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# Electrifying Commercial Vehicles: Challenges for 2027 and Beyond

With encouragement from regulators, automakers and drivers alike, the automotive industry has made immense progress toward the electrification of passenger cars and light-duty vehicles in recent years. In fact, U.S. electric vehicle (EV) purchases increased by 81% in 2018, even as overall new cars sales flattened. As a result, there are over 1 million EVs on American roads today, and the adoption rate is only expected to rise.

## Global View

Regulatory Rollout and Alignment, HD On-Highway

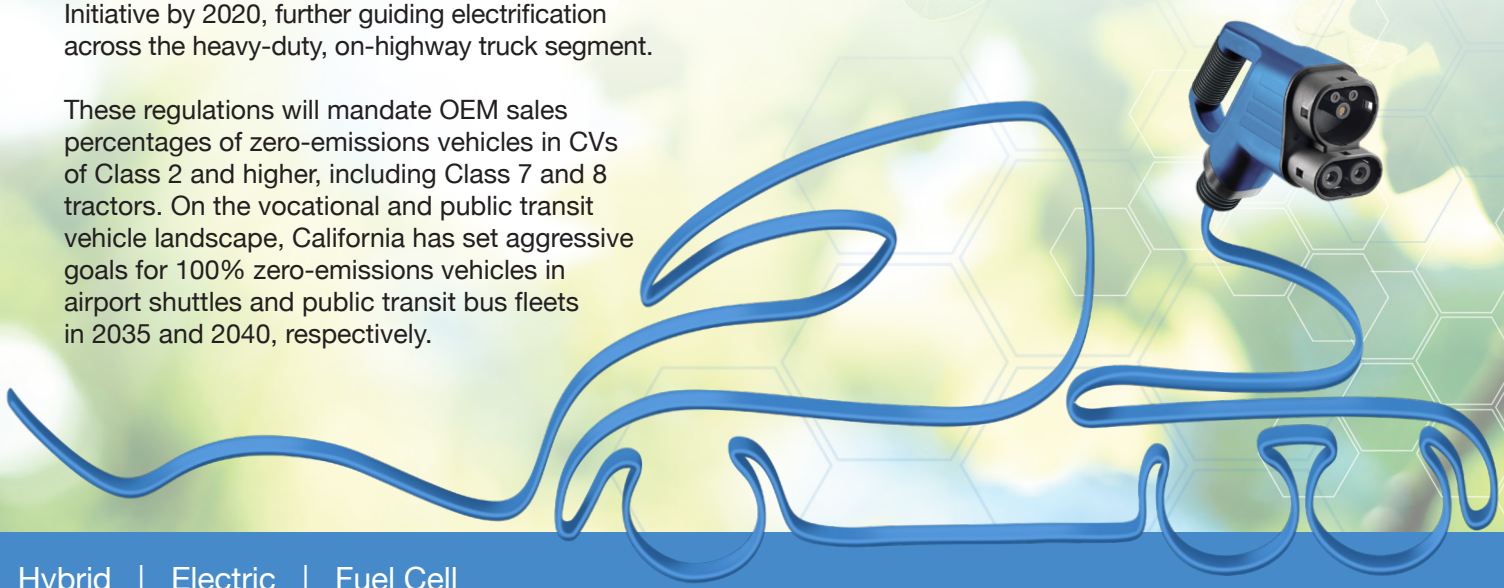
*9% CARB Zero-emissions Mandate*
*Advanced Clean Trucks Rule*
*Class 7-8 Tractors*

| | | | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| US | EPA | NOx | EPA 2010 NOx 0.2 g/bhp-hr | | | | | | | | | | EPA Low-Nox 0.0x g/bhp-hr |
| | | GHG | GHG Phase II | | | | | | | | | | |
| | CARB | NOx | Optional Low-Nox 0.1-0.02 g/bhp-hr | | | | | Low-Nox Phase in 0.08 g/bhp-hr, low-load cycle 3x FTP, idle | | | | | CARB Low-Nox Full 0.0x g/bhp-hr, low-load cycle TBD |
| | HDIUT | | NTE-based, Idle and Cold start exclusion | | | | | | | MAW-based (CO2 or work), idle and cold start exclusion | | | MAW-based (CO2 or work), idle and cold start inclusion |
| EU | NOx | | EU VI, 0.46 g/kw-hr, WHTC | | | | | | | | Proposed EU VII | | |
| | GHG | | 2019 Baseline | | | | | | | | 15% Reduction | | Propsed 30% reduction by 2030 |
| | HDIUT | | EU VI A, B, C | | EU VI D increased payload and power threshold | | | EU VI E cold start inclusive | | | Proposed EU VII | | |
| China | NOx | | China V | | China VI, alignment with EU VI | | | | | | | | |
| | HDIUT | | Urban-only RDE | | China VI A RDE gaseous only | | | | China VI B RDE gaseous and PN | | | | |

The passenger vehicle market is not the only industry segment making strides, as emerging regulations drive electrification initiatives in the commercial vehicle (CV) space. In support of the California Air Resources Board's (CARB) Advanced Clean Trucks regulations, the U.S. Environmental Protection Agency is set to announce new standards for the Cleaner Trucks Initiative by 2020, further guiding electrification across the heavy-duty, on-highway truck segment.

These regulations will mandate OEM sales percentages of zero-emissions vehicles in CVs of Class 2 and higher, including Class 7 and 8 tractors. On the vocational and public transit vehicle landscape, California has set aggressive goals for 100% zero-emissions vehicles in airport shuttles and public transit bus fleets in 2035 and 2040, respectively.

