

# Zero-Emission Truck and Bus Market Update



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**Owen MacDonnell**  
**Yin Qiu**  
**Xiaoyue Wang**  
**Shuhan Song**  
**Cristina Dobbelaere**  
**Cristiano Façanha, PhD.**

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CALSTART

## The Zero-Emission Technology Inventory (ZETI) and the ZETI Data Explorer

The Zero-Emission Technology Inventory (ZETI) is an interactive online resource to establish a current and shared knowledge base for worldwide commercially available offerings of zero-emission medium- and heavy-duty vehicles (ZE-MHDVs), including battery-electric and fuel-cell electric vehicles (CALSTART, 2022a).<sup>1</sup> The ZETI team also recently launched a companion tool that allows a user to explore, filter, and produce customizable figures from the data. The new ZETI Data Explorer is also publicly available and serves to provide another level of detail to all stakeholders interested in the progression of the ZE-MHDV market. The development of both resources is active and ongoing and the ZETI team strives to keep a current and accurate inventory available to users. The team encourages any questions, concerns, or feedback to be submitted to [info@globaldrivetozero.org](mailto:info@globaldrivetozero.org).

The following Global Zero-Emission Truck and Bus Market Update intends to provide an update to the zero-emission truck and bus market through the lens of model availability, vehicle range, original equipment manufacturer (OEM) status, and global availability by region. While the ZETI tool focuses on specific models, this report and the ZETI Data Explorer aim to provide stakeholders with a high-level overview of trends observed by region, vehicle segment, and technology. Though this report is limited in its static nature, the ZETI Data Explorer goes beyond what is presented below and examines key technical specifications such as range, energy storage, and payload of various vehicle types and segments. The ZETI team is thrilled to launch this new resource in a continued effort to improve the understanding and awareness of ZE-MHDV technology.

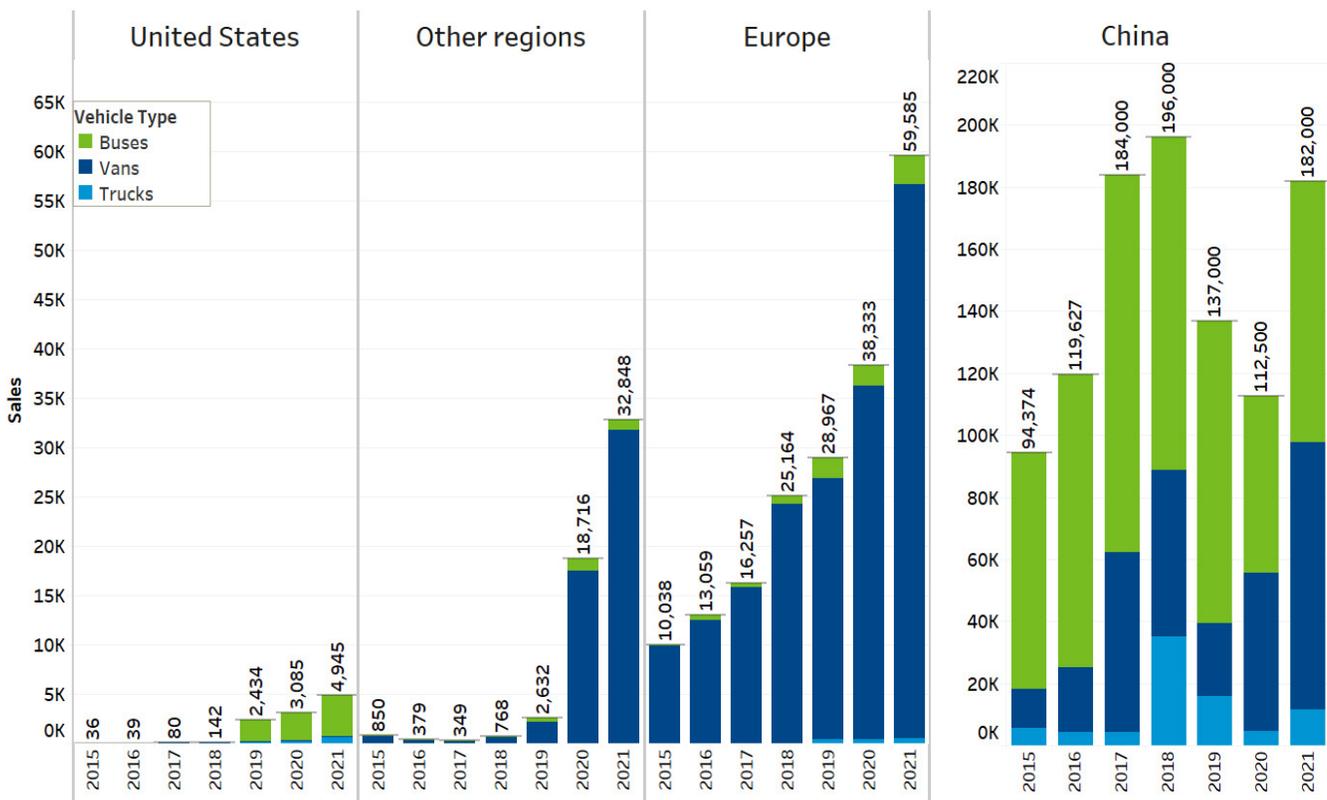
<sup>1</sup> In this report, commercial availability is defined as availability for production based on information provided by manufacturers.

