ZERO EMISSION FREIGHT INITIATIVE

Smart Freight Centre China

# China Zero Emission Freight Status Report 2022

August 2023

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### Acknowledgments

This report was organized by Mingyang, Zheng, Zero Emission Freight Initiative (ZEFI) Manager, organized the drafting and publication of the Status Report.

### About Smart Freight Centre China

Smart Freight Centre is an international organization focused on reducing greenhouse gas emissions from freight transportation. Smart Freight Centre China's vision is an efficient and zero emission global logistics sector. Smart Freight Centre China's mission is to collaborate with the organization's global partners to quantify impacts, identify solutions, and propagate logistics decarbonization strategies. Smart Freight Centre's goal is to guide the global logistics industry in tracking and reducing the industry's greenhouse gas emissions by one billion tonnes by 2030 and to reach zero emissions by 2050 or earlier, consistent with a 1.5°C future.

### About Zero Emission Freight Initiative

ZEFI is a non-profit, voluntary partnership that aligns research institutions, OEMs, key equipment and parts production and suppliers, energy production and suppliers, shippers, logistics and transportation companies, industry associations and other relevant stakeholders.

The vision for ZEFI is to accelerate the adoption of zero emission trucks and related freight efficiency solutions in China by enabling 1) Collaboration between key stakeholders; 2) Supportive policies, programs, and strategies; and 3) Consensus building among stakeholder on ZEFV pathways for China.

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# Foreword

Our $100 trillion global economy depends on reliable freight transportation. While freight and logistics still emit 11% of global greenhouse gas emissions and is a major contributor to local air pollution, the sector is stepping up and taking responsibility. About half of the world's 90 largest transport companies have set emission reduction targets to help reach our shared Paris Agreement climate goals. More than 170 companies consistently calculate and report global logistics emissions using Smart Freight Centre's (SFC) GLEC Framework, and the published ISO 14083 standard. Climate action plans are being developed by the 960 transport companies that report to CDP, but these plans still need strengthening.

Of the numerous actions to reduce emissions, both governments and industry have embraced zero emission trucks as a priority. Governments in California, the EU, China and elsewhere are tightening emission and fuel standards or mandating that new trucks sold produce zero emissions. Shippers and carriers commit to purchase or contract zero emission trucks through the Sustainable Freight Buyers Alliance, EV100+ and the First Movers Coalition.

China, which contributes to 27% of global emissions, can play a critical role in the transition to zero emission road freight both at home and abroad as it also has a 62% market share in zero emission vans and trucks. The Zero Emission Freight Initiative (ZEFI) was launched by SFC China together with 26 government agencies, companies, and other organizations in 2022 to accelerate the adoption of zero emission trucks and improve efficiency.

Together, we prepared the first China Zero Emission Freight Report in 2022, which describes trends in China's road freight sector, the development of zero emission truck technologies and sales, as well as the potential reductions in emissions from increased zero emission truck sales. It also analyzes the barriers and drivers of zero emission truck development, including charging infrastructure, purchase and operating costs, and government policies. To turn these insights into action, the report concludes with recommended actions for policymakers as well as industry players, including freight owners, transport companies, vehicle manufacturers, component suppliers, and energy and infrastructure providers.

It is our expectation that this report will increase knowledge about the opportunities for zero emission trucks and encourage all stakeholders to act. As the secretariat of ZEFI, SFC China will continue to hold annual summits and deep dive-sessions with stakeholders, support the electric truck pilot project in the Beijing-Tianjin-Hebei area, and provide companies with concrete guidelines and tools to deploy zero emission trucks in China. Next year, we will report on subsequent progress in the second Zero emission Freight Report.

I wholeheartedly encourage all companies and organizations that wish to contribute to the future of zero-emissions road freight in China to join ZEFI. We have every reason to believe that together we can be successful and benefits both individuals and companies not only in China, but also around the world.

