Smart Freight Centre China

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# New Energy Heavy-Duty Truck Industry Development Status Report

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## About Smart Freight Centre

Smart Freight Centre (SFC) was founded in Amsterdam in 2013 as an international non-profit organization dedicated to reducing greenhouse gas emissions from freight transport. SFC's mission is to work with global partners to quantify environmental impacts, identify solutions, and promote logistics decarbonization strategies.

Since entering the Chinese market in 2014, Smart Freight Centre has been committed to building a compliant, efficient, and sustainable logistics and freight industry in China in support of SFC's global carbon reduction goals.

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## Research Background

Smart Freight Centre (SFC) was founded in Amsterdam in 2013 as an international non-profit organization dedicated to reducing greenhouse gas emissions from freight transport. SFC's mission is to work with global partners to quantify environmental impacts, identify solutions, and promote logistics decarbonization strategies.

Since entering the Chinese market in 2014, Smart Freight Centre has been committed to building a compliant, efficient, and sustainable logistics and freight industry in China in support of SFC's global carbon reduction goals. SFC supports industry and government efforts in emissions measurement and reduction, and promotes the adoption of new energy heavy-duty trucks through its Zero Emission Freight Initiative platform. In addition, given the important role of sustainable aviation fuel in reducing emissions from global air freight, SFC is building an industry exchange platform for China and Asia. To achieve the long-term goal of zero-emission freight, SFC will establish systematic mechanisms across all projects to track and evaluate both potential and realized emission reductions.

The project emphasizes three core analytical perspectives:

- **China-Specific Perspective:** Understanding the leading role and differentiated value of China's pathway from the perspectives of market size, policy framework, energy structure, and supply chain capabilities.
- **Operational Scenario Perspective:** Assessing technical feasibility based on actual transport conditions, load characteristics, mileage profiles, and refueling needs.
- **System-Level Integrated Perspective:** Incorporating energy supply, vehicle technology, operational models, and industrial ecosystem collaboration into a unified framework to analyze their dynamic relationships and mutual constraints.

As the foundational module of the broader research system, this report is structured around the integrated perspectives outlined above. It aims to establish a clear, comparable, and fact-based foundation for subsequent analysis of technology pathways, technology-scenario matching, and OEM and supply chain competition.

## Research Objectives

This two-year research project aims to systematically answer the core question concerning the future development of China's new energy heavy-duty truck industry: **Against the backdrop of national energy restructuring, transformation of the transportation industry, and logistics system upgrades, how will China's road freight sector evolve, along which energy pathways will new energy heavy-duty trucks achieve large-scale development, and which market forces will ultimately drive their deployment?** To this end, the project builds a comprehensive analytical framework covering four dimensions—macro factors, scenario requirements, technology pathways, and OEM/supply chain dynamics—to identify the drivers, constraints, and future direction of the industry.

As the starting point of the project, this report aims to provide a structured review of the current state of China's new energy heavy-duty truck industry, establishing the consensus foundation and analytical framework needed for subsequent systematic research. Rather than pursuing exhaustive detail, the report focuses on key changes, emerging trends, and critical variables that must be incorporated into future research.

Specifically, the objectives of this report are:

- **Defining the scope of the problem:** Identify the core drivers and constraints behind the development of new energy heavy-duty trucks based on current macro policies, user demand, heavy-duty truck market dynamics, technology pathways, and typical application scenarios, thereby providing a starting point for understanding why the industry is evolving in its current direction.
- **Building an analytical framework:** Through a logical review of the industry's current status, this report initially establishes a three-level analytical pathway of "scenario—technology—OEM/supply chain," enabling subsequent research to conduct in-depth analysis within a unified methodological framework.

Given this positioning, this report does not attempt to provide an exhaustive description of the industry. Instead, it focuses on **clarifying key structures, identifying important variables, and establishing a common language, ensuring that subsequent research is built on a solid factual basis and a consistent logical framework.** Given the rapid pace of industry development, the content of this report will be updated based on new data, policies, and technological advances to ensure that key factors are continuously incorporated into the analysis and discussion.

# Research Object and Analytical Boundaries

## Definition of Heavy-Duty Truck

Although there is no official definition of "heavy-duty truck" in current Chinese regulations, a clear consensus exists in national standards and industry practice. Based on GB/T 15089-2001, "Classification of Motor Vehicles and Trailers," and GB/T 3730.1-2022, "Terms and Definitions of Motor Vehicles, Trailers, and Combination Vehicles—Part 1: Types," and with reference to common industry practice, this report defines "heavy-duty trucks" as **trucks and special-purpose vehicles with a maximum design gross mass exceeding 12,000 kg.**

## Core Functions of Heavy-Duty Trucks

Regardless of the powertrain, heavy-duty trucks are production equipment centered on heavy-load transport and high-intensity operations. Unlike passenger cars or light commercial vehicles, the value of a heavy-duty truck lies not in a single technical parameter or energy form but in its ability to consistently, reliably, and cost-effectively complete unit transport output tasks in specific scenarios.

Specifically, heavy-duty trucks must meet several basic and irreplaceable functional requirements: first, the ability to continuously carry large-tonnage cargo or equipment and operate reliably under high-load conditions; second, sufficient power, durability, and uptime to support high-frequency or long-duration operations; and third, an acceptable total cost of ownership under a given operational model, ensuring economic viability as production equipment.

Therefore, in the analysis of new energy heavy-duty trucks, the energy form is not an end in itself, but a technical means of serving the core functions described above. Any new energy technology pathway has practical significance and value for promotion only if it does not weaken—and ideally strengthens—the core functions of heavy-duty trucks. The subsequent analysis in this report uses this principle as the basic starting point for assessing the rationality of technology pathways and application scenarios.

## Scenario Classification

There is no unified standard for classifying heavy-duty truck application scenarios in industry research or practice. Different research institutions, OEMs, and policy documents often classify heavy-duty trucks based on dimensions such as **cargo type** (e.g., coal, steel, hazardous chemicals), **operation type** (e.g., tractor transport, dump trucks, mixer trucks, and special-purpose vehicles), or **industry attribute** (e.g., port logistics, construction, and industrial raw material transport). While such classifications help characterize specific industry needs, they are subject to inconsistent statistical methods, unclear scenario boundaries, and varying classification standards across entities, which can reduce comparability across studies. To improve consistency and operability, this report adopts a **classification centered on typical operating distance**, grouping heavy-duty truck application scenarios into three categories:

- Urban and intra-industrial park heavy-duty operations: Vehicles typically travel about 100 km per day, with relatively concentrated transport or operating ranges.
- Regional short-haul transport: Common on routes such as port-plant, mine-power plant, and rail-road intermodal connections; vehicles typically travel about 200 km per day.
- Inter-regional medium/long-haul and long-distance trunk line transport: Vehicles typically travel 500 km or more per day, with extremely high requirements for range, refueling efficiency, and operational continuity.

It should be noted that this classification is not intended as a strict definition of all heavy-duty truck application forms. Rather, it serves as an analytical tool for delineating the boundaries of different energy technologies in terms of range, refueling methods, economics, and operational suitability.

# 1

## 1 Policy and Macro Environment

The development of new energy heavy-duty trucks is shaped by multiple factors, including the macro environment, evolution of the energy structure, industry development stage, policy orientation, market demand, operational scenarios, and technological maturity. The interaction of these factors determines the long-term development trajectory of new energy heavy-duty trucks.

However, in China's development pathway for new energy heavy-duty trucks, policy and macro-environmental factors play a leading role in setting the direction and pace of change. International geopolitics, national energy restructuring, carbon peaking and carbon neutrality strategies, and the structural optimization of transportation and logistics all shape the long-term framework for industry evolution, including technology directions, infrastructure deployment, and industrial collaboration models. From national strategies to sector-specific policies, and from pilot demonstrations to subsidy mechanisms, the policy system forms the main axis of industry transformation. It should be noted that relevant policies and macro factors are not always specifically targeted at heavy-duty trucks; many address road transport, transportation energy systems, or logistics system transformation more broadly. Therefore, this chapter focuses on policy and macro content that is highly relevant to the evolution of the heavy-duty truck energy structure and changes in application conditions.

## 1.1. Policy Overview

This section systematically reviews the main policy frameworks influencing the application of new energy heavy-duty trucks and the energy transition of road transport in China. Given the broad scope and high frequency of policy issuance in China across energy, transport, logistics, industry, and related fields, this report does not elaborate on each policy provision in detail. Instead, it focuses on the logical structure and mechanisms through which policies take effect, categorizing them into two groups: **Strategy and Planning Policies** and **Application and Market Policies**. By clarifying the overall logic and layered functions of the policy system, this report introduces relevant policies in subsequent discussions on application scenarios, technology pathways, and market patterns to support a more accurate understanding of the feasibility boundaries and development pace of different technology routes and application scenarios.

### 1.1.1. Strategy and Planning Policies

In recent years, the Central Committee of the Communist Party of China, the State Council, and their general offices have issued a number of key top-level policy documents related to the evolution of

China's energy system, optimization of the transportation structure, and development of new energy vehicles. These plans, opinions, action plans, and other documents clearly reflect the overall direction of national strategy and provide an important basis for industry-level and local policies. They are therefore essential for understanding the evolution of the energy structure and vehicle technology pathways in China's land transport sector.

Once national-level strategies are formulated, sectoral authorities are responsible for breaking down, refining, and implementing national strategic goals. Unlike national policies, which focus on strategic direction and overall objectives, industry-level directional policies establish operational institutional frameworks through sector plans, guidance opinions, action plans, management measures, and technical standards across the energy, transport, logistics, and automotive sectors. These policies provide a stable basis for medium- to long-term corporate decision-making through sustained institutional supply and represent a structured extension of national top-level design at the ministerial level. Although industry policies are numerous and diverse in theme, their primary function is to refine and implement national strategies. This report cites them as needed in subsequent analyses of technology pathways, application scenarios, and market mechanisms, without providing a systematic review in this section.

After clarifying the division of functions between national and industry policies, this report focuses on national-level strategy and planning policies. It reviews their core content and underlying logic in chronological order to identify the phased characteristics of China's strategic deployment in energy and transportation. This provides a foundation for understanding the positioning and future evolution of new energy heavy-duty trucks within the land transport system.

- **2012-2019: Energy Security and Environmental Governance as Core Themes, with the Energy-Saving and New Energy Vehicle Industry Taking Shape**

This report takes the State Council's *Energy-Saving and New Energy Vehicle Industry Development Plan (2012-2020)*[1] (hereinafter referred to as the "Plan") as the starting point for the review, primarily because of its important position in the context of land transport energy. The Plan was formulated against the backdrop of rising vehicle ownership in China, increasing pressure on the balance between energy supply and demand, and growing urban environmental challenges. It placed "energy security—environmental governance—automotive industry transformation" within a unified strategic framework. The Plan clearly defined pure electric drive as the main strategic direction for new energy vehicles, identifying battery electric vehicles, plug-in hybrid electric vehicles, and fuel cell vehicles as key development pathways, while also improving the energy efficiency of conventional vehicles through energy-saving technologies. This top-level design positioned new energy vehicles as an important strategic lever for alleviating energy resource constraints, improving air quality, and driving the automotive industry toward higher-end development. It was subsequently implemented through fiscal subsidies and other policies, pushing the new energy vehicle industry into the early stage of marketization.

Between 2013 and 2019, the state further expanded systematic efforts related to air pollution control, energy restructuring, and integrated transport system development. On the one hand, the *Energy Development Strategy Action Plan (2014-2020)* proposed building a "safe, green, and efficient" modern energy system. It emphasized controlling total coal consumption, increasing the share of non-fossil energy, accelerating the development of natural gas and renewable energy, and optimizing energy production and consumption structures. These measures laid a directional foundation for subsequent oil-to-electricity and oil-to-gas transitions, as well as renewable electricity-driven transport in the transportation sector. On the other hand, in the area of air pollution control, the Central Committee and State Council issued a series of documents on environmental protection and ecological civilization construction[2][3], identifying motor vehicle emissions and the high share of medium- and long-distance road transport as key governance priorities, and guiding vehicle upgrades and structural adjustments in metropolitan areas and key regions. Meanwhile, in 2019, the Central Committee of the Communist Party of China and the State Council issued the *Outline for Building a Transport Power*[4], proposing to optimize transport energy structures, promote the application of new and clean energy, facilitate energy conservation and emission reduction in road freight, and advance electrification, new energy, and clean energy adoption in urban public transport and urban freight vehicles.

- **2020-2025: Under the Dual-Carbon Goal, Energy Revolution Becomes Integrated with Transport, Logistics, and Industrial Upgrades**

The year 2020 marked an important milestone for China's dual-carbon strategy and a key turning point for new energy vehicle policy. After China announced its goals of peaking carbon emissions by 2030 and achieving carbon neutrality by 2060 at the United Nations General Assembly, energy system restructuring and transportation decarbonization were incorporated into a unified national strategic framework. This provided a higher-level positioning for new energy vehicles in vehicle electrification and end-use energy electrification. The *New Energy Vehicle Industry Development Plan (2021-2035)*[5], released in October 2020, built on the basic direction of the 2012 Plan and further strengthened the role of new energy vehicles in international competition and national strategic emerging industries, proposing that vehicle electrification should be largely achieved by 2035. In 2021, the Central Committee of the Communist Party of China and the State Council issued the *Opinions on Fully, Accurately, and Comprehensively Implementing the New Development Concept and Advancing Carbon Peaking and Carbon Neutrality*[6] and the *Action Plan for Carbon Peaking by 2030*[7]. These documents proposed quantitative targets and key tasks for controlling total energy consumption and energy intensity, increasing the share of non-fossil energy, reducing carbon emissions per unit of GDP, and promoting green and low-carbon transportation. They explicitly incorporated "promoting the optimization and adjustment of the transport structure," "accelerating the development of new and clean energy vehicles," and "building a green and efficient modern logistics system" into the carbon peaking pathway.

The period from 2021 to 2025 corresponds to China's 14th Five-Year Plan period. During this period, national arrangements for energy structure transformation, integrated transport system development, and modern logistics system improvement became more systematic. The State Council General Office's *14th Five-Year Plan for Modern Logistics Development*[8] positioned modern logistics as a foundational system supporting high-quality economic development. It proposed optimizing cargo transport structures, promoting clean transport equipment, enhancing green logistics capacity, and advancing logistics system upgrades together with digitalization, intelligence, energy conservation, and emission reduction. Subsequently, the *Guiding Opinions on Further Building a High-Quality Charging Infrastructure System*[9] positioned charging infrastructure as a key foundation for integrated transport and energy development, emphasizing coordinated planning with transport networks and power grids to promote wider coverage and a more rational charging network structure. The 2024 *Action Plan for Effectively Reducing Total Social Logistics Costs*[10] adopted the perspective of improving logistics efficiency and ensuring high-quality economic operation. It integrated transport structure optimization, modern logistics system development, and the application of clean transport equipment within the same governance framework, proposing to comprehensively reduce social logistics costs through structural optimization and technological upgrading.

Overall, since 2012, China's top-level design has evolved from a stage focused on energy security and environmental governance to cultivate the energy-saving and new energy vehicle industry, to a stage under the dual-carbon goal that integrates energy revolution, transport system upgrading, and modern logistics system development. In this process, the role of new energy land transport in national strategy has also been elevated, shifting from an initial tool for energy conservation and emission reduction to an important component supporting energy transformation, logistics system restructuring, and manufacturing upgrading.

Looking ahead, the formulation of the 15th Five-Year Plan and rapid changes in the international policy environment will continue to shape the adjustment direction of China's road transport energy structure and may impose new requirements on technology route selection and industrial layout. This study will be updated promptly after the plan is released and will continue to monitor important national policy trends to ensure that judgments on technology pathways, application scenarios, and industry structure remain aligned with national strategy.

