Global Commercial Vehicle Market

NEWSLETTER

GLOBAL M&A PARTNERS

RIóN MERGERS AND ACQUISITIONS

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CONTENTS

The global market for light and commercial vehicles is a rapidly changing environment. While much attention has been paid to the light vehicle market, major megatrends such as climate awareness, autonomy, and product safety have been creating a rapidly changing environment for the global commercial vehicle industry.

This report covers:

- Growth of the Commercial Vehicle market;
- Alternate powertrain and fuel options;
- Industry eReadiness and its future;
- Technical advancements in the vehicle components;
- The progress, policies, and technologies to achieve zero emission;
- M&A deals & Public Comps analysis within this space.

This will be a long-term shift in the industry and will have a huge impact on the climate and the global economy.

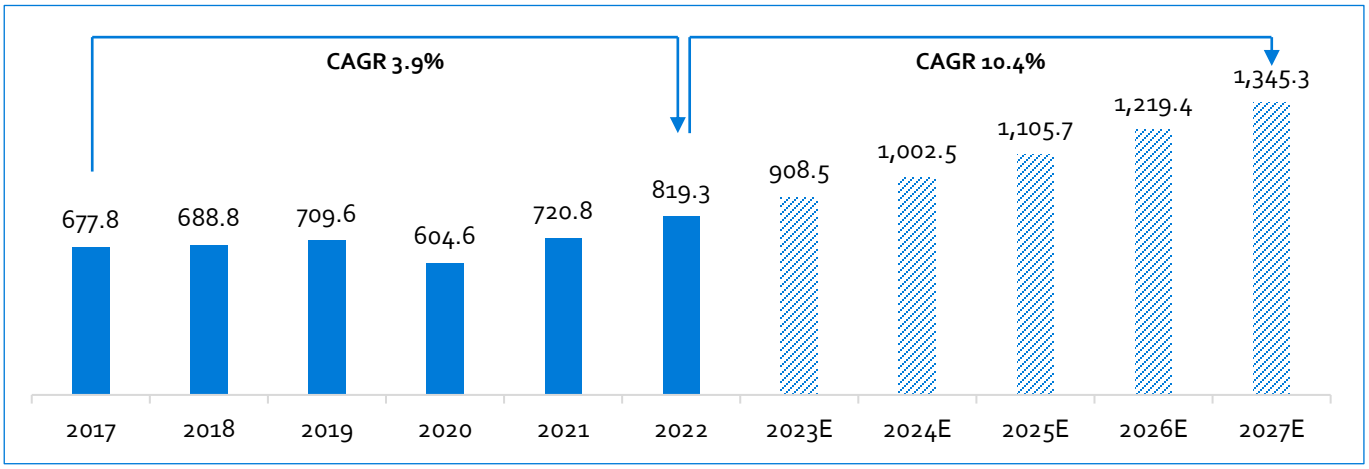
1.1 Introduction

The Global Commercial Vehicles Market was valued at **$819.3Bn** in **2022** and is estimated to reach **$1,345.3Bn** in **2027**, growing at a CAGR of **10.4%** from 2022 to 2027.

The commercial vehicle market's growth is largely dependent on overall economic growth, commercial, and industrial activity. This leads to an increase in commercial vehicle activity and ultimate production of commercial vehicles and their components.

Several factors have the potential to significantly reshape the commercial vehicle industry. These factors encompass emissions reduction strategies, alternative fuel adoption, advancements in connected technologies, and the implementation of predictive maintenance solutions, to name a few.

Global Market Size (in $Bn)



Source: The Business Research Company

Market Segments & Use Cases

The commercial vehicle market can be segmented across nine use cases:

Truck segment	Heavy-duty				Medium-duty		Light-duty	
Vehicle set-up	Tractor			Rigid (box, fridge, others)		Rigid / Coach		Cab-over-Engine	
Use case	Long-haul	Line-haul	Specials	Distribution	Specials	Distribution	Urban	Cargo van	Light truck
	• "Classic" long-haul with semi-trailer • Logistics and industries	• Repeated transports with semi trailer • Logistics and industries	• Heavy goods • Hazardous goods • Special applications	• Parcel and mail • Industries • Food • Municipal (garbage, firefighter, utilities etc.)	• Road construc-tion (dump truck, cement mixer etc.) • Special applications	• Parcel and mail • Industries • Food • Municipal (garbage, firefighter, utilities etc.)	• City service bus • Event short range transports	• Delivery Services • On-demand • Mobile Retail	• Small Business Operations • Utility and Service

Sources: Motorindiaonline, The Business Research Company, Strategy& analysis and IHS Medium Heavy CV Engine Installation (07/2022), Frost & Sullivan

Market Segments & Use Cases (Cont.)

Truck segment	Heavy-duty					Medium-duty		Light-duty	
Vehicle set-up	Tractor			Rigid (box, fridge, others)		Rigid / Coach		Cab-over-Engine	
Use case									
	Long-haul	Line-haul	Specials	Distribution	Specials	Distribution	Urban	Cargo van	Light truck
Trends	• HDV[1] have experienced a 2.5% historic CAGR growth over 2017-2022 and are expected to see a 6.4% growth from 2022-2027 • Increase in construction and development of infrastructure is a major factor driving the demand for heavy-duty trucks • Electric Heavy-duty commercial vehicles to witness steady sales • The Asia-Pacific region is the leading region of the market owing to several infrastructure investments and construction projects in progress and announced for the future					• MDV[1] have experienced a 3.4% historic CAGR growth over 2017-2022 and are expected to see a 7.1% growth from 2022-2027 • A continuous rise in last-mile delivery usage		• LDV[1] have experienced a 4.4% historic CAGR growth over 2017-2022, expected to see a 12.0% growth from 2022-2027 • Increasing government initiatives for the promotion of E-mobility	
Production volume share[1]	12%	20%	5%	18%	11%	15%	10%	5%	4%
Yearly mileage/ unit (km)	150,000	100,000	50,000	50,000	30,000	50,000	30,000	100,000	50,000
Annual emission share[2,3]	28%	31%	4%	14%	5%	8%	3%	5%	2%

HD = Heavy-duty trucks = class 8 (>15 tons), MD = Medium-duty trucks = class 3-7 (6-15 tons), LD = Light-duty trucks = class 1-2(<6 tons)
1) Global production of 16.8Mn units in 2022 2) Total CO_2 emission of 500 Mt by truck new registrations in 2022 3) Average consumption: ICE = diesel 0.35 l/km for HD, 0.25 l/km for MD, 0.24 l/km for LD

Market Dynamics

Trends	Relevance	Impact
Emission: Reduce greenhouse gas (GHG) emissions by modifying the vehicle structure, implementing green design, and promoting new energy vehicles	●	↑
Alternate Fuels: Shift toward alternative power sources like CNG, hydrogen, and electric battery due to rising environmental concerns	◕	↗
Connected Technologies: High-speed connections provide a safer driving experience by enabling companies to gather and quickly analyze data, for example, information on speed, fuel economy, emissions, etc. Connected technology in autonomous vehicles can enable the vehicle to communicate with their surroundings, enhancing safety and efficiency on the road	◕	↗
Predictive Maintenance: Data generated can be used to notify drivers and fleet managers when specific parts of a vehicle need maintenance services	◕	↗

Note: ◑ Degree of relevance of the trend to the commercial vehicle market → Degree of the impact of the trend on the commercial vehicle market

Sources: (1) Historical and estimated CAGR from The Business Research Company, PwC Truck Study 2022, Sustainabletruckvan, Researchandmarkets, Fortunebusinessinsights, Chipex, Strategy& analysis and IHS Medium Heavy; CV Engine Installation (07/2022)

Market Dynamics

Key Drivers

The following are some of the growth drivers which are expected to drive the market in the coming years:

EVs
Rising environmental awareness and increasing spend toward sustainable modes of transportation to drive demand

Technology Adaptations
More reliable and efficient transportation supported by software to optimize fuel usage, identify the best route, and avoid vehicle collisions or accidents will further aid in market growth

Rising Demand
Government spending on infrastructure projects, growing levels of economic activity, increasing road transportation, and recovery in global production & trade are factors contributing to increasing demand

Evolving Value Chain
New entrants have the chance to fill in existing need gaps in the value chain as a result of the changing future market requirements, thereby increasing the supply

Challenges

The following factors may adversely impact market growth, affecting both the manufacturers and the fleet operators in the commercial vehicle space.

R&D costs
Advanced technological features and innovation demand higher investments in R&D in exchange for delayed returns

Full Autonomy
The complexity involved in achieving full autonomy in all situations and conditions, as well as the political headwinds from replacing millions of jobs will hamper growth

Rising Fuel Prices
Fluctuations in prices of petrol & diesel has a lasting impact on the industry due to its non-renewable nature. It is the industry's most significant operating expense and hence, affects profitability

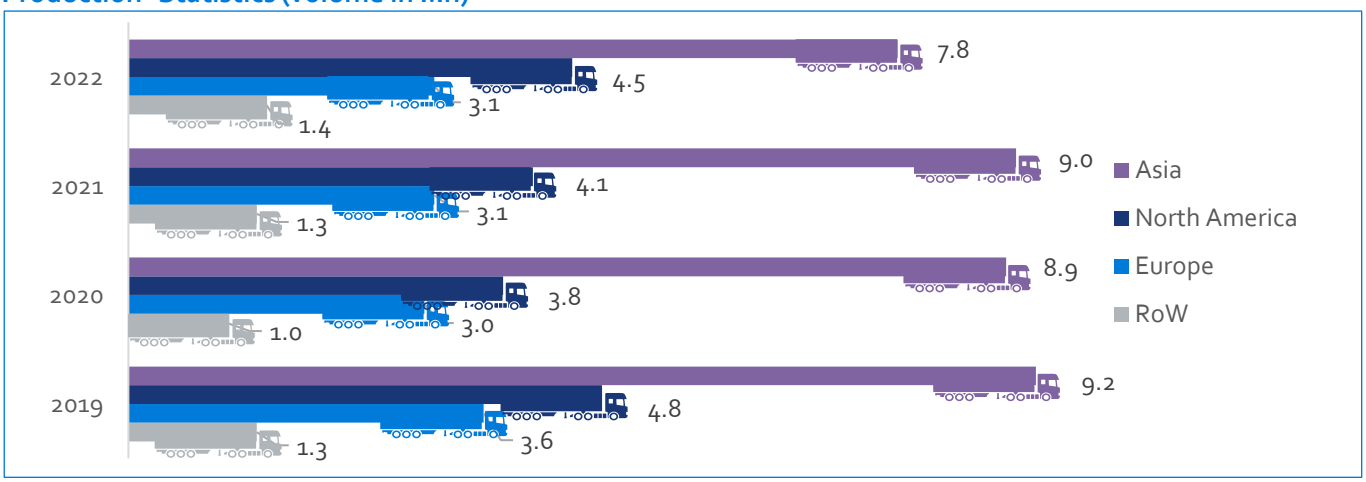
Regulations
Various regulatory requirements, such as emissions regulations, safety standards, etc., put additional burden on manufacturers, as they often require significant investment in research and development, new technology, and compliance measures

Sources: Motorindiaonline, Prnewswire

1.2 Commercial Vehicle Production & Sales

- The chart below shows the CV production across the regions such as Asia, North America, Europe, and RoW (rest of the world, which includes South America, Middle East and Africa).
- In 2022, the top markets i.e., Asia accounted for 49.9% of global commercial vehicle production followed by North America 24.6% and Europe 18.3%.
- The pandemic, ongoing military conflict in Europe, and global supply chain disruption have caused a fall in the overall production capacity over the past four years.

Production[1] Statistics (volume in Mn)

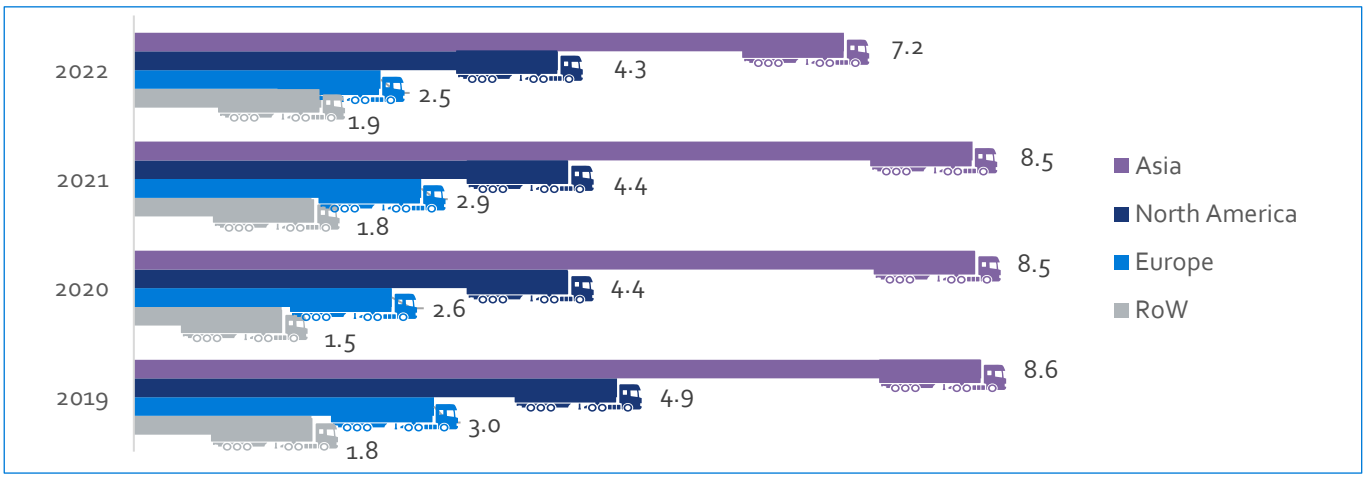


Note (1): Includes Vans - LCV; Trucks – M&HCV; and Buses - M&H buses

Source: ACEA

- The following chart shows the sales volume across Asia, North America, Europe, and RoW (rest of the world, which includes South America, Middle East and Africa).
- In 2022, Asia accounted for 47.6% of global commercial vehicle sales, followed by North America 26.1%, Europe 16.1%, denoting the three major regions for sales.
- The overall decline in sales volume can be attributed to multiple reasons such as rising inflation and interest rates as well as investment conservatism due to concerns of economic downturn and geopolitical instability.
- The chart shows a relatively greater volume of sales in North America when compared to vehicle production as the manufacturers were either importing vehicles from other countries to meet the demand or due to the stock clearance of existing inventory.

Commercial Vehicle[1] Sales (volume in Mn)



Note (1): Includes Vans - LCV; Trucks – M&HCV; and Buses - M&H buses

Source: ACEA

Source: ACEA-European Automobile Manufacturers' Association

1.3 Supply Chain

The World Bank reports that the quantity and severity of global disruptions have both increased over the past 20 years. Commercial vehicle OEMs must re-evaluate their current business practices and supply chains in light of ongoing disruptions and logistical advancements.

Destructive logistics capacities, microchip shortages, and energy price peaks as a result of high demand and low supply on the markets are causing a nightmare for suppliers and commercial vehicle OEMs.

Challenges due to covid-19 have been further aggravated by the Russia-Ukraine war which has resulted in difficulties for the global commercial vehicle supply chain. As a result, OEMs are turning to re- or near-shoring sourcing tactics to cope with persistent component shortages and chip scarcity.

The impact of supply chain disruption on select manufacturers is mentioned below:

Manufacturers		Impact
DAIMLER	Daimler	~25 types of chips Daimler Truck needed were in short supply
PACCAR	Paccar Inc.	Semiconductor shortage reduced truck deliveries in Q3'2021 by ~7,000 vehicles, however in 2022, with introduction of DAF trucks, supply chain improved by 45%
TRATON	Traton SE	Limited components availability resulted in high order backlogs and incoming orders were down by 5% in Q3'2022
VOLVO	Volvo	Struggled with a shortage of crucial components such as semiconductors, broader supply chain issues, and strained freight capacity
Ford	Ford	Limits on availability of certain parts of commercial vehicles led to increase in inflation-related supplier costs
TATA MOTORS	Tata Motors	Rise in price of commercial vehicles in the range of 1.5-2.5% in July'2022 and again in Jan'2023 due to steep rise in overall input costs
gm	General Motors	Market share down YoY due to timing of semiconductor impact and availability of dealer inventory in 2022

Sources: Rolandberger, Internationaltaxreview, Reuters, Paccar, Traton, The Business Research Company

Supply Chain

Effects of Russia-Ukraine War

The commercial vehicle market has been severely constrained by the ongoing conflict between Russia and Ukraine. The war has an influence on numerous technical areas, both directly and indirectly.