Sophie Punte

Founder and Board Member, Smart Freight Centre

# Introduction

In September 2020, the Chinese government announced that "China will strive to achieve its carbon peak by 2030 and carbon neutrality by 2060." This commitment to achieving "dual carbon" goals and pursuing high-quality development has become a fundamental part of China's national development policy.

China's transportation industry contributes approximately 10% to the country's total carbon emissions. Therefore, driving a low-carbon transformation within the industry is a critical component in reaching the country's "dual carbon" objectives. Road transportation is responsible for over 80% of total emissions, with road freight alone accounting for more than 60%. Therefore, reducing carbon emissions in road freight is a key factor in achieving the necessary low-carbon efforts in the transportation sector.

In light of the continuous growth in demand for road freight in China, it is clear that relying solely on multimodal transportation, increasing transportation efficiency and improving load rates is insufficient to achieve emission reduction goals. An early transition from traditional trucks to zero emission trucks will undoubtedly become a future development trend. The emissions produced by heavy-duty trucks in particular will play a pivotal role in contributing to overall emissions in the road freight sector.

According to statistics from the Motor Vehicle Emission Monitoring Center under the Ministry of Ecology and Environment, the total carbon dioxide emissions generated by heavy-duty vehicles in China accounted for 34% of the overall carbon emissions from the transportation industry in 2020. In terms of conventional pollutants, the "China Mobile Source Environmental Management Annual Report (2022)" indicates that, in 2021, nitrogen oxide emissions from heavy-duty trucks accounted for approximately 90% of the total nitrogen oxide emissions from all types of trucks, with hydrocarbon emissions also significantly exceeding those of other truck types.

This has led us to conclude that promoting the electrification of heavy-duty trucks is a crucial development strategy for reducing pollution and carbon emissions within China's transportation industry. This approach should also serve as a core strategy in achieving the "dual carbon" goals in this sector.

Based on the comprehensive background analysis, we present the "China Zero emission Freight Report 2022 " ("Report" hereafter). The primary objective of this report is to delve deeper into the current situation of this sector, the barriers it faces and the challenges of zero emission development in road freight transportation. It aims to foster collaboration among diverse stakeholders in the realm of zero-carbon freight transportation while offering guidance and recommendations to facilitate the advancement of zero emission freight transportation. The target audience of this report includes the freight industry, government decision-makers, research institutions, and other relevant stakeholders.

It is important to note that the policies and data presented in this report have been updated through the end of 2021, ensuring the most recent information possible is included. The report is organized into seven chapters, each addressing specific aspects of zero emission road freight transportation. The breakdown of the chapters is as follows:

Chapter 1: The Current Situation and Trends of China's Road Freight Development

This chapter offers an analysis and summary of the current state and trends of China's road freight industry. It includes an overview of the current state of road freight development, the status of road freight enterprises, and the goals and trends related to zero emission development in road freight.

Chapter 2: Development of Vehicle Technology

In this chapter, the focus is on the current development of vehicle technology in the road freight sector. It covers the overall landscape of truck products and technology, production and sales volumes for trucks, the application of different technologies and their level of development, pricing, and operating costs, as well as the development plans of major truck producers.

Chapter 3: Infrastructure Construction and Operation

This chapter provides a comprehensive summary of infrastructure development and operations that align with road freight transportation. It examines the matching of road traffic networks and service facilities, the progress of charging and other basic service facilities, and the status of development regarding hydrogen energy service facilities.

Chapter 4: Analysis of Policy

This chapter offers a thorough analysis of existing policies and markets related to zero emission road freight transportation.

Chapter 5: Analysis of Carbon Emissions

This chapter presents a preliminary analysis of carbon emissions and potential carbon savings associated with road freight transportation.

Chapter 6: Analysis of Typical Zero emission Freight Transportation Scenarios

Here, typical scenarios in zero emission freight transportation are analyzed to provide insights into their feasibility and effectiveness.

Chapter 7: Recommendations

The final chapter of the report provides recommendations to policymakers and industry members on promoting the development of zero emission road freight transportation.