## GLOBAL ZE-MHDV SALES DATA

Understanding the trajectory of the global ZE-MHDV market provides critical context for the trends and insights identified by ZETI. Global vehicle sales volumes and vehicle stock data can support further insights by complementing supply-side information on availability and capability with demand-side trends indicating market acceptance. Beginning with the global sales of ZE-MHDV, the ZETI data can illustrate a more comprehensive view of the market with the broader context in mind.

Figure 1 below represents the ZEV sales (volume of ZEV sales in each year) in the United States, other regions, Europe, and China from 2015 to 2021 (CALSTART, 2021b) (CALSTART, 2022b).<sup>2</sup> The bar charts show the annual ZEV sales for buses, vans, and trucks (IEA, 2022).

**Figure 1.** ZEV Sales in the United States, Other Regions, Europe, and China from 2015 to 2021



The total ZEV sales show a constant rise from 2015 to 2021 in the United States and led by the bus segment. In China, the total ZEV sales vary from year to year but are consistently led by the zero-emission bus segment. However, the share of vans is expected to take up a greater proportion of ZEV sales over the coming years.

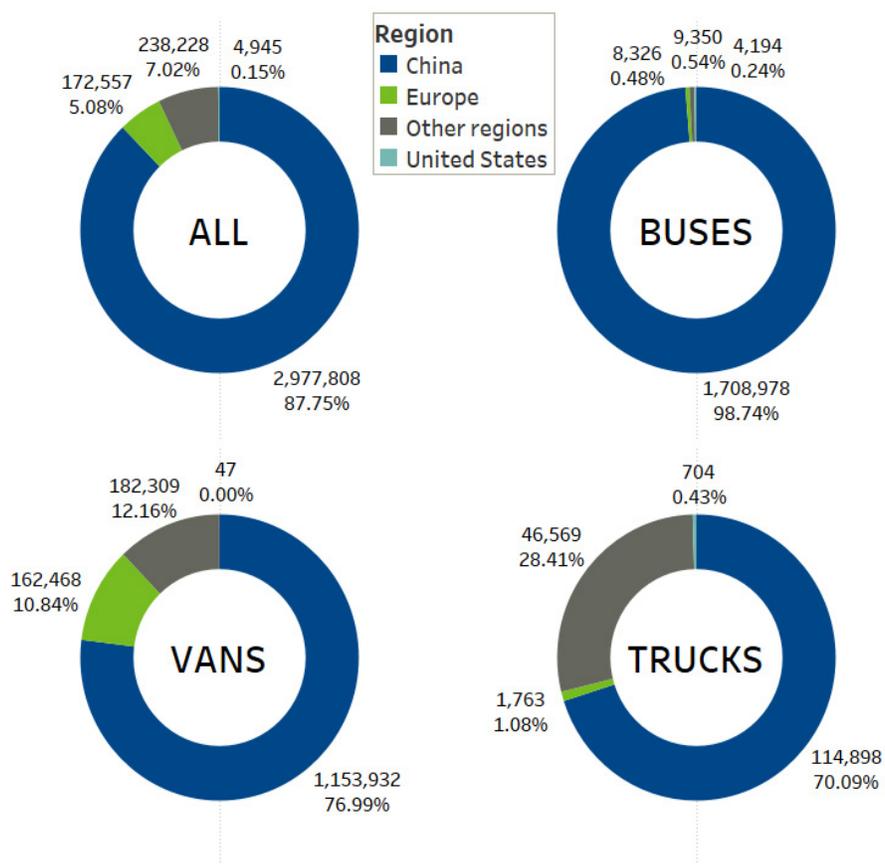
Zero-emission vans are one of the less operationally demanding MHDV segments leading sales in Other Regions and Europe, followed by buses and trucks. ZEV sales in the United States, Other Regions, and Europe have been growing progressively year-over-year, while China faced declines after sales reached a peak in 2018.

<sup>2</sup> The United States: ZEV sales in bus collection began in 2019.  
 Europe: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Italy, Luxembourg, Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom, and other Europe.  
 Other regions include: Canada, Chile, India, Japan, Korea, New Zealand, Uruguay, and rest of the world.

ZEV sales in the United States have an average year-over-year growth rate of 43.52% from 2019 to 2021, in other regions, the average year-over-year growth rate is 164.34%, and Europe enjoys an average year-over-year growth of 35.38% from 2015 to 2021. Truck sales in the United States, other regions, and Europe remain small but continue to track ongoing growth. Globally, zero-emission truck sales have grown 124.11% from 2015 to 2021.

Figure 2 depicts the ZEV stock (total cumulative ZEVs registered) by 2021 and shares of stock by region. It also captures the breakdown in the vehicle category of buses, vans, and trucks.

