中国商用车电动化发展研究报告

Electrifying China's Commercial Vehicle Fleet Towards Net-Zero Goals

能源与交通创新中心

The Innovation Center for Energy and Transportation

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Over the years, *i*CET has carved out a unique reputation as a leader in clean energy and sustainable transportation policymaking. We recognize the urgency of the climate problem, focusing on solutions for global actions while committed to the values and principles of innovation, sound scientific research, independence, and practicality.

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能源与交通创新中心（iCET）

2021年7月

Content

This is an executive summary of iCET's newly published research report on electrifying China's commercial vehicle fleet toward net-zero goals. See the full report at http://www.icet.org.cn/reports.asp.

Executive Summary

To reduce fossil energy consumption, improve air quality and tackle climate crisis, global auto industry is rapidly embracing electrification and zero-emission strategies. Commercial vehicles contribute significant shares to greenhouse gas emissions, nitrogen oxides and other air pollutants. However, with wider variety of usage scenarios and vehicle types, the challenges for their transition to zero-emissions are far greater than their passenger vehicle counterparts. At present, apart from California's "Advanced Clean Trucks" regulation which set specific targets for the sales of zero-emission trucks, other countries and regions have not yet proposed a clear roadmap for the electrification of commercial vehicles. In September 2020, the ambitious goal of "China's carbon dioxide emissions will reach its peak by 2030, and strive to achieve carbon neutrality by 2060", which is referred as 30/60 goal hereafter, was put forward for the first time at the 75th United Nations General Assembly. For commercial vehicles, this 30/60 goal is particularly challenging to achieve.

In terms of zero-emission transition, passenger vehicles have a much certain transitional pathway for large-scale electrification. Affected by factors such as economic costs, complex usage scenarios, and long-distance high-load operation characteristics, the zero-emission transition for commercial vehicles face multiple technological options and uncertainties. Up to now, electrification, inclusive of pure battery electric, plug-in hybrid, extended range, and hydrogen fuel cell technologies (also called new energy vehicle technologies in China), is the most discussed and favored technology direction with stronger policy support. In this research, therefore, only the impact of electrification development of Chinese commercial vehicles on oil consumption and GHG emissions will be studied. Other options such as using low-carbon or renewable liquid fuels to replace fossil energy will not be discussed for the time being.

In this study, we have analyzed the current electrification status of China's commercial vehicle fleet and the challenges in achieving the 30/60 goal, and drawn the following conclusions:

- At the macro level, China has not yet officially formulated a low-carbon development strategy for commercial vehicles. There are not yet clear pathways to demonstrate when and how the carbon emissions of the commercial vehicle sector will peak and achieve net-zero emissions at the end-user level.
- The electrification pace of different commercial vehicles is particularly unbalanced. Public buses have almost reached full electrification with 98% of sales share for new energy buses in 2020. The past five years have also witnessed the rapid development of electric urban logistics vehicles. However, challenges still exist in electrifying long-haul and high-load commercial vehicles, such as long-haul trucks, dump trucks and semi-trailer tractors. The sales of zero-emission vehicles accounted for less than 1% in these fields, as an average level in the past five years.
- Commercial vehicles are important transportation means for goods and production materials, whose market is greatly affected by the macro economy. Previous studies have shown the total number of commercial vehicles will probably peak after 2030. Generally, more vehicles would mean more greenhouse gases emissions when there are few zero-emission vehicles on road, bringing huge challenges for this sector to achieve the 30/60 goal.

With comprehensive analyses of the current status of commercial vehicles in China, this study explores the possible pathways and timetables for Chinese commercial vehicle fleet to achieve the 30/60 goal through scenario analysis. In this study commercial vehicles are divided into four major categories, i.e., buses, trucks, semi-trailer tractors and special vehicles. In our analysis, buses and special vehicles are further divided into three and six sub-categories respectively, as illustrated in Figure ES 1. The fuel types include gasoline, diesel, natural gas, pure electric, plug-in hybrid, and hydrogen fuel cell.