This is the inaugural edition of the "Report", and the Zero emission Freight Initiative (ZEFI) would like to express sincere gratitude to all those who have generously provided their support and valuable contributions. We would also like to wholeheartedly invite readers to share their opinions and feedback on the report.

# 1 Current Situation and Trends of Road Freight Development in China

## 1.1 Freight Service

Over the past five years, China's road freight volume has demonstrated overall stability, with road freight accounting for more than 70% of the total freight volume. The turnover of highway freight in China has remained relatively consistent. However, since 2018, there have been certain factors influencing this trend, including adjustments to statistical caliber, the implementation of policies promoting multimodal transportation, and the switch the coal transportation from road to rail. These factors have contributed to a decrease in the proportion of turnover of road freight relative to total freight, although it has consistently remained above 30%.

Regionally, East China, Central China, and North China exhibited the largest volume and turnover in freight in the country. In terms of specific routes, the Guangzhou-Beijing, Harbin-Beijing, and Xi'an-Beijing routes were the three busiest highway routes for freight transportation in China.

## 1.2 Truck Ownership and Production/Sales

According to statistics from the Ministry of Transport, the number of trucks in China is projected to decrease from 13.69 million in 2017 to 11.73 million in 2021. Of these, the number of ordinary trucks was 4.07 million, a decrease of 1.7%, while capacity was 49.23 million tons, representing an increase of 5.6%. Additionally, there are currently 603,900 specialized trucks with a capacity of 7.19 million tons; both numbers saw increases of around 20%. The number of tractors has also shown growth, reaching 3.47 million, an increase of 11.5%, while the number of trailers has risen to 3.59 million, reflecting a growth rate of 7.4%. It is worth noting that the ownership of trucks experienced a significant decline in 2019, aligning with the trends observed in the proportion of highway freight volume and freight turnover.

According to data on compulsory traffic insurance from the Ministry of Public Security, the sales volume of freight vehicles has shown consistent growth trend since 2017. It increased from 3.10 million units in 2017 to 4.19 million units in 2020, followed by a slight decrease to 3.87 million units in 2021. However, despite initial progress, the overall electrification rate of freight vehicles has not only failed to increase in recent years but has, in fact, decreased. In 2017, the electrification rate of freight vehicles reached a peak of 2.44%, but since has remained below 2%.

## 1.3 Development of the Highway Freight Industry

According to the 2021 China National Logistics Operation Report jointly released by the National Development and Reform Commission and the China Federation of Logistics and Purchasing, the total value of private sector logistics in 2021 reached 335.2 trillion yuan. This represented a year-on-year increase of 9.2% at comparable prices and an average annual growth rate of 6.2% over the past two years, returning to 2019 levels. The road freight industry employs 17.29 million individuals and includes 3.24 million road freight carriers, respectively accounting for 74% and 31% of total private freight sector turnover. Of these 3.24 million carriers, affiliated companies make up the majority, followed by comprehensive logistics providers, third-party fleets, and company logistics departments with commercial services. Of the 17.29 million freight drivers, individual drivers make up the majority, followed by full-time internal drivers, partner drivers, and part-time drivers.

## 1.4 Carbon Emissions and Air Pollutant Emissions from Road Freight Transportation

The growing demand for road freight has led to an increased number of trucks on roads, but China’s "dual carbon" goals have set clear requirements for low-carbon transition in the transportation sector. From 2010 to 2020, carbon emissions from China's transportation industry nearly doubled[1], increasing from 7.4% in 2010 to 11% in 2020 of all emissions. Statistics from the China Road Transport Association indicate that road transportation is responsible for over 80% of all carbon emissions from the transportation industry, with road freight accounting for over 60%. Achieving zero carbon emissions in road freight transportation is therefore crucial for addressing climate change and achieving China's "dual carbon" goals. Furthermore, trucks contribute 84% of the country's nitrogen oxide emissions and over 90% of particulate matter emissions. Heavy-duty trucks emit significantly higher levels of nitrogen oxide and particulate matter emissions compared to other types of trucks. Consequently, promoting zero emission freight has become a key pathway for achieving a low-carbon transition in the transportation sector and sustainable development goals in the road freight sector. Our primary focus should be on promoting the adoption of zero emission vehicles, optimizing transportation modes, sharing transportation resources, and adopting a long-term vision that encourages fleets and transportation vehicles to adopt zero emission clean energy solutions.