### 1.1.2. Application and Market Policies

In addition to top-level national strategic design and industry-level institutional planning, local governments and relevant ministries, including the NDRC, MIIT, MOT, MEE, and MOF, also issue policies that more directly target market entities. These documents primarily affect cargo owners, logistics service providers, and road transport operators, exerting immediate and specific impacts on vehicle purchase decisions, operating cost structures, technology choices, and compliance requirements. The mechanisms of these policies mainly involve economic incentives, scenario validation, operational convenience, and environmental constraints. They can generate observable and quantifiable behavioral changes in real operating environments, driving the gradual adoption of new energy commercial vehicles in specific regions, industries, and scenarios. At the same time, by improving refueling conditions, reducing operating costs, or increasing compliance pressure, these market-facing policies collectively help establish a sustainable operational foundation for new energy vehicles and create realistic conditions for large-scale promotion.

- **Fiscal and Tax Policies: Reducing Vehicle Replacement Costs and Creating the Most Direct Demand Pull**

Fiscal and tax policies are the most direct tools for promoting vehicle replacement at the industry level. By reducing vehicle purchase, replacement, and financing costs, they make new energy vehicles economically viable in more scenarios. Examples include the 2023 *Announcement on Extending and Optimizing the New Energy Vehicle Purchase Tax Exemption Policy*[11] issued by the Ministry of Finance and other departments, which exempts new energy vehicles purchased between 2024 and 2025 from vehicle purchase tax and halves the tax for vehicles purchased between 2026 and 2027. Another example is the NDRC and other departments' 2024 *Several Measures to Intensify Support for Large-Scale Equipment Renewal and the Replacement of Old Consumer Goods*[12], which provides retirement and replacement subsidies for operational diesel trucks meeting China-3 or lower emission standards and accelerates their replacement with lower-emission trucks. It should be noted that the effects of fiscal and tax policies often have a phased character, concentrating during the subsidy window and weakening significantly after subsidies are withdrawn. Therefore, the long-term effectiveness of fiscal and tax policies depends on whether they can help the industry form stable operational economics and a scaled market base during the transition period, enabling healthy market growth even after subsidies are phased out. This study will continue to monitor policy continuity, changes in industry cost structures, and corporate purchasing behavior after subsidy withdrawal to assess the long-term impact of fiscal tools on demand.

- **Demonstration and Pilot Projects: Building Real Operating Scenarios and Developing Replicable Business Models**

Demonstration mechanisms play a crucial role in the development of new energy commercial vehicles by accumulating replicable experience in typical scenarios through policy guidance. A case in point is MIIT's 2021 pilot program for battery swap applications in new energy vehicles[13], which included three cities featuring heavy-duty truck applications: Yibin, Tangshan, and Baotou. By conducting demonstration operations in different types of cities, the pilot aimed to systematically verify the operational efficiency, economics, and infrastructure requirements of the battery swap model in scenarios such as taxis, urban delivery, and heavy-duty trucks, providing decision-making references for broader subsequent application. However, the actual impact of demonstration policies depends on the breadth, depth, and effectiveness of pilot implementation. Whether they can generate sufficient replicable experience also depends on multiple factors, including local enforcement intensity, infrastructure conditions, and the engagement of industry participants. This study will continue to track the implementation progress and outcomes of relevant pilots in subsequent phases, assess their impact on different technology pathways, vehicle types, and operational scenarios, and provide a basis for final technology route analysis and industry outlook.

- **Traffic Right Concessions: Improving Operating Conditions to Enhance the Efficiency of New Energy Vehicles**

Traffic right policies primarily enhance the availability and operational efficiency of new energy commercial vehicles by improving access conditions, especially in scenarios with high timeliness requirements, such as urban delivery and industrial park logistics. Such policies typically include easing or lifting urban access restrictions, extending operating hours, optimizing temporary parking management, and strengthening regional coordination, making new energy trucks more accessible in core urban areas than conventional fuel vehicles. For example, a 2024 notice issued by the Beijing Municipal Commission of Transport[14] proposed providing traffic convenience for new energy logistics delivery vehicles according to vehicle type, time period, and area, effectively improving their operational accessibility within the Fifth Ring Road. Differentiated local management is becoming an important lever for enhancing the dispatch flexibility and transport efficiency of new energy trucks in urban logistics scenarios.

It should be noted that the actual effect of traffic right policies depends on the intensity of city-level enforcement, consistency of management rules, the balance between congestion management goals and freight demand, and the degree of alignment with supporting conditions such as charging infrastructure and roadside resource management. This study will continue to track policy implementation in typical cities to assess the impact of traffic right concessions on the operational efficiency and vehicle choice behavior of new energy trucks.

- **Environmental and Emission Regulatory Policies: Compliance Pressure as a Core Driver of Clean Transport Equipment Adoption on the Demand Side**

Environmental and emission regulatory policies play a "hard constraint" role in promoting the application of new energy commercial vehicles. Their mechanism differs from incentive-based policies such as subsidies or traffic rights. By setting strict emission requirements, clean transport ratios, and environmental performance assessment mechanisms, they create binding pressure on enterprises in key industries, thereby encouraging them to proactively adopt clean transport equipment to meet compliance requirements. Such policies are particularly prominent in upstream industrial chains, such as steel, cement, and coking, and typically involve ultra-low emission retrofits, performance grading management, and transport cleanliness requirements, directly affecting the choice of energy pathways in freight scenarios. Taking the steel industry as an example, the 2019 *Opinions on Promoting the Implementation of Ultra-Low Emissions in the Steel Industry*[15] issued by the MEE and other departments clearly stated that the share of clean transport methods for bulk materials entering and leaving facilities should not be less than 80%; any portion of road transport not meeting this target must use new energy vehicles or vehicles meeting higher emission standards. This requirement directly prompts steel enterprises and their logistics partners to accelerate the deployment of new energy transport equipment and promotes practical applications of new energy heavy-duty trucks in industrial logistics scenarios.

It should be noted that the effectiveness of environmental policies depends on multiple factors, including the intensity of local government enforcement, the transparency of performance classification assessments, enterprise industry attributes and environmental investment capacity, the availability of alternative transport modes, and the technical adaptability and operating cost structure of new energy vehicles in specific industry scenarios. Therefore, their impact on new energy vehicle demand varies by region and industry. In subsequent analyses of technology pathways and application scenarios, this study will also consider the demand-pulling effect of environmental regulatory policies on high-emission industries and assess their potential impact on the promotion of new energy heavy-duty trucks in different regions and operational scenarios, particularly in light of potentially stricter industry environmental requirements during the upcoming 15th Five-Year Plan period.

Overall, China's policy system for the energy transition of road transport and the development of new energy heavy-duty trucks shows a clear hierarchical evolutionary logic. Top-level national design, based on the requirements and strategic priorities of different periods, establishes phased overall deployment; market-oriented policy mechanisms directly influence vehicle choice, cost structures, and technology adoption behavior in operational scenarios. Industry and market changes are shaped by the direction of national strategy, but different regions, industries, and scenarios exhibit different paces and structural characteristics under the same policy framework. These differences have important implications for technology route selection, business model formation, and large-scale promotion pathways.

For this study, this means that analysis and discussion should treat national strategic direction as a boundary condition, industry policies as an institutional foundation, and market-oriented policy mechanisms as important variables affecting actual implementation. Based on the policy framework above, this study will continue to incorporate relevant policy factors to ensure that the discussion remains consistent, systematic, and forward-looking in relation to China's future energy transformation and transport development direction.

## 1.2. Other Factors

In addition to the domestic policy system, the international macro environment has a profound influence on the adjustment direction of China's road transport energy structure. Among these factors, the geopolitical landscape, global energy security, the international trade environment, and the climate and industrial policies of major economies may all affect the energy supply system, cost structure, and industrial competition landscape of new energy heavy-duty trucks.

Geopolitics and the global energy security landscape are profoundly shaping the long-term energy strategy choices of countries around the world. These external factors can alter the evolution of the global energy structure, inter-regional energy dependencies, and the strategic positioning of key energy technologies, thereby exerting structural impacts on heavy-duty truck energy pathways, the deployment of electricity and hydrogen infrastructure, and the future role of other fuels.

Internationally, Europe and the United States are two important sources of trends affecting the global energy landscape. Europe's recent energy strategy adjustments have made renewable energy substitution, end-use electrification, and hydrogen energy system development core priorities, accelerating the low-carbon and diversified transformation of the energy system and making defossilization a long-term strategic direction across sectors. In contrast, the recently released U.S. *National Security Strategy*[16] explicitly emphasizes energy dominance and the expansion of fossil fuel production, while questioning net-zero targets and the clean energy transition. Despite its political overtones, this strategic orientation will directly influence the future actions of the U.S. government in energy security, industrial policy, and international cooperation, thereby affecting the global landscape.

For this study, these factors do not directly determine the development pathway of China's new energy heavy-duty trucks, but they serve as exogenous variables that may affect China's strategic considerations regarding energy diversification, refueling infrastructure planning, critical material supply chains, and international cooperation. Therefore, in subsequent discussions and analyses, this study will incorporate geopolitics and the energy security landscape as important external boundary conditions, ensuring that the analysis more accurately reflects long-term structural changes in the future global energy system.

# 2

## 2 Market Status Overview

Before analyzing specific technology pathways, it is necessary to systematically review the overall situation, market structure, and key evolutionary characteristics of China's heavy-duty truck market. The heavy-duty truck industry is at the core of China's road freight system and represents an important intersection of energy consumption, vehicle technology transformation, and green logistics development. Its market structure, sales trends, penetration pace of different technology pathways, and competitive landscape among companies directly determine the scalable foundation for new energy heavy-duty trucks. This chapter starts with macro-level freight volume and then progressively examines terminal sales of heavy-duty trucks, the penetration rate of new energy models, and industry competition, providing a factual basis for understanding the real-world foundation, demand characteristics, and potential application space of different technology pathways.

It should be noted that the data used in subsequent chapters of this report are primarily based on terminal sales statistics, namely vehicle registration data. This metric was selected because terminal sales data more closely reflect real demand-side conditions. Compared with invoicing data published by the China Association of Automobile Manufacturers, registration data better capture the actual vehicle purchase decisions of logistics companies, thereby supporting a more accurate assessment of whether different technology pathways are genuinely accepted by the market and how effectively they penetrate practical applications.

## 2.1. Heavy-Duty Truck Market Overview

The feasibility and application space of heavy-duty truck technology pathways first depend on the scale and structure of overall road freight demand, and on how this demand is transmitted to the heavy-duty truck market. Therefore, this section begins with China's total social freight volume and road freight volume, reviewing the actual transport volume carried by roads, capacity demand, and major trends. It then further examines changes in terminal sales of heavy-duty trucks and the market penetration of new energy models.

### 2.1.1. Total Social Freight Volume and Road Freight Volume

Starting from the overall freight scale and transport structure helps clarify the basic market foundation for heavy-duty truck demand and its regional characteristics. Freight volume not only reflects the level of economic activity but also directly affects vehicle ownership, replacement cycles, and the market penetration of different heavy-duty truck energy pathways. As the dominant mode in China's logistics system, road freight provides the fundamental scale and structural stability needed for new energy heavy-duty trucks to develop into a scalable industry.

- **National Overall Freight Volume: Road Transport Maintains Absolute Dominance, While Demand Scale Continues to Expand**

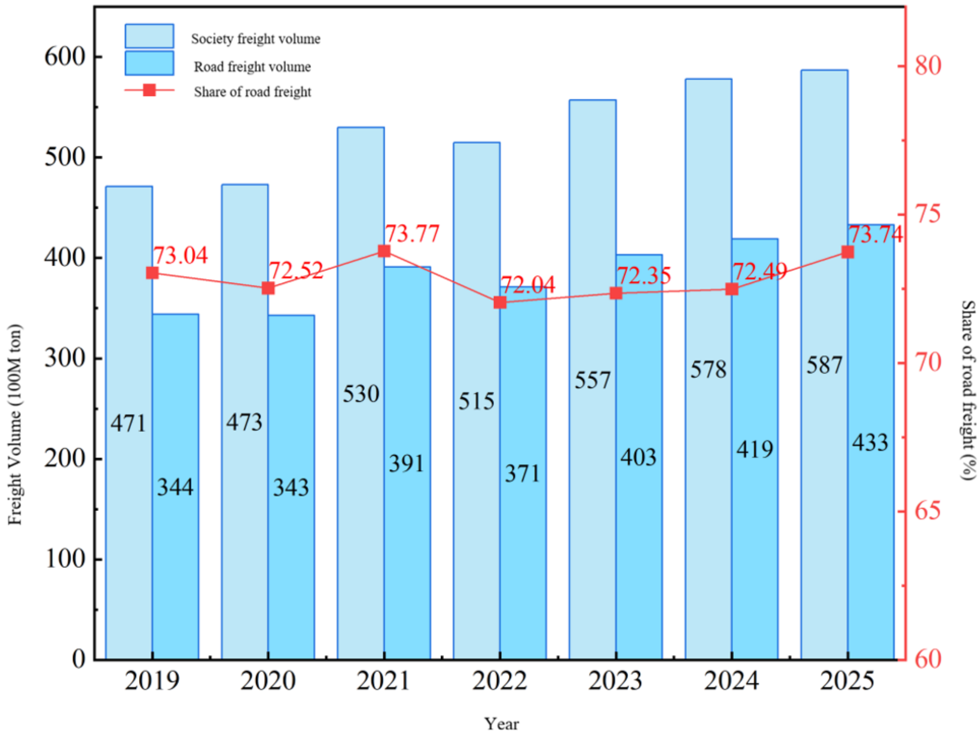


**Figure 1. China's Total Social Freight Volume and Road Freight Volume, 2019-2025 [18][19]**

Between 2019 and 2025, China's total social freight volume increased from 47.1 billion tons to 58.7 billion tons, representing cumulative growth of 24.6% over five years. The ability to maintain stable growth despite macroeconomic pressures from the pandemic, real estate contraction, and structural adjustments demonstrates the strong resilience of China's physical supply chain demand. During this period, the share of road freight remained stable at 72%-74%, indicating its irreplaceable role in China's logistics system. This demand stability means that the heavy-duty truck industry does not face structural demand collapse. Even with optimization of transport modes, the basic demand for road freight is expected to remain stable over the long term without sharp short-term declines. As China's supply chain network continues to move toward multi-center distribution and regional coordination, the core position of road freight is likely to be further strengthened.

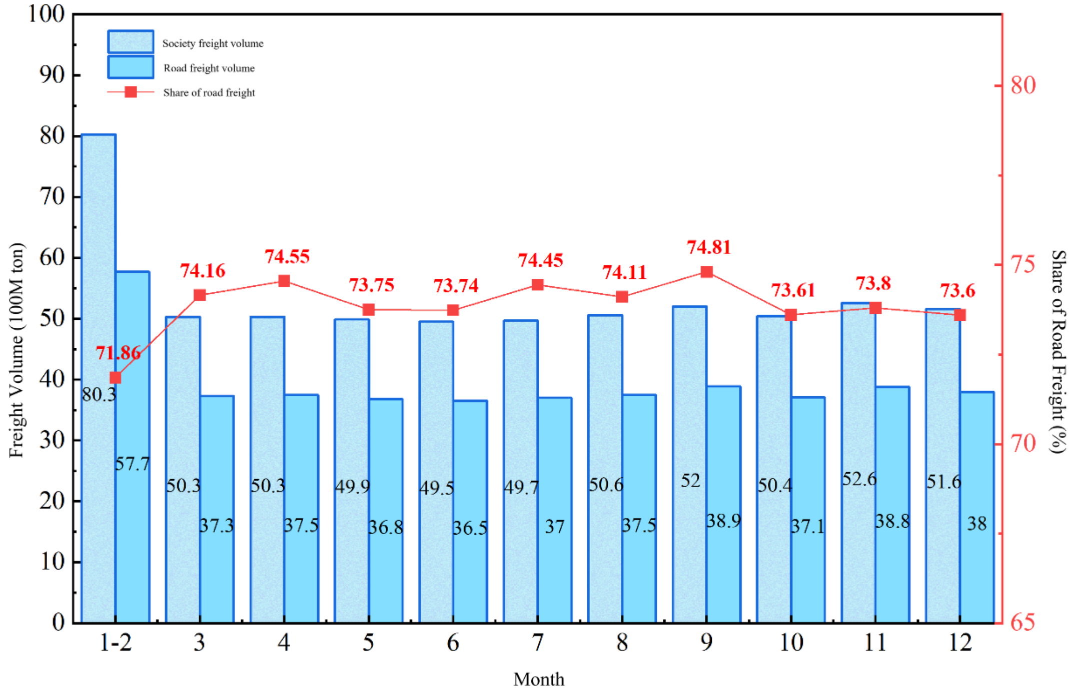


**Figure 2. China's Monthly Total Social Freight Volume and Road Freight Volume, January-December 2025 [19]**

In 2025, China's total social freight volume from January to December reached 58.7 billion tons, of which road freight volume reached 43.29 billion tons, accounting for 73.7% of total social freight volume. Road transport therefore maintained its leading position in the national logistics system. From a monthly trend perspective, freight volumes remained relatively stable throughout the year without significant fluctuations, reflecting the overall stability of national logistics operations.