- The price of metals used in commercial vehicles increased from high-grade nickel used in electric vehicle batteries to palladium used in catalytic converters to aluminum used in bodywork.
- Russia controls up to 44% of the world's palladium supplies, and Ukraine provides ~70% of global neon supplies. These two major raw elements are critical in the creation of semiconductor chips, which are required in practically all other sectors.

Although it is a "black swan" incident and not connected to enduring or fundamental problems in the market or the global economy, it is anticipated that the commercial vehicle market would recover from the shock over the course of the next few years.

Strategies by OEMs to safeguard business

Realizing that supply chains cannot be made completely immune from disruptions, commercial vehicle providers have implemented various strategies to safeguard their businesses. These include:

- **Deliver the "good enough" product:** Companies are reducing or even getting rid of non-essential features and components to prevent shipping delays. Commercial vehicle providers have discontinued driver-assistance systems and other features that require computer chips, which are in shortage
- **Develop better monitoring systems:** Better technologies are being developed to track the most important supply chain links and alert potential issues in real time
- **Resist the urge to centralize decision-making:** Centralization may lead to response times that the business cannot afford. An effective strategy involves finding the balance between centralized & distributed decision-making
- **Identify pragmatic ways to ensure supplies of crucial resources:** Solutions include paying premium prices to suppliers to secure access
    - Sourcing parts or materials from multiple suppliers
    - Redesigning the end product to rely on alternative inputs that are widely available
    - Standardizing more components across the company's suite of products and co-investing with suppliers to increase manufacturing capacity

Sources: Hbr.org, Sustainabletruckvan, Strategy and PwC

2.1 Developments within Component Categories

The commercial vehicle industry is constantly evolving to meet regulatory requirements, technological advancements, and customer expectations. The component categories are also changing due to various factors and advancements in technology. Factors such as connectivity and automation, safety and driver assistance, changing customer preferences, etc., are driving such change.
This section highlights the non-exhaustive advancements within each of the key component categories.

Active Safety Systems

Intelligent Cruise Control	Automatically maintain a reasonable following distance by measuring the distance from the vehicle in front and controlling the acceleration and deceleration
Intelligent Trace Control	Automatically apply brakes to each wheel, thereby assisting drivers in effortlessly maintaining control and in keeping the vehicle on the cornering line as steered. It determines if the vehicle is departing from steered path
Intelligent 4X4 System	Adjusts power output to the front and rear wheels to assist drivers in making smooth turns
e-Pedal	Allows the driver to just use the accelerator pedal to start, accelerate, decelerate, and stop the vehicle

Passive Safety Systems

Airbag Control Units (ACU)	ACU supports in handling more content and prompt communication with other components. It detects and evaluates the intensity of accidents. Based on the assessment, they trigger action to appropriate systems
Occupant Safety Monitor	Sense the position of the passengers within the vehicle and dynamically adjust the airbag deployment
Safety Domain Control Unit	Integrates information from forward-looking environment sensors, thus reducing the risk of an accident and limiting the damage

Sources: LocoNav, Nissan, Financialexpress,

Technical Advancements

Braking System

Orbis-Periodic Wave Disc-Brake	Weighing less than 50% on average than conventional cast iron brakes, it uses advanced aerodynamics to enhance surface cooling, minimizes dangerous brake fade, and improves fuel efficiency and vehicle range.
Brake Caliper	The green fist brake calipers a.k.a. Green Caliper are more compact and lighter, and can save ~2 kilograms (kg) in weight per brake caliper plus ~3 kg more, per brake disc. Its lighter weight and residual brake torque extend the range of the vehicle

Body Exteriors and Chassis

Magna Morphing Surfaces Technology	It makes use of active, "bendable" surfaces that can be designed to visually integrate into a vehicle's body while opening or closing to improve cooling, venting, or aerodynamics
Qualcomm Snapdragon Digital Chassis	Set of cloud-connected platforms for telematics and connectivity, digital cockpit, and driver assistance and autonomy
Chassis 2.0	ZF Chassis 2.0 concept provides a flexible base for automated and electric vehicles. Smart actuators are combined with a scalable E/E architecture and wide-ranging functions

Powertrain and Driveline

Allison's eGen Power® series	Fully integrated electric axles, eGen Power is a bolt-in solution compatible and easily customizable to vehicle frame, suspension and wheel ends, and is well suited to most OEM vehicle assembly processes
CeTrax 2	Integrated and modular electric central drive for heavy-duty special vehicles. Enable OEM customers to offer ICE and electric drivelines in a single-vehicle platform
Parametric Trunnion Tripot	Increases durability life, allowing for the use of more compact and lightweight joints
Ball Spline Axle Halfshaft	Halfshaft solution offers expanded plunge/angle capabilities, expanded durability, and unparalleled noise, vibration, and harshness (NVH) performance even at extremely high operating angles

Sources: Financialexpress, Continental, Magna, Qualcomm, ZF, Allisontransmission, Nexteer

Technical Advancements

Fuel Tanks

High Pressure Hydrogen Tank	Large high pressure hydrogen tank for use on the fuel cell trucks running on hydrogen. Has an eight-fold capacity as compared to the passenger fuel cell vehicle tanks

HVAC Systems

Smart Air Conditioning Framework	The Internet of Things (IoT) systems, which are embedded with sensors, programming, and availability, are used by new HVAC technology. It enables the HVAC system to communicate with other connected devices and exchange data
Thermally-driven air conditioning	Thermally driven cooling system utilizes solar energy and is strengthened by combustible gas, making it an extraordinarily effective and efficient framework

Tanker and Silo

Modul CA	Rear support landing gear designed exclusively for silo vehicles. Its features include a module drive on the inside, low maintenance due to an integrated lubricant cartridge, and a continuous back plate for high variability during installation
DCA AIRMASTER PLUS	First and only trailer axle that stores compressed air for the brakes and air suspension in the axle housing. This component saves more than 50kg in weight

Tires

Tire Pressure Monitoring System (TPMS)	Measures the pressure inside a tire, transmits the reading, and displays it. Alerts the driver of a critical situation through a corresponding signal
Goodyear SightLine	SightLine intelligent tires have a sensor that tracks data as diverse as inflation and road-surface conditions. It also comprises a device that collects data and transmits it to Goodyear's cloud environment
V-Steel Port Container Straddle (VPCS) Radial Tire	Tires created specifically for straddle containers used in intermodal yards and port terminals. The redesigned VPCS has improved load capacity, speed rating, and durability built into the design

Exhaust Systems

CatVap	This fuel treatment technology (CATalytic eVAPoration process) developed to reduce emissions from internal combustion engines. This can also be used with biofuels and electricity-based fuels (e-fuels), in addition to diesel. It is currently being tested on the road for use in commercial vehicles

Sources: Businesswire, Ebaircontrol, Global Trailer, Financialexpress, Orangemantra, Fleetpoint,TireReview, eeNewsEurope

Technical Advancements

Seating Systems

Reconfigurable Seats	A smart device enables seats to be swiveled to allow social interaction, or folded and stowed to free up space
Seats with Integrated Features	Seats with controls that allow users to regulate the ventilation and warmth, deliver a massage, or provide a distraction if they are getting tired. These smart seats can also be built as recliners to allow drivers to lie down while driving RECARO
Intelligent Seating	This intelligent seating system sensors monitor occupants' health conditions, such as heart rate and stress levels, and alter the seating to suit the occupants' preferences if it is not ideal given their state and position in the chair

Steering Systems

Direct Adaptive Steering	Transmits the driver's steering inputs, moving the tires by translating the driver's steering into electrical impulses and separately adjusting the angle of the tires and the steering power
Steer-by-Wire (SbW)	Uses algorithms, electronics, and actuators to replace the mechanical steering linkage between the hand wheel and road wheels. SbW offers a wide performance range and improves maneuverability with dynamic variable steering ratio. It supports conventional driving as well as various degrees of Automated Driving (AD) in all vehicle types, including ICEs and EVs
Stowable Steering Column	Allows the steering wheel to be retracted into the dashboard when automated, hands-free driving is activated. The amount of space available for the driver can be increased by using it in traditional vehicles when it is not in motion

Automotive Lighting

Laser light for headlights	Their brightness is ~4x that of a LED. They have the longest range provided by any current headlight technology, offering improved visibility resulting in increased road traffic safety
Bend lighting headlamps with LED technology	Intelligent LED headlight systems give drivers optimal vision even on the edge of roads or with approaching vehicles, offering better protection from possible accidents. It has five, individually-controllable chips providing flexibility to switch on or off according to the driving situations and positions of other road users
Flexible OLEDs in vehicle lighting	OLEDs are flat light sources that achieve more homogeneity and can be steplessly and individually dimmed. OLEDs feature incisions in the lighting area and offer higher flexibility beyond concave and convex bending
Automotive Lighting	FlecsForm™ enables uniform lighting in an extremely thin package, complex shapes, improved power, and thermal efficiency. This allows for complete design freedom and brand differentiation MAGNA
Display and Communication Lighting	Magna mini LED displays enable advanced display communication. With a brightness 20x higher than LCD display technology, visibility at high contrast ratio is capable in full daylight MAGNA

Sources: Rcoeng, Nissan, Nexteer, Osram, Magna

3.1 Readily available gas stations formats currently offered

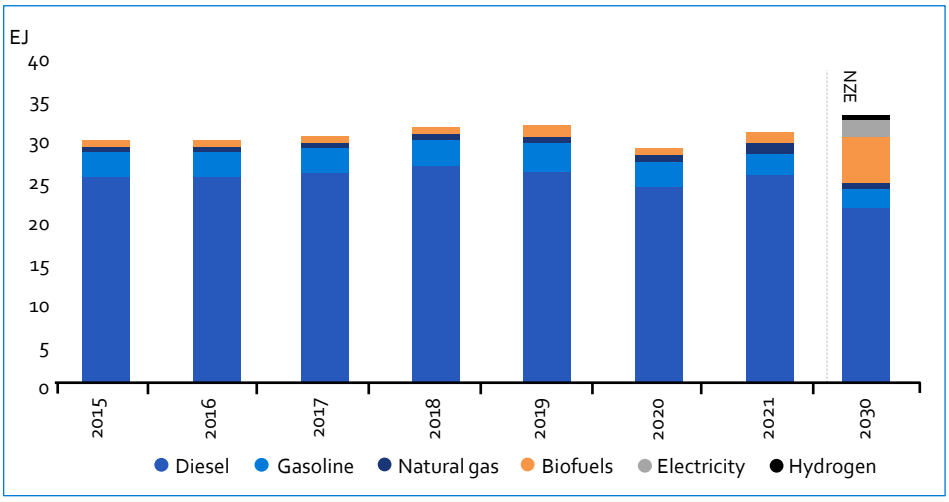
Throughout 2022, energy prices in Europe and other regions skyrocketed to their highest levels since 2008. The International Energy Agency estimates that higher fossil fuel prices accounted for 90% of the increase in electricity prices in 2022, and that fossil gas prices alone accounted for more than half this rise.

Despite having the lowest share of renewable energy across demand sectors like Building, Industry, and Agriculture, many countries had renewable energy mandates or enabling policies as of the end of 2022. Most of these were biofuel blending mandates, electric vehicle targets, or 100% bans on internal combustion engine vehicles. The global momentum towards net zero-emission drives change in policy, with a stronger focus on decarbonization than on the penetration of renewables along with increase in pace for the electrification of vehicles, with support policies ranging from tax incentives and stimulus packages to specific targets for electric vehicles. Policies for charging infrastructure have also gained attention. The US Department of Transportation proposed standards for a National Electric Vehicle Charging Network that utilizes renewable electricity. In France, new legislation makes it mandatory for parking lots that have 80 spots or more to install solar photovoltaic (PV) systems for electric vehicle charging within three to five years.

Hydrogen production for road transport is seen as suitable for use in heavy-duty vehicles that drive long distances. India launched a Green Hydrogen and Green Ammonia Policy in February 2022 and announced a National Hydrogen Mission, with specific mention of the transport sector.

A successful rollout of zero-emission vehicles will help reduce overall energy consumption via efficiency advantages over internal combustion engines. Furthermore, the shift away from fossil fuels will require markets to scale up for battery electric and hydrogen trucks and electric buses with supporting infrastructure including EV charging stations, expanded transmission capacity, and battery storage. Doing so in line with the Net Zero Scenario can see electricity, which currently accounts for less than 0.5% of sectoral energy, and hydrogen (negligible share today), increase to around 7% and 2% of sectoral energy by 2030 respectively, which will act as a step closer to less dependency on fossil fuels.

Global energy demand for trucks and buses by fuel, 2000-2021, and 2030 in the Net Zero Scenario



Sources: Ren21 Renewables Report 2023, IEA

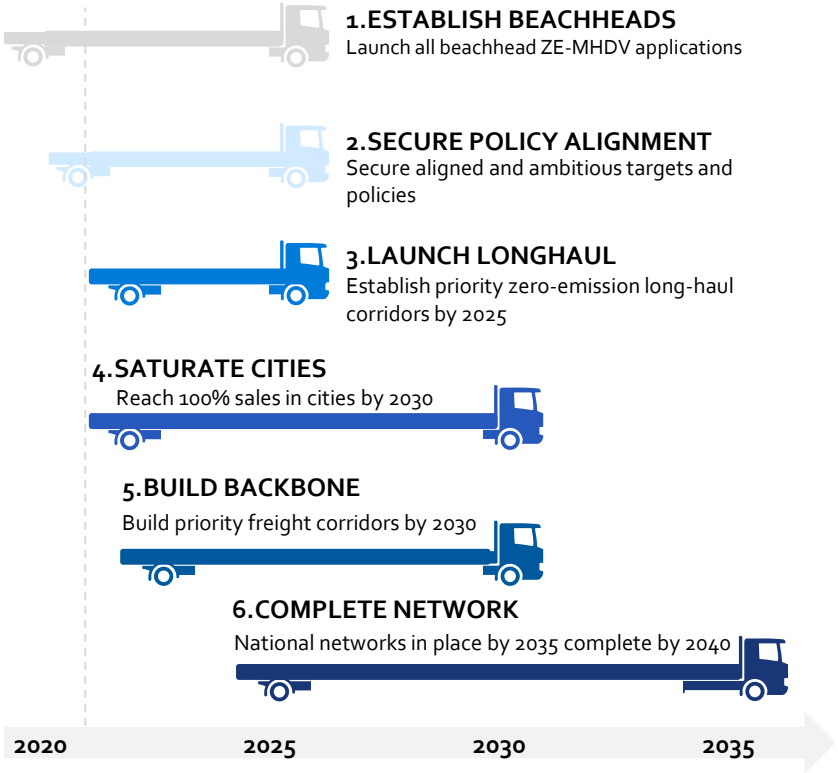
Source: IEA.Org

3.2 Global adoption of zero-emission in commercial vehicles

The Global Memorandum of Understanding (MOU) on zero-emission medium- and heavy-duty vehicles (ZE-MHDVs) – aiming for 30% new MHDVs to become zero emissions by 2030, and a full transition to ZE-MHDVs in new fleets by 2040 – has been established to facilitate the achievement of net-zero carbon emissions by 2050.
It is the first global agreement aligning the goals of national governments to decarbonize trucks and buses, a segment of the market that contributes disproportionately to CO_2 emissions and air pollution. The initiative includes 22 countries including US, UK, Canada, EU, India, Japan, New Zealand, Chile and others.