**Figure 2.** Global ZEV Stocks and Shares by the United States, Other Regions, Europe, and China in 2021

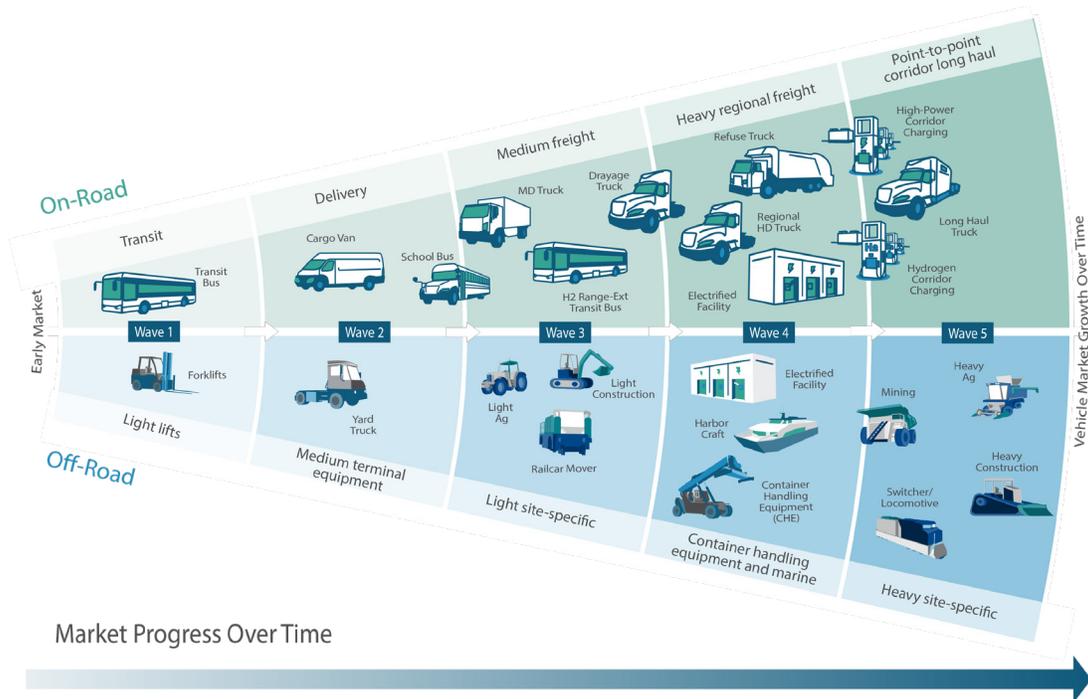


The total ZEV stock for each region in 2021 reflects the approach established by CALSTART's Beachhead Strategy (Figure 3). Buses and vans lead deployments, with truck volumes growing and technology and operational capacity continuing to improve (CALSTART, 2022c).

## BEACHHEAD STRATEGY

The Beachhead Strategy, developed in partnership between CALSTART and the California Air Resources Board (CARB), is foundational to Drive to Zero's theory of change and follows the logical progression of ZE-MHDVs based on characteristics unique to each vehicle type. The Beachhead Strategy identifies the commercial vehicle market segments where zero-emission technologies are most likely to succeed first. Those are typically urban applications where vehicles operate along known routes and relatively shorter distances and can charge overnight at depots. Because zero-emission technologies are transferable across vehicle applications, these early successes can enable technology to mature before transferring to heavier vehicles traveling for longer distances. The Beachhead Strategy aligns closely with the market and product strategies of major truck and component makers worldwide and has been incorporated into CARB's three-year investment plan strategy.

**Figure 3.** Beachhead Strategy



Similar drivetrain and component sizing can scale to early near applications

Expanded supply chain capabilities and price reductions enable additional applications

Steadily increasing volumes and infrastructure strengthen business case and performance confidence

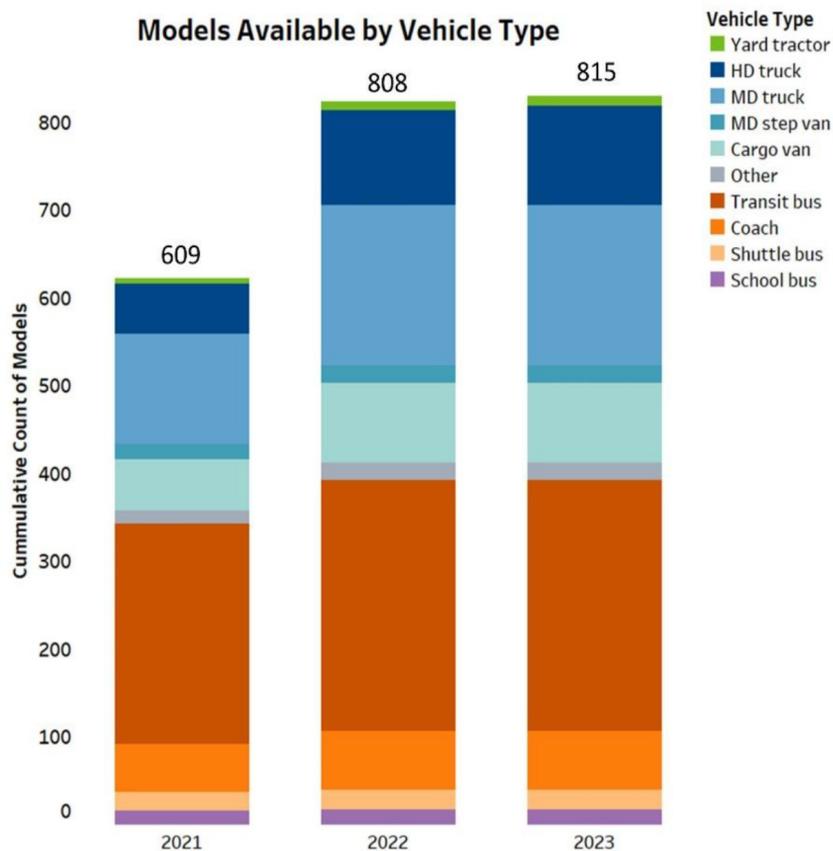
## ZE-MHDV MODEL AVAILABILITY GROWING

Figure 4 displays the number of zero-emission truck and bus models on the market available today and in the near future. Vehicle availability has grown nearly 33% from 2021 until the end of 2022 (from 609 models to 808 models).