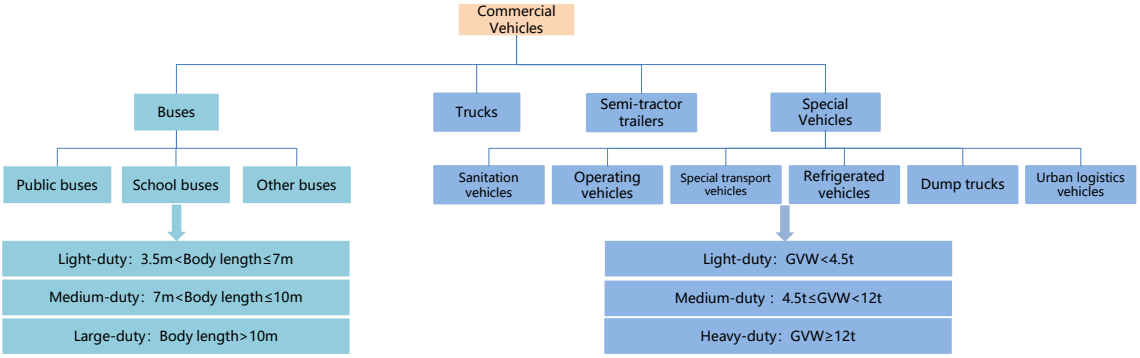

Figure ES 1 Major and sub-categories of commercial vehicles in this study

As the only region in the world to establish zero-emission commercial vehicle mandatory targets as set in "Advanced Clean Trucks" regulation, California's experience is worth learning. China, however, has not yet set zero-emission goals for commercial vehicles. Therefore, in this study two scenarios are proposed to assess the impact of zero-emission transition on carbon emissions in commercial vehicles. The first scenario is based on California's targets for zero-emission trucks and is called "California Policy Reference Scenario" (S1), while the second scenario relies on China's current policy and its inertial development in the future which is called "Chinese Policy Continuation Scenario" (S2). Key assumptions in these two scenarios are shown in the table below.

Table ES 1 Key assumptions in the two scenarios in this study

	California Policy Reference Scenario	**Chinese Policy Continuation Scenario**
Market size	• Estimated peak sales of 5.5 million by 2030-2035	
Fuel consumptions (FC)	On the basis of 2019 level, · FC decreases 10% for buses and 8% for all other categories by 2025 · FC decreases 15% for buses and 10% for all other categories by 2030 · FC decreases 20% for buses and 15% for all other categories by 2035 · FC decreases 25% for buses, 20% for dump trucks and semi-tractor trailers, and 22% for trucks and all other special vehicles by 2060	

Timing for 100% zero-emission vehicle sales *	· Public buses by 2029 · All other categories by 2045	· Public buses by 2025 · Sanitation Vehicles by 2035 · School buses, Operating vehicles, and urban logistics vehicles by 2045 · Other buses, special transport vehicles, Refrigerated vehicles and dump trucks by 2050 · Trucks and Semi-tractor trailers by 2060
Technological options	· Focusing on zero-emission vehicles · Limited application of hybrid-electric technology with 6-15% peak sales share of hybrid-electric vehicles for different categories, and phasing out by 2045 · Vehicles powered by natural gas and methane phasing out by 2045	· Simultaneous development of energy-saving and new energy vehicles · Higher application of hybrid-electric technology that S1 with 6-40% peak sales share of hybrid-electric vehicles for different categories, and phasing out by 2059 · Vehicles powered by natural gas and methane phasing out by 2045

Note: * (1) By-year requirements for the sales of zero-emission vehicles in different commercial vehicle categories in S2 were determined based on their status quo and potentials of electrification transition in China.

(2) In view of the different classification standards of commercial vehicles between California and China, the sales requirement of zero-emission Class 2b-3 trucks in California in S1 is the same as that of all light-duty vehicles except for light-duty buses in S2, the sales requirement of zero-emission Class 4-8 trucks in S1 is the same as that of all medium- and heavy-duty vehicles except for medium- and large-duty buses in S2, and Class 7-8 tractor trailers in S1 as all semi-tractor trailers in S2 in this study.

In these two scenarios, the peak energy demand of the commercial vehicle fleet is about 266 Mtoe (million tons of oil equivalent) for the "California Policy Reference Scenario (S1) and 276 Mtoe for Chinese Policy Continuation Scenario (S2) respectively. In S1 the energy demand curve has a sharper shape which means the total energy demand has the potential to decrease rapidly after reaching the peak. In S2, however, the peak shape is relatively round and blunt, and after about seven or eight years of buffering, the energy demand begins to show a rapid downward trend. This is mainly due to the higher sales requirements of zero-emission vehicles in S1 while in S2 the application of zero-emission vehicles requires a certain adaptation period.