A prerequisite for the large-scale adoption of new energy heavy-duty trucks is sufficiently large and structurally stable demand. Data on total social freight volume and road freight volume show that road transport carries more than 70% of freight volume, indicating that heavy-duty truck ownership and replacement demand have a stable long-term foundation and are unlikely to experience structural contraction due to shifts in freight transport modes. In other words, the market penetration space for new energy heavy-duty trucks over the next 10-15 years is not about capturing share in a declining market, but about identifying structural breakthroughs within a large and long-term stable market.

- **Regional Structure: East China Dominates National Freight Flows, While Southwest China Leads in Growth**

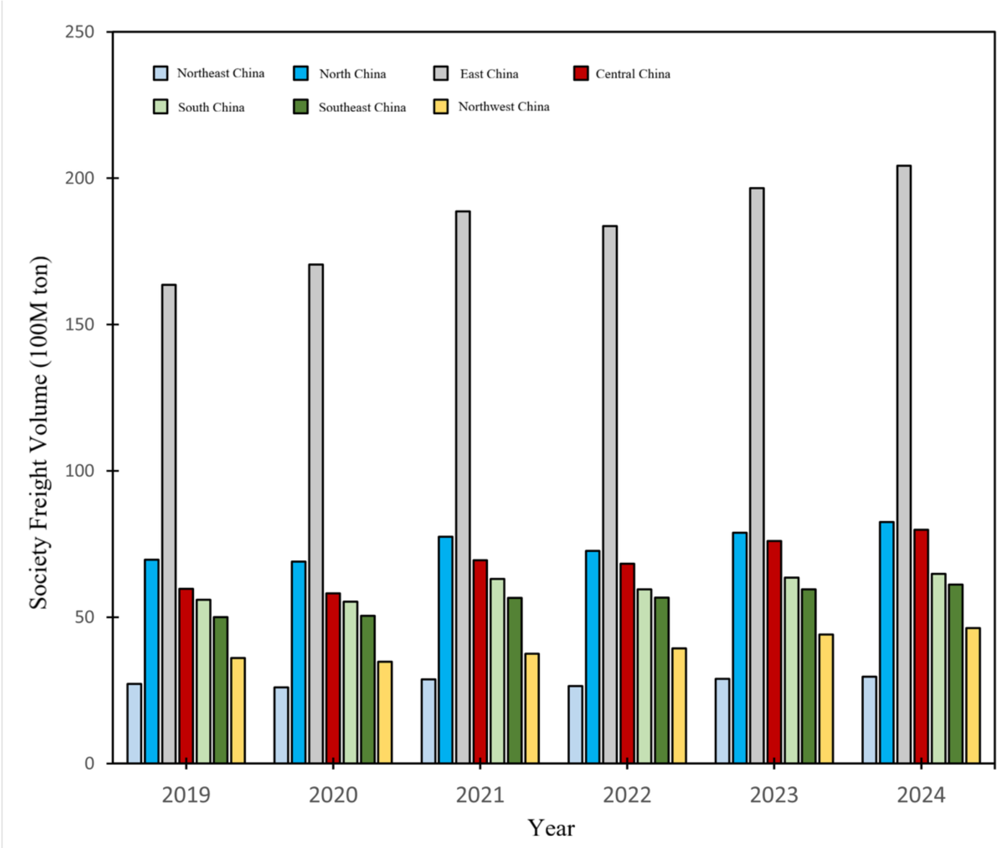


**Figure 3. China's Regional Total Social Freight Volume, 2019-2024** [20][21]

Regional total social freight volume aggregated from raw data published by the National Bureau of Statistics.

Between 2019 and 2024, freight volumes across China's regions exhibited clear geographical disparities. From the perspective of regional distribution of total social freight volume, **East China** has long accounted for about one-third of the national total, making it the country's most important freight demand center. **North China and Central China** form the second tier and serve as important logistics hubs supporting inland and northern economic growth. **South China and Southwest China** follow closely: South China serves as a critical gateway for foreign trade and investment, while Southwest China is a key region for western development. **Northwest and Northeast China** account for relatively limited shares, reflecting their comparatively smaller economic output and freight circulation scale relative to the national level.

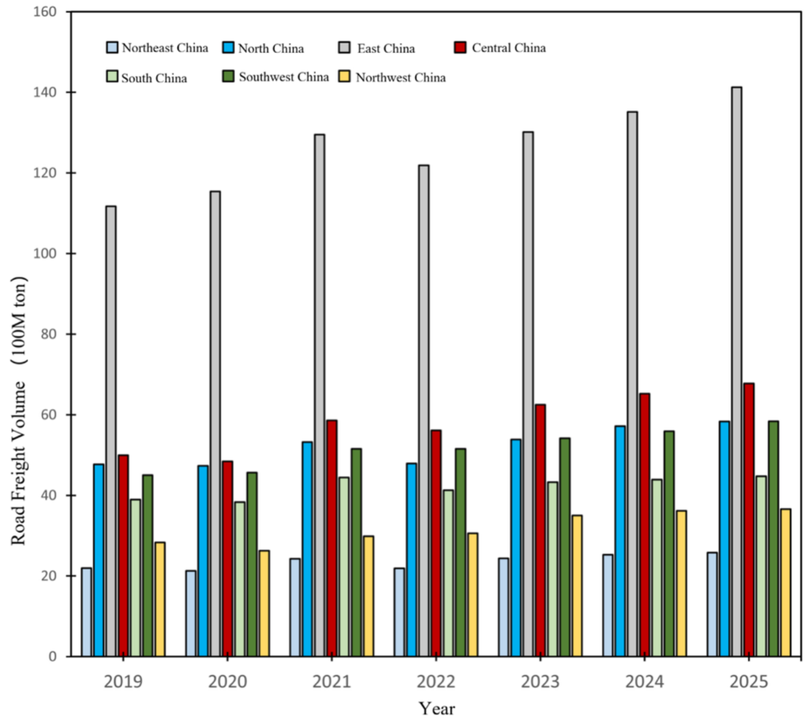


**Figure 4. China's Regional Road Freight Volume, 2019-2025 [20][22]**

Focusing on **road freight volume** using 2024 data, regional differences are evident. The share of road freight in total social freight volume in **Southwest China** is approximately 91%, indicating that road transport occupies an overwhelmingly dominant position in the region's current transport system. Due to geographical conditions and infrastructure layout, freight transport in this region relies heavily on road networks. **Northeast, Central, and Northwest China** also have high road freight shares, at approximately 83%, 83%, and 78% respectively, indicating strong dependence on road transport, with road networks bearing much of the flexibility and accessibility of their freight systems. In **East, North, and South China**, where transport modes are more diversified, the share of road freight is lower, at approximately 67%, 68%, and 69% respectively. Integrated transport systems in these regions are more diversified, with railways, waterways, and aviation sharing about one-third of freight demand.

The significance of regional structure lies not only in where goods are located, but also in revealing the geographically differentiated future penetration potential of new energy heavy-duty trucks. Future market penetration is expected to follow a pathway of "regional differences—scenario differentiation—route stratification." Regions with high road dependence may more easily form large-scale electrification pilots, while regions with more developed integrated transport systems may take the lead in hydrogen energy, fast charging, and intelligent operations. Differences in energy structure, electricity prices, refueling infrastructure density, and industrial layout across regions will profoundly shape the national penetration pattern of new energy heavy-duty trucks over the next decade, leading to stronger geographical differentiation among energy pathways.

In summary, for this study, this stable and differentiated freight structure provides a clear framework for technology pathway selection and regional penetration of new energy heavy-duty trucks:

- **Stable market foundation:** Long-term stability in transport demand means that heavy-duty truck ownership and replacement demand will remain continuous.
- **Regionalized promotion as the main trend:** Different energy pathways are likely to achieve breakthroughs in different regions.

### 2.1.2. Terminal Sales of Heavy-Duty Trucks and New Energy Heavy-Duty Trucks

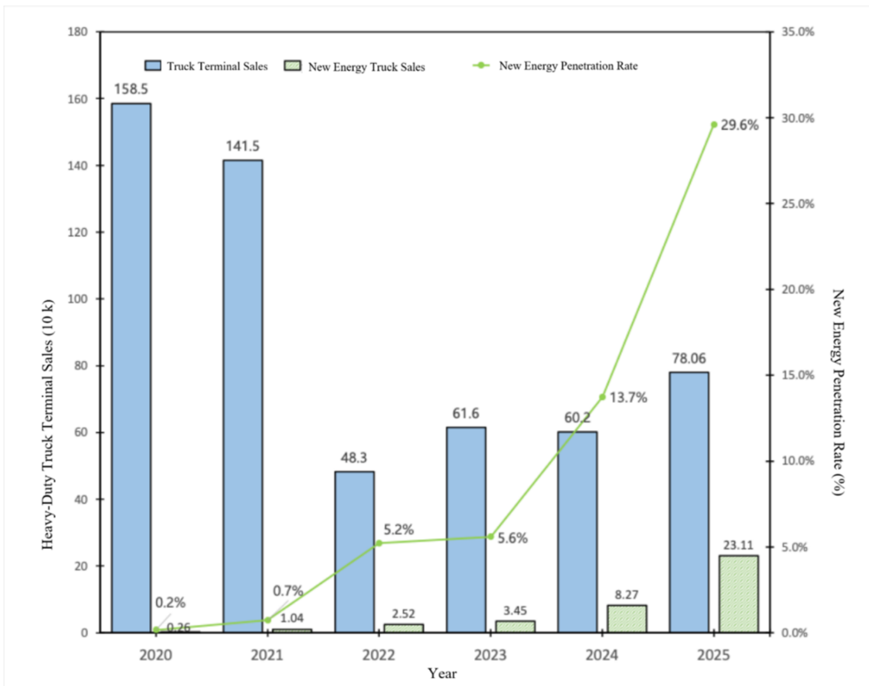


**Figure 5. China's Terminal Sales of Heavy-Duty Trucks and New Energy Heavy-Duty Trucks, and New Energy Heavy-Duty Truck Penetration Rate, 2020-2025 [23][24][25][26][27]**

- **Overall Heavy-Duty Truck Market: From Peak to Plateau**

Data show that terminal sales of heavy-duty trucks in China peaked at 1.585 million units in 2020 before entering a downward adjustment. Sales fell to 1.415 million units in 2021 and then dropped sharply by 65.9% to 483,000 units in 2022. Based on the freight volume data discussed in Section 2.1.1, the sharp decline in 2022 was not caused by a collapse in transport demand. Rather, it reflected the gradual fading of the demand surge triggered by the transition to the China-6 emission standard, combined with high oil prices, low freight rates, macroeconomic slowdown, and dealer inventory pressure [27]. From 2023 to 2025, as the impact of earlier policy-related factors weakened, the market gradually returned to a scale range driven by normal replacement demand, although it remained far below the 2020 peak. This shift indicates that the **heavy-duty truck market is moving from an incremental market to a stock-based market**, with future scale increasingly influenced by economic structure, transport efficiency, and policy direction rather than by new capacity demand alone.

This shift from extensive expansion to refined efficiency improvement is highly consistent with recent changes in the logistics system. Growth in freight volume no longer translates linearly into higher heavy-duty truck sales, due to factors such as transport digitalization, accelerated development of multimodal transport, improved vehicle utilization, and increased industry concentration. Therefore, the decline in sales does not necessarily indicate weak transport demand; rather, it reflects a fundamental adjustment in industry capacity from scale-oriented expansion toward efficiency-oriented optimization.

- **New Energy Heavy-Duty Trucks: Continuous Rapid Growth, Rapidly Increasing Penetration Rate**

In stark contrast to the overall heavy-duty truck market trend, terminal sales of new energy heavy-duty trucks have continued to grow, increasing from 2,600 units in 2020 to 231,100 units in 2025—an increase of more than 30 times over five years. During the same period, the penetration rate of new energy heavy-duty trucks rose from 0.16% in 2020 to 28.9% in 2025. The particularly rapid increase in 2024 and 2025 indicates that new energy heavy-duty trucks have shifted from being supplementary products to becoming an important source of structural growth.

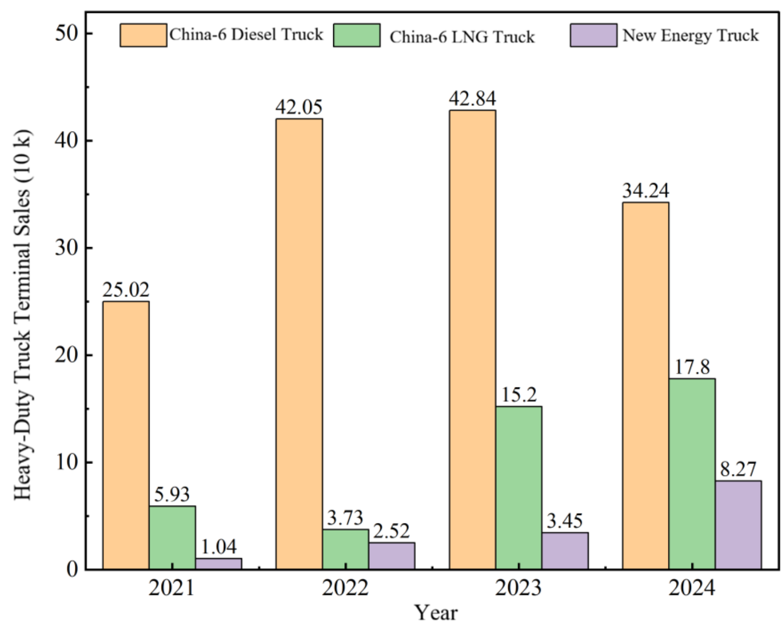


**Figure 6. China's Heavy-Duty Truck Terminal Sales by Energy Type, 2021-2024 [23][28][29][30]**

Available public data also confirm the diversified evolution of China's incremental heavy-duty truck market by energy type. Since the full implementation of the China-6 emission standard, China-6 diesel heavy-duty trucks have remained the main power type in the incremental terminal sales market from 2022 to 2024, although their sales scale has fluctuated. Meanwhile, LNG heavy-duty truck sales grew rapidly after 2023, with their share increasing significantly. Although new energy heavy-duty trucks still have a lower absolute sales volume than diesel models, they have maintained a high growth rate and have become one of the core incremental sources driving structural change in the market.

It should be noted that this figure reflects the structure of new sales rather than the overall vehicle stock. It therefore cannot be used to determine changes in the share of diesel vehicles across the entire operating fleet. However, the distribution of power types in new sales already shows that China's heavy-duty truck industry is gradually shifting from a structure once dominated almost entirely by diesel toward a multi-path pattern in which diesel, natural gas, and new energy vehicles coexist in new sales, with increasingly diversified competition among different energy routes.