Zero-emission medium-duty step vans are tracking 18% growth (17 models to 20) over the same period. Heavy-duty truck models reflect 88% growth from 2021 to 2022 (57 models to 107 models). Cargo vans grew by 56.9% from 58 available models to 91 available models. Zero-emission transit buses, by far the overall model leader and the most-established zero-emission application, are expected to end 2022 with 285 available models – a steady 14% rise between 2021 and 2022 (251 models to 285 models), the majority of which are available in the Chinese market. The availability of zero-emission school bus models, a segment-specific to North America, rose notably by 13% from 16 models in 2021 to 18 models by 2022.

Globally, the most robust model-availability growth comes from zero-emission cargo vans and heavy-duty trucks, growing 56% and 87% year-over-year respectively between 2021 and 2022. Cargo vans are considered a foundational technology for the overall zero-emission commercial vehicle market under the Beachhead Strategy.

**Figure 4.** Global ZE-MHDV Model Availability from 2021 to 2023



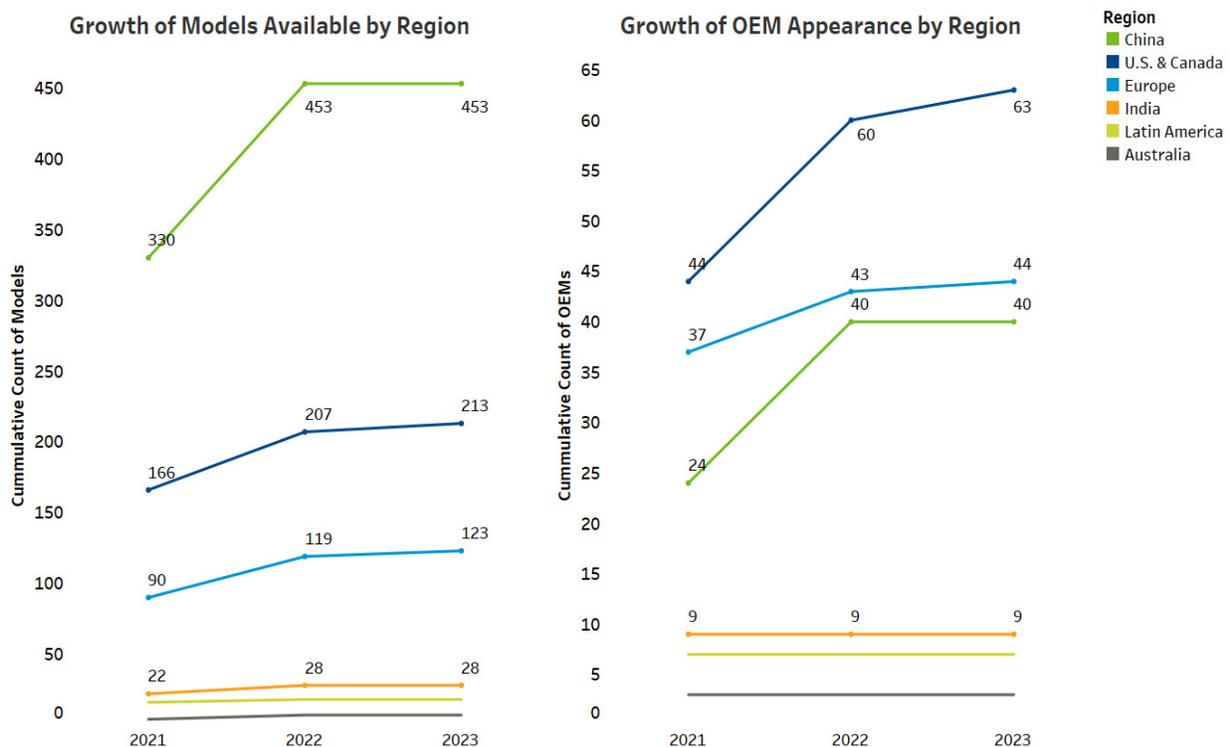
The growth of transit bus models remains stable as the segment matures, while zero-emission truck (ZET) models are quickly closing the gap as the market for the technology advances. Growing the segments highlighted in the early waves of the Beachhead Strategy is key to accelerating the broader market because components in these vehicles can be used in other more specialized or demanding vehicle types.

Zero-emission heavy-duty trucks have shown preliminary promise in urban freight and short hauling operations under 150 miles per day, while electric cargo van deployments have grown across the board, largely due to the accelerated trends in e-commerce coupled with a commitment to last-mile decarbonization by many global carriers (CALSTART, 2021c).