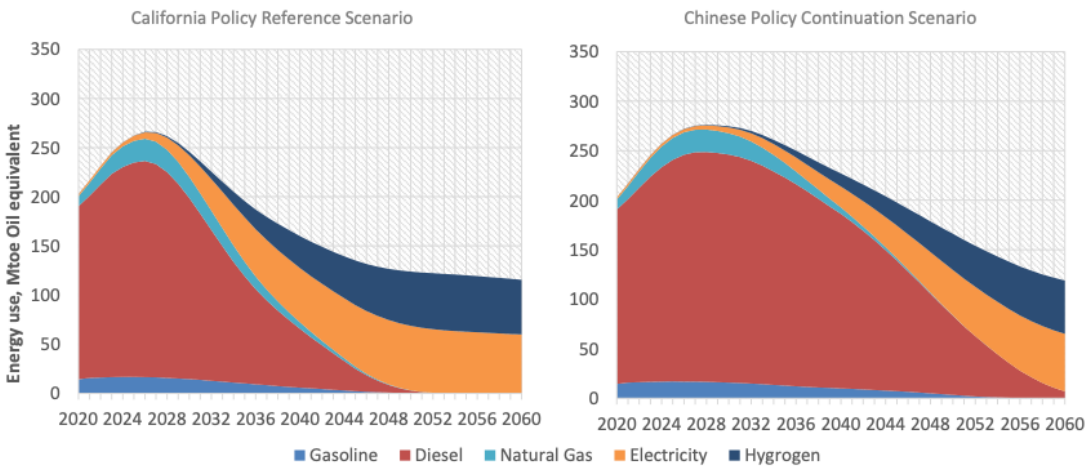

Figure ES 2 Energy use of the commercial vehicle fleet under two scenarios in this study

The carbon emissions of the commercial vehicle fleet in the "Chinese Policy Continuation Scenario (S2)" will reach its peak by 2028, only two years later than in the "California Policy Reference Scenario (S1)" at the end-user level. But the faster the fleet electrifies, the lower peak level of carbon emissions will be achieved. It's a generally agreed view that the carbon emissions for the commercial vehicle fleet in China at the end-user level will soon enter the plateau period because of the limited room for the growth of the commercial vehicle fleet and the continuous improvement of its fuel economy. Results also show that the peak carbon emission level is about 5% lower in S1 than that in S2 due to a higher market share of zero-emission vehicles in S1. Moreover, faster application of zero-emission vehicles will also lead to the rapid decline of carbon emissions after peaking.

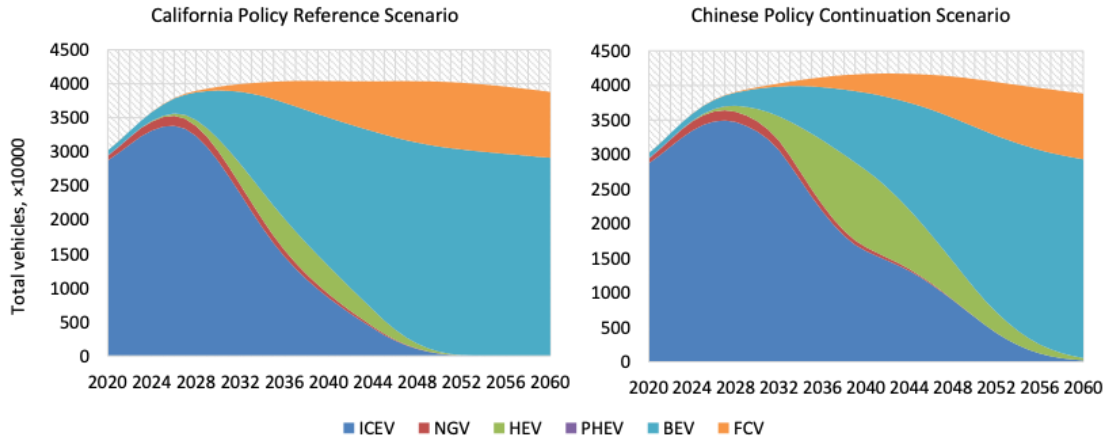

Figure ES 3 By fuel type inventory of commercial vehicles under two scenarios in this study

The net-zero emission goal at the end-user level for the commercial vehicle fleet will be achieved by 2055 in the "California Policy Reference Scenario (S1)", but later than 2060 in the "Chinese Policy Continuation Scenario (S2)". Carbon emissions reduced in S1 comparing to S2 during 2020-2060 are about 8.4 billion CO2e, equivalent to nearly 13 times the carbon emissions of China's commercial vehicle fleet in 2020, or about 70% of China's total carbon emissions in 2020.