[1] Zhang Yuhong: Research on Structural Energy Conservation and Emission Reduction of Road Transportation[J], Energy and Energy Conservation, 2021(2): 2
张宇鸿：《道路交通运输结构性节能减排研究》[J]，《能源与节能》，2021(2):2

# 2 Zero emission Truck Technology

## 2.1 Technology Development

Currently, the two main forms of zero emission truck technology in the market are pure electric and hydrogen fuel cells. Pure electric truck technology is relatively mature, especially for medium and short-distance light trucks. However, hydrogen fuel cell vehicles are still in the early stages of development and require breakthroughs in key technologies in terms of production, storage, transportation, and refueling. While purchase and operating costs of zero emission trucks are still higher than traditional fuel trucks, there are advantages in terms of costs to charge them and the fact that the produce fewer emissions.

## 2.2 Technical Performance

Zero emission truck models that have been announced have a driving range of between 300-400km and 200-300km, with a small number exceeding 500km. Most vehicles have a total weight of less than 3.5 tons, with heavy-duty trucks accounting for a smaller proportion. The power density of battery packs ranges between 0.142 and 0.164kg/kWh.

## 2.3 Cost Analysis

The cost of using hydrogen fuel cell trucks throughout their lifecycle is more than twice that of traditional fuel vehicles, resulting in higher procurement and operational costs. Currently, there is no significant economic benefit in using hydrogen fuel cell trucks. However, as the technology matures and the scale of application expands, operating costs are expected to decrease. It should be noted that hydrogen fuel cell trucks have advantages over pure electric trucks in terms of power density, weight, and driving range. They also require less time to fuel, which can alleviate concerns over "mileage anxiety."

A cost analysis of different types of zero emission trucks shows that pure electric heavy-duty trucks that use battery swapping schemes have significant economic benefits and can effectively replace traditional fuel vehicles. Pure electric trucks that use quick charging solutions are more costly overall but can still be a viable option depending on specific usage requirements. Hydrogen fuel cell trucks currently have higher operating costs, but in initial stages can be used in pilot applications for new technologies.

## 2.4 Market Performance Overview

While sales of zero emission trucks have grown significantly in recent years, they still make up a limited proportion of all trucks at less than 2%. In 2021, zero emission heavy-duty trucks saw a reversal in growth with sales of 10,448 units throughout the year, four times the sales volume in 2020. Pure electric heavy-duty trucks accounted for most sales, with a significant portion being rechargeable heavy-duty trucks and a smaller portion being battery-swapped heavy-duty trucks. Hydrogen fuel cell heavy-duty trucks represented a small proportion of total sales. Sany Automobile, Yutong Group, and CAMC (Hanma Technology) were among the top companies in pure electric heavy-duty truck sales, each selling over 1,000 units in 2021.

# 3 Infrastructure Construction and Operations

## 3.1 Development of Charging and Swapping Infrastructure and Services

In recent years, China has witnessed rapid development in the construction of battery charging and swapping infrastructure due to the promotion of new energy vehicles. As of the end of 2021, the country had a total of 2.61 million charging stations and 1,298 battery swapping stations. These infrastructure services are primarily concentrated in economically developed regions such as the Pearl River Delta, Yangtze River Delta, and Beijing-Tianjin-Hebei region, laying a solid foundation for the growth in the new energy vehicle industry. By comparison, however, the number of hydrogens refueling stations remained relatively small, with a total of 218 stations in operation as of the end of 2021.