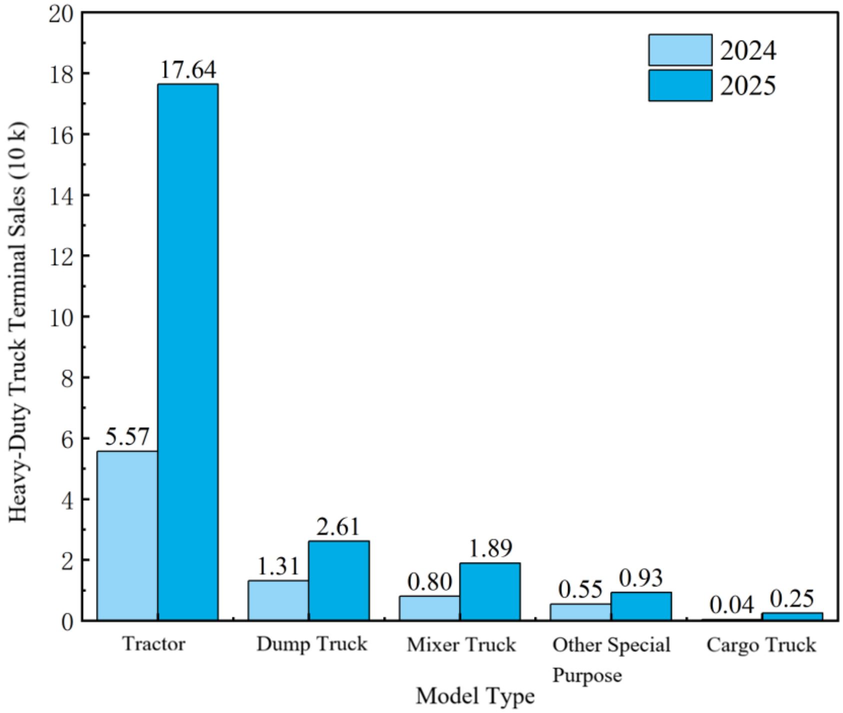


**Figure 7. China's New Energy Heavy-Duty Truck Terminal Sales by Model Type, 2024-2025 [32][33]**

From the perspective of model distribution, terminal sales growth of new energy heavy-duty trucks in 2024 and 2025 showed a highly concentrated pattern, with tractors emerging as the most important and most significant growth driver. Specifically, terminal sales of new energy heavy-duty tractors were approximately 55,700 units in 2024 and surged to 176,400 units in 2025, with year-on-year growth far exceeding that of other models. Their absolute increment accounted for the majority of overall growth in the new energy heavy-duty truck market. This change further increased the share of tractors within the new energy heavy-duty truck segment, making them the most representative model in the industry's energy transition. Tractors typically have relatively fixed routes, high operating mileage, and high vehicle utilization in trunk line logistics, making it easier to amortize the initial cost of new energy models through scaled operations and to coordinate vehicle deployment with charging or battery swap infrastructure. Therefore, as new energy technologies and refueling conditions continue to mature, it is unsurprising that tractors have taken the lead in volume growth.

In summary, China's heavy-duty truck market is undergoing a structural transformation. After significant fluctuations, terminal sales of heavy-duty trucks have stabilized, while the internal market structure is undergoing fundamental differentiation. The penetration rate of new energy heavy-duty trucks has increased rapidly from near zero to approximately 29.6% within six years, indicating that the market has officially entered an era of diversified power structures in which diesel, LNG, and new energy vehicles coexist. Within the new energy heavy-duty truck market, tractors have become the dominant model, accounting for more than two-thirds of sales, whether viewed by model type or technology route.

### 2.1.3. Overall Heavy-Duty Truck Market Structure

During this critical period of structural transformation in the overall heavy-duty truck market, reviewing the competitive landscape of core market participants is essential for analyzing the industry's future structure.

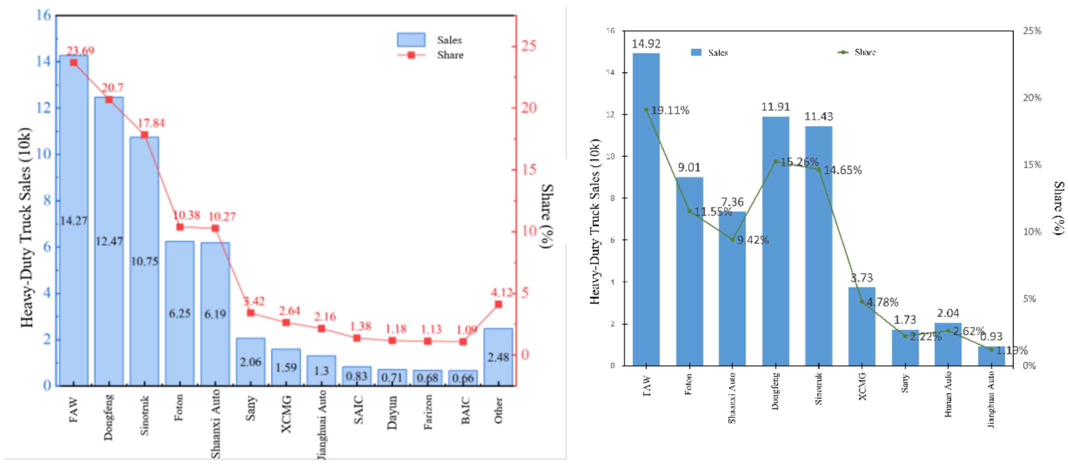


**Figure 8. China's Heavy-Duty Truck Terminal Sales Market Structure, 2024-2025 [24]**

From the perspective of terminal sales market structure, China's heavy-duty truck market in 2024 remained highly concentrated, with the top five companies (CR5) collectively accounting for approximately 82.9% of market share. Among them, FAW, Dongfeng, and SinoTruk together accounted for more than 60%, maintaining an absolute leading position. Foton and Shaanxi Automotive formed the second tier, while the overall industry remained highly concentrated. Large-scale manufacturing capabilities, distribution and service networks, supply chain systems, and long-established customer bases continue to serve as important competitive barriers in the traditional heavy-duty truck market.

However, terminal sales data for 2025 show noticeable changes in the market structure. Although leading companies still dominate the market, industry concentration declined significantly compared with 2024, with CR5 falling to approximately 69%, while the share gap among leading companies also narrowed. At the same time, the ranking and composition of the top five companies underwent considerable adjustment, indicating stronger market dynamism. This suggests that, against the backdrop of the new energy transition, product-structure adjustment, and changing market demand, the previously stable competitive landscape of the overall heavy-duty truck market is now facing greater challenges.

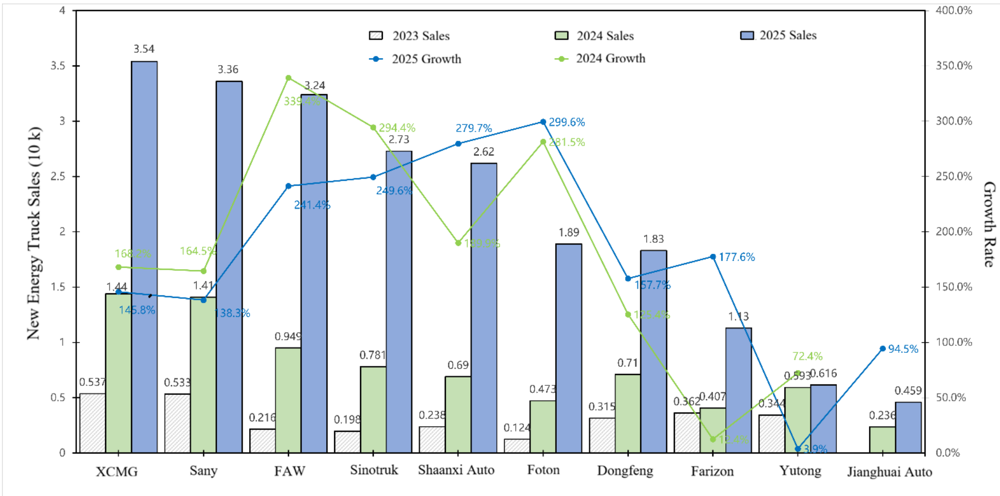


**Figure 9. China's New Energy Heavy-Duty Truck Terminal Sales Market Structure and Year-on-Year Growth Rates, 2023-2025** [27][34][35]

The new energy heavy-duty truck market presents a distinctly different competitive landscape. Changes in the company distribution of terminal sales from 2023 to 2025 show that the competitive structure remains in a dynamic stage of evolution, with clear phased characteristics.

In 2023, the leading group in the new energy heavy-duty truck market remained unstable, and the composition of the top five companies differed noticeably from the following two years. This reflected significant variation among companies in the pace of sales volume release, product launches, and market performance during this stage, with the industry as a whole still undergoing testing and adjustment. In contrast, the composition of the top five companies in 2024 and 2025 remained consistent, and relative rankings changed only slightly. This indicates that, after earlier fluctuations, the leading structure of the new energy heavy-duty truck market has begun to stabilize, and the market positions of leading companies are gradually becoming more established.

A closer look at the sales structure shows that the gap between the third-ranked company and the top two narrowed in 2025 compared with 2024, indicating that competition within the leading tier remains active. Although market concentration is increasing, neither an absolute monopoly nor a duopoly has yet formed. Overall, the new energy heavy-duty truck market is gradually transitioning from an early stage characterized by rapid change and frequent ranking shifts to a stage in which market shares are becoming relatively more stable while competition remains intense.

The competitive landscape of the new energy heavy-duty truck market contrasts sharply with that of the overall heavy-duty truck market. The overall market remains relatively stable and highly concentrated, while the new energy segment, as an incremental market, is still experiencing rapid changes in participant composition and competitive order. This is highly significant for this study. The future development of new energy heavy-duty trucks remains in a period of rapid transition, and their growth speed, the penetration capacity of different energy routes, and changes in the industry structure will not simply follow the competitive logic of the traditional diesel era. Instead, they will depend heavily on companies' strategic investment pace, product and technology portfolios, and scenario-entry strategies in the new energy field.

## 2.2. LNG Heavy-Duty Trucks

LNG heavy-duty trucks are not typically classified as new energy heavy-duty trucks. However, given their significant share of the current heavy-duty truck market and their role as an important alternative fuel pathway, they are included in this report for comparative discussion.

LNG heavy-duty trucks use liquefied natural gas as fuel. Compared with conventional diesel heavy-duty trucks, they offer advantages such as lower fuel costs and better environmental performance, and have gradually gained market attention and recognition. Against the backdrop of energy conservation, emission reduction, and the low-carbon transition, LNG heavy-duty trucks have become an important clean fuel option with broad application potential in specific transport scenarios.

### 2.2.1. Market Status

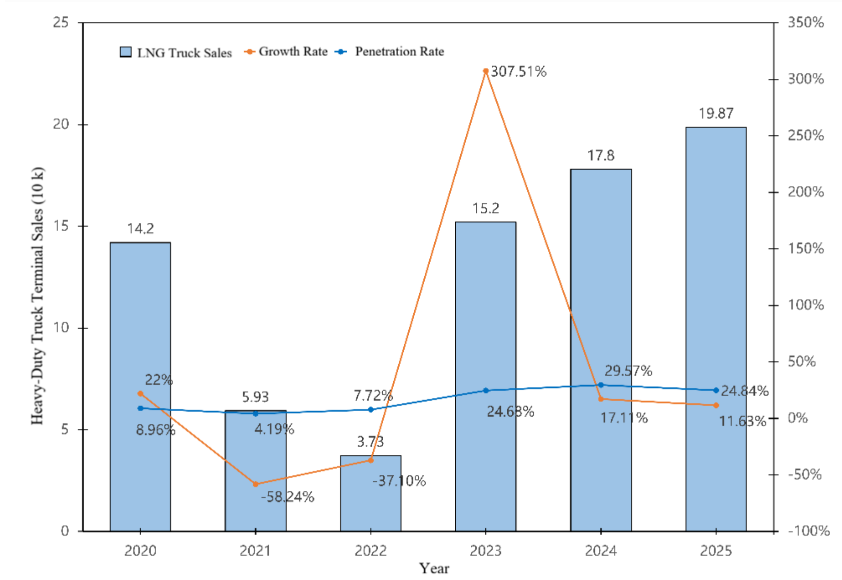


**Figure 10. China's LNG Heavy-Duty Truck Sales and Penetration Rate, 2020-2025 [29][30][35][38][39][40]**

In recent years, China's LNG heavy-duty truck market has exhibited a highly price-sensitive cyclical pattern, which can be summarized as "rapid growth—deep pullback—strong rebound—steady increase." Although this process has involved significant fluctuations, repeated market cycles have also verified the technological maturity and scalability of LNG heavy-duty trucks.

In 2020, annual sales of LNG heavy-duty trucks reached 142,000 units, with a penetration rate of approximately 9%. Against the backdrop of relatively low natural gas prices and a clear oil-gas price differential, the fuel cost advantage of LNG heavy-duty trucks in medium- and long-haul trunk line transport began to emerge, and the market initially verified their scalability in terms of economics and operational feasibility.

In 2021-2022, the LNG heavy-duty truck market rapidly entered a deep pullback. Sales fell to 59,300 units in 2021, down 58.2% year on year, and further declined to 37,300 units in 2022, down 37.1% year on year. The core reason for this phase was not technical or product-related issues, but rather the significant increase in international natural gas prices, combined with weak domestic freight demand, which substantially narrowed—or even temporarily reversed—the oil-gas price differential. As a result, the fuel cost advantage on which LNG heavy-duty trucks had relied weakened rapidly, end-user purchase willingness declined significantly, and the market entered a short-term trough.

As international and domestic natural gas prices fell in 2023, the price differential between LNG and diesel widened again, and previously suppressed replacement demand was released intensively, leading to a strong rebound in the LNG heavy-duty truck market. Sales surged to 152,000 units in 2023, a year-on-year increase of 307.5%, not only quickly offsetting previous declines but also surpassing the historical high of 2020 for the first time. The market penetration rate also rose significantly to 25%. This rebound shows that LNG heavy-duty trucks still have strong market elasticity and substitution capacity once price conditions recover.

Entering 2024, the LNG heavy-duty truck market gradually shifted from a retaliatory rebound to steady growth at a high operating level. Annual sales increased to 178,000 units, up 17.1% year on year, with a market penetration rate of approximately 30%. During this phase, the market maintained relatively stable expansion at a high penetration level, and LNG heavy-duty trucks gradually established their position as an important alternative energy model in the heavy-duty transport sector.

In 2025, terminal sales of natural gas heavy-duty trucks reached 198,700 units, an increase of 12%, approximately 20,000 units higher than the cumulative total for 2024 [40]. At the same time, however, the market penetration rate fell slightly from approximately 29.6% in 2024 to approximately 24.8%. This indicates that although the LNG heavy-duty truck market continues to expand, the accelerating penetration of new energy heavy-duty trucks may slow the growth rate and limit the potential for further increases in LNG penetration.

Overall, LNG heavy-duty trucks have completed the transition from an "alternative technology option" to a "mature and scalable pathway." Their market fluctuations reflect the cyclical nature of energy prices, changes in freight demand, and periodic competition among different energy routes, rather than uncertainty in the technology pathway itself. In the coming period, LNG heavy-duty trucks are expected to remain primarily deployed in medium- and long-haul trunk line transport scenarios, forming a realistic substitution relationship with diesel heavy-duty trucks. However, their room for further penetration will increasingly be influenced by new energy heavy-duty trucks, advances in electrification technology, and changes in the overall transport energy structure.

- **Current Technology Status of LNG Heavy-Duty Trucks**

The core advantages of LNG heavy-duty trucks are reflected in their strong fuel economy. During periods when the oil-gas price differential is stable, their total cost of ownership (TCO) is highly competitive. They also offer long range and high refueling efficiency: a single fill can support travel of more than 1,000 km, and refueling typically takes only 5-10 minutes, making them particularly suitable for long-haul trunk line transport. At the same time, their environmental performance is better than that of diesel heavy-duty trucks, with lower carbon emissions and reduced particulate and other pollutant emissions. As the most mature alternative fuel solution beyond diesel, LNG heavy-duty trucks have already achieved large-scale market application and have established relatively complete technical reliability and service systems.

However, the development of LNG heavy-duty trucks remains constrained by several factors. Insufficient gas station network coverage can significantly affect operational flexibility; fuel prices are vulnerable to fluctuations caused by international market conditions and seasonal factors, which may weaken their economic advantage; higher purchase costs compared with diesel models create financial pressure for users; and from the medium- to long-term perspective of the energy transition, LNG remains a transitional energy source whose carbon reduction potential may not match that of zero-emission technologies such as battery electric or hydrogen fuel cell vehicles.