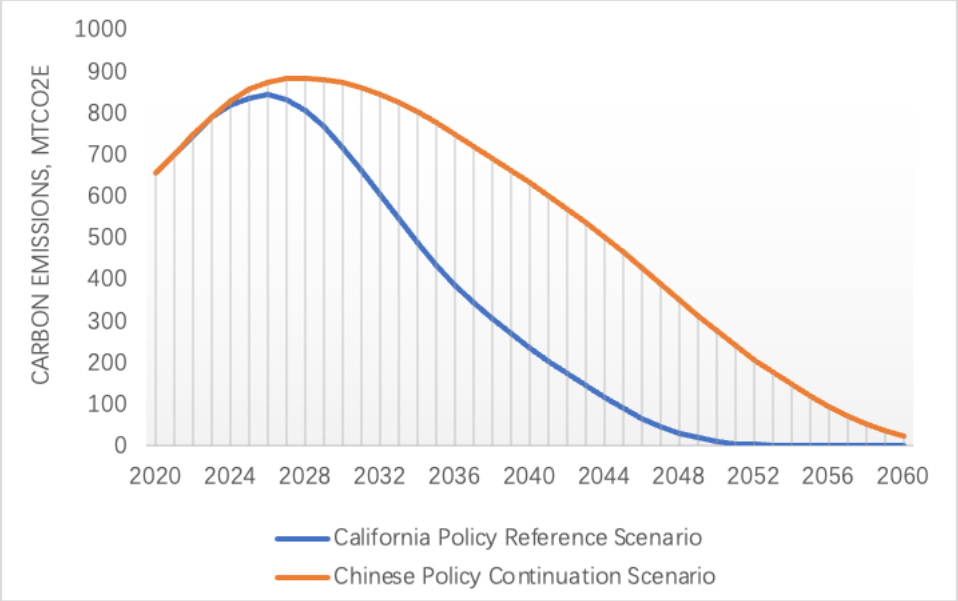

Figure ES 4 Carbon emissions of commercial vehicle fleet under two scenarios at the end-user level

On the basis of findings in this study, we suggest more efforts on the following three aspects to achieve the 30/60 goal in commercial vehicle sector, which are to:

- Formulate ambitious zero-emission mandatory targets for commercial vehicles in line with China's national conditions, including mid-term targets for 2030 and long-term targets for 2060. It is recommended that the long-term goal to be set based on the overall emission reduction targets under the premise of technological neutrality. In this case the enterprises will find out the most appropriate plans rather than applying the technologies that may otherwise be abandoned later. The zero-emission vehicle credit mechanism is also considered useful for achieving the 30/60 goal.

- Set differentiated targets in various commercial vehicle categories given the unbalanced application of zero-emission vehicles. In the first place we suggest continue to encourage and support the electrification of public vehicles such as public buses, sanitation vehicles etc. Secondly it is important to keep an eye on the categories which have huge potential for electrification

but with low development pace, such as school buses. Generally, different usage types of commercial vehicles face different key barriers shifting towards zero-emission, so the critical task is to identify key barriers and solve these problems. For the vehicles with high frequency of use that are hard to electrify in short time, such as dump trucks, heavy-duty trucks, and semi-tractor trailers, it is suggested to embrace a wider variety of low-carbon technologies in addition to pure electrification.

❍ Use more diverse low-carbon fuels for commercial vehicles. Statistics collected in this study show that for non-passenger commercial vehicles, diesel and natural gas-powered vehicles are the domain types and the former takes up an average of more than eighty percent in the past five years. Since vast majority of traditional internal-combustion-engine based commercial vehicles will not be replaced in a short time, using more diverse low-carbon fuels in the commercial vehicle sector will contribute to the continuous reduction of carbon emissions. It is recommended that China learn from and introduce policies similar to California's "Low Carbon Fuel Standard" to drive the diversification of vehicle energy use.