Currently, two mainstream charging technologies are in use: AC and DC. Power output for AC charging is generally 7-14 kW and charging time is relatively slow. However, AC charging stations have lower power capacity requirements and cost less, making them more suitable for public parking lots, shopping malls, and residential areas. DC charging, on the other hand, offers higher power output levels of 30-120 kW or more, allowing for faster charging times. However, DC charging requires higher power capacity and costs more, making it more common in public charging stations, company-owned vehicle charging stations, or specialized fast charging stations. Battery swapping station designs include single side, overhead and two-sided battery swapping stations, which require an average of 3-5 minutes to swap out batteries.

Significant progress has been made in establishing standards for charging and swapping systems, including basic overall standards as well as standards for plug-in charging, wireless charging, battery replacement, and the construction and operation of charging and swapping stations, effectively covering all the major aspects of these facilities including parts procurement, construction, and operations. China's charging standards, proposed in 2015, have become one of four major international standards. The development of high-power charging technology solutions and intelligent managed charging systems is being promoted, while local government regulatory platforms have been launched to enhance the ability to regulate these facilities. As of the end of 2020, there were 46 provincial and municipal regulatory platforms in operation across the country, creating detailed and stratified regulatory mechanisms and processes applied mostly in cities like Beijing and Shanghai.

In terms of model innovation, the use of Internet technologies has led to the emergence of a number of different operating platforms, which are either self-built and self-operated, outsourced, or cross-border. These platforms provide functions that range from station construction, managing charging, operations, and maintenance, to accounting, report development, big data analysis, marketing and database management. This integration of charging networks, vehicle networks, and the internet has greatly improved user experience. Large platforms offer retailer or franchise models that support small and medium-sized operators, loweing entry barriers and expanding the scale of the industry. Internet companies like Gaode, Baidu, and Didi have also entered the online charging station market, increasing user traffic by making it easier to find and use charging stations.

Our analysis shows that the unit cost of charging facilities in China has significantly decreased, and Chinese charging technology standards have received international recognition. The integration of internet services has also reached a relatively advanced stage with charging services and industry regulation are both highly digitized, while charging operators and full-service providers have developed innovative platform-based models. However, China still faces challenges in disruptive technologies like high-power fast charging stations and vehicle-network interaction. In the future, strengthening innovation and standardization in charging and battery swapping technologies, speeding up the development and promotion of high-power charging standards, fostering cross-industry collaboration, and promoting collaborative upgrades among all stakeholders in the industry will be key to the next stage of development.

## 3.2 Development of Hydrogen Energy Infrastructure and Services

Since the inclusion of promoting the construction of infrastructure such as hydrogen refueling in the Report on the Work of the Government in 2019, China's focus on hydrogen refueling infrastructure has gradually increased. This was further emphasized in the Medium- and Long-Term Plan for the Development of the Hydrogen Energy Industry (2021-2035) jointly issued by the National Development and Reform Commission and the National Energy Administration in 2022. As of the end of 2021, China had built a total of 234 hydrogen refueling stations, 106 of which were constructed in 2021, placing China first in the world in terms of scale.

While China has made progress in the construction of hydrogen refueling stations, a technology gap still exists between China and countries like the United States and Japan where hydrogen refueling stations typically have a fueling capacity of 70MPa, whereas nearly 90% of the hydrogen refueling stations in China currently have a capacity of only 35MPa for gaseous hydrogen. China is also highly dependent on imports of key equipment for 35MPa hydrogen refueling stations as efforts to localize have been insufficient. Furthermore, the reliability of these stations under high load conditions still needs to be tested, while technology for large-scale hydrogen refueling facilities for liquid hydrogen has yet to mature.

Compressors, which represent a significant portion of the cost of hydrogen refueling facilities, are an area where China is relatively underdeveloped. A locally developed 45MPa compressor is being used in 35MPa hydrogen refueling stations and has recorded over 5,000 hours of use, while a 90MPa compressor for use in 70MPa hydrogen refueling stations is currently in the technical research stage and is expected to enter the trial phase in 2023. However, similar compressors in European and American countries still have significant advantages in terms of ultra-high-pressure resistance, service life, and manufacturing processes.