In summary, with advantages in economics, range, and environmental performance, LNG heavy-duty trucks have become a scalable alternative power option for long-haul transport. However, their future development will still depend on the expansion of gas station networks, the stability of gas prices, and their continued positioning within the clean energy transition.

### 2.2.2. Application Scenarios

In China, the application scenarios of LNG heavy-duty trucks are strongly influenced by the oil-gas price differential and demand for tractor models. In regions with abundant LNG supply, gas station networks are generally more complete and the oil-gas price differential is more pronounced, making LNG heavy-duty trucks more competitive in terms of refueling convenience and operating economics. Based on the author's observation, in regions with strong demand for bulk resource transport, such as coal transport, and where tractors account for a high share of heavy-duty truck sales, LNG heavy-duty trucks are more favored because of their suitability for long-haul trunk line transport.

- **Concentration in LNG Resource-Producing Regions and Long-Haul Trunk Line Logistics**

| Year | Rank | Province | Sales | Share in National Production (%) | Share of Top 3 Provinces (%) |
|---|---|---|---|---|---|
| 2021 | 1 | Shanxi | 16100 | 27.1 | 50.4 |
| | 2 | Xinjiang | 7397 | 12.5 | |
| | 3 | Shaanxi | 6413 | 10.8 | |
| 2022 | 1 | Shanxi | 12500 | 33.5 | 67.9 |
| | 2 | Xinjiang | 9109 | 24.4 | |
| | 3 | Hebei | 3716 | 10 | |
| 2023 | 1 | Shanxi | 44000 | 29 | 53.1 |
| | 2 | Hebei | 23000 | 15.2 | |
| | 3 | Ningxia | 10000 | 8.9 | |
| 2024 | 1 | Hebei | 27400 | 15.4 | 39.2 |
| | 2 | Shanxi | 27300 | 15.3 | |
| | 3 | Henan | 15200 | 8.5 | |
| 2025 | 1 | Hubei | 28600 | 14.4 | 32.9 |
| | 2 | Shandong | 19700 | 9.9 | |
| | 3 | Shanxi | 17000 | 8.6 | |

**Figure 11. Sales and Share of Top Three Provinces for LNG Heavy-Duty Trucks, 2021-2025** [29][30][37][38][40]

Because the operation of LNG heavy-duty trucks depends heavily on gas source accessibility, gas infrastructure layout, and transport organization methods, their market expansion often shows clear regional differences. Observing provincial sales distribution therefore helps explain how LNG heavy-duty trucks achieved breakthroughs in different phases based on specific local conditions and then gradually expanded outward. The results show that the regional distribution of LNG heavy-duty trucks has evolved from "high concentration" to "gradual dispersion." From 2021 to 2023, the combined share of the top three provinces in annual sales remained above

50% for an extended period, indicating high dependence on a small number of provinces during the early stage of development. Since 2024, this concentration has declined clearly, with the combined share of the top three provinces falling to about 40% and then further to about 33% in 2025, indicating that LNG heavy-duty trucks are gradually expanding from early localized breakthroughs to a broader range of regions.

This evolution is related both to the geographical characteristics of LNG supply accessibility and economics, and to the demand suitability of typical application scenarios. On the one hand, in the early development stage, LNG heavy-duty trucks were more likely to achieve large-scale application in regions with relatively stable gas supply, more mature gas station networks, and clear oil-gas price differential advantages, resulting in highly concentrated sales in a few provinces. On the other hand, from the perspective of demand suitability, the provinces with the highest sales are often located in regions with stable bulk cargo transport demand and a high share of trunk line tractors. These regions typically have concentrated cargo sources, long transport distances, and high annual vehicle mileage, which gives fuel costs a greater weight in total operating costs and makes it easier to amplify the economic advantages of LNG heavy-duty trucks in long-haul trunk line scenarios.

With the gradual improvement of gas infrastructure, stronger gas source organization capabilities, and the replication of application experience, LNG heavy-duty trucks' dependence on individual provinces or local conditions is weakening. Their market distribution is gradually shifting from early "resource and corridor concentration" toward broader trunk line logistics regions.

### 2.2.3. Major Market Players and Competitive Landscape

| Year | Sales (10k) | Top 5 Brands | | | | | | Top 3 Share (%) | Top 5 Share （%） |
|---|---|---|---|---|---|---|---|---|---|
| | | Rank | 1 | 2 | 3 | 4 | 5 | | |
| 2020 | 14.2 | Brand | Sinotruk | FAW | Shaanxi Auto | Dongfeng | Dayun | 73.4 | 83.9 |
| | | Penetration （%） | 29.3 | 24.2 | 19.9 | 5.3 | 5.2 | | |
| 2021 | 5.93 | Brand | FAW | Sinotruk | Shaanxi Auto | Dongfeng | Foton | 67.86 | 87.19 |
| | | Penetration （%） | 27.38 | 22.27 | 18.21 | 14.05 | 5.28 | | |
| 2022 | 3.73 | Brand | FAW | Shaanxi Auto | Sinotruk | Dongfeng | Foton | 69.56 | 90.09 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Penetration (%) | 32.23 | 18.73 | 18.6 | 13.1 | 7.43 | | |
| 2023 | 15.2 | Brand | FAW | Sinotruk | Shaanxi Auto | Dongfeng | Foton | 67.88 | 93.13 |
| | | Penetration (%) | 33.48 | 17.7 | 16.7 | 16.3 | 8.95 | | |
| 2024 | 17.8 | Brand | FAW | Sinotruk | Dongfeng | Shaanxi Auto | Foton | 70.6 | 95.15 |
| | | Penetration (%) | 31.94 | 23.61 | 15.05 | 14.43 | 10.12 | | |
| 2025 | 19.87 | Brand | FAW | Sinotruk | Dongfeng | Shaanxi Auto | Foton | 67.8 | 96.6 |
| | | Penetration (%) | 27.8 | 21.6 | 18.4 | 15.6 | 13.2 | | |

**Figure 12. Market Sales Share of Leading LNG Heavy-Duty Truck Brands, 2020-2025 [29][30][36][37][38][40]**

As the LNG heavy-duty truck market continues to expand, vehicle manufacturers are increasing their presence and competing across multiple dimensions, including technological innovation, product upgrades, and scenario expansion. The market is characterized by **high concentration among leading firms and stable oligopolistic dominance**. Sales and market share data from 2020 to 2025 show that the combined share of the top five companies in China's LNG heavy-duty truck market continued to rise, from approximately 84% in 2020 to 96.6% in 2025. This indicates that market resources are accelerating their concentration toward leading companies, while the survival space for new entrants and small and medium-sized brands has been sharply compressed. Among them, FAW has consistently ranked first in the industry as its market share continued to increase. The market shares of the top five companies show an overall upward trend, while the gaps among them are gradually narrowing. The five leading companies—FAW, SinoTruk, Dongfeng, Shaanxi Automotive, and Foton—jointly control the majority of the market through deep technological accumulation, comprehensive sales networks, and mature brand influence.

- **Types of Competitors and Strategic Differences**

The top five brands in the 2025 LNG heavy-duty truck sales ranking collectively demonstrate the comprehensive competitiveness of leading manufacturers. These companies generally regard technological innovation and product iteration as core drivers. Among them, FAW has performed particularly well, guided by three major strategies: "traditional energy as ballast, new energy breakthrough, and global expansion" [40]. With the strong performance of its high-end LNG models, such as the J7 and Yingtu, in gas-saving performance, million-kilometer reliability, and driving comfort, FAW has effectively met user needs in resource transport scenarios such as coal and aggregate transport, establishing a solid product reputation. In addition, through continuous optimization of core powertrain technology and improvement of overall vehicle reliability, FAW has significantly reduced users' long-term operating costs while ensuring high uptime, thereby building a strong competitive moat around the brand.

## 2.3. Electric Heavy-Duty Trucks

### 2.3.1. Market Status

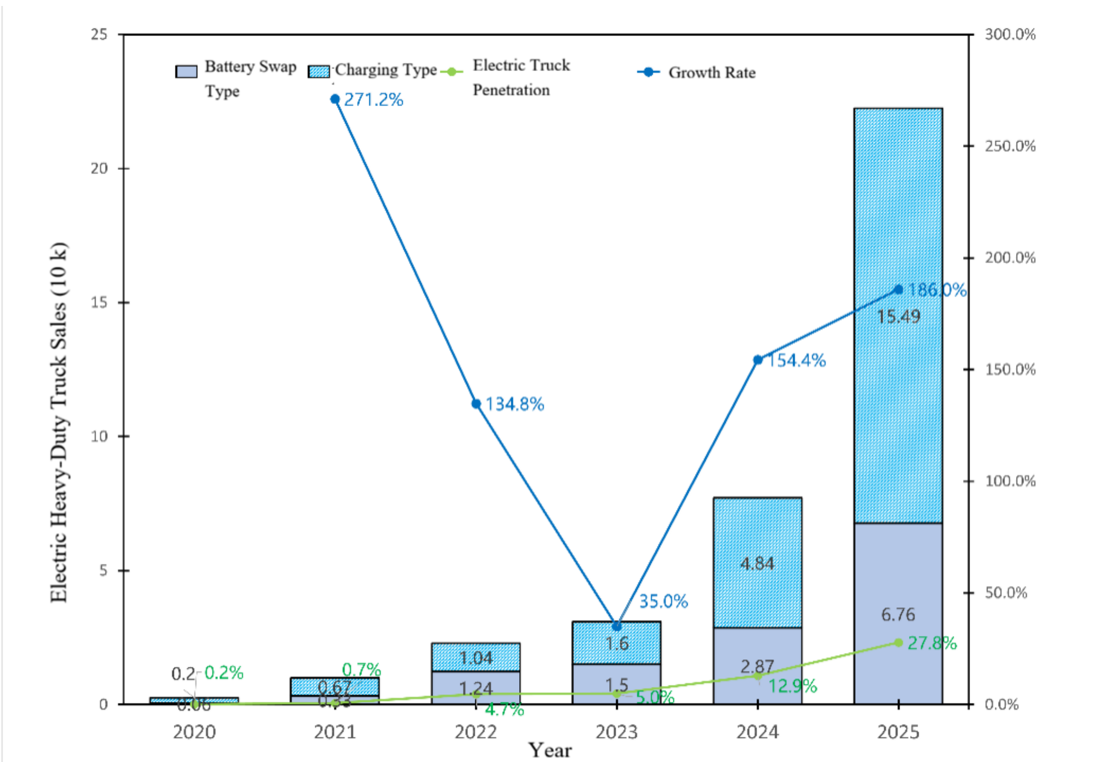


**Figure 13. China's Electric Heavy-Duty Truck Sales and Penetration Rate, 2020-2025 [41][42][44][45][47][48]**

Over the past five years, pure electric heavy-duty trucks have rapidly evolved in the Chinese market from a near-zero base to a stage approaching scale. From 2020 to 2021, market penetration remained below 1%, with the sector still in the stage of technical verification and demonstration introduction, and market development relying mainly on policy support. Since 2021, driven by the dual-carbon goal, key regional demonstration projects, market-oriented policy incentives, and the gradual emergence of economic viability in typical scenarios, electric heavy-duty trucks have entered a phase of continuous growth. By 2024, their market penetration rate had risen to approximately 13%, forming a clearly visible market scale for the first time and indicating that the pure electric route had crossed an important threshold from policy-driven demonstration to market-driven expansion. According to registration data[48], electric heavy-duty truck sales reached 222,500 units in 2025, representing year-on-year growth of 186%. This growth rate was significantly higher than that of the overall heavy-duty truck market, indicating that pure electric heavy-duty trucks are moving from early localized scenario breakthroughs toward broader large-scale expansion.

As penetration rises rapidly, a key question emerges: **Is the current growth momentum sustainable?**

Judging from market evolution in recent years, the development of pure electric heavy-duty trucks is affected by both short-term constraints and long-term positive drivers. Short-term restraining factors mainly come from two areas: first, the earlier purchase rush for diesel vehicles triggered by the transition to the China-6 emission standard, which placed the overall heavy-duty truck market in a stock-digestion phase; and second, the withdrawal of national new energy vehicle purchase subsidies, which increased initial purchase costs and caused some price-sensitive users to postpone electrification decisions. These short-term factors have created some disruption, but they do not change the long-term growth trend of electric heavy-duty trucks. The rapid sales growth in 2025, following the significant leap in 2024, also indicates that earlier growth was not merely a temporary volume release driven by short-term stimulus, but was supported by improving economics, better infrastructure, and expanding scenario suitability. In the future, the electric heavy-duty truck market may still experience periodic fluctuations due to industry cycles, price competition, and policy timing. In the long run, however, its growth momentum is gradually shifting from policy-driven support to market- and operation-driven logic, and the overall penetration trend is expected to continue strengthening.

- **Internal Structural Evolution of Pure Electric Heavy-Duty Truck Technology Routes: Differentiation Between Charging and Battery Swap**

During the rapid growth of pure electric heavy-duty trucks, the charging and battery swap technology routes have also begun to diverge. From the data, no single model formed an absolute dominant position in the early stage. In 2020-2021, battery swap heavy-duty trucks accounted for only 20%-30% of pure electric sales. With the concentrated implementation of MIIT's battery swap application pilots in Tangshan, Baotou, and other regions during 2021-2022, the high-utilization advantage of battery swap in specific heavy-duty truck scenarios—such as steel mills, mines, ports, and short-distance shuttle transport—was quickly verified. Its share once rose to more than 50% in 2022, showing a clear phase of concentrated volume release. However, this growth was mainly driven by policy demonstrations and regional scenario matching, rather than by a broad structural preference across the overall market.

Since 2023, the competitiveness of the charging route has increased significantly. Supported by improvements in both cost structure and scenario suitability, charging heavy-duty truck sales reached approximately 154,900 units in 2025, accounting for nearly 70% of pure electric heavy-duty truck sales and becoming the mainstream technology route in the electric heavy-duty truck market [48].

Overall, the changing market shares of charging and battery swap routes reveal clear pathway characteristics. Battery swap has irreplaceable advantages in timeliness and operational efficiency in typical high-frequency scenarios. However, as charging infrastructure gradually improves and the economic advantages of charging become more apparent, the charging route has developed broader adaptability and stronger expansion momentum during the scale-up phase.

- **Differentiated Ecosystems of Charging and Battery Swap Routes**

As the two mainstream refueling routes in the current new energy heavy-duty truck sector, battery swap and charging heavy-duty trucks each have distinct technical characteristics, applicable scenarios, and business logic.

The core feature of the **battery swap model** is "vehicle-battery separation." By separating the battery asset from the vehicle, users only need to purchase the vehicle body and rent batteries and swap services according to demand, significantly reducing initial purchase costs and improving the financial affordability of vehicle operations. Another core advantage is refueling speed: a single battery swap takes only 3-5 minutes, comparable to refueling a conventional fuel vehicle, greatly improving vehicle uptime and operational efficiency. This makes the model particularly suitable for high-frequency, fixed-route transport scenarios. In addition, swap stations conduct centralized, slow, constant-temperature, intelligent charging and battery maintenance, which helps extend overall battery life and enables the use of off-peak electricity for charging, supporting peak shaving and valley filling while improving economic and environmental performance. However, the model also faces significant challenges: the upfront construction cost of a single swap station is high; the high degree of standardization required for battery packs and vehicle interfaces leads to limited cross-brand and cross-model compatibility, making isolated systems easy to form; instantaneous power demand during swapping can place pressure on the local grid; and the operation and maintenance system is relatively complex.

The **charging model** relies on a mature and unified charging technology system. Facility construction costs are relatively low, deployment is flexible, and infrastructure can range from centralized charging stations to distributed small chargers. Unified interface standards and strong cross-brand compatibility make charging the most universal refueling method. In addition, charging generally uses progressive power input, placing relatively controllable pressure on the local grid and involving lower operation and maintenance costs. However, its main limitation is slower refueling speed. Even with fast charging, charging typically takes 1-2 hours, occupying operating time and making the model less suitable for scenarios requiring high continuous operation intensity and very fast vehicle turnover. In addition, large-scale charging capacity is constrained by land resources, grid access conditions, and parking-space availability, which may limit rapid expansion in certain areas.