## MODEL AVAILABILITY AND OEM PRESENCE ACROSS GLOBAL REGIONS CONTINUES TO FOLLOW UPWARD TRAJECTORY

Figure 5 illustrates the growth in models and original equipment manufacturers (OEMs) offering ZEVs by region. The United States and Canada have experienced steady growth from 166 models to 213 models from 2021 to 2023 driven by a strong MD truck market. Even so, from the perspective of overall model availability, China represents the vast majority of the ZEV market globally, being home to approximately 453 models available in 2023 driven by the demand for zero-emission transit buses. Europe shows moderate growth in available models (from 90 to 123) and OEMs (from 37 to 44).

**Figure 5.** Models Availability and OEM Growth by Region

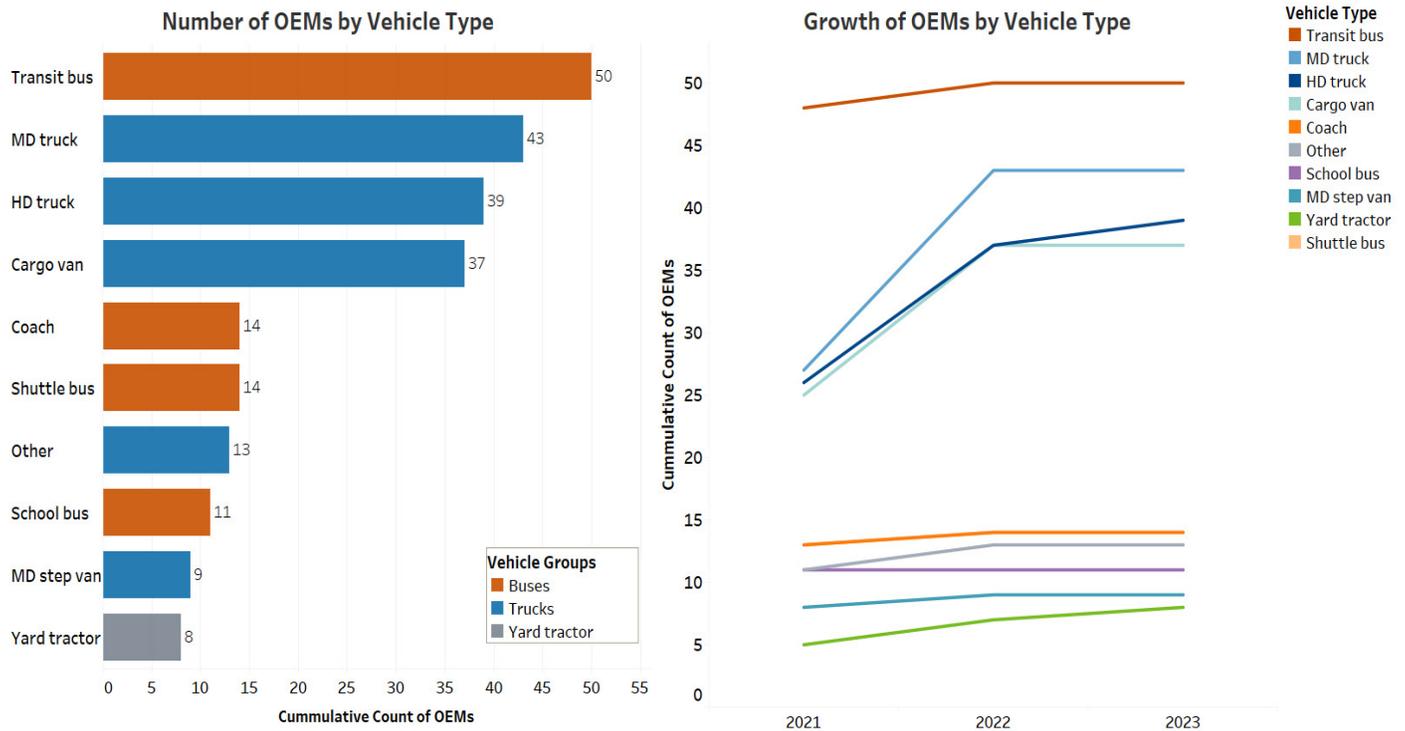


\*OEM Appearance indicates OEMs with at least one zero-emission vehicle model offering in the region.

## OEMS ACROSS ALL VEHICLE TYPES STEADILY INCREASING GLOBALLY

Figure 6 below shows that the number of OEMs with ZEV offerings by specific vehicle segment has been steadily increasing. It indicates increased competition between manufacturers, especially between well-established OEMs that already have strong businesses in internal combustion technology and newcomer OEMs that focus entirely on electrification. Currently, more OEMs have prioritized manufacturing ZE transit buses, but OEMs manufacturing the various truck segments have also shown sharp growth through 2022. The MD truck market has experienced a drastic increase from 2021 to 2022 with more than 40 OEMs offering new ZEV models. HD truck and cargo van have 39 and 37 OEMs respectively, and they both have experienced steady growth in the respective OEMs with an available vehicle in the future. Increased competition bodes well for the future of all segments highlighted and will increase pressures to reduce costs and increase efficiency all around.