As the current number of hydrogens refueling stations in China is unable to meet the demand for large-scale commercial application, adopting a hybrid construction model that combines oil, gas, hydrogen, and electricity would help accelerate the layout and construction of hydrogen refueling stations in China. While energy decarbonization and the restructuring of energy use are major trends, the widespread adoption of new energy requires advancements in related technologies and infrastructure. A hybrid construction model would integrate new energy fuel sources into traditional gas stations, facilitating the transition from traditional energy to new energy. Leveraging an established gas station network for the layout of hydrogen refueling stations could address barriers such as slow approval processes and site selection. Moreover, it would also reduce the number of hazardous locations within in cities and conserve land resources.

# 4 Policy

Over the past five years, policy incentives and government support have played a crucial role in the rapid development of new energy trucks in China. With a focus on reducing pollution and carbon emissions in the transportation sector, the government has recognized new energy vehicles as the future of the automotive industry. As a result, China has formulated and implemented a series of policies that provide subsidies for the purchase of new energy trucks, preferential road access rights, and the acceleration of infrastructure construction. These policies have laid a strong foundation for market-oriented promotion and technological advancement of new energy trucks, supported by a comprehensive development plan over the medium to long term.

## 4.1 Subsidies for New Energy Trucks

From 2015 to 2022, national subsidies for new energy trucks have been consistent. However, 2017 marked a turning point when the central government subsidies were reduced by 20% from the previous standard. After this, subsidies were gradually phased out, with a further 30% in 2022 compared to 2021 and the termination of subsidies new energy vehicle purchases on December 31, 2022. Vehicles registered after this date would also no longer receive subsidies. However, throughout this process, the technical requirements for new energy vehicles were increased, which encouraged the promotion and adoption of high-performance batteries.

In response to the central government's call for new energy subsidies, local governments have actively issued their own subsidy policies applicable to their respective regions. Provinces and cities such as Yunnan, Chongqing, Shanghai, Guangdong, Hainan, Zhejiang, Jiangsu, Hubei, Shanxi, and Henan have implemented local subsidy policies for new energy trucks.

## 4.2 New Energy Truck Road Access Rights

Since 2018, China has relaxed national policies on the road access for new energy trucks, promoted a free parking policy for these vehicles, and facilitating city access. Provinces and cities across China have actively responded to this policy by easing restrictions on the movement of new energy trucks and making access to cities more convenient. Several regions have adjusted restrictions on diesel trucks, allowing new energy trucks to travel on sections of road and during times during which conventional large trucks are prohibited. A number of regions have also granted new energy trucks 24-hour access to urban areas.

## 4.3 New Energy Infrastructure Construction

From 2014 to 2021, China introduced national policies that focused on the construction of new energy infrastructure. These policies aimed to improve charging facility standards and the implement a plan for the development of new energy vehicle charging facilities. It also encouraged private capital to invest in the construction of charging facilities, while also actively using existing urban facilities to promote the construction of charging facilities and improve distribution. Furthermore, policies encourage the integration of charging facilities with other existing facilities such as parking lots. Many provinces and cities have also introduced their own policies, setting specific goals and requirements for the construction of new energy infrastructure, while also providing financial subsidies to encourage development.

## 4.4 Development Plan for New Energy Trucks

Since 2020, China has introduced national plans specifically targeting the development of new energy vehicles, including new energy trucks. These plans outline development goals and requirements for new energy trucks and clean freight. In response to the central government's plan to promote the high-quality development of the new energy vehicle industry, provinces and cities have formulated their own plans based on regional industrial development with local policies aimed at driving the future development of new energy trucks.