1. Establishes a common and understandable framework for electrifying complex truck and bus markets rapidly
2. Sets clear and common global targets for ZE-MHDVs
3. Launches the early implementation of long haul ZE-MHDVs; this segment takes longer to implement but is a large percentage of GHG emissions.
4. Focuses accelerated outcomes on urban applications most suitable to early electrification, critical to meeting 30% ZE truck goal by 2030
5. Establishes the backbone framework of the zero-emission freight system with sufficient lead time for full build-out by 2040
6. Fully enables 2040 target by ensuring that no ZE-MHDV is out of reach of the recharging/ refueling network

Six-Stage Strategy for ZE-MHDV Market Acceleration (CALSTART, 2022)



Key areas critical for moving toward rapid decarbonization of MHDV

Target
Setting clear and well-defined targets will allow stakeholders to develop policy of their own and prepare for the transition

Regulations
Helps solidify the trajectory of the market and further encourage a positive outlook for zero-emission technology

Incentives
Will encourage OEMs to ramp up their production and R&D efforts which results in a positive feedback loop of cost reduction over the long term

Infrastructure
Proper infrastructure will ensure timely, cost-efficient route for execution and implementation of zero-emission technologies

Innovative Policy
Establish robust and innovative policies for ZE-MHDVs and support the above key areas

Source(s): Multi-country action plan for the global memorandum of understanding on zero-emission Medium- and Heavy-Duty Vehicles – Nov'22

3.3 Government Regulations & Policy Trends

Americas

EV Charging Infrastructure

- The U.S. Department of Energy announced $7.4 Mn in funding for seven projects to develop innovative medium-and heavy-duty EV charging and hydrogen corridor infrastructure plans serving millions of Americans across 23 states.
- Forum Mobility, a zero-emission trucking solutions provider, recently announced a $400 Mn commitment to deploy over 1,000 DC fast-chargers to support the policy.
    - The charging infrastructure will serve the thousands of heavy-duty electric trucks projected to begin operating at the San Pedro and Oakland ports in California over the next decade.
    - The charging depots will create 600+ new union jobs in disadvantaged communities while reducing harmful emissions at the ports and along freight corridors

Alternative Fuel & Carbon Reduction Program

- The U.S. Department of Transportation (DOT) established the Alternative Fuel Corridor (AFC) Grants program to deploy publicly accessible electric vehicle charging and hydrogen, propane, and natural gas fueling infrastructure. Currently, propane fueling infrastructure for MHDVs is limited.
- By Nov'23, DOT plans to establish the carbon reduction formula program for states to reduce transportation emissions which includes activities such as truck stop electrification, public transportation, and deployment of alternative fuel vehicles, including charging or fueling infrastructure and the purchase or lease of zero emission vehicles.

Tax Credit & Truck Emissions Reduction Study

- Beginning January 1, 2023, a tax credit will be available to businesses for the purchase of new Commercial Electric Vehicles (EVs) and Fuel Cell Electric Vehicles (FCEVs). The maximum tax credit may not exceed $7,500 for vehicles under 14,000 lbs. and $40,000 for vehicles above 14,000 lbs.
- DOT to study, coordinate and provide grant funding to test, evaluate, and deploy projects to reduce idling truck emissions, including port electrification and efficiency improvements particularly from HDV.

Proposed Standards under Inflation Reduction Act

- Light- and Medium-Duty Vehicle Proposed Standards: The U.S. Environmental Protection Agency (EPA) announced the "Multi-Pollutant Emissions Standards for Model Years 2027 (MYs 2027) and Later Light-Duty and Medium-Duty Vehicles," building on the EPA's existing emissions standards for passenger cars and light trucks for MYs 2023 through 2026.
    - Plans to leverage advances in clean car technology to further reduce both climate pollution and smog- and soot-forming emissions as per Clean Truck Plan started in Aug'21.
    - Projects that EVs could account for 67% of new LDV sales and 46% of new MDV sales in MY 2032 and is projected to reduce gas emissions by 46% and 44%, by respective sales.
- Heavy-duty Truck (HDT) Proposed Standards: The EPA announced the "Greenhouse Gas Standards for Heavy-Duty Vehicles - Phase 3," with projected benefits range from $180 Bn to $320 Bn, would apply to vehicles (such as delivery trucks, refuse haulers or dump trucks, public utility trucks, transit, shuttle, school buses) and trucks typically used to haul freight. It commits $1 Bn to incentives and infrastructure projects for HDVs between 2023 and 2031.

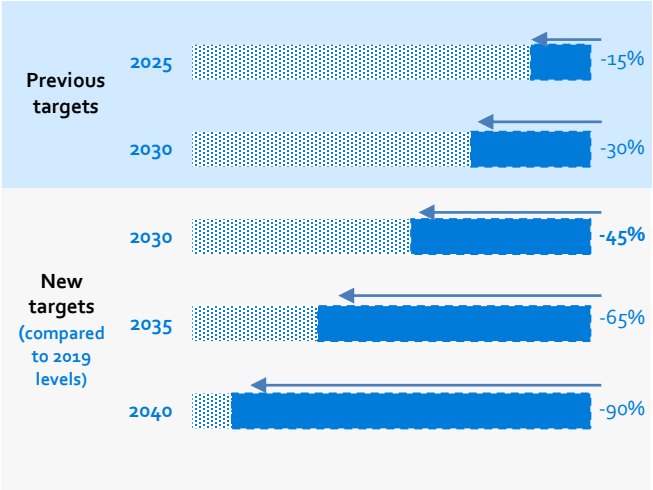
Source(s): U.S. Environmental Protection Agency, Alternative Fuels Data Center (USA)

Progress towards zero-emission future

Europe

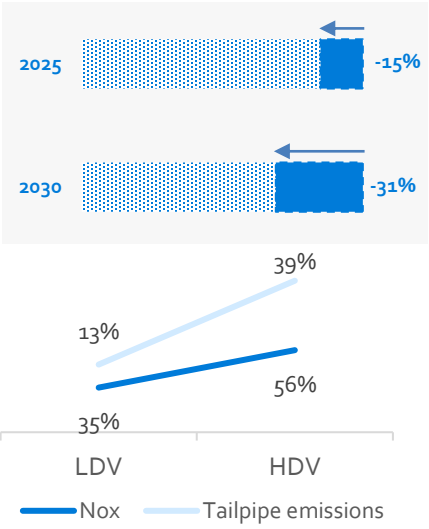
Targets for new heavy-duty vehicles (HDVs)

- Plan to reduce CO_2 emissions in the transport sector - trucks, city buses, and long-distance buses, responsible for over 6% of total EU greenhouse gas (GHG) emissions and more than 25% of GHG emissions from road transport.
  - EU new standards, in comparison to 2019 level , states "45% emissions reductions from 2030"; "65% emission reductions from 2035" and; "90% emissions reduction from 2040".
  - Also proposed to make all new city buses zero-emission as of 2030.
  - To support, investments need to be channeled into ZEVs, recharging and refueling infrastructure, for which the EU has already proposed the Alternative Fuels Infrastructure Regulation to develop the necessary charging infrastructure to support the green transition of the HDV sector.



Targets for Light-duty vehicles (LDVs)

- Plan to reduce CO_2 emissions in the transport sector – Light commercial vehicles, defined as a percentage reduction from the 2021, states "15% reduction from 2025" on and "31% reduction from 2030".
  - Offers tax credit system for the manufacturers from 2025, which will allow relaxation of a manufacturer's specific emission target, if its share of new zero- and low-emission vehicles (ZLEVs) registered in a given year exceeds 15% ZLEV from 2025 on and 30% ZLEV from 2030.
  - In Nov'22, the EU proposed Euro 7 Regulations that combine LDV and HDV regulations into one act, seeking a 35% and 13% reduction of NOx and tailpipe emissions respectively from LDVs and 56% and 39% from HDVs relative to Euro 6/VI.
  - Introduced minimum durability standards for LDV batteries of 80% performance by year 5 (or 100 000 km), and 70% performance between years 5 and 8 (or 160 000 km).



Green Deal Industrial Plan

- A plan to enhance the competitiveness of Europe's net-zero industry and support the fast transition to climate neutrality, builds on previous initiatives and relies on the strengths of the EU Single Market, complementing ongoing efforts under the European Green Deal and REPowerEU, and meet goals with the Paris Agreement.
- With respect to commercial vehicles, the plans supports public and private investments in net-zero tech and industrial innovation with projects such as RDI of battery technologies, demonstration plants for manufacturing materials in the supply chain of electric vehicle batteries, hydrogen propulsion technologies, and innovative advanced biofuels plants.

Source(s): European Union

Progress towards zero-emission future

Asia-Pacific

China

New Energy Vehicle Industry Development Plan

- To promote the in-depth implementation of the "New Energy Vehicle Industry Development Plan (2021-2035)", improvement of the electrification level of vehicles in the public sector and accelerate the construction of a green and low-carbon transportation systems. A couple of ministries in China got together and launched a pilot program for the period 2023-2025. Key tasks include:
  - Establish and improve intelligent transportation systems, and green energy supply systems
  - Improve the charging and swapping infrastructure
  - Optimize the scrapping and replacement of old vehicles into new energy vehicles, and accelerate the full electrification of vehicles in the public sector

Australia

Government Initiatives

- The Australian Government has joined the international Zero-Emission Government Fleet Declaration which outlines Australia's aspirations to procure 100% zero-emissions vehicle classes (light, medium and heavy-duty) for the Government fleet by 2035.
- Increase in supply of Affordable and accessible EV's: The Government will work in consultation with stakeholders to design a Fuel Efficiency Standard for passenger and light commercial vehicles that are broadly consistent with standards in place in major advanced markets and make a strong contribution to meet emissions reduction goals.
- Establish the resources, systems, and infrastructure to enable rapid EV uptake: The Government is establishing hydrogen highways (hydrogen refueling networks) for key freight routes, recognising the opportunity to grow Australia's hydrogen industry and the potential benefits for long-distance freight transport. Also, focus on building EV charging infrastructure for commercial vehicles.

Japan

Support for Commercial Vehicles

- In order to achieve the penetration target of the "Green Growth Strategy for Carbon Neutrality by 2050", electric buses, electric taxis, electric trucks, fuel cell trucks and excellent hybrid vehicles, the government will subsidize part of the cost required for the introduction of the EV infrastructure and improve public transportation.
- Under the "Environmentally Friendly Advanced Truck and Bus Introduction Acceleration Project", they plan to introduce plug-in hybrid buses and natural gas trucks.
- To promote fuel cells in industrial vehicles for the realization of a hydrogen society, they plan to introduce fuel cell buses and taxis and for promotion of electrification of commercial vehicles and electric trucks.
- Japan also has fuel efficiency standards for heavy-duty vehicles, which state that efficiency must improve by around 13% for trucks and 14% for buses by the fiscal year 2025 compared to 2015.

Source(s): International Energy Agency, Ministry of China, Ministry of Japan

3.4 OEM mandates for commercial vehicles

Global original equipment manufacturers (OEMs), have set 2040 as the date by when all new truck sales will be zero-emission or fossil free as per CALSTART 2021 report, in line with Global Agreement on Zero-Emission Trucks and Buses that includes sub-national government, industry and fleet endorsements.

Global Mandates

- OEM's target is to provide vehicle product diversity in all applications and regions. A few OEMs target to produce low volumes (500+ units/year) of long-range capable (300-plus miles between charging/fueling) ZE-MHDV tractors by 2025.
- In line with Global MOU, all OEMs target to have long haul (300-to-500-mile range with fast charge/fuel capability) by the end of 2035. Daimler, Volvo, and Traton recently signed a joint venture to create a European high-performance fast-charging network to support the target.
- To increase deployment of ZE-MHDV and to reach the necessary volumes to meet emissions targets outlined by the Paris Agreement, OEMs must rapidly ramp up production in line with supportive government policy ecosystems.

Amercias

- To be eligible for incentives under the Inflation Reduction Act, a program intended to meet the aim of building a clean energy economy, the OEMs should keep the average listed retail price for the eligible BEVs in the limit set as per the act.
- In the US, Navistar announced targets of 50% zero-emission new vehicle sales by 2030 and 100% by 2040, to be in line with zero emission policy.

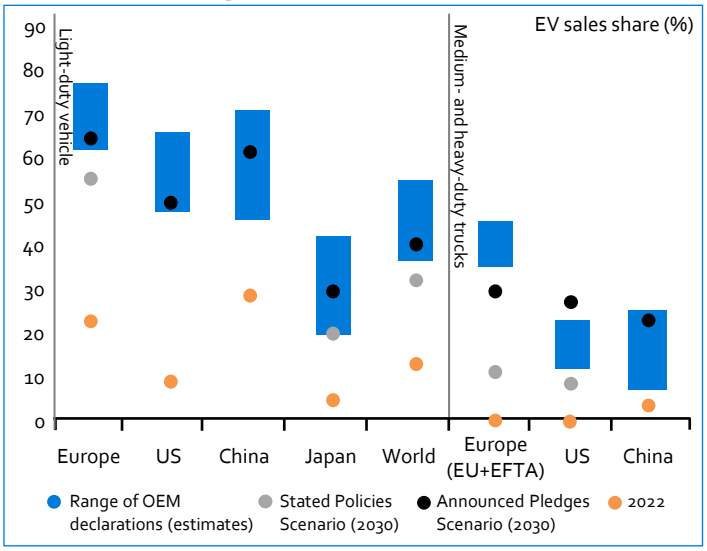
Europe

- The electrification plans of OEMs anticipated the adoption of the new EU CO_2 standards for LDV, with the result that combined OEMs ambitions roughly match or exceed the 2030 electric LDV sales share in the Stated Policies Scenario (STEPS).
- Heavy-duty vehicle makers are most ambitious about the European market, with targets reaching around 40% zero-emission vehicles sales in 2030. This exceeds what is projected in the STEPS and APS, despite the European Commission's proposal for a 100% zero-emission target for city buses by 2030, and a 90% CO_2 reduction target for trucks for 2040.

Asia-Pacific

- In China, carbon neutrality (rather than new energy vehicle sales shares) targets of heavy-duty OEMs have typically been at the group or brand level; Dongfeng, BAIC Group, FAW, and SAIC have set targets for carbon peaking, carbon neutrality or net zero-emissions or some combination of the three.
- Japan aims to introduce 5,000 electric HDVs by 2030, with a JPY 13.6 Bn ($120 Mn) plans to electrify HDVs and taxis and has given targets to OEMs to be in line with fuel efficiency standards for HDV & Green Growth Strategy for all CVs.

OEM targets & registrations in the Stated Policies and Announced Pledges scenarios (STEPS & APS), 2030



Source(s): Global Roadmap for reaching 100% zero emission Report (June 2022), IEA Global EV Outlook 2023

Source: IEA.Org

3.5 Alternate Powertrain Options

Given the need to meet new emissions requirements, commercial vehicle OEMs are considering a number of solutions to move away from purely petroleum-based powertrains.
Five green technology options exist to decarbonize trucks: While BET, FCT and LNG are promising, CAT and SYT competitiveness is questionable.

Alternative powertrain options for trucks: Typical characteristics and evaluation

BET

Purely battery electric truck

Battery Electric Truck (BET)

Direct use of electricity in electric motor for propulsion; battery used as energy storage

Competitive Technology (+)

- Decreasing vehicle costs as well as increasing load capacity and range
- High efficiency, low energy costs and high public acceptance

FCT

Hydrogen-powered fuel cell truck

Fuel Cell Truck (FCT)

Conversion of electricity into hydrogen; fuel cell to transfer hydrogen into electricity to be used in electric motor for propulsion

Competitive Technology (+)

- Decreasing vehicle and energy costs
- High flexibility due to low refuelling speed (compared with charging and high public acceptance)

LNG

LNG fuel-powered truck

Liquefied Natural Gas (LNG)

Conversion of natural gas into mechanical energy; spark-ignited internal combustion engine is used for conversion

Competitive Technology (+)

- Low refuelling time ~7mins
- Higher range of over 1,000km

CAT

Overhead catenary hybrid truck

Catenary Hybrid Truck (CAT)

Direct use of electricity in electric motor for propulsion; small battery used as energy storage, as main energy is transferred via catenary

Competitiveness Questionable (-)

- Non-scalable upfront investments with under-utilization of infrastructure
- Low public acceptance

SYT

Synthetic fuel-powered ICE truck

Synthetic Fuel Truck (SYT)

Conversion of electricity into carbonaceous fuel or "synthetic fuel" (Power-to-Liquid or Power-to-Gas); internal combustion engine used for propulsion

Competitiveness Questionable (-)

- High renewable primary energy investments due to low end-to-end efficiency
- High latency of additional renewable energy production to facilitate large-scale "synthetic fuel"

Sources: Sustainabletruckvan, Strategyand.PwC

3.6 Progression Toward Alternative Fuels

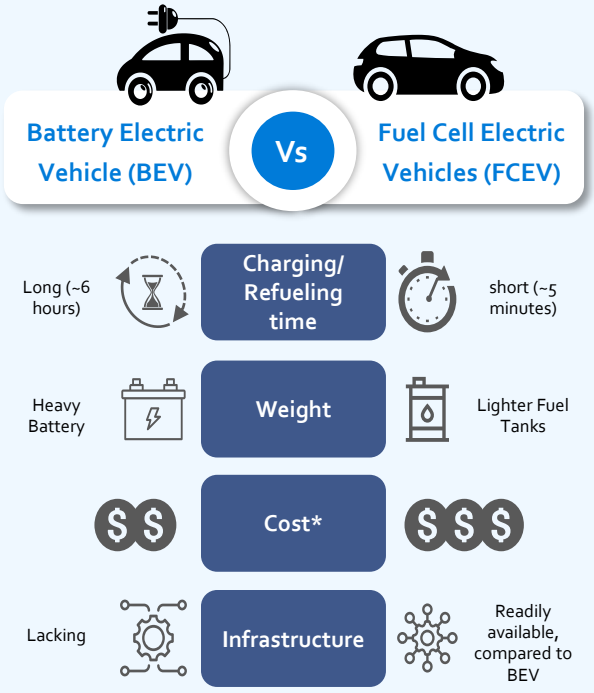
Due to its impact on climate change and its contribution to global warming, the transport industry has been under scrutiny for many years. Thus, zero-emission vehicle (ZEV) technologies will play an instrumental role in driving global decarbonization. The commercial vehicle industry is progressing towards alternative fuel to lower its carbon footprint.