Making The World
**CLEANER** And More
**EFFICIENT**



Hybrid | Electric | Fuel Cell

The CV industry (both vehicle OEMs as well as the supply base) is fully engaged in discussions with regulatory bodies while aggressively developing new technologies that will be needed to develop compliant products and meet the demands of end users. Early prototype and demonstration vehicles are now being deployed, but we are only just at the start of this commercial vehicle electrification journey.

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## Key Challenges for Electrified Heavy-Duty Trucks

While electric powertrains are on the way to becoming mainstream for light-duty applications – driven by the well-recognized benefits of zero point-of-use emissions, low noise and good driving dynamics – the adoption of electrified powertrains in heavy-duty trucks is expected to be slower.

There are several compelling reasons that support the predicted slower adoption, the biggest hurdle being upfront costs. The underlying technology is largely proven, and the market interest in high. At present, the production cost of a traditional internal combustion powertrain is significantly lower than an electrified powertrain, in large part due to the cost of battery packs.

Battery costs are decreasing but have not yet reached the required cost to be commercially viable in the absence of incentives. Because fleets are heavily focused on total cost of ownership, which includes the initial price as well as ongoing running costs, such as fuel and maintenance, the economic drivers for rapid industry change are not yet fully in place.

Another open question for electrified CVs is charging infrastructure, compounded by the huge variety in how these vehicles are operated. Depot-based, predictable-route delivery vehicles may be a solvable problem; however, long-haul heavy-duty trucks present a different challenge as travel routes are extensive and unpredictable, and unladen vehicle weight is frequently an important parameter. All of which means that the industry has not yet pinpointed the best recharge strategy.

Despite these issues, OEMs are still making progress. In fact, a handful of companies have developed smaller-scale electrified trucks for niche applications in regions where air quality is a critical issue. For fleets with short, predictable routes that start and stop in the same location – think buses, delivery trucks and waste management – electric technology has been fully embraced. While this currently represents a relatively small number of fully electric vocational trucks on the road today, enthusiasm is high, creating greater momentum for expanding technology to larger-scale networks.

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## EV Technologies on the Verge of Scalability for CVs

Before electrified commercial vehicles can become a widespread reality, there are some powertrain challenges that need to be addressed first. Batteries, motors and control approaches top the priority list, so the industry is closely watching developments in both technical as well as supply logistics. These include:

### 1. Raw materials for battery packs.

As the most widely adopted power source on the market, demand for batteries is very high. The cost of raw materials, including lithium and cobalt, is a major concern, as is the potential scarcity of those materials when considering increased demand.

The majority of the world's lithium is produced in Australia and South America, where questions remain about economically accessible reserves and the ability to scale up production. Close to two-thirds of the global supply of cobalt, an element critical for today's battery technology, is produced by the Democratic Republic of Congo, where political instability and human rights violations have been common in the last decade. As more resources become available, material costs will decrease enough to make a stronger push for mass production.

### 2. Renewed interest in hydrogen fuel cells.

OEMs are following the use of hydrogen fuel cells as a viable power source for heavy trucks, which combine the low- to zero-emissions benefits of electric vehicles with the chemical fuel advantage of conventional engines. Hydrogen fuel cells offer long-range distances on a single charge with a short refueling time as well as virtually zero emissions, which make them an attractive solution for areas where air quality standards are tighter and infrastructure is more robust, such as California.

To scale fuel cells for CVs, industry leaders are considering them in stand-alone solutions as well as hybridizing them with battery electric vehicles in range-extending and emergency devices. As an example, researchers at the National Renewable Energy Laboratory are developing advancements in fuel cell technology that will allow for easier adoption. Project goals cover fundamental research to overcome technical barriers and manufacturing improvements, enabling high-volume fuel cell production.

### 3. Electric powertrain integration progress.

Once electric power sources are finalized for Class 8 trucks, the next hurdle is powertrain integration. The existing framework for CV combustion engine powertrains is not interchangeable with the cleaner power sources in development, which means the entire powertrain needs to be reconsidered and redesigned.

Electrified axles and transmissions will be instrumental in achieving powertrain integration for heavy trucks, and some key OEMs are joining forces with suppliers to make a greater impact. For example, Cummins and Allison Transmission have collaborated to create a hybrid-electric propulsion system. This new solution, designed primarily for hybridized vocational buses, recently received certification from CARB.

Additionally, advances in regenerative braking will be crucial in addressing the considerable weight fluctuations, greater size distribution and longer travel distances that come with commercial trucks. Systems could be required to collect, store and manage regenerative brake energy produced by a relatively large number of wheels, and developers are already building solutions.

## Perfecting the Short Haul

The industry will see greater adoption rates of electrified solutions for short-haul trucks in the coming years, which can be applied to long-haul applications if scaled correctly. Implementing advanced measurement and engineering tools will be critical for managing the latest powertrain technologies – especially as OEMs seek verification and validation data.

Early adoption encourages industry leaders to overcome challenges for electrified vocational trucks on a more manageable scale in preparation for full fleets of electrified CVs. As a result, the early stages of exploration and application are in progress, and that's a solid first step.

### ABOUT HORIBA

A business segment of the HORIBA Group, Automotive Test Systems (ATS) has developed global leadership in the fields of battery and fuel cell test stands, data management solutions, driveline test systems, engine test systems, brake test systems, wind tunnel balances, emissions test systems and test facility automation. HORIBA ATS is able to offer its customers complete solutions with full turnkey capability for all industries using electric motors, internal combustion engines and turbines. These include the automotive, heavy-duty, off-road, consumer goods, marine, aerospace and locomotive sectors.