# 5 Carbon Emissions Analysis

Road freight transportation contributes significantly to carbon emissions. In 2020, the annual volume of carbon emissions from newly sold trucks was 145 million tons. Heavy-duty trucks accounted for the majority of carbon emissions at 83%, followed by light trucks at 15%. Within these two categories, tractor trucks, dump trucks, and ordinary trucks were found to have the highest levels of carbon emissions. Diesel vehicles were responsible for 89% of carbon emissions as medium- and heavy-duty trucks rely primarily on diesel fuel. Carbon emissions for light trucks were comparable for both diesel and gasoline powered vehicles.

New energy trucks have the potential to contribute to carbon savings. It is estimated that in 2020, newly sold new energy trucks reduced annual carbon emissions by nearly 310,000 tons. City vehicles, garbage trucks, and vans were found to have relatively high carbon savings. However, replacing existing fleets with new energy trucks is currently limited to short-distance or urban transportation scenarios and it has been more challenging to reduce carbon emissions in heavy-duty trucks such as trailer trucks and fence cargo vehicles.

With improvements in technology and improved infrastructure, there is huge potential for expanded use of new energy trucks in long-distance transportation and heavy-duty trucking, which could lead to further carbon savings in the future.

# 6 Analysis of Typical Zero emission Freight Application Scenarios

The analysis of zero emission freight application scenarios focuses on three distance-base categories: closed-route scenarios, short-distance routes under 100km on public roads, and long-distance routes of more than 100km on public roads.

## 6.1 Closed-Route Scenarios

In closed-route scenarios at facilities such as ports, steel mills, and mining areas, pure electric heavy-duty trucks are widely used. They are typified by fixed routes with short average single haul distances and high frequency requirements. Pure electric heavy-duty trucks are well-suited for these scenarios due to their ability to operate at idle or low-speeds, improving fuel economy and reducing pollution levels. State-owned enterprises, which mainly operate ports, steel mills, and mines, have been speeding up their low-carbon transitions and procuring large numbers of zero emission trucks. In closed-route scenarios, heavy-duty trucks mainly use battery swapping models, which can be completed in a few minutes. Independent purchasing and operating models for vehicles and power systems are also used, helping to reduce initial investment and operational overhead.

## 6.2 Short-Distance Public Road Scenarios

Examples of scenarios that include short-distance routes on public roads are links between highways and railways, coal mines to power plants, and ports to steel plants. These scenarios have fixed routes with one-way distances that range from 20-100km. Compared with closed-route scenarios, the companies and purchasing models in these scenarios are more diverse with some companies adopting leasing models and other innovative approaches to reduce vehicle overhead. For example, the Caofeidian Port Group leased pure electric heavy-duty trucks for dry bulk transportation, and the G7 Green Port replaced its diesel trucks with pure electric heavy-duty trucks for coal transportation. Charging and swapping service providers have also worked with partners to build battery swapping stations in a number of locations.

International freight carriers and logistics companies in a number of industries have also experimented with zero emission heavy-duty trucks in China, but use remains limited and most are still at the trial stage in terms of operations.

## 6.3 Long-Distance Public Road Scenarios

Long-distance transportation on public roads mainly covers cargo trucks that use highways and expressways. These scenarios entail longer distances and higher requirements in terms of vehicle range and infrastructure distribution. Battery swapping pure electric heavy-duty trucks and hydrogen fuel cell heavy-duty trucks are most commonly for long-distance shipping. Battery swapping models have been successfully implemented in cross-provincial shipping for coal, but charging stations are less commonly used in long-distance truck shipping because of long charging times.

Pure electric systems are the most mature technology in new energy heavy-duty trucks, particularly for short to medium distance route and closed-route scenarios. Battery swapping is widely used in short-distance scenarios, while long-distance transportation scenarios still pose challenges for zero emission trucks, as electric heavy-duty trucks still have a limited range, which requires careful infrastructural planning. Hydrogen fuel cell vehicles may be more suitable for long-distance transportation in the long run, but higher purchase prices and the limited umber of hydrogen refueling stations are also currently a challenge.