In this context, there is increasing use of hydrogen as an alternative fuel in the commercial vehicle space. As they enable businesses to transition from current models without having to make significant investments in new technology or equipment, hydrogen-powered vehicles are the primary factor that can revolutionize the sector.

The following points highlight the benefits of using Hydrogen fuel:

- No emissions. Instead of releasing pollutants, hydrogen-powered vehicles emits water vapour
- Lower maintenance costs compared to traditional engine designs and higher fuel efficiency
- Storage tanks are made of lighter and stronger composite materials than traditional steel containers thereby improving performance

BEVs vs FCEVs: How do they compare ?



*In comparison to Internal Combustion Engine

For Longhaul Trucking

Long distances, unpredictable routes, high uptime requirements, strict driving-time regulations, and the importance of high payloads have made this sector particularly hard to decarbonize.

With current energy densities, batteries are too heavy, charging speeds are too slow, and infrastructure is not yet available to directly electrify trucks on particularly challenging routes.

As a result, long-haul trucking has focused on hydrogen-powered fuel and hydrogen combustion, which are attractive for two reasons:

1. Faster refueling and greater range can increase the uptime potential for trucks
2. Lower weight compared with batteries can increase payload capacity

Last-Mile Delivery

Last-mile delivery trucks, such as parcel delivery vehicles, represent one of the important vehicle segments.

Its core aspects include the capability to haul cargo, efficiency in low cost of ownership, and reliability.

Advanced safety features, electrification of the fleet, and customized solutions to meet last-mile needs are being looked upon. Growth trends include:

1. Fleet managers are looking forward to make deliveries safer, more efficient, and sustainable
2. Increasing societal and legislative pressure to replace aging fleets with more fuel-efficient options has opened-up opportunities for delivery vehicle manufacturers and upfitters

Sources: Innovationnewsnetwork, Mckinsey, International Council on Clean Transportation, Work Truck Magazine

3.7 Current gas offerings

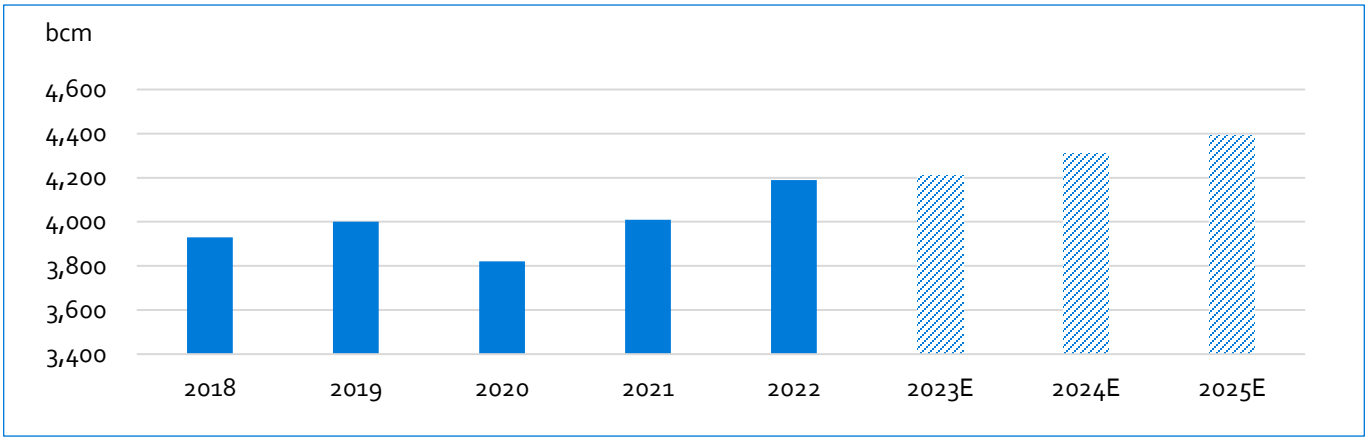
As per the International Energy Agency (IEA), the expected global natural gas demand will reach over 4,370 billion cubic meters (bcm) annually in 2025, growing at an average annual growth rate of 1.5% per year for the 2019-25 period.

In the coming years, the Asia Pacific region will account for over half of incremental global gas consumption, mainly due to the development of gas in China and India. With strong prospects, the outlook is highly dependent on the country's future policy direction. LNG, which remains the main driver of international gas trade, most of the growth in future LNG imports will come from India, China and other emerging Asian markets. Due to its lower energy density, CNG is not optimal for long-haul heavy transport. However, LNG trucks can range over 1,000 km and are suitable for such transport.

Key highlights include:

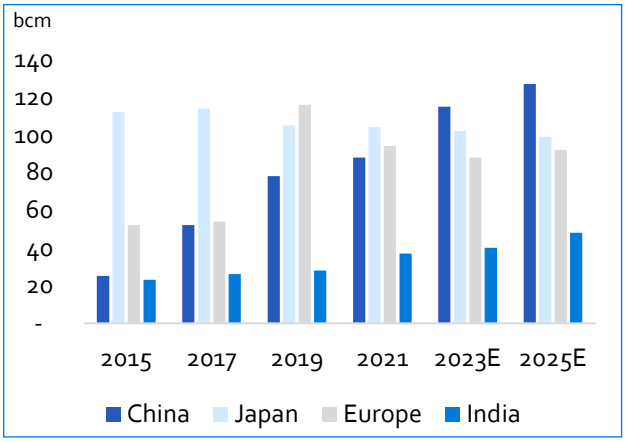
- China alone accounts for 22% of total LNG demand in 2025, contributing almost 40% of growth in total imports over the forecast period of 2019-2025
- India also leads LNG growth accounting for about 20% of incremental trade, and sees its imports increase by 50% between 2019 and 2025 to support strong growth in demand

Global gas demand forecasts, 2019-2025



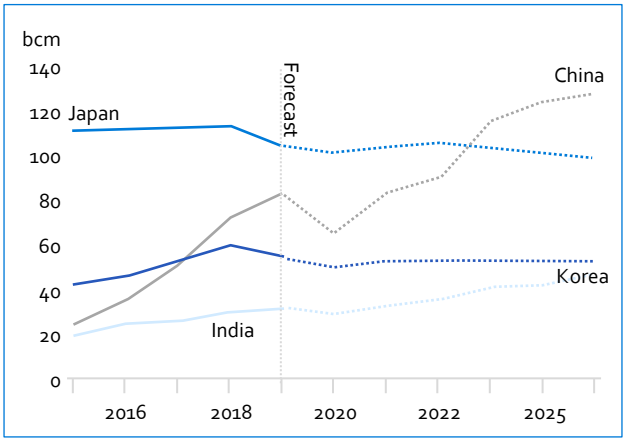
Source: IEA.Org

LNG imports for selected countries, 2015-2025



Source: IEA.Org

Evolution of LNG imports in the top four LNG importing countries in 2015-2025



Source: IEA.Org

Sources: International Energy Agency (IEA), Europarl.europa.eu

New Entrants In The Space

Alternate fuels will have a strong impact on the overall decarbonization of the industry, and several new companies are developing ground up designed new products to meet this challenge. In response to the growing demand for vehicles with lower tailpipe emissions, many new companies are entering into the space to capitalize on this opportunity. In this section, we have listed the select few companies who have entered the market, along with details about their product offerings and solutions.

HQ: UK

- Founded in 2015, **Arrival** primarily produces lightweight commercial vehicles
- Its fleet includes vans, buses, and cars
- It reduced production targets and laid off workforce to curb costs in 2022, due to increasing losses and inability to raise additional funds
- In Apr'23, it merged with 2nd SPAC, Kensington Capital, with its USP of advanced materials and manufacturing technologies to increase functionality while reducing costs

HQ: US

- Founded in 2017, **AYRO** designs and produces zero emissions vehicles and systems
- Provides customizable low-speed electric vehicles (LSEVs) for campus / facility mobility needs, last-mile delivery, and micro distribution

HQ: US

- Founded in 2013, **Cenntro Electric Group** is a designer and manufacturer of electric light and medium-duty commercial vehicles
- Also provides fully digitalized autonomous driving solutions empowered by the Cenntro- iChassis
- Serves variety of corporate and governmental organizations in support of city services, last-mile delivery and other commercial applications

HQ: Sweden

- Founded in 2016, **Einride** designs, develops and deploys technologies for freight mobility. Its solutions include:-
  - Digitalization: Einride Saga allows shippers & carriers to offer faster, greener and cheaper freight
  - Electrification: conversion of diesel freight into electric
  - Automation: offers autonomous vehicles with remote oversight and drive capability

Sources: Autocarpro, Financialexpress, Arrival, Ayro, Cenntroauto, Einride

New Entrants In The Space

HQ: UK

- Founded in 2022, **Helixx** provides all-electric commercial vehicles which use rapid battery swap technology to optimize operational time and profitability. Its fleet includes:-
  - Cargo commercial goods vehicles: ideal for cargo transportation
  - Pick-up truck: ideal for construction businesses
  - Two passenger models: a minivan and an open-body Tuk

HQ: US

- Founded in 2018, **Kodiak Robotics** offers the advanced autonomous technology for long-haul trucking. Its solutions include:-
  - kodiakDriver: automated driver for long-haul miles
  - kodiakNetwork: transfer points to facilitate the exchange from local human to long-haul automated trucks
  - kodiakOnTime: suite of fleet management tools to monitor Kodiak-driven trucks remotely

HQ: US

- Founded in 2009, **Motiv** delivers medium-duty commercial all-electric trucks and buses, along with charging infrastructure and guidance for deploying commercial fleets.
- The company specializes in step vans, shuttle buses, and box trucks.
- Provides zero-emission vehicles for moving people and goods with 98% uptime and intense customer-driven focus.

HQ: US

- Founded in 2014, **Nikola Corporation** is a technology innovator and integrator, enabling customers to integrate next-generation truck technology, hydrogen fueling infrastructure, charging solutions, and related maintenance. Operate in two business units:-
  - Truck: develop & commercialize BEV & FCEV Class 8 trucks
  - Energy: develop & construct network of hydrogen fueling stations

Sources: Kodiak, SEC Filing (Nikola), Helixx, Motiv

New Entrants In The Space

RIVIAN

HQ: US

- Founded in 2009, **Rivian Automotive** designs, develops and manufactures category-defining EVs and accessories, sells directly to customers in consumer and commercial markets.
  - Commercial vehicle models: EDV-700 & EDV-500
  - Commercial services: FleetOS, centralized fleet management subscription platform
  - Consumer vehicles: R1T (two-row, five-passenger pickup truck) & R1S (three-row, seven-passenger SUV)
  - Charging solutions: DC fast charging sites & waypoints chargers

VIA

HQ: US

- Founded in 2010, **Via Motors** is a leading company that designs, manufactures, and markets electric commercial vehicle with advanced electric drive technology.
- Offers cab chassis / cutaway, stake body, service trucks, shuttle bus, walk-in van and standalone skateboard in various class types.
- Also offers 100% electric commercial truck platform, scalable for variety of drive systems, vehicle types and sizes.

Actions taken by current OEMs

In recent times, as the adoption of zero-emission fuels rises, the OEMs have started adapting to technologies to control green house emissions, shifting from their traditional production methods and constantly figuring out ways to optimize the process. Some of the actions taken by OEMs include:

Research & Development- The OEMs are continuously researching to produce 100% alternate powertrain commercial vehicles at a reduced cost to further curb emissions

Transitioning from traditional fuels to alternative fuels and EVs- With an around-the-globe policy of zero-emission, OEMs are converting fuel-based transport to low or zero-emission fuels to meet the target set by respective countries by using the latest technologies

Increase in production of hybrid models- Since the transition will take time to adapt and infrastructure for alternative fuels will be developed over time, production and demand for hybrid commercial vehicles are on the rise and OEMs are catering to the rising demand

Building infrastructure- Across the globe EV charging, green fuel stations, and other infrastructure for alternative fuels are being developed by OEMs with support from the government, through subsidies and tax credit

Sources: SEC Filing (Rivian), Via Motors, Roland Berger

3.8 Commercial Vehicle eReadiness

The alternate powertrain of commercial vehicles will play a crucial role in reducing the carbon footprint. OEMs continue to invest in the alternative power train but struggle to transform them into appealing products, services, and solutions offering that can be sustained as value streams. Operators are willing to upgrade their CV fleets but require OEMs to improve their quality.

Market prospect on eReadiness of Fleet Operators and OEMs

Openness toward Battery Electric Vehicles (BEVs)- Although operators are receptive to fleet electrification, they lack both the personal expertise and attractive product and service offerings needed to overcome barriers

Putting Customers First- Putting the product first won't help electrification take off - fleet operators require their vehicle, auxiliary service, and solution offerings consistently tailored to their needs

Solutions- Fleet operators demand complete alternate powertrain solution offerings that cover the entire vehicle lifecycle. OEMs must openly embrace their clients' needs

Digital Services- To avoid typical pitfalls, OEMs must develop a completely new skill set for designing and delivering digital services

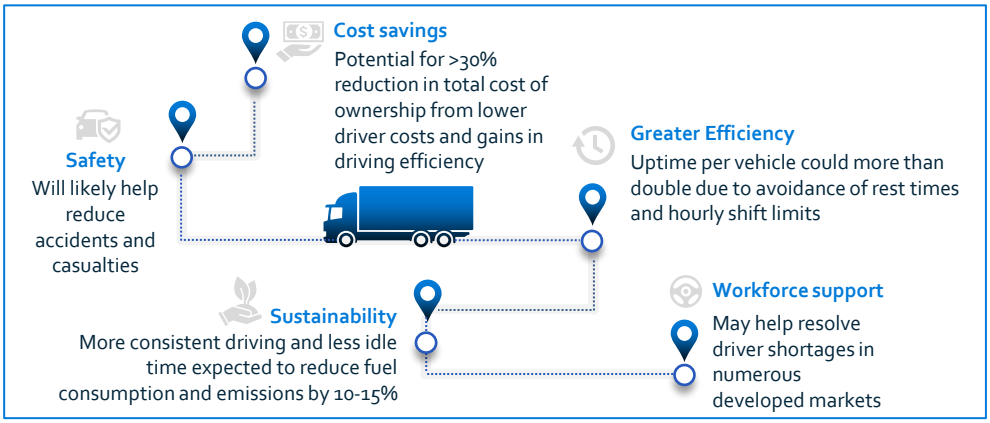
Recommendations for Commercial Vehicle OEMs

1. **Revamp value proposition-** To fully capitalize on growing interest in alternate fuel or battery electric truck and bus-related products and services, define truly customer-centric offerings
2. **Reduce hurdles-** Assist clients' purchase decisions with appealing offers and a compelling business case by providing adequate real-world experience to reduce their operational concerns
3. **Enhancing Customer Proximity-** To make the shift between physical and digital touchpoints as easy as possible, complement traditional sales aspects with an ideal online direct-to-consumer experience
4. **Solution Architect-** Re-define e-solution space combining hardware, software and services. Significant competitive advantage may result from engaging in non-core activities, but doing so requires new organizational competencies
5. **Digital Proficiency-** Build the skills to avoid common pitfalls by developing an understanding of the unique problems that come with designing and implementing digital business models in the setting of a partner ecosystem

Source: Strategyand.PwC

3.9 Future of Autonomous Trucks

> **The development of autonomous vehicles (AV) has the potential to revolutionize how people and goods move around the globe. Although personal autonomous vehicles receive the most of media attention, long-haul trucks present one of the most attractive applications for fully autonomous vehicles.**
>
> **~BCG Analysis**



Autonomous trucks have the potential to solve the issue of labor shortage affecting the trucking industry. Long-haul trucking jobs in particular are challenging to fill since many drivers are averse to being away from home on jobs that often involve being on the road for ~3-6 weeks at a time. Through labour savings and improvements in driving efficiency, it is estimated that autonomous driving technology might lower the total cost of ownership (TCO) of long-haul transportation by more than 30%.

