET sales were just over 1.15% that of diesel truck sales.

New regulations and incentives are coming, with Euro 7 emissions standards set to make BETs an even cheaper solution than diesel in the coming years. At the same time, in many countries like France and Germany there are very good road toll incentives that impact the TCO of BETs, to the point that even now it is a sensible economical decision on TCO to add large numbers of BETs to HDV fleets.

Figure 2. Truck Sales by Fuel Type, 2020-2022, European Union

Fuel Type	2023	2022	2021	2020
Battery Electric*	8,810	3,786	2,157	973
Hybrid Battery*	268	115	44	29
Hydrogen*	65	55	14	9
Diesel**		326,992	316,123	

* Source: European Alternative Fuels Observatory data

**Source: ACEA diesel truck sales for EU, EFTA and UK

USA

According to the US [Environmental Defense Fund](#), total ZE HDV sales in 2022 amounted to 0.05% of all HDV registrations. Given that close to 250,000 units of all propulsion systems a year are registered, this is just 125 units. As a comparison, this is less than 1% of semi trucks sold in China the same year, and less than 10% of the BETs sold in Europe that year.

As with Europe, there is transformation underway. Tesla launched its Semi in 2023, which sells for US \$250,000 per unit after Federal Tax Credits are applied and with such tax credits achieves a TCO very similar to that of a diesel Class 8 semi. However, according to Tesla's Q4, 2023 shareholder deck, this vehicle is still classed as being in 'pilot production' and not in mass produced volume production at present.

The US Inflation Reduction Act, if maintained under future presidential administrations, will continue to offer incentives to fleet buyers and OEMs alike to transition to ZE HDVs until 2032. Though it is too early to state, it is generally recognized this should have a major impact on US ZEV truck sales.

2. LSP ACQUISITIONS OF ZE HDVS

In 2023, Marek Gawronski, E-mobility and Sustainability Director of Volvo Trucks Poland said, "Big players in the transport and logistics industry play key roles in the move towards climate neutrality and guiding the industry's efforts to lower its carbon footprint". He said this in reference to DHL Supply Chain Poland's delivery of a number of Volvo BETs, and rightly argued that the big players set an example to the smaller ones.

Though many of the more sustainability committed large logistics service providers (LSPs) have fairly detailed breakdowns of their low emission fleets, even the best like DHL and Le Groupe La Poste don't go into sufficient detail about their HDV and LCV fleets' propulsion systems. As such, we have taken a litmus of the US and European ZE HDV markets via truck manufacturers (OEMs) as opposed to their client LSPs.

BETs

BYD USA - 2022

In 2022, China based Build Your Dreams (BYD) announced an order of 200 Class 8 BEV HDV tractors for Einride's operations in the US market. These were for drayage, regional haul and distribution work and had a range of 200 miles.

DAF - 2023

Also for Einride, DAF Trucks announced an order for 50 DAF XD electric HDVs for its European operations. These came with a variety of battery pack configurations and had different ranges up to 500km that were not specifically announced.

Daimler Trucks - 2023

Multinational truck OEM Daimler Trucks announced a letter of intent from European road haulage giant DB Schenker for an order of 100 eActros Long Haul HDVs with a 500km range that would be delivered in 2024.

Daimler Trucks-owned US OEM Freightliner's eCascadias are participating in the US Run On Less BET research project, and are being used by Penske, Schneider, UPS, US Foods, and OK Produce in the research project.

MAN Trucks - 2023

Also for DB Schenker, Germany based MAN Trucks announced an order for 100 Ultra tractors and swap body BETs. The first 10 will be delivered in H1 2024 and the remaining by 2026.

Electric Freightway - UK BET trial - 2024 on

OEMs Renault Trucks, Volvo Trucks and DAF will lease or sell 140 BET HDVs to clients including Royal Mail, Kuehne+Nagel, Amazon UK, Maritime Transport, United Utilities Water, Fergusons and AF Blakemore.

The Electric Freightway scheme is a UK government supported programme that includes the Gridserve EV charging network for a long-term study into the usability of BETs. All participants submit various data to the organisation while live-trialling the BET HDVs.

Nikola

Nikola sells a BET, the Tre BEV that is being trialled in the US Run on Less study, operated by Watt EV. As with its FCETs, Nikola isn't at the volume production stage of its BETs.

Renault Trucks - 2024

XPO ordered 165 Renault Trucks e-Tech units including 105 tractor units. These will be used for XPO Logistics France operations for suburban and regional use.

Scania - 2023

Scandinavian OEM Scania UK announced that 100 EV HDVs had been ordered by Consortium Purchasing, an independent fleet owner that leases the vehicles to a number of clients including Culina Group. This was part of a 2,500 HDV order with the majority of the units, diesel powered. Delivery was planned for mid 2024.

Tesla - 2023

Though heavily hyped, according to Tesla's 2023 Q4 financial reports the Tesla Semi is only at 'pilot production' stage. Its vehicles have been supplied to PepsiCo for the US Run on Less study for \$250,000 per unit. This is considerably more than the \$180,000 per unit price broadcast by Elon Musk.

