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Total cost of ownership for heavy trucks in China: Battery-electric, fuel cell, and diesel trucks

BACKGROUND

Heavy-duty vehicles, dominated by diesel-powered engines, are a major contributor to greenhouse gas emissions and air pollution. In China, trucks make up 8% of the on-road vehicle fleet but are responsible for 52% of the particulate matter and 74% of the nitrogen oxides from on-road vehicle emissions, as well as 47% of greenhouse gas emissions from road transport activities. Road freight trucks also contributed more than 6.1% of all greenhouse gas emissions in China in 2015. Thus, the widespread adoption of zero-emission heavy-duty vehicles is a necessary step for the reduction of climate and air pollutant emissions from road freight.

In this study we analyze the total cost of ownership (TCO) of battery-electric trucks and fuel cell electric trucks, for three segments: tractor-trailers, dump trucks, and straight trucks. The study aims to identify the year when TCO parity between zero-emission and diesel trucks is achieved in Beijing, Shanghai, and Shenzhen.

FINDINGS

- **All battery-electric truck segments can achieve TCO parity with diesel trucks as of the second half of this decade.** Battery-electric trucks witness lower energy consumption and lower fuel costs per unit energy in comparison to diesel trucks, giving them a significant fuel cost advantage that more than compensates for the higher truck purchase costs. By the end of the decade, battery-electric tractor-trailers are projected to be 50,000 CNY cheaper than their diesel counterparts while straight trucks will be 100,000–150,000 CNY cheaper.
- **The battery-electric dump truck will have a cost advantage relative to its diesel counterpart as early as 2024-2025.** Battery-electric dump trucks consume relatively low amounts of energy thanks to the brake energy recovery feature in electric powertrains, while diesel dump trucks have the highest fuel consumption across all segments due to their highly transient driving patterns. This provides battery-electric dump trucks with a substantial fuel cost advantage, making them cost-effective by 2024-2025.
- **Fuel cell electric trucks will almost reach TCO parity with diesel trucks toward the end of the decade for straight and dump trucks.** Dump and straight tucks can achieve cost parity just after 2030, mainly driven by the fuel cell unit cost

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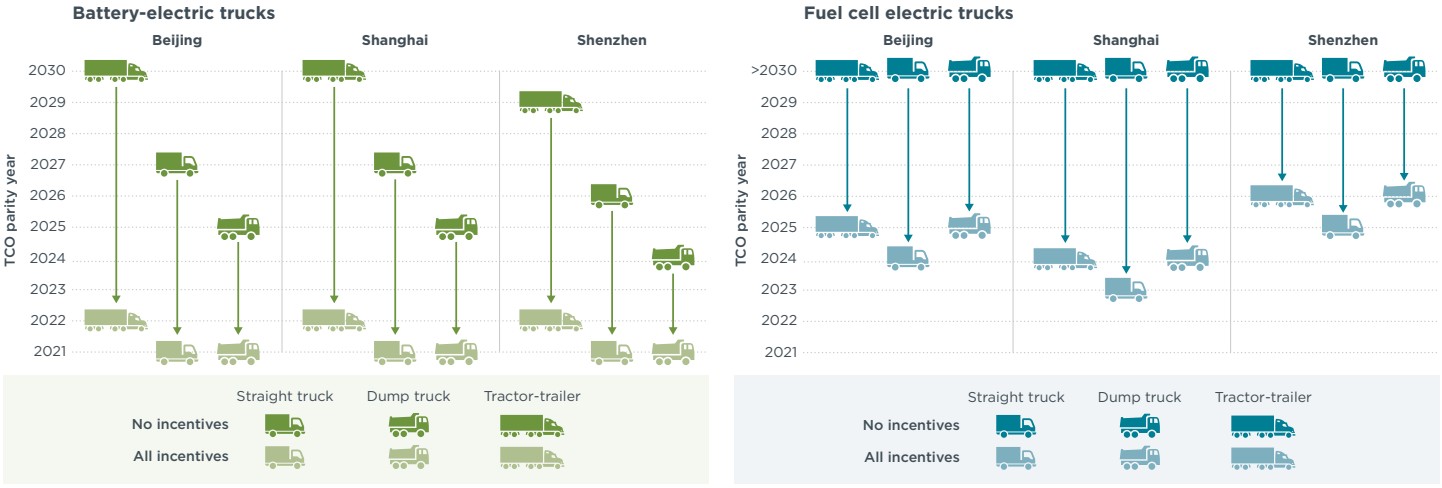
reduction due to economies of scale. Tractor-trailers will reach cost parity far beyond 2030; the cost gap relative to their diesel counterparts could fall below 500,000 CNY by 2030.

» **The use of green hydrogen fuel in fuel cell electric trucks requires extensive policy measures to compete with battery-electric and diesel trucks.** Green hydrogen is expected to have high production costs, with differences in green hydrogen prices arising across the different Chinese cities. The largest TCO gap with diesel is observed with fuel cell tractor-trailers fueled with green hydrogen, reaching 1,000,000 CNY in Shanghai and 2,000,000 CNY in Shenzhen. Other truck segments have a slightly lower TCO gap.

» **Targeted policy measures can bring forward by several years the TCO parity of BETs and FCETs compared to diesel trucks.** An earlier point of TCO parity has the potential of creating a robust demand for zero-emission trucks in the first half of the current decade. This, in turn, translates into market incentives for vehicle manufacturers to increase the model availability and ramp-up production. The reduction of manufacturing costs is largely dependent on the volume of production—due to learning curves and economies of scale. Thus, demand side policies targeting lower TCO for battery and fuel cell electric trucks can have long-lasting positive impacts on the supply.



Summary of TCO parity years for zero-emission trucks with and without policy incentives

RECOMMENDATIONS

» **Set ambitious sales requirements for HD-NEVs in the near term.** Truck operators will reap the economic benefits of HD-NEVs only if there is a robust supply of them. California provides a best-practice example for the setting of targets, requiring 11% of new heavy rigid trucks to be zero-emission by 2025 and 50% by 2030. For tractor-trailers the zero-emission sales requirements are 5% and 30% by 2025 and 2030, respectively. China's ambition to become carbon-neutral by 2060 requires that the central government introduce targets at least as ambitious as those adopted in California.

» **Set long-term zero-emission sales targets to provide manufacturers a clear picture for future product planning and investment.** The combination of near-

term binding sales requirements with long-term non-binding targets set by the government is desirable. The former ensures the immediate kick-start of the needed supply chains; the latter provides the certainty that the investments made will have a long life. The combination of the two is important for creating a large and long-lasting market whose economies of scale will drive down manufacturing costs, and consequently, the TCO of HD-NEVs.

» **Provide incentives to bring the TCO parity of HD-NEVs with diesel trucks to the first half of this decade.** Policy can create adequate incentives to close the TCO gap between diesel HDVs and HD-NEVs in the next five years. Subsidies—which are not fiscally sustainable—should be limited in scope and duration to stimulate demand in early phases. Policies following the polluter pays principle can generate the revenue needed to fund incentive programs in the long term.

» **Design policies that are application-specific, but technology-neutral.** Policies must target the deployment of zero-emission vehicles in the segments with the highest CO_2 emissions, such as tractor-trailers. At the same time, they should aim for a level playing field between battery-electric and fuel cell trucks, to favor the most cost-effective technological pathway in the long term. Our analysis shows that battery-electric trucks have a cost advantage in the absence of incentives.

PUBLICATION DETAILS

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