Thus, several autonomous driving companies have been developing the technology to bring solutions to market, realizing the compelling business case for self-driving trucks.

An important feature of the artificial intelligence (AI) technology used in autonomous vehicles is that it easily handles traffic conditions that occur frequently. This makes it ideal for interstate highways because they are constructed to the same general standards and often have fewer hazards, such as pedestrians, that could confuse an autonomous vehicle (AV) traversing an urban or suburban street. They also tend to perform better on highways where other vehicles are travelling in the same direction, within a certain speed range, and are separated from oncoming traffic by a clearly defined median barrier.

Constraints of Driverless Autonomous Vehicles

Even though driverless trucks have the promise to revolutionize the future of commercial logistics, there are several issues that need to be anticipated and addressed effectively. Some of the drawbacks include:

- Operating in densely populated cities has challenges because of unexpected pedestrians and less predictable traffic
- Since it uses software, hackers can infiltrate the system and introduce vulnerabilities to delivery, including overriding the controls
- Self-driving trucks require technology and intelligence for processing and management, they can malfunction due to a small error or computer glitch
- It poses significant challenge for the state and federal governments with regards to licensing infrastructure
- It is still a challenge to attain full autonomy in all conditions

Source: BCG

3.10 Shift to Biofuels

The transition of the industry to emission-free trucks is advancing as a result of regulatory changes in the majority of nations, the increased competitiveness of "green" powertrains, and growing public awareness of the effects of climate change.

Green Regulation

Forces driving the adoption of green powertrains include:

- Both the European Union and the US are working to tighten laws on commercial vehicles with internal combustion engines and encourage the adoption of zero- and low-emission trucks at the macro or policy level.
- For instance, the European Green Deal, which was unveiled in December 2019, aims to reduce Europe's 2030 GHG emission target to 55% of 1990 levels.
- Meanwhile, 15 American states, led by California, are attempting to limit the use of trucks with internal combustion engines at the same time. They declared ceilings for the sales of zero-emission automobiles by each manufacturer in November 2020.
- Regardless of the political situation at the federal level, these state-level initiatives are likely to cause a sustained rise in demand for zero-emission automobiles.

Drivers

- Rise in fossil fuel prices and the pollution they generate are driving up demand for biofuels.
- The use of biofuels is being encouraged by government regulations aimed at decreasing vehicle emissions. It is anticipated that government initiatives to promote the use of high-biofuel blends will increase bioethanol consumption.
- During the projected period, the trend of growing flex-fuel automobile use is likely to continue. Flex-fuel vehicles allow end users to select their own biofuel-fossil fuel blend, which is expected to increase demand for automobile biofuels.
- The market is expected to be driven by rising sales and demand for commercial vehicles.
- Furthermore, a rise in environmental concerns with increasingly stringent GHG regulations is projected to drive demand over the next few years.

Source(s): Boston Consulting Group Press Article, Transparent Market Research

ICE v/s BEV: Comparison

Innovations in battery technology reduced the total cost of ownership of BEVs significantly from when they were first introduced and are now poised to become the main form of propulsion. There are still many puts and takes relative to BEV adoption, but technological advancements have closed many historical gaps regarding performance and cost.

	ICE	BEV
Powertrain	ICE powertrain converts fuel to kinetic energy in the engine	In an EV, the Direct Current (DC) from the battery is converted to Alternating Current (AC) and supplied to the motor
Energy Efficiency	The average ICE has a fuel efficiency of only 40%, out of which 60% is lost via heat and friction	EVs consume far less energy traveling the same distance as compared to an ICE vehicle
Cost of Fuel	An average gallon of gas[1] is ~USD3.8, and a standard ICE vehicle holds ~14 gallons (~53L). Therefore, **~$53** is the cost to fill up an average tank	The average cost of 1kW of electricity[1] is USD0.14/hour. A standard EV takes ~7.2kWh/hour to reach the full charge of 50kWh, which means the average cost of a full EV charge is ~**$7**
Environment	ICEs emit CO_2 and other greenhouse gases, which contributes negatively to climate change	BEV carbon emissions occur at a centralized powerplant EVs produce batteries made with a variety of chemicals. The extraction of these rare earth metals and disposal remain a challenge
Grants & Incentives	There are no government exemptions on ICE vehicles	There are various government grants, subsidies, and incentives to help reduce the cost of owning an EV
Cost of Product	ICE vehicles are cheaper to manufacture at a scale	BEVs are costlier at today's scale, and hybrids cost more than BEVs
Chemical Energy	ICE source of energy is provided by a fuel like petrol or diesel	For EV, source of energy is provided by a rechargeable battery.
EMI gaskets	As ICE vehicles only produce electromagnetic fields momentarily, EMI gaskets are not required	Required by EV designers in order to seal and insulate housings and enclosures for delicate electronics.

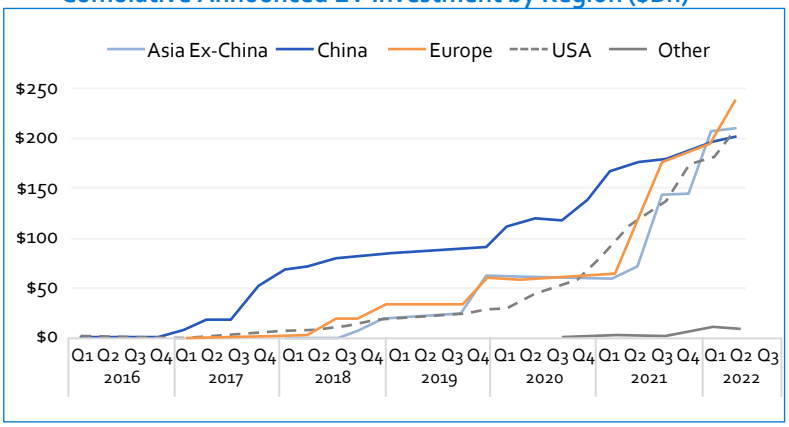
Source(s): Siemens Blog and Web Research, (1): as of 19thJune'23

3.11 Capital Invested in EV and other technologies

Due to a major increase in industries like logistics and supply chain enterprises, the adoption of electric vehicles is evident in many growing economies. Governments from all around the world are exerting pressure on automakers to invest in the development of electric vehicles and minimize carbon emissions brought on by the combustion of diesel fuel.

- By 2030, the move to EVs will require $860 Bn in global investments from battery and vehicle manufacturers.
- The US is likely to receive about a quarter of all investments ($210 Bn), more than other nations.
- The US had only $51 Bn investment in domestic EV and battery manufacturing indicated by corporations at the end of 2020, less than half of the $115 Bn planned for China at that time and trailing both Europe and the rest of Asia.

Cumulative Announced EV Investment by Region ($Bn)



Source: Atlas EV Hub

- As of the end of 2022, the US, Europe and the rest of Asia have all exceeded China in terms of announced investments but China still has a significant advantage in terms of the number of EVs on the road.
- Governments and environmental agencies are also interfering by passing strict emission rules and laws in response to growing environmental concerns, which is anticipated to drive up the cost of producing fuel-efficient diesel engines. As a result, the market for new commercial vehicles with diesel engines is anticipated to develop rather slowly in the near future, which will increase demand for fuel cells.

Future Outlook

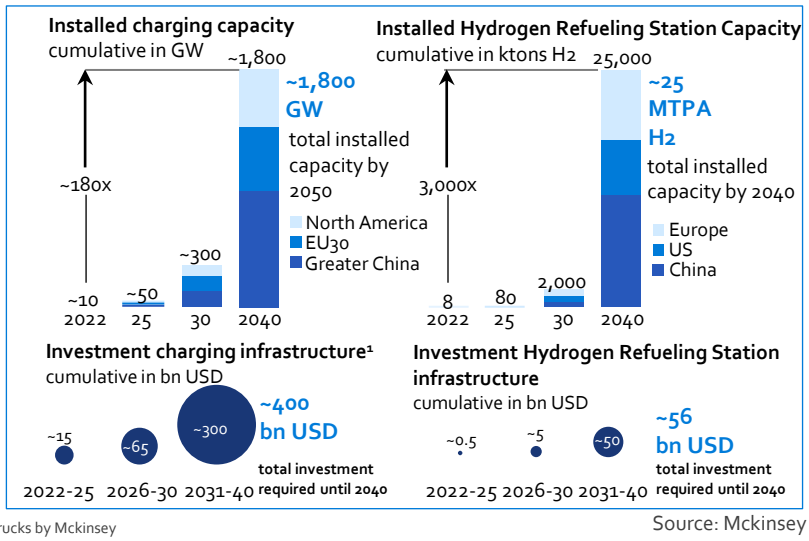
$450 Bn to be spent by 2040 on infrastructure refueling

By 2040, it is estimated that $450 Bn would be needed for investments in the development of the refueling infrastructure needed for BEVs and FCEVs, with China likely receiving most of these investments because of its extensive truck fleet.

- As a result, the deployment of BEV charging infrastructure will start to plateau around 2040, while FCEV infrastructure deployment is anticipated to more than triple in the 10 years after 2040.
- Early years will see slower chargers and smaller hydrogen refueling stations (HRS), gradually moving toward a higher share of fast chargers with 500 kilowatts (kW) or more and HRS sizes of 4,000 kg daily capacity.

MDT & HDT charging infrastructure

Current Trajectory Scenario



Source(s): Atlas EV Hub, Mordor Intelligence, Preparing the world for zero emission trucks by Mckinsey

Source: Mckinsey

3.12 Market comparison and growth Projection

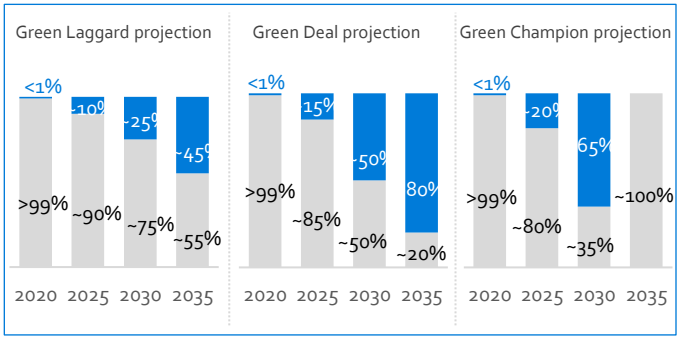
BCG in one of its reports, shows a roadmap and the dynamics of demand in the world's biggest markets: Europe, United States & China, in three scenarios for each: The Laggard, Target, and Leadership scenarios.

Europe

- Europe could turn into a green laggard if its targets for reducing vehicle emissions stay static at 30% in 2030. In that worst case, the demand for zero-emission powertrains will rise from 1% in 2020 to just 25% in 2030
- If it delivers on its Green Deal, with emission-cut targets rising to around 50% in 2030, the demand for green trucks will rise to as much as 50% of all the new ones sold
- The demand for zero-emission trucks would then shoot up to 65% by 2030, and 100% of all the new commercial vehicles sold by 2035

Europe's Three Scenarios

If Europe is aggressive, zero-emission commercial vehicles could account for 65% of sales by 2030



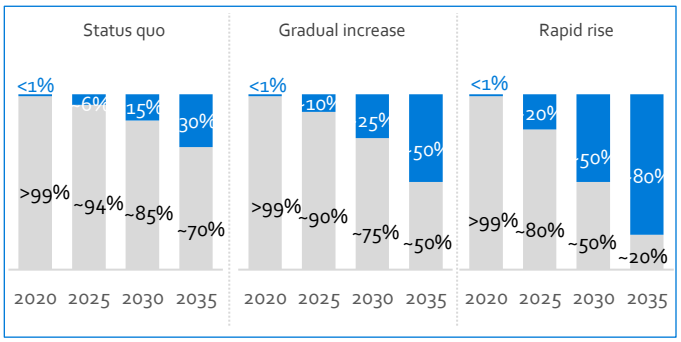
Source: BCG Analysis

United States

- The US could remain a green laggard, with its emission-reduction targets staying at the current level of 12% a decade from now. If that happened, the demand for zero-emission vehicles would rise to just 15% by 2030
- It could gradually step up its emission-cut targets, with several states pushing the use of green trucks, increasing the demand for zero-emission vehicles to 25% by 2030.
- It could become a green champion if the Biden administration, as it promised when it came to power, makes California's emission goals the national standard. That alone would ensure that sales of zero-emission vehicles would top 50% of the US market by 2030

Three Projections for the US

In the US, sales of zero-emission commercial vehicles will reach at best 50% by 2030



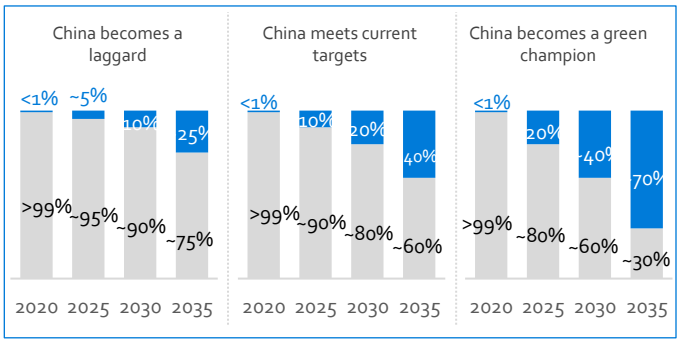
Source: BCG Analysis

China

- If the Chinese government doesn't push the state-owned manufacturers, which are focused on reducing emissions from their diesel engines, to make more zero-emission vehicles, the latter's share will rise from the current 1% to just 10% by 2030
- China's carbon emissions won't peak until the 2030s, so the state doesn't see the need to cut emissions immediately. Tighter regulations and stricter implementation will cause the demand for zero-emission vehicles to rise to 20% by 2030
- With the country's truck makers, such as FAW, already kicking off the production of electric trucks, the demand for them would then rise to as much as 40% of the market by 2030

China's Demand Scenarios

In China, sales of zero-emission vehicles might reach 40% by 2030



Source: BCG Analysis

Source(s): BCG Report

3.13 Current & Announced zero-emission CV models by type

The number of zero-emission truck models offered has continued to expand in 2022, with nearly 840 current and announced MHDV models in the Global Drive to Zero Emission Technology Inventory database.

The trend of new model development has shifted from buses to medium- and heavy-duty trucks.