### 2.3.2. Application Scenarios

The penetration path of pure electric heavy-duty trucks shows a gradual expansion from closed to open operating environments, from short-distance to longer-mileage operations, and from fixed routes to more complex scenarios. This evolution is not random; it is jointly determined by economics, infrastructure conditions, operational organization capabilities, and policy support. Based on existing market cases, the scenario expansion of electric heavy-duty trucks can be broadly divided into three stages: closed-scenario initiation, penetration into public-road short- and medium-haul transport, and exploratory breakthroughs in public-road long-distance transport[49].

- **Stage 1: Closed Environments as the Starting Point for Electric Heavy-Duty Trucks**

Electric heavy-duty trucks were first deployed in closed scenarios such as steel mills, power plants, mines, and ports. These scenarios share several common characteristics: relatively fixed operating areas, short transport distances, typically point-to-point loops, high requirements for transport efficiency, frequent idling or low-speed operation, and concentrated pollutant emissions subject to strong regulatory pressure. Scenario owners typically build dedicated charging or battery swap stations, creating closed-loop operations. Under these conditions, the refueling needs, range requirements, and vehicle dispatch models of electric heavy-duty trucks can be more easily matched to operational conditions, allowing their economics to be verified first.

- **Stage 2: Public Road Short- and Medium-Haul Transport Scenarios, Expansion from Single Points to Regions**

With improvements in vehicle reliability and public refueling networks, pure electric heavy-duty trucks have begun to expand into short- and medium-haul scenarios on public roads, such as rail-road intermodal transport, coal mine-to-power plant routes, and port-to-steel plant routes. These routes are generally relatively fixed, with one-way distances of around 20-100 km. In such scenarios, refueling can rely on stations along the route, public charging stations, or self-built facilities operated by enterprises, and the economic advantages of electric heavy-duty trucks are beginning to emerge across a wider range of operators. The expansion of these scenarios shows that electric heavy-duty trucks have developed cross-enterprise and cross-scenario operational capabilities, and that vehicle deployment no longer depends entirely on fully closed systems.

- **Stage 3: Public Road Long-Distance Transport Scenarios, Facing Breakthroughs but Still in Pilot Stage**

Public-road long-distance transport includes trunk line transport on expressways and national roads. This is currently the most challenging application area for electric heavy-duty trucks. Long-distance trunk line transport places extremely high requirements on vehicle range, charging speed, and the density and reliability of refueling networks along the route. It also brings several practical challenges: long-range batteries increase vehicle weight and cost; refueling time and infrastructure layout directly affect vehicle turnover; and operating conditions at highway speeds are more volatile, requiring higher vehicle reliability. This scenario represents the next development step for electric heavy-duty trucks but remains in the early stage of technical verification and pilot exploration. Large-scale application will depend on further breakthroughs in battery energy density, the maturity of ultra-fast charging technology, and the systematic deployment of a national heavy-duty truck charging network. Continuous improvements in "three-electric" technologies—battery, motor, and electronic control—are currently driving advances in vehicle range, refueling efficiency, and lightweighting, thereby laying the performance foundation for medium- and long-haul applications.

### 2.3.3. Major Market Players and Competitiveness Analysis

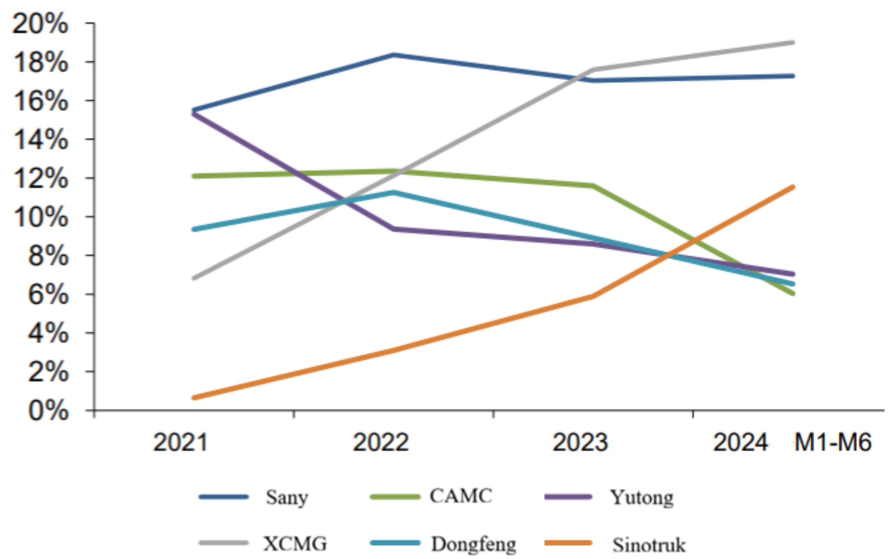


**Figure 14. Market Share of Leading Electric Heavy-Duty Truck Enterprises, 2021-2024 H1** [42]

Looking at the market share trends of major enterprises from 2021 to the first half of 2024, the electric heavy-duty truck market presents a competitive structure distinctly different from that of the traditional heavy-duty truck market, characterized by **diverse participants, significant share volatility, and an unsettled competitive landscape.** Throughout the observation period, no single company was able to maintain the leading position for an extended period, and rankings among leading players changed frequently. The market shares of some early leaders declined significantly; for example, Yutong and CAMC were gradually overtaken by later entrants after 2022. At the same time, some companies achieved rapid breakthroughs within a relatively short period. XCMG showed a more robust upward trend from 2021 to 2024, while Sany's market share remained consistently within the range of approximately 15%-20%, making it one of the few companies in the market to maintain relatively stable competitiveness.

This volatility reflects the fact that competition in the electric heavy-duty truck industry currently depends less on legacy market position and more on the suitability of technology route selection, vehicle matching with key scenarios, product iteration speed, cost-control capabilities, and the ability to integrate financing and ecosystem solutions. In the early stage dominated by pilot projects, companies that could quickly implement closed-environment solutions were more likely to gain an early lead. As the market gradually shifts toward economics-driven growth, companies with large-scale manufacturing capabilities, product reliability advantages, and stronger capital investment capacity have begun to accelerate their catch-up.

- **Types of Competitors and Strategic Differences**

From the perspective of participant structure, players in the electric heavy-duty truck market can be divided into four main categories[42]: traditional heavy-duty truck OEMs, construction machinery enterprises, cross-industry manufacturers, and new entrant startups. Different types of enterprises differ in technical accumulation, organizational models, market focus, and business boundaries, and these differences directly affect their strategic pathways and competitive performance in the electric heavy-duty truck market.

**Traditional heavy-duty truck enterprises**, represented by FAW, SinoTruk, Dongfeng, Shaanxi Automotive, and Foton, have a deep foundation in the traditional diesel and LNG heavy-duty truck markets. In the transition toward electrification, their core advantages lie in their mature vehicle manufacturing capabilities, complete supply chain systems, extensive dealer and after-sales service networks, and long-established brand recognition among users, making them important forces in large-scale market promotion. Among these enterprises, SinoTruk has achieved relatively rapid electrification progress in recent years. From 2021 to 2024, its electric heavy-duty truck market share continued to increase, and its product portfolio expanded significantly. According to information on its official website[50], SinoTruk has launched 13 electric heavy-duty truck models, covering mainstream 4×2 and 6×4 tractors, with battery capacities mainly concentrated in the 200-500 kWh range. It has also developed five specialized models for the niche market of single-side dock tractor transport in ports.

**Construction machinery enterprises** such as XCMG and Sany entered the new energy heavy-duty truck market relatively early, relying on their long-standing technology and manufacturing experience in the construction machinery sector. These manufacturers also frequently appear among the market share leaders. From 2021 to 2024, Sany was one of the companies with the most stable and highest market share, consistently maintaining a share of approximately 15%-20%, making it one of the few brands with sustained advantages in the electric heavy-duty truck market. Sany's product strategy emphasizes large battery capacity and long range. Its website currently shows that it has launched 15 electric heavy-duty truck models, mainly 6×4 and 4×2 tractors[51], with battery capacities generally around 400 kWh and high-end models reaching 636 kWh, supporting a range of approximately 500 km. XCMG has also shown a rapid increase in market performance through a richer product portfolio covering a wider range of operating scenarios, with its market share rising from less than 10% in 2021 to over 15% in 2024, temporarily overtaking Sany. Its website[52] shows that it has launched more than 20 electric heavy-duty truck models, covering 4×2 and 6×4 tractors, construction dump trucks, urban muck trucks, and other special-purpose vehicles, with battery capacities generally concentrated in the 400-600 kWh range. XCMG's XG2-EX610S charging tractor has a maximum battery capacity of 800 kWh, making it one of the electric heavy-duty trucks with the strongest range performance in the industry.

**Cross-industry manufacturers** include Yutong Group, Farizon, CAMC, and others. These companies mostly come from the new energy bus or passenger vehicle sectors, with mature three-electric technology systems and experience in vehicle electrification, and they entered the new energy heavy-duty truck market relatively early. However, as the market has moved from pilot programs to large-scale competition, their market shares have continued to decline since 2022. Although cross-industry companies have advantages in basic technologies such as electric drive and electronic control, they have not yet established a stable competitive foundation in the heavy-duty truck niche market and are generally in a phase of share contraction.

**New entrant enterprises** are represented by DeepWay, Windrose, and others. As new entrants to the market, they have flexible organizational structures and a strong focus on electric heavy-duty trucks, aiming to promote industry transformation through innovation. Taking DeepWay as an example, its electric heavy-duty truck products are designed around the actual operational needs of trunk line transport, emphasizing vehicle lightweighting, aerodynamic optimization, high battery energy density, high electric-drive efficiency, and deep integration of autonomous driving software and hardware. Its Xingchen series models cover mainstream 4×2 and 6×4 tractors, support both charging and battery swap refueling systems, and have battery capacities mainly concentrated in the 500-600 kWh range. DeepWay places greater emphasis on hardware-software collaboration, vehicle-road-cloud integration, intelligent dispatch platforms, and total life cycle operating cost management, attempting to establish differentiated advantages through system-level capabilities rather than single-vehicle performance alone.

Overall, the competitive landscape of electric heavy-duty trucks has not yet been finalized, and the characteristics of this incremental market make it difficult for any single company to maintain a leading position over the long term. For this study, this means that the evolution of technology routes cannot be analyzed solely from the technology itself, but must be assessed together with OEMs' resource allocation capabilities, product systems, regional presence, and choices of key entry scenarios. In the next three to five years, as large-scale business models gradually become clearer, the industry may still experience another round of competitive reshaping. Therefore, in subsequent technology pathway assessments and scenario analyses, this study will focus on the strategic preferences of leading companies, the alignment between their technology routes and regional energy structures, and the speed and scale of their deployment in core scenarios, in order to more accurately judge the feasibility and market evolution direction of different routes.

## 2.4. Hydrogen Fuel Cell Heavy-Duty Trucks

### 2.4.1. Market Status

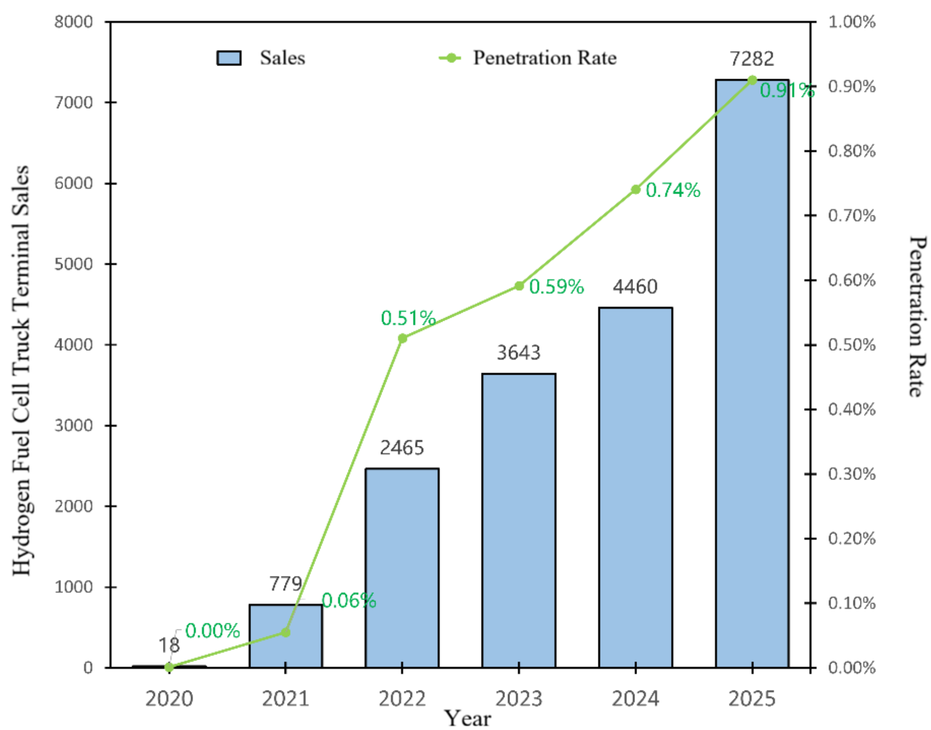


**Figure 15. Terminal Sales and Penetration Rate of Hydrogen Fuel Cell Heavy-Duty Trucks, 2020-2025** [62][63][64][65][66]

Hydrogen fuel cell heavy-duty trucks use hydrogen as fuel and convert chemical energy into electrical energy through a fuel cell system to power the vehicle. As an efficient and clean secondary energy carrier, hydrogen produces no carbon dioxide or pollutant emissions during vehicle operation. Hydrogen fuel cell systems also offer long range and high refueling efficiency, making them an important potential pathway for the low-carbon transition of heavy-load transport.

From 2020 to 2025, China's hydrogen fuel cell heavy-duty truck industry moved from an incipient stage toward rapid development. In terms of terminal sales, the market showed a clear upward trend. In 2020, only 18 vehicles were sold, with a market penetration rate of just 0.001%, indicating that the industry was still in the initial stage of technical verification and policy planning. Since 2021, strongly supported by the national "reward instead of subsidy" policy, the market has experienced explosive growth, with sales rising to 779 units—an increase of more than 42 times—and the penetration rate increasing to 0.055%, marking the beginning of the large-scale demonstration application stage. This growth momentum continued in 2022, with sales increasing to 2,465 units. Although the growth rate eased to 216.4%, the absolute increase remained significant. In 2023 and 2024, the sales growth curve gradually stabilized, reaching 3,643 units and 4,460 units respectively, with annual growth rates of 47.8% and 22.4%, while the penetration rate rose steadily to 0.591% and 0.741%. In 2025, hydrogen fuel cell heavy-duty truck sales reached 7,282 units, representing growth of 65.27%. However, despite strong growth momentum, the current penetration rate remains below 1%, objectively indicating that the market is still in an early stage. Large-scale adoption continues to face systemic challenges, including high hydrogen production costs, limited green hydrogen supply, inadequate hydrogen refueling infrastructure, and constraints in core fuel cell technologies.