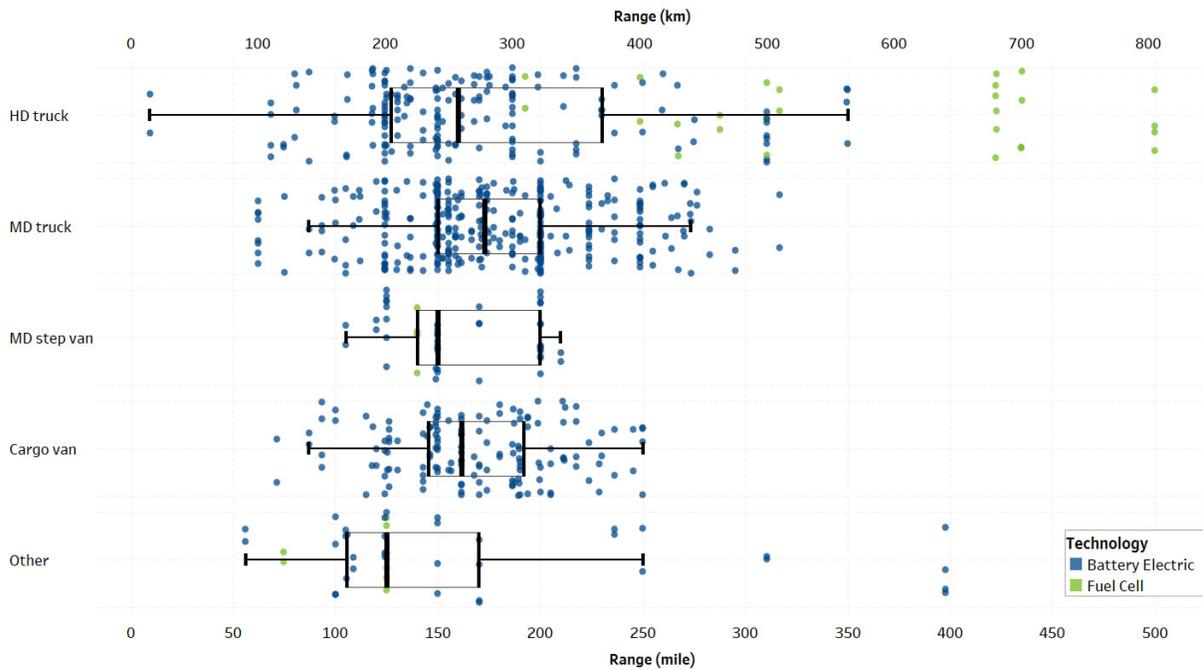
**Figure 6.** Number of OEMs and Growth of OEMs by Vehicle Type Globally



## GLOBAL ZET MEDIAN RANGE GROWING

Figure 7 below represents the distribution of ranges available by ZET segment. Medium-duty trucks, medium-duty step vans, and cargo vans on the market in 2022 have median ranges of 276km/173mi, 241km/150mi, and 261km/162mi respectively, according to manufacturer data. This allows zero-emission trucks to meet a growing variety of urban delivery and regional duty cycles.

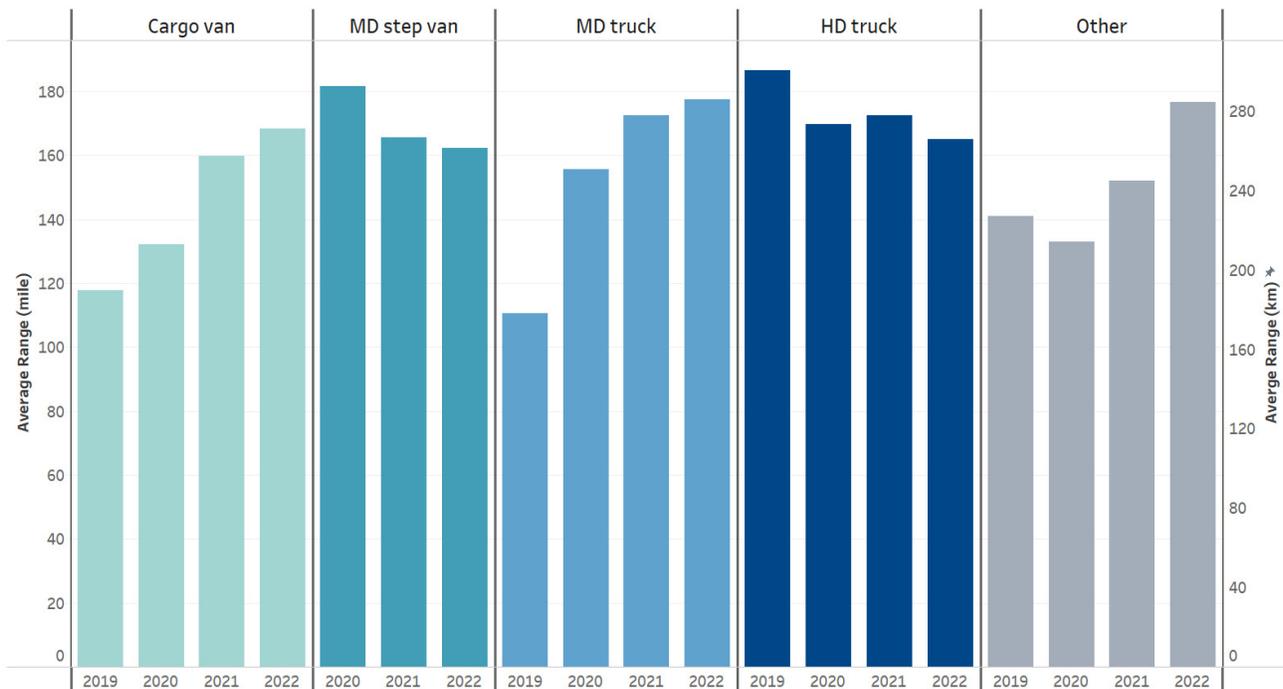
**Figure 7.** Distribution of Global Zero-Emission Truck Range by Vehicle Segment