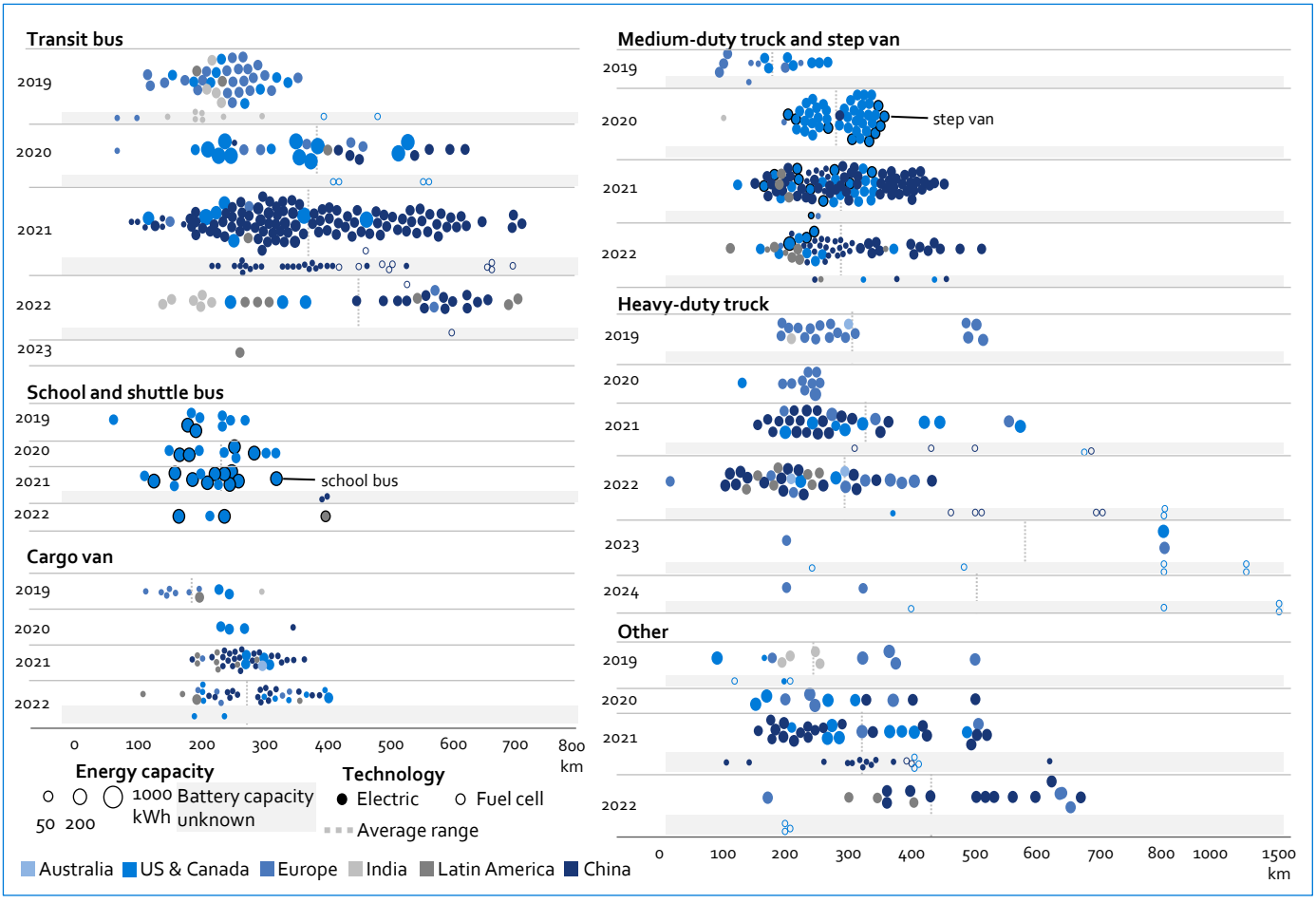
- Of the 220 models that became available in 2022, more than half were either medium-duty trucks (over 60 models) or heavy-duty trucks (over 50 models), reflecting the fact that truck manufacturers are increasingly gaining confidence in supplying larger, heavier zero-emission models with greater payloads.
- The majority (over 90%) of the already available medium-duty and heavy-duty truck models are battery electric; 12 models of fuel cell heavy-duty trucks are currently available – and another 8 are due to become available in 2023-24.

Of commercially available bus and truck models in 2022:

- 60% (over 500 models) were produced by CVOEMs headquartered in China.
- 20% (over 170 models) were produced by North American CVOEMs
- 15% (over 120 models) by European CVOEMs

Although, the inventory is continuously updated, the below snapshot may not be fully comprehensive due to new model announcements and small manufacturers not yet captured in the inventory. ZEVs include BEVs, PHEVs and FCEVs. "Other" category includes garbage, bucket, concrete mixer, mobile commercial and street sweeper trucks. HDV and transit bus figures include announced models for 2023-2024.

Current and announced zero-emission commercial vehicle models by type, release date and range, 2019-2023



Source(s): Global EV Outlook 2023

Source: IEA

3.14 Growing adoption of technologies in CV

With demand and regulation forcing the global shift to green trucks, manufacturers plans to develop new strategies to survive with the first step being to convince fleet operators and creating the charging infrastructure. Even before digital connectivity and autonomous driving technologies trigger tectonic changes, the launch of zero-emission vehicles is likely to disrupt the sector in the near future, over the next five to 10 years. Regulatory changes in most countries, the increasing competitiveness of "green" powertrains, and raising awareness of the implications of climate change are accelerating the industry's migration to emission-free trucks. In the future, the fuel cell will play an important role in e-mobility for heavy commercial vehicles due to its range and fast refueling times.

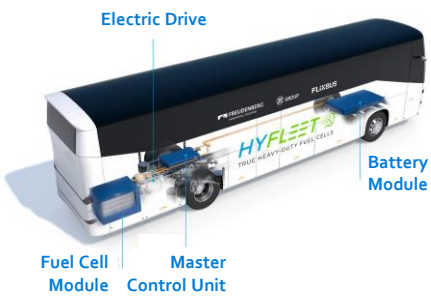
Technologies for HDV's & LDV's:

- **Plug-and-work one-box-solution:** Manufacturers and solution providers like ZF, offer innovative solutions to efficiently electrify Power Take-Offs for operating work equipment with the advantage of zero local emissions and significantly reduced noise by creating the optimal connection between the vehicle energy management and the modular electric power take-off including the electric motor.

- **Electric Drive Systems or eAxle:** A traditional axle housing and differential incorporating an electric motor, an inverter and a thermal management system. Most eAxles are also equipped with a multi-speed transmission for high and low torque demands. While the basic concept is similar across the industry, suppliers are taking varying approaches to put these axles on the roads depending on their target vehicle segment, required power output, and desired vehicle range.

- **Lightweight aerodynamic tail for trailers:** Designed to improve fleet fuel economy and reduce environmental impact by lowering CO_2 emissions. 4.3% fuel savings at highway speeds, no driver interaction, and speed-dependent operation. EPA verified and C.A.R.B pre-approved device.

- **E-mobility:** Projects like "HyFleet", a project to design and test a purely electrically powered coach, aim to study and identify important findings for the optimum design of fuel cells in coaches.



Source(s): BCG Report, Web Search

3.15 Zero-emission infrastructure for Commercial Vehicles

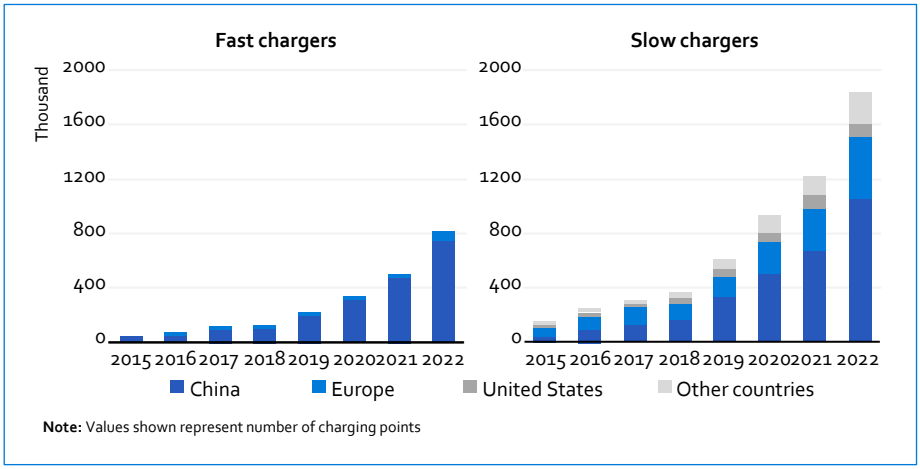
EV charging Infrastructure

Public charging points are increasingly necessary to enable wider EV uptake. At the end of 2022, there were 2.7 million public charging points worldwide, more than 900 000 of which were installed in 2022, about a 55% increase on 2021 stock, and comparable to the pre-pandemic growth rate of 50% between 2015 and 2019. There are mainly two types of charging points: Fast charges & Slow chargers.

Trends for LDV

- Europe and China accelerated the growth of the installation of charging stations with an increase of 55% over the period.
- Across the EU, the infrastructure will further develop, as indicated by the provisional agreement on the proposed Alternative Fuels Infrastructure Regulation (AFIR), plans to make €1.5 Bn available by the end of 2023.

Installed publicly accessible LDV charging points by power rating and region, 2015-2022



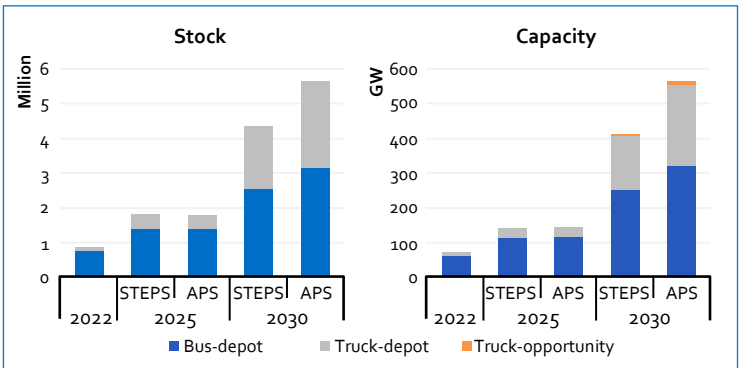
Note: Values shown represent number of charging points

Source: IEA analysis based on country submissions

Charging Need for Heavy-Duty Vehicles

- Electric trucks and buses will rely on off-shift charging for the majority of their energy which will be largely achieved at private or semi-private charging depots or at public stations on highways, and often overnight.
- Improvement in the availability of "mid-shift" fast charging for rapid commercial adoption of electric trucks in regional and long-haul operations is expected.
- Fast and ultra-fast charging will be needed to extend the range such that operations currently covered by diesel can be performed by battery electric trucks with little to no additional dwell time.
- Alternative solutions include installing stationary storage and integrating local renewable capacity, combined with smart charging, battery swapping and electric road systems.
- To scale up, with €500 Mn in collective investments from the three heavy-duty manufacturing groups, Traton, Volvo, and Daimler established an independent JV, Milence in 2022. It aims to deploy 1,700+ fast (300 to 350 kW) and ultra-fast (1 MW) charging points across Europe.
- In China, co-developers China Electricity Council and CHAdeMO's "ultra ChaoJi" are developing a charging standard for heavy-duty electric vehicles for up to several megawatts.
- Globally, stock of charging points for HDV is expected to increase more than sixfold from 2022 to 2030 in the APS with more opportunity for truck chargers than bus.

Global HDV charger stock and capacity by type, 2022-2030



Notes: HDV = heavy-duty vehicle; STEPS = Stated Policies Scenario; APS = Announced Pledges Scenario; EVSE = electric vehicle supply equipment. Charger stock in 2022 is estimated based on the number of electric buses and trucks

Source: IEA analysis

Source(s): Global EV Outlook 2023 Report by IEA

Zero-emission infrastructure for Commercial Vehicles

Hydrogen's Power Infrastructure

There is pressure on the transport sector to quickly decarbonize. Building infrastructure to supply trucks, buses, and light commercial vehicles is essential as the demand for hydrogen in transportation is on the rise.
Long-haul trucking has proven to be particularly difficult to decarbonize due to its extensive distances, erratic routes, high uptime demands, stringent driving time restrictions, and emphasis on large payloads.
Batteries are too heavy, charging rates are too slow, and infrastructure is not yet in place for trucks to be directly electrified on particularly difficult routes with the current energy densities.

As a result, hydrogen-powered fuel and hydrogen combustion have received a lot of attention in long-haul trucking, which is appealing for two reasons.

- The possible uptime for trucks can be increased with quicker refueling and better range.
- Their less weight than batteries allows for greater payload capacity.

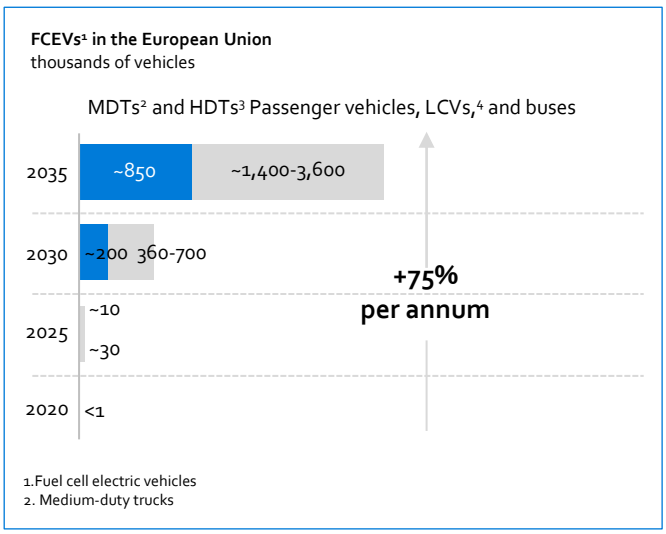
These elements work together to lower the TCO of hydrogen trucks, which is the KPI that the fiercely competitive transportation sector has to manage.

Opportunities in Hydrogen

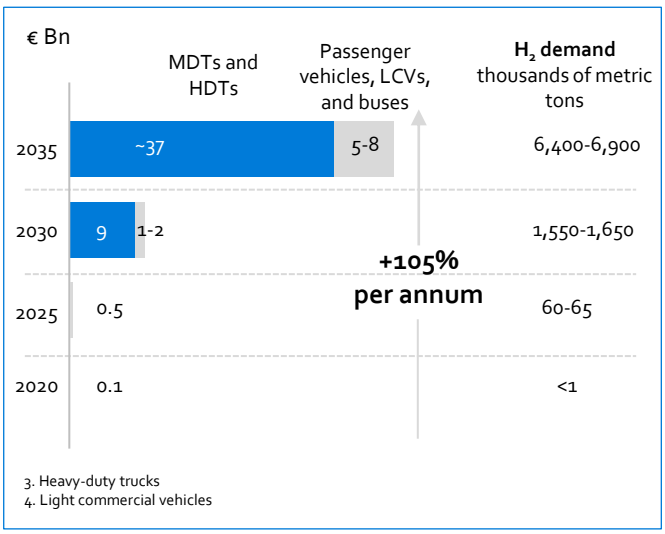
Over the coming years, it is expected to see a significant increase in the number of hydrogen-powered vehicles on the road. It is anticipated that around 95% of demand by volume will come from commercial vehicles. Out of the regions adopting hydrogen-powered commercial vehicles, Japan and South Korea are regions with more demand for such vehicles in the passenger segment instead of commercial.

- By 2035, as many as 850,000 hydrogen-fueled medium- and heavy-duty trucks (MDTs/HDTs) could be on the road in Europe. Between them, they would consume 6,900 metric kilotons of hydrogen per year and require up to 4,800 hydrogen refueling stations (HRS).