While zero emission heavy-duty trucks have made progress in a number of scenarios, there are still areas that require further improvements in basic technologies and further development of supporting infrastructure to realize their full potential.

# 7 Recommendations

## 7.1 Policy Recommendations

### 7.1.1 Develop phased and targeted subsidy policies

Relevant government departments should introduce subsidies for heavy-duty pure electric trucks and hydrogen fuel cell trucks that use phased and targeted approaches. Subsidy levels can be adjusted over time, while operational subsidies (for vehicle operations, charging, swapping service fees, hydrogen fuel subsidies etc.) can be increased to compensate for the difference in cost between zero emission and traditional fuel heavy-duty trucks.

### 7.1.2 Provide greater road access

Relevant government departments should provide greater road access to zero emission heavy-duty trucks, both in terms of road sections and time periods that restrict access to regular heavy-duty trucks. Reductions in road tolls could also encourage the use of zero emission trucks by improving overall operational efficiency and mileage costs.

### 7.1.3 Speed up infrastructure integration

Areas that are suitable for upgrading existing facilities should integrate the construction of integrated energy refueling infrastructure into their development plans. Zero emission freight corridors should be constructed and there should be a unified planning process for energy refueling infrastructure. Land and power services should allocate typical refueling facilities like highway service areas and gas stations to service zero-emissions trucks. Simplifying approval processes and providing policy support for the construction of new infrastructure would also promote adoption.

### 7.1.4 Improve infrastructure standards

Government should work with enterprises and industry organizations to develop standards for battery packs, vehicle interfaces, battery swapping equipment, and methods used in the construction and operation of swapping stations. Compatibility issues between battery packs of different brands and developing a standardized system for the operation of swapping stations should be addressed. Additionally, standards and specifications for testing, monitoring, and safe operation of hydrogen refueling stations should be formulated.

### 7.1.5 Conduct targeted pilot projects

Building upon the success of existing pilot projects, key regions such as the Beijing-Tianjin-Hebei corridor, Yangtze River Delta, Pearl River Delta, and the Chengdu-Chongqing region should expand the scope of zero emission freight pilot programs based on local needs. Multi-stakeholder cooperation mechanisms that involve freight carriers, transportation service providers, vehicle manufacturers, and energy and infrastructure service providers should be established to pave the way for commercial operations.

## 7.2 Industry Recommendations

### 7.2.1 Promote demand for zero emission truck usage

Carriers should incorporate the use of zero emission trucks into their investment and procurement strategies as an integral part of their carbon peak and neutrality strategy. Reliable methods for calculating logistics transportation emissions should be established to demonstrate actual emissions reductions and encourage the adoption of zero emission trucks.

### 7.2.2 Encourage shipping companies and fleets to adopt zero emission trucks

Shipping enterprises and fleets should actively collaborate with cargo owners to conduct pilot projects, increase their experience in operations and maintenance, and explore the feasibility of large-scale adoption with the ultimate goal of providing zero emission transportation services.

### 7.2.3 Develop zero emission trucks that meet market demand

Vehicle manufacturers and component suppliers should work to develop models and technologies that align with market demand. They should evaluate market potential based on application scenarios and regional demand, formulate commercialization strategies, and increase the penetration rate of zero emission trucks.

### 7.2.4 Improve the distribution of infrastructure

Energy and infrastructure service providers should align with government plans for improving energy and power systems. Based on these plans, they should improve the distribution of infrastructure and provide energy support for zero emission freight transportation. Exploring green energy and smart energy refueling solutions can help to reduce emissions and improve energy efficiency.

### 7.2.5 Collaborate on developing sustainable business models

Stakeholders in the zero emission freight ecosystem should explore new business models that achieve cost parity for zero emission trucks as soon as possible. This includes providing low-cost purchasing models for small-scale fleets through rental or battery leasing, collaborating with suppliers to offer maintenance and insurance replacement services, and integrating into the ecosystem to achieve mutual benefit and sustainable growth.

# Join our quest for efficient, zero emission freight and logistics for China.

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