As zero-emission technologies become more efficient, an increasing variety of heavy-duty ZETs with improved performance will become available. According to manufacturer data, heavy-duty ZETs on the market in 2022 now boast a median range of 241km/150mi. They will soon include a mix of battery electric and hydrogen fuel cell electric options. Range-leaders for HD-ZETs available today include Volvo’s VNRe, Freightliner’s eM2 106, and eCascadia. In real-world deployments, ZE-MHD trucks have the potential to achieve 300 miles in one charge, but environmental and working conditions are critical to factor in as well (RMI, 2022). Volvo’s VNRe achieved a median range of 120 miles while BYD’s 8TT and Q3M reached median ranges of 100 miles in pilot projects (CALSTART, 2022d). According to data from the U.S. Department of Transportation, approximately two-thirds of trucks travel no more than 50 miles from their base each day, and more than 80% travel no more than 100 miles (U.S. DOT, 2022). Distances between these points are sufficient to meet the needs of over 80% of use cases and will be increased in the future to meet the more challenging duty cycles.

Figure 8 shows some changes in range. The average distance traveled by cargo vans has increased from 117.71 miles in 2019 to 168.33 miles in 2022. There has also been an increase in the estimated range of MD trucks by 67.01 miles (from 110.65 miles in 2019 to 177.66 miles in 2022).

**Figure 8.** Progression of Average (Mean) Annual Zero-Emission Truck Ranges from 2019 to 2022



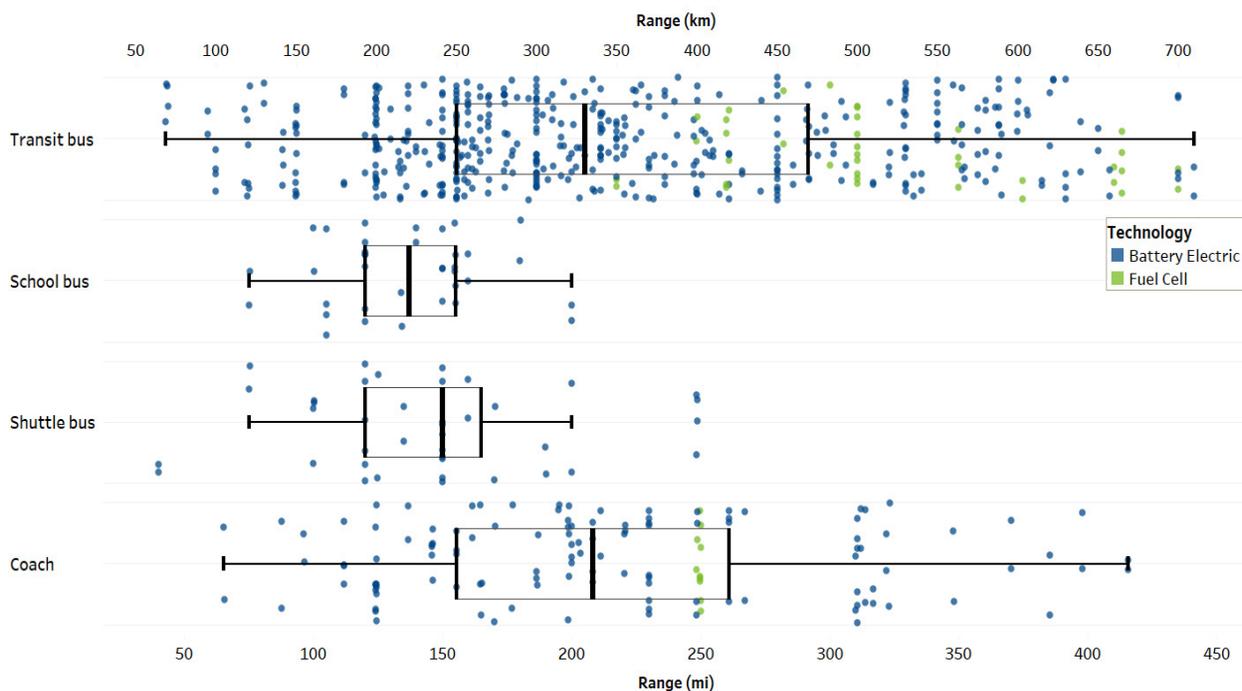
The number of miles traveled by other vehicles (many being refuse trucks) has increased slightly from 140.95 miles in 2019 to 176.73 miles in 2022. Manufacturers and governments' focus might cause the vehicles to change, too. For example, the ranges of HD trucks and MD step vans have experienced a slight drop over the last four years. Fleets and cities' have focused resources on regional hauling which may explain the minor decrease in reported ranges by OEMs.