The hydrogen refueling market in the European Union is projected to increase 105% per annum by 2035



H_2 refueling market in the European Union



Source: Mckinsey

Source(s):Mckinsey

4.1 Key M&A Transactions

Date	Target	Country	Description	Buyers	Deal Value	EV	EV/ Revenue (x)	EV/ EBITDA (x)
Jun-23	Cela Srl		Designs and constructs various truck types including catering trucks, water towers trucks, etc.	Consilium SGR	-	-	-	-
May-23	Mitsubishi Fuso Truck and Bus Corporation		Manufacturer of trucks including heavy, medium, and light duty trucks, light duty buses and light duty vans	Hino Motors	-	-	-	-
May-23	Two of Faurecia's commercial vehicle manufacturing plants and their related activities		Comprises commercial vehicle manufacturing facilities in Columbus, Indiana and Roermond, the Netherlands	Cummins Inc.	153.0	-	-	-
Mar-23	A.R.S. International		Manufactures truck trolley, trailers, and body	Vinay Tripathi and Rama Tripathi	0.3	0.3	0.2x	-
Jan-23	KamLitKZ		Manufactures automotive components for commercial vehicles	HEAT Motors LLP	-	-	-	-
Jan-23	Turnkey Industries		Manufactures custom truck bodies, trailers, transporters	K-Solv Group	-	-	-	-
Dec-22	Hyzon Motors Europe		Manufactures and sells heavy trucks and buses	Hyzon Motors	4.8	9.7	-	-
Dec-22	Ghh Group		Develop, design and manufacture vehicles like dump trucks, drilling rigs etc. for mining industry	Komatsu	-	-	-	-
Dec-22	U.S. Upfitters-INLAD		Manufactures converting commercial trucks, vans, SUVs	Driverge Vehicle Innovations	-	-	-	-
Dec-22	A. Stucki Company		Manufactures railcar dynamic control products to freight	Stellex Capital Management LLC; Eldridge Industries	-	-	-	-
Nov-22	All assets of Industrial Metal Products		Manufacturer of truck beds	Oy Hilltip	-	-	-	-
Nov-22	Sumitomo Heavy Industries Construction Cranes Co., Ltd.		Manufactures, repairs, and sells construction equipment	Sumitomo Heavy Industries	52.5	154.5	0.6x	-
Aug-22	E.J. Metals, LLC		Designs and manufactures wildland, all-terrain, and specialty fire trucks and firefighting systems	Skeeter Brush Trucks	-	-	-	-
Jul-22	GINAF Trucks Nederland		Manufactures heavy duty and EV medium duty trucks	Clean Logistics	4.4	4.4	-	-
Jul-22	IPLTech Electric		Manufactures and distributes electric heavy commercial vehicles	TI Clean Mobility	12	-	-	-
Jul-22	Assets of Lion Truck Body		Comprises truck bodies manufacturing business	GreenPower Motor	1.4	1.4	-	-
Jul-22	Hercules Enterprises		Manufactures Truck Trailers	Randon Implementos e Participações	39.6	39.6	-	-
Jun-22	Haldex		Manufactures brake and air suspension products	SAF-Holland SE	474.5	477.1	1.0x	9.1x

Source: FactSet

Precedent Transaction Analysis

Date	Target	Country	Description	Buyers	Deal Value	EV	EV/ Revenue (x)	EV/ EBITDA (x)
Jun-22	C.E.I. Costruzione Emiliana Ingranaggi		Manufactures spare parts for trucks and buses	Fidelity	-	-	-	-
Jun-22	Maxi Metal		Manufactures fire trucks and utility trucks	Oshkosh Corporation	19.7	18.0	-	-
May-22	Cherokee Truck Equipment		Manufactures truck and utility vehicle equipment and its parts	ML Utilities Fleet Solutions	-	-	-	-
May-22	S&R Truck		Builds heavy trucks, fire trucks, repairs, and distributes milk tankers	Hastreiter	-	-	-	-
Mar-22	Integrated Machinery Solutions		Manufactures hoists, end trucks, gearing and gear boxes, load blocks, etc.	DeShazo Crane Company, LLC	-	-	-	-
Feb-22	EV Now		Manufactures electric buses, trucks, etc.	Nex Point Public	0.9	1.2	-	-
Jan-22	Hitachi Construction Machinery		Manufactures and sells construction machineries worldwide	ITOCHU; Japan Industrial Partners	1,602.7	9,430.0	1.1x	7.6x
Dec-21	Excelway of Ausa Center		Engaged in design, manufacture, marketing, and sale of compact commercial vehicles	Madvac and A. Kaoussis	-	-	-	-
Oct-21	Bull Head Products		Manufactures aluminum truck bodies	Ilustrato Pictures International	0.5	0.5	0.5x	-
Sep-21	Shenzhen Dongfeng Automobile		Manufactures garbage trucks, concrete mixer vehicles, vans, and road trailers	Hans' Energy	16.3	65.2	-	-
Aug-21	Iracemápolis Plant		Comprises commercial vehicles manufacturing business	Great Wall Motor	-	-	-	-
Aug-21	Rocky Mountain and Bakken Region Assets Of BJ Services		Manufactures truck tractors, acid and cementing equipment	Nations Capital	-	-	-	-
Aug-21	Southwest Products		Manufactures trucks, generators, and custom engines	Interstate Companies	-	-	-	-
Jul-21	Plant in Campinas		Plant comprises truck manufacturing plant	-	-	-	-	-
Jul-21	Hellenic Vehicle Industry		Produces and supplies vehicles for military and commercial use	Plasan Sasa	-	-	-	-
Jun-21	Wilcox Group		Manufactures aluminum bodies for rigid and tipping trailers	Total Vehicle Solutions Group Limited	-	-	-	-
May-21	The Reefer Group		Manufactures refrigerated vehicles	Amundi Private Equity Funds S.A., NCI SAS	-	-	-	-
May-21	Clean Logistics GmbH		Designs and modifies existing heavy trucks and buses from local public transport	Clean Logistic SE	-	-	-	-
May-21	JOST		Manufactures vehicle connection components	Enact, Endless LLP	-	-	-	-

Source: FactSet

Precedent Transaction Analysis

Date	Target	Country	Description	Buyers	Deal Value	EV	EV/ Revenue (x)	EV/ EBITDA (x)
Mar-21	Bell Equipment		Manufactures, distributes, and exports materials handling equipment like dump trucks and JCB excavators, etc.	I A Bell and Company	123.3	162.2	0.4x	10.0x
Mar-21	Crane Carrier		Manufactures, and sells custom, heavy-duty, and vocational chassis	Battle Motors	-	-	-	-
Mar-21	STS Group		Supplier of components and systems for the commercial vehicle	Adler Pelzer Holding GmbH	91.3	81.9	0.3x	4.4x
Mar-21	Talleres Velilla		Manufactures hydraulic cranes, crane trucks, and hydraulic truck platforms	France Elévateur	9.5	9.5	-	-
Feb-21	Mottinger Kran- und Transport		Manufactures and sells truck cranes, low loaders, in-loaders, and trailers	Schmidbauer Komplement	-	-	-	-
Feb-21	OSW Equipment & Repair		Manufactures dump truck bodies, dump body accessories, and trailers	Federal Signal Corporation	-	-	-	-
Jan-21	Fns Fahrzeugbau Und Nutzfahrzeugservice		Manufactures commercial vehicle and other services	Hiab Germany	-	-	-	-
Jan-21	SAIC-IVECO Commercial		Manufactures a range of heavy-duty trucks and special trucks	Shanghai New Power Automotive Technology	280.2	-	-	-
Dec-20	Ike Robotics		Manufactures self-driving trucks	Nuro	-	-	-	-
Dec-20	Nevo Motors		Manufactures zero emission heavy-duty trucks	Aemetis Properties Riverbank	-	-	-	-
Dec-20	Fujian New Forta Automobile Industry		Manufactures trucks and buses	Zhejiang Leapmotor Technology	-	-	-	-
Nov-20	Nantong Gaokai Auto Manufacturing		Manufactures and sells heavy trucks	Scania	-	-	-	-
Nov-20	Langendorf		Manufactures commercial vehicles for transporting goods	Wielton	-	-	-	-
Sep-20	Equipements Lourds Papineau		Manufactures equipment for light and heavy trucks	Aebi Schmidt Holding	-	-	-	-
Jul-20	CIMC Vehicles		Engages in the production and sale of semi-trailers and truck bodies	China International Marine Containers & Consortium	82.1	1,208.5	0.4x	4.8x
Jun-20	Shenzhen Dongfeng Automobile		Manufactures special purpose vehicles	Shenzhen Auto Industry and Trade	26.2	52.3	-	-
May-20	Anhui Ankai Futian Shuguang Axle		Manufactures commercial vehicle parts	Guangxi Fangsheng Group	6.8	17.1		
May-20	C.E.I. Costruzione Emiliana Ingranaggi		Manufactures spare parts for trucks and buses	Alto Partners	-	-	-	-
Feb-20	Stargate Manufacturing		Manufactures dump trailers, straight truck bodies, and transfer trailers	Hugo Corporation	-	-	-	-

Source: FactSet

Precedent Transaction Analysis

Date	Target	Country	Description	Buyers	Deal Value	EV	EV/ Revenue (x)	EV/ EBITDA (x)
Feb-20	Temsa ulasim araçlari sanayi ve ticaret anonim sirketi		Manufactures buses, midi-buses, and light trucks	PPF Industry & Consortium	30.8	30.8	-	-
Jan-20	Navistar International		Manufactures commercial trucks, and commercial buses	Dusk	9,414.7	8,551.4	1.0x	19.4x
Jan-20	R. H. Sheppard		Manufactures engineered products for truck, bus, rails	Bendix Commercial Vehicle Systems LLC	149.5	149.5	-	-
Dec-19	UD Trucks		Manufactures and markets diesel engines, trucks	Isuzu Motors	2,280.9	2,280.9	0.9x	-
Nov-19	Assets of ST Engineering Hackney		Comprises truck bodies and trailers manufacturing business	Workhorse Group	7.0	7.0	-	-
Oct-19	Shandong Transportation		Manufactures passenger cars, electric buses, cranes, trucks	Shandong Heavy Industry	-	-	-	-
Oct-19	Juratek		Develops commercial vehicle components	Management team of Matt Robinson, Toby Whewell and Mark Clegg	-	-	-	-
Sep-19	Fortress Resources		Manufactures and sells a range of vehicle bodies, work trucks	Spartans Motors USA, Inc.	90.1	90.1	2.3x	-
Aug-19	Welgro		Manufactures trucks for the transport of animal feed, flour products, etc.	Rhein Invest	-	-	-	-
Jul-19	German Dry Docks & Consortium		Comprises construction machinery and heavy trucks	Rhr Reederei Heinrich RÖNner	-	-	-	-
Jun-19	Dagang Holding Group		Manufacture, sale, R&D and service of road construction and maintenance machineries and equipment	Yingqi Investment	100.7	490.9	17.3x	-
May-19	Temsa ulasim araçlari sanayi ve ticaret anonim sirketi		Manufactures buses, midibuses, and light trucks	True Value Capital	31.0	-	-	-
May-19	FAD Wheels		Manufactures steel wheels for vehicles, forklift trucks	Gianetti Ruote	-	-	-	-
May-19	Northend Truck Equipment		Manufactures and supplies different truck bodies and trailers	OSW Equipment & Repair, LLC	-	-	-	-
Apr-19	FAW Jiefang Automotive		Manufactures heavy, medium, & light-duty trucks	FAW Jiefang Group	3,775.1	3,775.1	0.4x	-
Feb-19	Hoist Liftruck Mfg.		Manufactures and markets lift trucks and terminal tractors	Toyota Industries North America	-	-	-	-
Feb-19	OHR - Omni Hydraulik Ritter		Produces brake pedals for construction vehicles	Safim	-	-	-	-
Dec-18	Texelis SAS		Manufactures power transmission systems for use in heavy-duty vehicles	Groupe Siparex & Consortium	-	-	-	-
Dec-18	Galdax		Manufactures and wholesales tires for trucks, buses	Stockwik Förvaltning	-	-	-	-

Source: FactSet

Precedent Transaction Analysis

Date	Target	Country	Description	Buyers	Deal Value	EV	EV/ Revenue (x)	EV/ EBITDA (x)
Nov-18	Nordic Traction		Manufactures tyre chains and bogie tracks for heavy Vehicles, tractors	AB Max Sievert	-	-	-	-
Nov-18	Morgan-Multivans Canada		Operates as a commercial truck body manufacturer	Morgan Canada Corporation	-	-	-	-
Sep-18	Drake Equipment of Arizona		Manufactures work trucks and trailers	Salt Creek Capital II	-	-	-	-
Sep-18	IGLOOCAR		Manufactures and supplies specialty truck bodies	Petit Forestier	-	-	-	-
Aug-18	American Hauler Industries		Manufactures enclosed truck trailers	American Cargo Group	-	-	-	-
Aug-18	FairFax Industries		Manufactures semi-trailers, truck bodies, livestock crates, etc.	Action Manufacturing & Supply	-	-	-	-
Jul-18	Sigma Industries		Offers products for the heavy-duty truck, coach, etc.	10854611 Canada (NanoXplore)	23.1	22.4	0.5x	7.4x
Jun-18	Frauenthal Automotive Torun		Manufactures u-bolts for truck, bus, and trailer	Hendrickson USA	-	-	-	-
May-18	Yunnan FDG Automobile		Manufactures electric vehicles	-	12.6	20.5	-	-
Mar-18	Iveco Venezuela		Manufactures trucks and bus chassis	Miranda Capital Partners	-	-	-	-
Jan-18	Inner Mongolia North Hauler Joint Stock		R&D, production, and sales of off-highway mining trucks	Tewo Enterprise Management Consulting	119.9	450.4	3.3x	47.8x
				Mean			**2.1x**	**14.7x**
				Median			**0.6x**	**9.1x**

Source: FactSet

5.1 Public Comparable Analysis

Company	Market Cap (USD mn)	Ent. Value (USD mn)	EV/Sales			EV/EBITDA			P/E		
			2021A	2022E	2023E	2021A	2022E	2023E	2021A	2022E	2023E
Commercial Vehicle											
Original Equipment Manufacturers (OEMs)											
Volvo AB Class B	41,982	55,219	1.3x	1.2x	1.2x	7.8x	7.9x	7.1x	12.7x	11.7x	9.7x
PACCAR Inc.	43,714	49,581	2.1x	1.7x	1.6x	15.7x	11.1x	8.9x	23.6x	14.5x	10.5x
Daimler Truck Holding AG	29,629	45,239	1.0x	0.8x	0.8x	11.7x	9.0x	6.7x	11.4x	9.7x	8.1x
Traton SE	10,692	31,778	0.9x	0.7x	0.7x	6.3x	5.9x	5.7x	19.1x	7.5x	4.5x
Isuzu Motors Limited	9,359	11,848	0.5x	0.5x	0.5x	4.6x	4.6x	4.7x	10.8x	8.6x	8.0x
Ashok Leyland Limited	5,990	9,337	2.7x	1.8x	1.9x	20.0x	20.0x	20.3x	NM	52.6x	24.7x
Oshkosh Corp	5,656	5,714	0.7x	0.7x	0.7x	8.9x	12.0x	8.3x	17.8x	24.7x	14.1x
Iveco Group NV	2,442	5,145	0.3x	0.3x	0.3x	4.2x	4.3x	4.2x	16.0x	10.2x	10.5x
REV Group, Inc.	789	1,047	0.4x	0.4x	0.4x	8.2x	8.2x	8.1x	10.9x	15.7x	13.2x
NFI Group Inc.	666	1,950	0.8x	0.9x	0.7x	22.4x	NM	35.0x	NM	NM	NM
High			**2.7x**	**1.8x**	**1.9x**	**22.4x**	**20.0x**	**35.0x**	**23.6x**	**52.6x**	**24.7x**
Average			**1.1x**	**0.9x**	**0.9x**	**11.0x**	**9.2x**	**10.9x**	**15.3x**	**17.3x**	**11.5x**
Median			**0.9x**	**0.8x**	**0.7x**	**8.5x**	**8.2x**	**7.6x**	**14.4x**	**11.7x**	**10.5x**
Low			**0.3x**	**0.3x**	**0.3x**	**4.2x**	**4.3x**	**4.2x**	**10.8x**	**7.5x**	**4.5x**
Suppliers											
Cummins Inc.	34,705	41,773	1.7x	1.5x	1.3x	14.6x	12.0x	8.4x	16.3x	15.6x	12.2x
Knorr-Bremse AG	12,307	14,254	1.8x	1.9x	1.7x	10.3x	13.2x	11.0x	18.2x	22.7x	19.7x
Allison Transmission Holdings, Inc.	5,141	7,319	3.0x	2.6x	2.5x	8.9x	7.8x	6.9x	10.8x	9.0x	8.5x
Wabash National Corporation	1,217	1,568	0.9x	0.6x	0.6x	28.5x	7.5x	4.6x	41.9x	10.8x	5.5x
JOST Werke SE	806	1,012	0.8x	0.8x	0.7x	6.8x	6.2x	5.4x	12.8x	11.4x	9.8x
Douglas Dynamics, Inc.	687	958	1.8x	1.6x	1.5x	12.9x	11.9x	10.9x	17.4x	15.8x	18.2x
Randon SA Implementos e Participacoes Pfd	831	1,762	1.0x	0.8x	0.8x	7.5x	6.0x	5.3x	7.4x	8.5x	9.1x
Iochpe Maxion S.A.	398	1,323	0.5x	0.4x	0.4x	4.1x	4.3x	4.1x	7.7x	6.9x	6.6x
Commercial Vehicle Group, Inc.	372	522	0.5x	0.5x	0.5x	7.7x	11.1x	7.2x	11.7x	22.7x	11.7x
Castings Plc	218	174	0.9x	0.7x	0.6x	6.2x	6.2x	5.2x	24.3x	13.9x	12.0x
Core Molding Technologies, Inc.	207	232	0.8x	0.6x	0.6x	9.4x	7.9x	6.4x	NA	17.0x	14.5x
High			**3.0x**	**2.6x**	**2.5x**	**28.5x**	**13.2x**	**11.0x**	**41.9x**	**22.7x**	**19.7x**
Average			**1.3x**	**1.1x**	**1.0x**	**10.6x**	**8.6x**	**6.8x**	**16.8x**	**14.0x**	**11.6x**
Median			**0.9x**	**0.8x**	**0.7x**	**8.9x**	**7.8x**	**6.4x**	**14.5x**	**13.9x**	**11.7x**
Low			**0.5x**	**0.4x**	**0.4x**	**4.1x**	**4.3x**	**4.1x**	**7.4x**	**6.9x**	**5.5x**