Volvo Trucks - 2022

Volvo announced a deal with DHL Group where it would deliver 44 Volvo BET trucks in the FE, FL and FM variants. Amongst others, six were ordered for DHL Parcel UK, two for DHL Freight and five Volvo FM units were ordered for DHL Supply Chain Poland.

Volta Trucks

Volta Trucks is an important new BET manufacturer that in late 2023 had to file for bankruptcy due to problems with its battery manufacturer Proterra. When it briefly went into administration it had 5,000 orders for its Volta Zero truck.

In February 2024, now owned by Luxor Capital, it has gone into series production through Austria based Steyr Automotive with a planned volume of 500 units in 2024 and 2,000 a year thereafter.

Prior to bankruptcy it had known interest from DSV Panalpina and DB Schenker. It is not known which LSPs have retained their orders with the company after the changes in ownership.

FCETs

As can be seen in the truck sales data at the beginning of this piece, very few FCET units are actually sold worldwide. Here we will touch on a number of trials and sales data.

Hyundai Class 8 Xcient

Hyundai is one of just two major OEMs to sell class 8 HDVs outside of China at present. It has 47 Xcient HDVs in use in Switzerland, 30 in Northern California, and 355 units in operation in its home country of South Korea.

Nikola Trucks

Nikola Trucks sold 42 The FCETs in 2023, the majority to the wholesale market for onward sales. These vehicles use compressed gas hydrogen systems and have a claimed 500 mile range.

Iveco

Iveco was involved in a JV with Nikola to produce BET and FCEV vehicles for the European market. This deal has since fallen through and Iveco now has 100% control of the organisation originally supported by Nikola.

Currently it is live trialling 16 FCETs by the Germany based H2Haul hydrogen road transport research project.

Daimler Trucks

Announced in 2023, from mid 2024 Daimler Trucks is to supply its Gen H2 liquid hydrogen FCET vehicles to a number of LSPs for live road trials. The vehicles will remain under direct supervision and responsibility of Mercedes Benz Trucks and will operate on specific routes in Germany. They will be refuelled at destination fuelling units.

Participants in the trial include Amazon, Ineos, Holcim and Weidmann & Winz.

Japanese HDV Research Project

Due to a positive government policy towards hydrogen, Japan is one of the world's leading nations where it comes to hydrogen refuelling infrastructure. As with the European BEV private car market, its network is centred around private cars with leading Japanese OEMs such as Toyota and Honda producing FCEV cars at volume.

In May 2023, four major Japanese LSPs announced plans to live trial an FCET. These companies are Asahi Group, Seino Transportation, Next Logistics and Yamato Transportation. Seino Transportation and Yamato Transport figure among the 100 top LSPs in the world as monitored by GSCI.



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Case Study DHL

In late 2023, DHL Supply Chain North America announced plans to transition 30% of its HDV fleet to zero or low emissions fuel by 2030. This is part of DHL Supply Chain's global ambitions to move 30% of its fleet in 17 countries where it has 94% of its transport emissions by 2026.

DHL Supply Chain is investing €200m over three years to help achieve this aim. Jim Monkmeyer, President of Transportation at DHL Supply Chain said that battery electric trucks (BETs) aren't just about saving the planet. "We see electric trucks as a strategic investment that offers numerous advantages for our company and the communities we serve."

The company has been using battery powered transportation for more than eight years to date. In the US DHL Supply Chain has discovered that beyond the advantages to the climate:

- Class 8 BETs use 50% of the energy of a diesel equivalent, saving money on energy
- The same BETs have greater horsepower and torque than their diesel equivalents
- Drivers of Class 8 BETs report that the reduced vibration and noise of the vehicles lead to lower fatigue, enabling them to drive more safely for longer

As such, BETs shouldn't only appeal to the 'vegan, knit your own sandals' brigade but to a great extent to the 'raw steak eating Texan' too.

Yard tractor beginners pool to the open road ocean

DHL Supply chain is an industry leader and early adopter of low emissions transport technology, and many other road freight companies look to the Germany based multinational for leadership in the transition to the goal of zero emissions trucking. It started in the US by moving its yard tractors to battery electric.

Stephen Schlabiniski, VP of operations excellence at the GoGreen division of DHL Supply Chain recently said, "We learned to swim in a pool by using yard tractors. Now we have the confidence we can swim and can go to the ocean to apply the same learning to the on-the-road Class 8 trucks."

In 2023 the company added 30 new yard tractors to its fleet, taking its North American yard tractor fleet to 60, and stopping buying diesel yard tractors altogether. It has now taken its learnings to the big wide ocean of regional on-the-road trucking.

Class 8s on the open road

As of early 2024, DHL Supply Chain has put 13 Class 8 BETs on the road in California, North Carolina, Ohio and Pennsylvania. Monkmeyer added, "This is not a truck, it's a system - a symbol of our commitment to creating a cleaner, more efficient and more sustainable transportation landscape". He was referring to the infrastructure required here, where the company is installing destination truck chargers both at its own sites and at those of clients it sends goods to. With the installation of roadside HDV chargers in highway service stations across the continent, so Monkmeyer's "system" is gradually emerging with the use of the Class 8s on the big wide ocean of North America's road network.