In the promotion of hydrogen fuel cell heavy-duty trucks, **metropolitan areas play a major role**. In 2020, the Ministry of Finance and four other departments jointly issued the *Notice on Carrying out Demonstration Applications of Fuel Cell Vehicles*, adjusting the previous fuel cell vehicle purchase subsidy policy to a "reward instead of subsidy" model. The policy provides rewards to eligible metropolitan areas for industrializing key technologies and conducting demonstration applications of fuel cell vehicles, aiming to promote a new development model characterized by **proper planning, differentiated priorities, and coordinated advancement**[53]. At present, China's fuel cell vehicle demonstration areas have formed a "5+N" pattern, with Beijing-Tianjin-Hebei, Shanghai, Guangdong, Zhengzhou, and Hebei as the five national-level demonstration areas, while other cities are also actively participating[54]. The Beijing-Tianjin-Hebei metropolitan area focuses on key components such as fuel cell stacks and membrane electrodes, with the domestic content rate increasing from less than 10% before the demonstration to more than 90%, and the cost of fuel cell systems falling by 80%[56]. Shanghai, leveraging the Yangtze River Delta region, has built 40 hydrogen refueling stations[56]. The Guangdong metropolitan area is developing the Guangzhou-Shenzhen-Foshan hydrogen energy industry innovation corridor, focusing on logistics, cold chain, and port scenarios, and promoting fuel cell heavy-duty trucks and buses[54]. The Zhengzhou metropolitan area focuses on hydrogen heavy-duty trucks, sanitation vehicles, and buses, achieving large-scale operation in trunk line logistics and municipal scenarios. The Hebei metropolitan area relies on the Zhangjiakou National Renewable Energy Demonstration Zone to promote wind- and solar-powered hydrogen production and application scenarios such as hydrogen buses and intercity logistics vehicles[56].

- **Strengths and Weaknesses Are Both Prominent**

The core advantage of hydrogen fuel cell heavy-duty trucks is their ability to address the three key requirements of **range, efficiency, and environmental performance**, which are difficult for pure electric heavy-duty trucks and conventional diesel heavy-duty trucks to balance simultaneously in long-haul, heavy-load scenarios. The energy density of hydrogen fuel cell systems is much higher than that of power batteries. The mass energy density of compressed hydrogen or liquid hydrogen is 3.2 times that of diesel and as much as 150.6 times that of lithium-ion batteries[57], helping reduce vehicle weight and preserve more cargo space. At the same time, hydrogen fuel cell heavy-duty trucks offer higher energy efficiency and stronger range performance. Their refueling time of about five minutes is close to that of diesel vehicles and far shorter than that of charging-based electric vehicles, making them well aligned with long-haul application scenarios such as trunk line logistics, port collection and distribution, and mining transport. In terms of environmental performance, if hydrogen fuel cell heavy-duty trucks use green hydrogen produced from clean energy sources such as wind and solar power, they can achieve near-zero emissions on a life cycle basis.

Despite these clear advantages, the further market development of hydrogen fuel cell heavy-duty trucks still faces a series of challenges.

**Economic challenges related to total life cycle cost:** Currently, the purchase cost of hydrogen fuel cell heavy-duty trucks is approximately three to four times that of diesel vehicles. This is mainly due to high vehicle manufacturing costs, reliance on imported key materials and components such as platinum catalysts and proton exchange membranes, and the complexity of overall vehicle integration and production processes. In addition, operating costs remain high, with substantial costs across hydrogen production, storage, transport, and refueling[58]. The construction cost of a hydrogen refueling station can reach around CNY 15 million, and both construction and operating costs further increase hydrogen prices. Under these combined factors, the overall cost of hydrogen fuel cell heavy-duty trucks remains insufficiently competitive, making it difficult to form a sustainable commercial closed loop at this stage[59].

**Inadequate storage, transport, and refueling infrastructure:** Hydrogen storage and transport are prerequisites for large-scale application. Hydrogen has a low boiling point, low density, and small molecular size, making storage and transport difficult and costly, while also imposing high safety requirements. At the current stage, on-board high-pressure storage, tube trailer transport, and pipeline transport all face bottlenecks in efficiency, cost, or scalability. Meanwhile, the number of domestic hydrogen refueling stations remains limited. Their scattered distribution and low utilization make it difficult for the refueling network to support cross-regional, high-frequency trunk line transport by heavy-duty trucks. As a result, the application scope of hydrogen fuel cell heavy-duty trucks is still largely limited to pilot programs and small-area operations, making networked expansion difficult.

**Environmental concerns caused by limited green hydrogen supply:** The environmental value of hydrogen fuel cell heavy-duty trucks depends heavily on the hydrogen source structure. At present, domestic hydrogen is still mainly produced from coal and other fossil energy sources, while the share of genuinely renewable green hydrogen remains very low due to high costs, limited scale, and unstable supply[60]. Without a large-scale, low-cost, and clean hydrogen supply system, the decarbonization advantages of hydrogen fuel cell heavy-duty trucks cannot be fully realized at the life cycle level.

### 2.4.2. Application Scenarios

- **Stage 1: Heavy-Duty Operations in Closed Areas**

Early applications of hydrogen fuel cell heavy-duty trucks were mostly concentrated in closed heavy-duty operating scenarios, with initial deployments mainly focused on short-distance shuttle transport in relatively closed areas such as ports, mines, and factory sites. Driven by environmental demonstration projects led by local governments or large state-owned enterprises, these closed areas often have concentrated emissions and strong environmental pressure. The use of near-zero-emission heavy-duty trucks can both complete high-load transport tasks and improve local environmental quality, while also making it easier to build supporting hydrogen refueling infrastructure at an early stage and verify technical feasibility.

- **Stage 2: Fixed-Route Medium- and Long-Haul Trunk Line Logistics**

At present, the application of hydrogen fuel cell heavy-duty trucks is moving from closed environments to open roads, with initial large-scale operations emerging on specific routes. Core scenarios have shifted toward point-to-point trunk line transport in resource-based regions, such as coal transport routes from mining areas in Shanxi and Inner Mongolia to the Beijing-Tianjin-Hebei region, as well as raw material and finished product transport routes for large steel enterprises. In these scenarios, the 49-ton hydrogen fuel cell tractor has become the mainstream model. These routes feature concentrated cargo sources, stable transport demand, and fixed operating paths, making it relatively feasible to plan hydrogen refueling stations along the route and create conditions for commercial closed-loop operations.

Looking ahead, hydrogen fuel cell heavy-duty trucks have relatively clear natural suitability in certain niche scenarios. First, in ultra-long-distance trunk line transport with high requirements for continuous operation, fast refueling and long range allow vehicles to maintain higher daily utilization rates, which pure electric heavy-duty trucks currently find difficult to achieve without significantly increasing battery weight and charging time. Second, in extremely cold regions or under high-intensity heavy-load conditions, hydrogen fuel cells offer relative advantages in low-temperature performance, power stability, and continuous output capacity. Third, in transport tasks that are highly sensitive to vehicle weight and effective payload, higher energy density helps improve single-vehicle transport capacity and operational efficiency.

In addition, the current and potential application scenarios of hydrogen fuel cell heavy-duty trucks share several internal logics. First, environmental regulatory constraints make hydrogen fuel cell heavy-duty trucks valuable in emission-sensitive areas. Second, their dependence on infrastructure means that they are more suitable for promotion in corridors and routes with highly concentrated transport organization. Third, life cycle efficiency is critical: hydrogen fuel cell heavy-duty trucks can compete with conventional energy routes only under high-intensity and stable operating conditions.

### 2.4.3. Major Market Players and Competitiveness Analysis

Overall, China's hydrogen fuel cell heavy-duty truck market is still undergoing significant reshaping, with diverse participants, high dynamism, and an unsettled competitive structure.

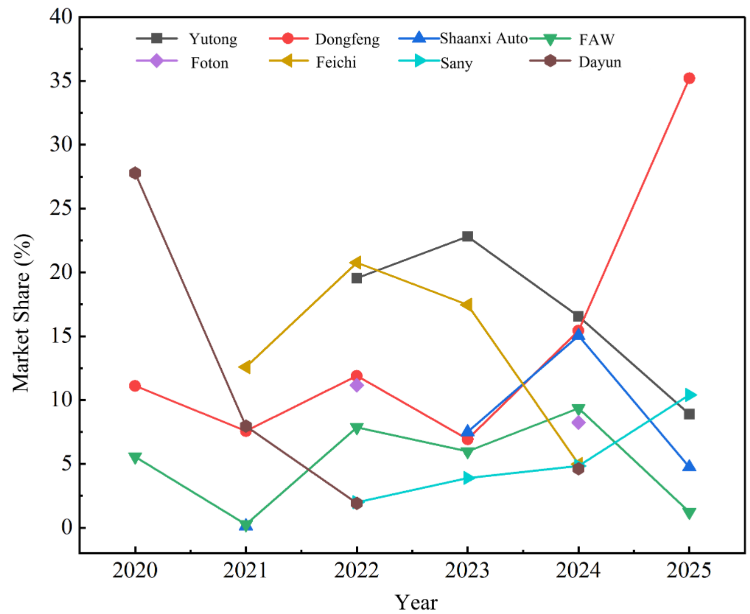


**Figure 16. Market Share of China's Hydrogen Fuel Cell Heavy-Duty Truck Enterprises, 2020-2025** [61][62][64][67]

One notable change is that enterprises that held leading positions in the early stage have not necessarily maintained their advantages. For example, Dayun was among the market leaders with a high share in 2020, and Feichi maintained strong competitiveness in 2021-2022. However, by 2025, the market influence of both companies had declined significantly. This indicates that early leadership in the hydrogen fuel cell heavy-duty truck market was driven more by pilot projects and localized market breakthroughs than by stable large-scale competitive barriers.

At the same time, participation by traditional heavy-duty truck enterprises is increasing significantly. Traditional vehicle manufacturers such as Dongfeng, Shaanxi Automotive, and FAW have gradually accelerated their deployment since 2022. Dongfeng's market share rose rapidly to approximately 35% in 2025, making it one of the most prominent leading companies, while Sany Group has also entered the first tier in the past two years. In contrast, although Yutong Group held a leading position in 2023 and 2024, its market share declined in 2025. These changes indicate that market competition remains in a dynamic adjustment stage and has not yet formed a relatively stable structure comparable to that of the traditional diesel heavy-duty truck market.

At this stage, the hydrogen fuel cell heavy-duty truck market remains strongly project-driven and region-driven, with market shares highly affected by the pace of demonstration project implementation, regional policy support, and batch-order delivery. As traditional vehicle manufacturers continue to increase investment, the industry's competitive logic is gradually shifting from early first-mover advantages and project-driven growth toward competition based on system-level capabilities.

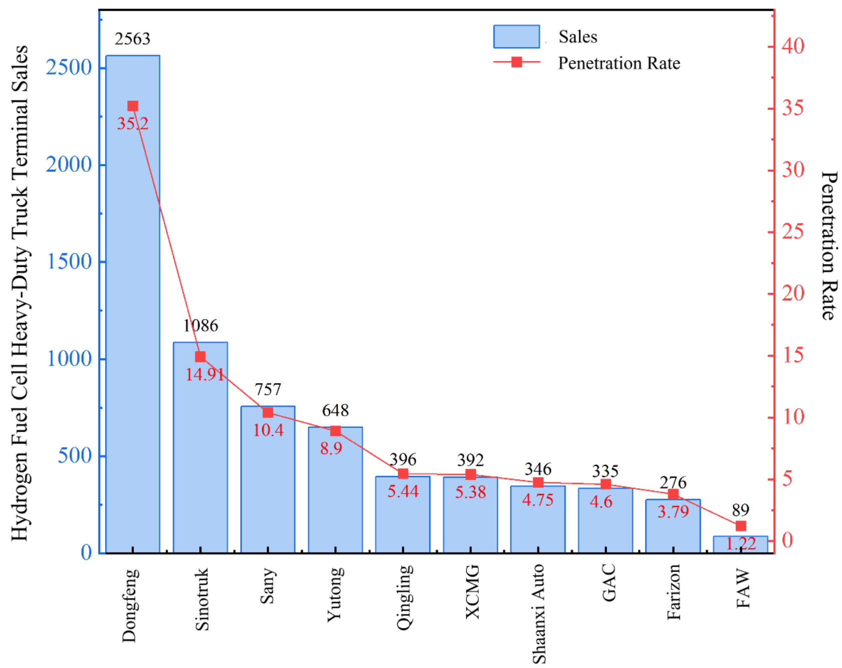


**Figure 17. Terminal Sales Market Structure of China's Hydrogen Fuel Cell Heavy-Duty Trucks, 2025** [67]

The list of the top five brands in China's hydrogen fuel cell heavy-duty truck market in 2025 shows a trend toward stabilization, although specific rankings remain subject to change. Compared with 2024, the top five companies remained the same, but their rankings changed, indicating that a leading group has begun to form while the market structure has not yet fully solidified. In terms of share changes, Dongfeng and Sany were among the few brands that increased their shares in 2025 compared with 2024. Dongfeng's increase was particularly significant, while the shares of other leading brands declined to varying degrees.

- **Types of Competitors and Strategic Differences**

In the hydrogen fuel cell heavy-duty truck market, **traditional heavy-duty truck leaders** represented by Dongfeng, Shaanxi Automotive, and FAW were not the earliest entrants, but they have gradually incorporated hydrogen fuel cell heavy-duty trucks into their mainstream product portfolios after steady strategic planning. These companies fully leverage their large-scale manufacturing capabilities, mature sales and service networks, and deep understanding of major customer needs, enabling them to make steady market progress over time. They focus on traditional advantageous regions and mainstream logistics scenarios, such as regional trunk line transport, port collection and distribution, and green logistics projects within large industrial enterprises. According to information on the Shaanxi Automotive website, its hydrogen fuel cell heavy-duty truck products include dump trucks and tractors, which are suitable for fixed short-distance scenarios such as urban construction muck, coal, and crushed stone transport, as well as steel, aggregate, finished profile, and container transport[67].

**New energy technology integrators**, represented by Yutong Group, entered the market from a relatively strong starting point by relying on accumulated experience in three-electric system integration, integrated vehicle electronic and electrical architecture, and energy management. Their strategy focuses on providing systematic new energy solutions. Yutong leveraged public-sector customer resources accumulated in the bus sector and was among the first to enter closed or semi-closed demonstration operation scenarios. However, as traditional heavy-duty truck enterprises fully entered the market and expanded into open transport scenarios, especially long-haul trunk line tractors, Yutong's shortcomings in durability and adaptability to extreme operating conditions in specific heavy-duty truck scenarios gradually became more apparent. This has weakened its early-mover advantage and placed pressure on its market share.

**Specialized manufacturers** that focused on hydrogen energy at an early stage, such as Feichi, concentrated their early strategies on specific demonstration projects and regional market development. These companies gained significant advantages during the initial stage of industrial policy implementation through keen sensitivity to industry trends and flexible decision-making mechanisms, and they once held leading market positions. According to information on Feichi's official website, its hydrogen fuel cell heavy-duty trucks mainly include tractors, dump trucks, scrubber trucks, logistics vehicles, and other models. Its tractors are suitable for medium- and long-haul operating scenarios of more than 800 km, while other models are suitable for port shuttle, municipal special-purpose, mining transport, and other scenarios[68]. However, as industry competition shifted from completing demonstration tasks to comprehensive market competition involving large-scale manufacturing and cost control, their relative weaknesses in production systems, supply chain cost optimization, and cross-regional sales and service network construction led to a significant decline in market share in later stages.

At the same time, **industrial ecosystem collaborative players**, represented by Sany, have also emerged in the market. Their strategies show clear scenario-oriented characteristics. Rather than directly competing in mainstream markets such as conventional tractors, they deeply integrate their strong industrial foundation and customer resources in construction machinery, focusing on niche markets such as hydrogen mixer trucks and port tractors. According to information on Sany's official website, its hydrogen fuel cell heavy-duty trucks are mainly tractor models, suitable for scenarios such as steel, aggregate, coal, plant, and port transport[69]. This strategic layout enables these companies to gradually build a sustainable market foundation in niche segments with relatively high entry barriers and clear synergies with their main business, supporting steady improvements in market share.

# 3

# 3 Logistics Scenario Development Trends and Impact Analysis

After experiencing global supply chain shocks, rapid breakthroughs in digital technology, and structural adjustments in the domestic logistics system, China's logistics and transport industry is moving toward a new development stage driven jointly by regionalization, diversification, and digitization. The operating mechanism of the logistics system is undergoing profound changes: supply chain organization is restructuring from intercontinental extension to intra-regional models, operational models are shifting from experience-driven to data-driven, cost management is moving from local optimization to full supply chain coordination, and green and low-carbon goals are accelerating the renewal of energy structures and transport equipment. These changes are not only reshaping the efficiency structure and competition methods of the logistics industry itself but also placing entirely new demands on the technology pathways, market landscape, and industrial ecosystem of the heavy-duty truck industry.