Source(s): FactSet as of 30-Jun-2023

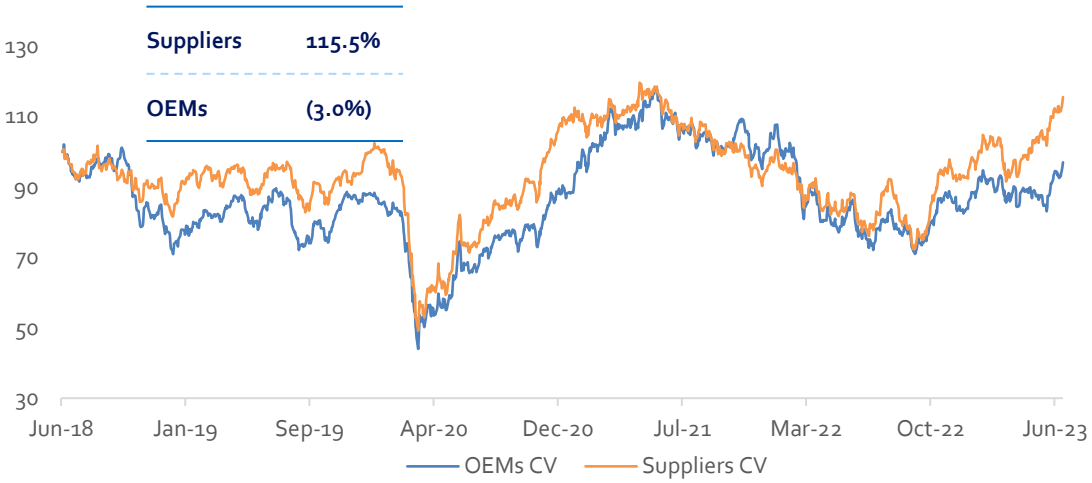
Public Comparable Analysis

Company	Market Cap (USD mn)	Ent. Value (USD mn)	EV/Sales			EV/EBITDA			P/E		
			2021A	2022E	2023E	2021A	2022E	2023E	2021A	2022E	2023E
Passenger Vehicle											
Original Equipment Manufacturers (OEMs)											
Tesla, Inc.	829,681	813,548	15.1x	10.0x	8.1x	86.5x	46.3x	47.6x	108.6x	58.8x	71.4x
Toyota Motor Corp.	260,582	431,810	1.5x	1.6x	1.6x	10.1x	10.1x	11.9x	12.1x	13.6x	11.9x
Mercedes-Benz Group AG	85,987	178,769	1.1x	1.1x	1.1x	8.4x	5.7x	6.4x	5.5x	5.6x	5.8x
Volkswagen AG Pref	67,238	255,117	0.9x	0.9x	0.8x	4.7x	5.1x	4.9x	4.2x	4.3x	3.8x
Bayerische Motoren Werke AG	81,370	164,879	1.3x	1.1x	1.0x	7.0x	7.0x	6.7x	5.9x	4.2x	7.0x
Honda Motor Co., Ltd.	54,405	88,188	0.7x	0.7x	0.7x	4.2x	4.2x	6.5x	9.7x	10.4x	9.3x
General Motors Company	53,603	141,704	1.1x	0.9x	0.9x	6.6x	6.6x	8.7x	5.2x	4.9x	5.5x
Ford Motor Company	60,532	161,758	1.2x	1.0x	0.9x	14.7x	12.5x	10.7x	9.4x	7.9x	8.4x
Hyundai Motor Company	42,967	112,789	1.1x	1.0x	1.0x	11.3x	9.7x	7.8x	9.7x	6.7x	5.1x
Kia Corp.	27,003	17,208	0.3x	0.3x	0.2x	2.7x	2.3x	1.7x	6.8x	6.1x	4.4x
High			**15.1x**	**10.0x**	**8.1x**	**86.5x**	**46.3x**	**47.6x**	**108.6x**	**58.8x**	**71.4x**
Average			**2.4x**	**1.9x**	**1.6x**	**15.6x**	**10.9x**	**11.3x**	**17.7x**	**12.3x**	**13.3x**
Median			**1.1x**	**1.0x**	**1.0x**	**7.7x**	**6.8x**	**7.2x**	**8.1x**	**6.4x**	**6.4x**
Low			**0.3x**	**0.3x**	**0.2x**	**2.7x**	**2.3x**	**1.7x**	**4.2x**	**4.2x**	**3.8x**
Suppliers											
Denso Corporation	52,581	55,272	1.1x	1.2x	1.2x	8.6x	8.6x	8.5x	30.6x	24.4x	17.4x
Bridgestone Corporation	29,094	31,607	1.1x	1.0x	1.1x	5.5x	5.8x	5.2x	9.2x	12.8x	10.8x
Aisin Corporation	9,026	15,284	0.4x	0.5x	0.5x	4.1x	4.1x	5.1x	8.7x	18.9x	11.2x
CIE Automotive, S.A.	3,660	5,539	1.4x	1.4x	1.2x	8.2x	8.3x	7.1x	12.2x	11.6x	10.5x
Toyota Boshoku Corp.	3,331	2,955	0.2x	0.2x	0.2x	3.2x	3.2x	3.5x	11.2x	21.3x	12.5x
Nifco Inc.	3,168	2,743	1.1x	1.2x	1.2x	7.1x	7.1x	7.3x	18.1x	19.6x	16.4x
Dorman Products, Inc.	2,481	3,251	2.4x	1.9x	1.6x	15.6x	15.1x	10.7x	16.7x	16.5x	15.3x
Dowlais Group PLC	2,250	2,250	NA	NA	0.3x	NA	NA	2.9x	NA	9.3x	9.1x
American Axle & Manufacturing Holdings, Inc.	968	3,507	0.7x	0.6x	0.6x	4.2x	4.6x	4.6x	8.8x	13.4x	21.9x
Standard Motor Products, Inc.	813	1,149	0.9x	0.8x	0.8x	6.8x	6.9x	8.1x	8.1x	10.2x	11.2x
High			**2.4x**	**1.9x**	**1.6x**	**15.6x**	**15.1x**	**10.7x**	**30.6x**	**24.4x**	**21.9x**
Average			**1.0x**	**1.0x**	**0.9x**	**7.0x**	**7.1x**	**6.3x**	**13.7x**	**15.8x**	**13.6x**
Median			**1.1x**	**1.0x**	**0.9x**	**6.8x**	**6.9x**	**6.1x**	**11.2x**	**15.0x**	**11.9x**
Low			**0.2x**	**0.2x**	**0.2x**	**3.2x**	**3.2x**	**2.9x**	**8.1x**	**9.3x**	**9.1x**
Overall High			**15.1x**	**10.0x**	**8.1x**	**86.5x**	**46.3x**	**47.6x**	**108.6x**	**58.8x**	**71.4x**
Overall Average			**1.5x**	**1.2x**	**1.1x**	**11.2x**	**9.0x**	**8.8x**	**16.0x**	**14.8x**	**12.5x**
Overall Median			**1.0x**	**0.9x**	**0.8x**	**8.0x**	**7.5x**	**6.9x**	**11.4x**	**11.7x**	**10.5x**
Overall Low			**0.2x**	**0.2x**	**0.2x**	**2.7x**	**2.3x**	**1.7x**	**4.2x**	**4.2x**	**3.8x**

Source(s): FactSet as of 30-Jun-2023

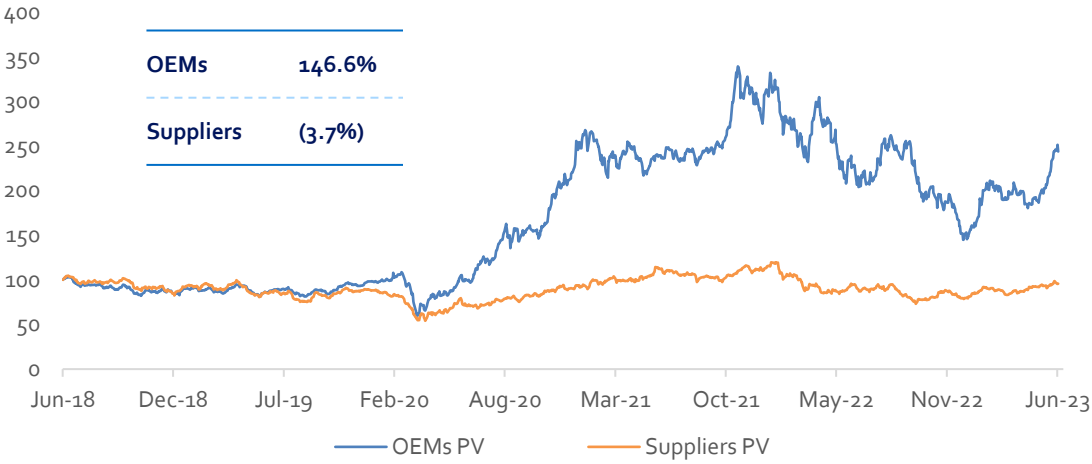
5.2 Share Price Performance – Last Five Years

Commercial Vehicle



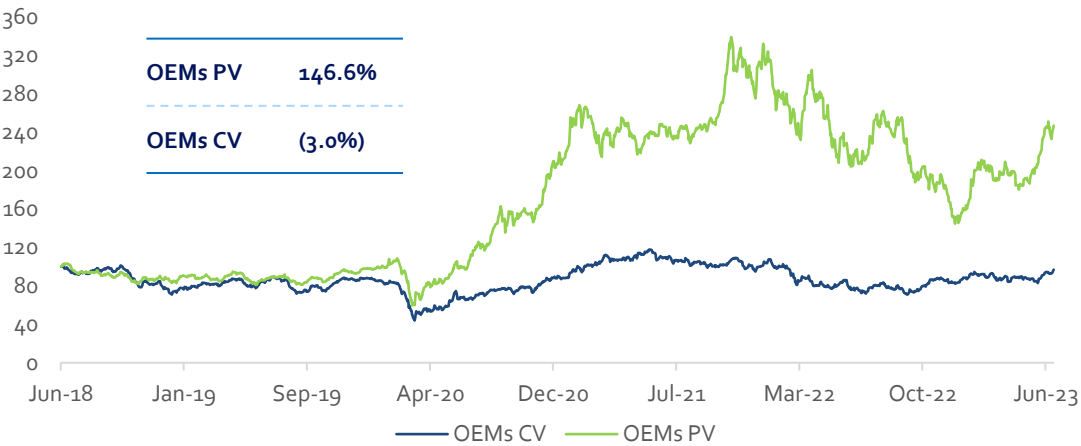
We see that historically commercial vehicle Suppliers have been outperforming OEMs, even during the Covid era as suppliers tend to be more specialized and focused on specific components or systems, which can make them nimbler and more adaptable to changing market conditions

Passenger Vehicle



In the case of passenger vehicle OEMs and Suppliers, OEMs have performed better historically as passenger vehicle OEMs tend to have more established brands and larger market shares, which can provide them with greater stability and predictability in terms of revenue and earnings

Commercial Vehicle & Passenger Vehicle OEMs Comparison



Passenger vehicle OEMs have generally outperformed commercial vehicle OEMs in recent years as commercial vehicle OEMs have faced a number of challenges in recent years, including increased competition, rising fuel costs, and regulatory pressures.

Source(s): FactSet as of 30-Jun-2023

6.1 Global Team

AMERICAS

Todd Cassidy
Brown Gibbons Lang & Co
tcassidy@globalma.com
USA

Eduardo Meouchi
RIóN
emeouchi@globalma.com
MEXICO

Esteban Olivera
Fenix Partners
eolivera@globalma.com
ARGENTINA

Martin Azcarate
Fenix Partners
mazacarate@globalma.com
ARGENTINA

Paulo Cury
Condere Consultoria
pcury@globalma.com
BRAZIL

Mônica H. Carvalho
Condere Consultoria
mcarvalho@globalma.com
BRAZIL

Luiz Eduardo Andrade
Condere Consultoria
landrade@globalma.com
BRAZIL

Martin Plettner
RIóN
mplettner@globalma.com
MEXICO

EUROPE

Pal Farkas
Invescom Corporate Finance
pfarkas@globalma.com
HUNGARY

Véronique Zeid-Maurel
Financière de Courcelles
vzm@globalma.com
FRANCE

Harold Brummelhuis
JBR Strategy
h.brummelhuis@globalma.com
NETHERLANDS

Mike Göller
IOM Advisory GmbH
mgoeller@globalma.com
GERMANY

Guillaume Piette
Financière de Courcelles
gpiette@globalma.com
FRANCE

Gustian van der Linde
JBR Strategy
g.vanderlinde@globalma.ncom
NETHERLANDS

Philipp Elsen
IOM Advisory GmbH
pelsen@globalma.com
GERMANY

Federico Cappa
Broletto Corporate Advisory S.r.l.
f.cappa@globalma.com
ITALY

Mike Allen
Zeus Capital
mike.allen@zeuscapital.co.uk
UNITED KINGDOM

Thomas Labryga
IOM Advisory
labryga@globalma.com
GERMANY

Luigi Sandulli
Broletto Corporate Advisory S.r.l.
l.sadulli@globalma.com
ITALY

Paul McGlone
Zeus Capital
paul.mcglone@globalma.com
UNITED KINGDOM

Alexander Von Griesheim
RIóN
agriesheim@globalma.com
SPAIN

Andrea Scarsi
Broletto Corporate Advisory S.r.l.
a.scarsi@globalma.com
ITALY

Source(s): Global M&A Partners Website

Global Team

REST OF THE WORLD

Tamotsu Majima
Recof Corporation

tmajima@globalma.com
JAPAN

Yoshihiko Nakagawara
Recof Corporation

ynakagawara@globalma.com
JAPAN

Jacob Hoyeon Won
Locus Capital Partners

jhwon@globalma.com
KOREA

Bruno Moussey
FDC Asia

bmoussey@globalma.com
THAILAND

Sebastien Laurent
FDC Asia

slaurent@globalma.com
THAILAND

Rory Mallon
Financière de Courcelles

rmallon@ globalma.com
MALAYSIA

Yair Ephrati
Value Base

yephrati@globalma.com
ISRAEL

Nathan Chang
FCC Partners

nathan.chang@globalma.com
CHINA

CY Huang
FCC Partners

chuang@globalma.com
TAIWAN

Source(s): Global M&A Partners Website

RIóN MERGERS AND ACQUISITIONS

GLOBAL M&A PARTNERS

About Us

Established in 1999, Global M&A Partners is a leading international partnership of investment bankers specializing in mid-market transactions. We provide sector expertise, international scope, and deep local market knowledge and execution capabilities for our clients. We operate with local offices across 4 continents and have completed over 1,500 transactions during the last ten years, typically ranging from €50 to €500 million.

Our Automotive team maintains coverage of the broad automotive sector, including automotive supply chain, automotive aftermarket, and the on- and off-highway commercial vehicle sectors.

We have executed numerous transactions for private, public, or institutionally backed companies, including mergers & acquisitions, restructurings, and capital raising.

The team brings a unique perspective, having spent time as operators and advisors to the sector, leading to deep and entrenched sector relationships. Given our sector experience, transaction expertise, and unparalleled access to local decision makers, we can work together to offer customized M&A solutions and premium valuations for our clients.