Additionally, several new entrants with lower ranges could bring the average down as HD trucks represent a segment of the market with fewer vehicles available than other segments, making the average more susceptible to change. It also suggests that the range already available is sufficient for the current needs of fleets so newer models may not need to push for more extreme range.

## GLOBAL ZEB MEDIAN RANGE GROWING

Figure 9 below represents the distribution of ranges available by ZEB segment. According to manufacturer data, zero-emission transit buses on the market in 2022 have a median range of 330km/205mi, with several manufacturers reporting ranges greater than 470km/292mi. Roughly half of ZEBs available in 2022 have a manufacturer-reported range between 200km/124mi and 470km/292mi, sufficient for most urban transit operations.

**Figure 9.** Distribution of Global Zero-Emission Bus Range by Vehicle Segment

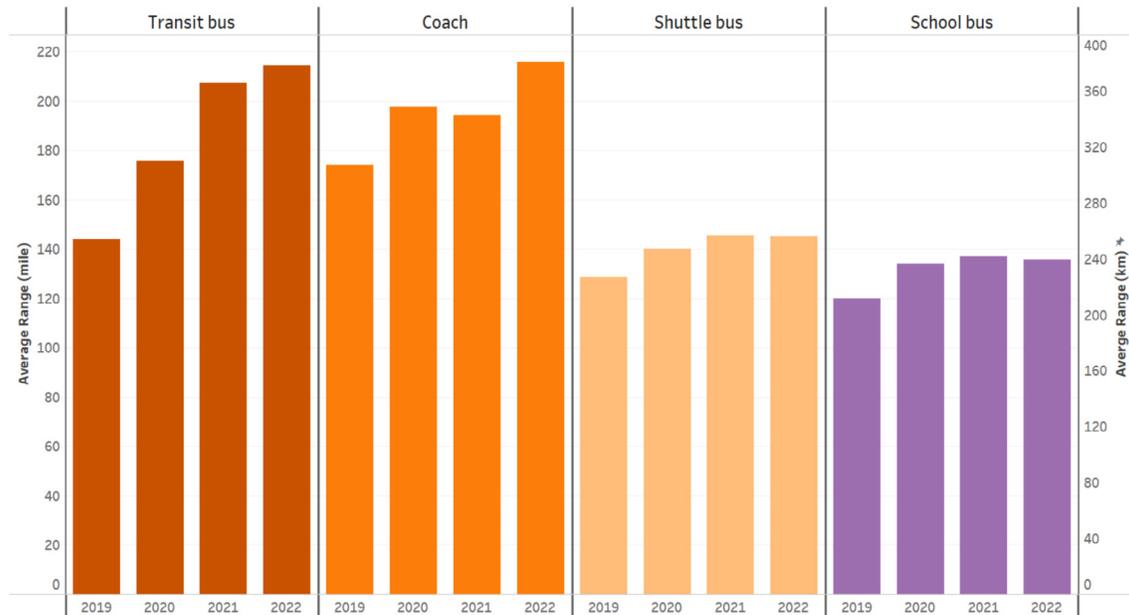


According to manufacturer data, zero-emission school buses and shuttle buses are reported to have a median range of 388km/137mi and 241km/150mi, respectively. To put the school bus range in context, case studies from the National Renewable Energy Lab show that most school bus routes fall between 50 and 100 miles (80-160km), with route length decreasing significantly when buses operate in urban settings (NREL, 2022). ZE school buses on the market today boast ranges that could easily complete the studied routes.

One of the biggest manufacturers in the U.S. & Canada, New Flyer, has the current range-leading ZEB with an average range of 350 miles. European manufacturer Ebusco has an average range for transit buses of 318.5 miles and became one of the range leaders within Europe.

In Figure 10, an upward trend in range is shown for bus types including transit buses, coaches, shuttle buses, and school buses. Transit buses show a strong rise from 144.10 miles in 2019 to 214.40 miles in 2022. The estimated range of the coach has also increased by 41.87 miles (from 174.17 miles in 2019 to 216.04 miles in 2022). The ranges of school buses and shuttle buses show steady growth along with others.

**Figure 10.** Progression of Average (mean) Annual Zero-Emission Bus Ranges from 2019 to 2022



## OUTLOOK FOR FUTURE RESEARCH

The Zero-Emission Technology Inventory and ZETI Data Explorer are constantly being updated with the most recent vehicle information as new models come to market. This report will be updated semi-annually with new data and insights.

**For more information visit the tools on the Global Drive to Zero website: <https://globaldrivetozero.org/>. We welcome any questions or concerns and invite collaboration in the pursuit of maintaining the most accurate and up to date inventory possible.**

## DATA NOTE

Vehicle and model specific data in this report is drawn primarily from the Global Commercial Vehicle Drive to Zero Program's Zero Emission Technology Inventory v8.0. (ZETI) which uses manufacturer-reported information to provide insights on the various technologies available or coming to market.

Zero-emission vehicle sales and stock data are drawn from two sources: primarily the IEA's Global EV Data Explorer which covers the majority of country-specific data. However, there are several gaps which were complemented by sales data drawn from EV Volumes. Country-specific data that was sourced from EV Volumes include: Austria, Chile, Luxembourg, Turkey, and Uruguay. All other country-specific data is from the IEA. Data on U.S. sales volumes was drawn from CALSTART's Zeroing in on ZETs/ZEBs reports.

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