Against this background, this chapter starts with the development trends of the logistics industry, reviewing how key forces such as global supply chain restructuring, digitalization, automation, cost optimization, and green transition jointly act on the evolution of transport scenarios. It further analyzes how these trends will profoundly affect the heavy-duty truck industry in the future, aiming to provide basic information for subsequent technology pathway analysis and industry outlook.

## 3.1 Logistics Industry Development Trends

To identify the trends that have the greatest impact on road freight, especially new energy heavy-duty trucks, this study comprehensively reviews major global logistics trend reports [70][71][72][73], combines previous exchanges with industry stakeholders (cargo owners, logistics enterprises, vehicle manufacturers, energy enterprises, etc.), and considers the policy direction of China's road transport, summarizing several core trends closely related to land transport.

### 3.1.1. Regional Restructuring of Globalization

Over the past decade, global supply chains have undergone profound changes. Supply chain disruptions caused by the pandemic, rising geopolitical tensions among major economies, intensifying trade barriers, energy price volatility, and the impact of extreme weather on port and shipping systems have exposed the vulnerability of the traditional globalization model that relies on a single manufacturing center and long-chain intercontinental transport. After experiencing multiple rounds of supply chain shocks, enterprises have begun to reassess the reliability of the "cost-optimal" model, placing supply chain resilience, risk controllability, and regional balance on the same or even higher priority than cost.

Against this background, a new round of global supply chain restructuring trends characterized by "polycentralization, regionalization, and nearshoring" is gradually taking shape. **Polycentralization** means that global manufacturing capacity is no longer concentrated in a few countries but is simultaneously forming new industrial and logistics clusters in Asia, the Americas, Europe, and other regions. **Regionalization** is reflected in the continuously increasing degree of closure of production, consumption, and logistics within regions, with the importance of intra-regional cross-border transport rising. **Nearshoring** means enterprises moving their supply systems from distant countries to regions closer to major markets and with more stable political environment. Such actions aim to reduce intercontinental transport risks, shorten replenishment cycles, and improve control on global supply chain. The above-mentioned trends together drive the transformation of global supply chains from a deep global integration model to a resilient network with multiple regional centers.

**If these trends continue,** the growth of intercontinental long-distance transport will be reduced, while the demand for intra-regional short- and medium-haul transport, inter-regional land-based cross-border transport, and connectivity between inland ports and hubs will significantly increase. The importance of multimodal transport and road-rail-water coordination will rise, and regional logistics infrastructure will form more a networked collection and distribution system. The accelerated spatial contraction of supply chains will make logistics enterprises pay more attention to transport timeliness, cost stability, and organizational flexibility. These changes may together cause **road transport** to play a more centered role in the connection and circulation of regional supply chains.

For the road freight industry, especially the development of new energy heavy-duty trucks, the growth of intra-regional transport demand means that more transport tasks will be performed on routes of short- and medium-haul, high-frequency, and with less uncertainty. Such scenarios highly overlap with the operational advantages of pure electric heavy-duty trucks, which may give electrification a stronger economic foundation and higher penetration potential. At the same time, differences in energy structure, refueling infrastructure, industrial layout, and policy orientation across regions will also drive the energy pathways of new energy heavy-duty trucks to show obvious regional differentiation. For example, regions with lower electricity costs and higher density of refueling infrastructure may prioritize the formation of pure electric pathways, while regions with abundant hydrogen resources or policy preferences may achieve breakthroughs in hydrogen energy heavy-duty trucks first.

Overall, the trend of regional restructuring of globalization not only changes the spatial pattern of cargo flow but also reshapes the functional positioning of road transport in supply chains, creating new opportunities for the development of new energy heavy-duty trucks.

### 3.1.2. End-to-End Digitalization and Visualization

With the rapid development of the Internet of Things (IoT), big data, blockchain, digital-twin technology, cloud computing, and intelligent terminals, the logistics industry is shifting from a traditional decentralized, manual operation-driven model to a vehicle-station-cloud integration. Although the industry as a whole is still in a continuous evolution stage, end-to-end digitalization and visualization have become key trends for the next round of efficiency improvement and model restructuring in the logistics system. The key target is to achieve a higher level of transparency, controllability, and predictive capability, enabling the logistics system to have stronger resilience and coordination capabilities in a more complex market environment.

Multiple factors are affecting this trend: first, supply chain timeliness requirements are continuously increasing, and traditional operation methods relying on manual scheduling and empirical judgment are unable to cope with more frequent demand fluctuations; second, enterprises are under increasing operating cost pressure and need to use digital means to improve vehicle utilization, optimize routes, reduce empty mileage, thereby reducing overall costs; third, government policies is promoting logistics digitalization upgrades, including developing digital transport, promoting capacity resource sharing, and advancing green transport system development; fourth, ESG and climate disclosure requirements are increasing, forcing enterprises to strengthen end-to-end carbon emission visualization. These factors together make end-to-end digitalization a capability that logistics enterprises must develop.

The essence of this trend is to connect scattered nodes in the logistics chain, achieving real-time information flow between vehicles, terminals, warehouses, order management platforms, and upstream and downstream supply chains. By deploying IoT devices on vehicles, building intelligent dispatch systems at terminals, and forming unified data platforms in the cloud, logistics enterprises can monitor key operational indicators such as vehicle location, energy consumption status, load conditions, route deviations, and refueling needs in real time. Digital twin technology further enables enterprises to simulate and predict logistics networks, identifying capacity bottlenecks, dispatch pressures, and potential risks in advance. When data accumulation reaches a certain scale, intelligent scheduling algorithms can also dynamically optimize transport routes and refueling strategies based on order distribution, energy prices, road conditions, and vehicle performance.

For the road transport industry, the advancement of end-to-end digitalization will significantly change vehicle operation methods. Transportation will shift to a network-centered collaborative model, with vehicle operation routes, refueling plans, and attendance schedules increasingly relying on platform system optimization rather than drivers' personal experience. Fleet management will also evolve into real-time management and predictive management, with fault warning, operational efficiency diagnosis, and economic optimization becoming new industry standard capabilities. New energy heavy-duty trucks, with their stronger transparency in energy consumption management, carbon emission accounting, and TCO optimization, may stand out in more scenarios. For example, battery status monitoring and precise management, intelligent energy consumption prediction, and automated scheduling and refueling planning enable pure electric and battery swap heavy-duty trucks to maintain stability and economy in more complex transport scenarios. **As the level of end-to-end visualization increases, the scenario suitability of new energy heavy-duty trucks is likely to be significantly enhanced**, and their penetration may have the opportunity to expand from closed industrial parks and short-distance shuttle scenarios to more open and complex public road transport systems.

### 3.1.3. Automation and Operational Modernization

As digital foundation capabilities develop, the logistics industry is accelerating toward an automation-centered modernization stage. Different from digitalization, the automation referred to in this section places more emphasis on the upgrade of physical operational capabilities, representing a fundamental restructuring of warehousing, transport, and capacity dispatch systems. This trend has been regarded as one of the most far-reaching forces of change in the next decade in multiple global logistics trend reports.

Compared with previous years, the industry's focus has shifted from local equipment automation to systematic efficiency improvement centered on transport organization, with the two trends that have the greatest impact on road transport and the heavy-duty truck industry reflected in the following aspects. First, **autonomous driving technology** is advancing rapidly, especially in trunk line highway and closed industrial park scenarios [74][75]. The core value of autonomous driving is not to completely replace drivers but to improve driving safety and energy efficiency through speed control, automatic platooning, and intelligent driver assistance, while significantly reducing labor cost pressure in ultra-long-distance transport. Second, the degree of automation in warehousing and terminal operations continues to rise, with facilities such as automated sorting, automated forklifts, and intelligent dock loading and unloading becoming mainstream configurations in logistics nodes. This automation does not directly change the heavy-duty truck itself but will significantly improve the coordination of the logistics chain and impose higher requirements on vehicle operation. For example, in automated ports and large intelligent warehouses, vehicles must have higher queue management capabilities, precise positioning capabilities, and digital interface capabilities with terminal dispatch systems to match high operation speed.

Overall, automation and operational modernization not only change the operation methods of the logistics industry but also reshape the technical requirements for transport equipment. Heavy-duty trucks will gradually transform from simple transport tools to mobile nodes integrating sensors, algorithms, and network coordination capabilities. This means that future heavy-duty trucks must have more stable operational performance and deep interface capabilities with platform systems.

#### 3.1.4. Cost Optimization and Resource Optimization

Multiple global logistics trend reports point out that cost pressure is becoming the most direct force changing logistics organization methods, and this pressure is not a short-term phenomenon but will exist in a longer term as global supply chain complexity increases, capital costs rise, and customer requirements for stability and punctuality increase. The result is that the entire industry is shifting from pursuing scale to pursuing efficiency.

The core of this trend lies in logistics enterprises' re-examination of **everything from vehicle purchase, energy costs, labor, to vehicle idle rates**. As transport uncertainty increases, enterprises gradually reduce their focus on costs of specific items and processes and turn to take total life cycle cost and network-level resource efficiency as key decision-making bases. This drives the logistics system to evolve toward a higher degree of intensification and platformization: capacity integration, route sharing, return trip resource optimization, coordinated dispatch, and regional alliances may become mainstream practices. For large logistics providers, this means accelerating the transformation to large-scale fleet management, regional dispatch centers, and integrated service solutions. For small and medium-sized logistics enterprises, cost pressures in energy, vehicles, maintenance, and other areas will prompt them to further rely on the network capabilities of platform-based enterprises or large freight forwarders.

The cost optimization trend has a particularly direct impact on the road transport industry. **First,** enterprises with large-scale organization capabilities are more likely to successfully implement new energy routes. **Second,** the energy pathway choice for heavy-duty trucks will be increasingly driven by TCO (total cost of ownership), not just purchase cost or policy incentives. Energy price fluctuations, refueling efficiency, vehicle turnover rates, and capacity scheduling capabilities will all become key variables affecting operating costs. **Third,** the resource intensification trend will accelerate the industry's shift from dispersed fleets to platform-based coordinated fleets, creating a closer synergy between the refueling infrastructure of new energy vehicles, capacity dispatch platforms, and regional logistics hubs. This means that for new energy heavy-duty trucks to further increase their penetration rate in the future, it will depend not only on the economics of the vehicle itself but also on whether they can integrate into regionalized, large-scale logistics organization systems.

#### 3.1.5. Green Transition and Circular Economy

Green transition and circular economy have become irreversible long-term trends in the logistics industry. Trend reports generally point out that this transformation is driven not only by regulation but also by active demands from the market side—international brands, e-commerce platforms, and large manufacturing enterprises are incorporating supply chain carbon emissions into key performance indicators, forcing logistics enterprises to transition to cleaner, more transparent, and more circular operational models.

This trend covers three levels. First, the **energy structure** is shifting from fossil energy to renewable energy-driven transport equipment, including pure electric, hydrogen, and renewable fuels (such as biodiesel and SAF). Second, green logistics is not limited to vehicle power but also includes green warehousing, green packaging, route optimization, recyclable pallet systems, and **recycling systems** for reverse logistics. From the perspective of the entire supply chain, recycling is moving from an add-on to a systemic design and is gradually being incorporated into corporate ESG requirements and cost optimization models. Third, the green transition trend drives higher requirements for **transparency and traceability**, with carbon emission quantification, certification, and digital reporting becoming normal practices for large supply chain enterprises, making green transport capabilities an important competitive factor for enterprises.

For the road transport industry, the green transition and circular economy trends are directly changing vehicle technology pathways and operational boundaries. First, new energy heavy-duty trucks may no longer be just a "low-emission option" but a necessary condition to meet supply chain green commitments and enter the transport networks of key customers. As more manufacturing, consumer goods, and multinational companies require Scope 3 emission reductions, new energy routes will gain higher priority in trunk line logistics, road-rail intermodal transport, and park logistics. Second, the proportion of renewable energy used may also become an important factor affecting the competitiveness of energy pathways, forming a sustainable pattern where multiple technologies coexist, including energy transition of oil-to-electricity, oil-to-hydrogen, and renewable fuel substitution. Third, the introduction of circular systems (such as battery recycling, power battery reuse, and green packaging return systems) will prompt logistics enterprises to pay more attention to total life cycle value in asset management and vehicle selection, rather than just short-term investment returns.

## 3.2 Impact on the Heavy-Duty Truck Industry

### 3.2.1. Impact on Technology Pathways

Synthesizing the logistics development trends discussed above, it is clear that the relative advantages of new energy technology routes are strengthening. The regional restructuring of globalization and the growth of intra-regional short- and medium-haul transport, as well as cross-border trunk line logistics, mean that a growing number of transport tasks are concentrated on high-frequency routes with controllable operations and relatively stable mileage patterns. These scenarios are naturally favorable to new energy heavy-duty trucks with low energy consumption, low maintenance costs, and stronger operational controllability, especially the pure electric pathway. In such scenarios, traditional diesel vehicles will find it increasingly difficult to maintain cost advantages and will no longer be the default option for all applications.

Under the new logistics organization model, the priority of vehicle technology capabilities has also changed significantly. Heavy-duty trucks not only need stronger range, refueling efficiency, and operational stability, but also need to be integrated into digital operating systems to enable real-time coordination of energy consumption, mileage, refueling strategies, location, and scheduling.

Digitalization is transforming vehicles from independent operating units into mobile network nodes that can be optimized at the system level. Future new energy heavy-duty trucks must be deeply connected with transport capacity platforms, dispatch systems, energy management systems, and terminal control systems; otherwise, their economic, efficiency, and reliability advantages cannot be fully realized in large-scale operations. At the same time, the development of autonomous driving, intelligent terminals, and vehicle-road coordination requires vehicles to have the underlying capabilities needed for future upgrades, including open electronic and electrical architectures, expandable space for sensor deployment, and connectivity with automation systems.

In addition, the green transition and circular economy trends directly incorporate battery life management, power battery recycling, and the share of renewable energy used into comparisons of technology routes. Future assessments of whether a given route is feasible will need to consider not only range, safety, and cost, but also whether the route can remain viable under long-term carbon and resource constraints.

### 3.2.2. Impact on Market Landscape

At the market landscape level, the high concentration of the traditional diesel heavy-duty truck market is rooted in the long-term accumulation of product maturity, sales channels, and service networks. This pattern will not disappear in the short term. However, as the main incremental market, the new energy heavy-duty truck segment is significantly more open and dynamic. Combined with the logistics trends discussed above, the current reshaping of competitive power is likely to continue for some time.

Logistics regionalization, the dual constraints of cost and green transition, and digital operating models have collectively changed the conditions for market success. The key competitive factors are no longer limited to single-vehicle performance, price, or brand reputation. Instead, they increasingly depend on whether companies can provide integrated solutions that combine vehicles, energy supply, digital platforms, scenario-based services, and operational support. In this context, manufacturers with stronger scenario-entry capabilities, regional resource integration capabilities, and ecosystem coordination capabilities may gain advantages in the next stage of competition.

For enterprises seeking to maintain or gain advantages in the next round of industry restructuring, the key is not simply to follow emerging concepts, but to translate the trends identified in Section 3.1 into actionable capabilities. This means making more focused regional and scenario choices rather than attempting to cover all regions and all routes; concentrating resources on selected niche scenarios with clear operational logic; and shifting from selling vehicles alone to providing operable logistics solutions that integrate energy coordination, digital platform connectivity, financial solutions, and operational support alongside the vehicle product. Under the green transition, companies also need to build capabilities in carbon accounting, low-carbon energy coordination, battery life cycle management, and circular economy integration, so that their products and services can meet the increasingly explicit decarbonization requirements of cargo owners and logistics operators.

For this study, this means that in subsequent analyses of technology pathways and application scenarios, OEM and supply chain capabilities and strategic choices must be treated as endogenous variables. Whether a given route can move from pilot applications to large-scale deployment depends largely on whether sufficiently capable market participants are willing to invest in that route and whether they can translate the opportunities created by logistics trends into operable and replicable commercial closed loops in specific regions and scenarios.

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