3. NEW EUROPEAN REGULATIONS IMPROVE THE TOTAL COST OF OWNERSHIP OF ZERO EMISSION TRUCKS

Two sets of European regulations are set to put zero emission truck (ZET) sales into overdrive in the coming years. European focused NGO Transport & Environment estimates that as many as 30% of new trucks on the road in 2030 will be zero tailpipe emission.

European Union General Approach to HDV emissions

Where the European Parliament needs to formally ratify the new regulations, the three main bodies - European Commission, European Council and European Parliament have in principle agreed a general approach on heavy duty vehicles' (HDVs) emissions. When ratified, with some exemptions for military, agricultural and things like rubbish collection vehicles, newly registered HDVs on Europe's road must:

- Have 45% lower CO₂e emissions from 2030 as against 1990s levels
- 65% lower CO₂e emissions from 2035
- 90% lower emissions from 2040

Such demands from the European Union are going to push the logistics industry hard in the direction of acquiring ZETs as against internal combustion engine (ICE) vehicles. Freight manager at Transport & Environment, Fedor Unterlohner commented at the time, "European producers now have a clear trajectory to ramp up production of electric and hydrogen rigs and be ready for the challenge of Tesla and Chinese rivals."

TCO at break even for BETs and diesel

As we have found in Transport Intelligence's recent total cost of ownership (TCO) research, BETs are already at the crossover point where they are at a comparable cost to run as diesel vehicles. We estimate that BETs cost €1.14/km where ICE HDVs cost €1.18. As such, the time is right from an economic as well as regulatory point of view to consider large fleet purchases of BETs.

A number of major LSPs like DHL Supply Chain have already taken the leap, with the distribution arm of DHL Group committing to replacing 30% of its HDV fleet with ZETs in 17 countries by 2026. The new Euro 7 regulations that will apply to both newly registered EU and UK vehicles, will improve TCO even further.

Euro 7 - costs disproportionately hit ICE HDVs

The new Euro 7 regulations, on approval from the European Parliament probably later this year, will considerably add to the TCO of ICE trucks from around 2027. Euro 7 is less about greenhouse gases and more about the other noxious substances that affect public health and include:

- Carbon monoxide
- Hydrocarbons
- Non-methane volatile organic compounds
- NO_x
- Ammonia (for the first time)

- Particulate matter from brakes and tyres, also for the first time

Research commissioned by the European Automobile Manufacturers Association (ACEA) puts the TCO costs at a far higher level - perhaps as many as 10 times - as that suggested in the EC Impact Assessment.

One of the key issues, admitted by the EC, is that fuel economy will fall by 3.5% for ICE HDVs. Frontier Economics, which did the research, suggested that manufacturers will have to pay as much as €12,500 per HDV in production and this will be passed onto customers. It stated, "Take for example a long-haul truck with a mileage of around 1m km and a fuel consumption of 25l/100km. At a diesel price of €2/l, a 3.5% fuel increase would result in €17,500 in added fuel costs over the assumed mileage of the truck."

With these two figures - €12,500 in added capital cost and €17,500 in fuel costs, the ICE vehicle will have an added €30,000 in TCO in a one million km lifetime. Ti estimates that an ICE HDV will cost close to €1.18/km already, so this added cost would be in the order of 2.5% for a million km.

The new Euro 7 regulations make demands on battery life that Frontier Economics estimate will add just €750 to a BET TCO in capital costs. Ti estimates that the TCO of a BET is €1.14/km before Euro 7, which over a million km would result in an added cost of 0.07%. As such, the ICE HDVs will be hit considerably harder than BETs. We have not forecast the TCO of BETs for 2027, but BETs will be cheaper than now by a margin even without Euro 7 factored in.

Other European regulations improving TCO

Worthy of note, the 2.5% uplift in ICE HDV TCO is going to hit at a similar time to preferential ZET tolling on the main roads of the bloc. With new ZET preferential tolling, we estimate that BETs will get a 12.5% reduction in TCO over that of ICE HDVs over 600,000km. This preferential treatment will further improve the economic incentive of going electric. With the cost of fuelling factored in, hurdle by hurdle, the excuses to not choose a BET over an ICE vehicle are falling.

No firm dates...

Unlike the UK where Parliament's agenda changes with the makeup of MPs, the European Parliament will certainly consider the new emissions regulations regardless of the European elections. Two questions remain - when will these regulations pass into law, and will MEPs have the appetite to support them in their current form? Where the Greens and Social Democrat blocs of MEPs are in full support, given the wave of protest against certain climate change related reforms in recent months, will they have sufficient numbers to drive such regulation forward?

One thing is certain - while the text might differ in some form from its current state, such regulation will pass through, and probably in 2024. Once again, even with uncertainties we raise here, they cannot be ignored.

Fleet managers need to look into BETs now

With a typical new HDV ownership span of an HDV in the order of 5-7 years, these new regulations put ZET acquisition squarely on the desk of fleet managers even now. A sizeable proportion of regional use BET HDVs will make up fleets from just 3-4 years from now, and as such the time to consider the fleet makeup and infrastructure for future ZETs has come.

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