# China Green Freight Assessment

## Project Report

**China Automotive Technology and Research Center**

**Beijing Operations**

**October, 2018**

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## Executive summary

Vehicles account for approximately 55% of the total gasoline and diesel consumption in China each year, and more than 70% of the annual increase of oil consumption is consumed by new vehicles sales.[1] Oil consumption in China exceeded 556 million tonnes in 2016, with imports reaching 65.4%.[2] Heavy-duty vehicles have become the top fuel-consuming vehicle category in China due to higher fuel consumption rates and greater annual driving mileage.

This report aims to develop an in-depth understanding of China's road freight system and evaluate the potential benefits of promoting green freight programs in China. In addition, the assessment is intended to serve as a reference for government agencies developing policies to promote transport efficiency, reduce energy consumption, and mitigate the environmental impacts from freight trucks.

Supported by the International Council on Clean Transportation's (ICCT) experience and freight assessment methodologies, the China Automotive Technology and Research Center Beijing Operations (CATARC Beijing) has developed in-depth research on developing trends in Chinese freight market, freight vehicle characteristics, and penetration of fuel-efficiency technologies. The nine key findings of this assessment are:

1. Freight transported by road accounts for 80% of the total freight market. Most carriers in the road freight market are private individual operators.

2. With the development of high-speed railways, the market share of rail freight will increase rapidly, particularly for coal and large goods.

3. Over-load and over-limit operations are quite common in the Chinese road freight industry. Currently, enforcement is the main method used to address over-load and over-limit operation in China. Since the 2016 implementation of "9.21" regulations, long-haul freight vehicles now generally operate at standard-load but over-limiting remains a problem. However, over-loading is still very common among urban delivery vehicles.

4. Straight trucks represent the most common body type used for road freight in China, however, the population of tractor-trailers is increasing rapidly.

5. The market shares of alternative fuel and pure electric heavy-duty trucks are

[1] Compiling Instructions of "Fuel Consumption Limits for Heavy-duty Commercial Vehicles"
[2] "Report of Oil and Gas Industry Development, 2016," CNPC Economics and Technology Research Institute.

increasing rapidly, particularly in the urban delivery market. Also, the market penetration of pure electric vehicles is increasing sharply due to government policies.

6. The driving speed of freight vehicles in China is relatively low due to traffic congestion. The average speed of mainline freight vehicles is about 60km/h and the speed of urban delivery vehicles averages 30 – 40km/h.

7. The selection of fuel-saving technologies depend primarily on vehicle size. Most vehicles under 4.5 tonnes employ electric driving systems due to government policy. For most vehicles greater than 12 tonnes, fuel-saving technologies include alternative fuels, light-weighting, and those that reduce aerodynamic drag and rolling resistance.

8. Although fuel consumption is a factor considered by freight carriers and individual users, it is not the most important criteria in truck purchase decisions.

9. Driver training programs that promote fuel savings require low investment from operators and offer distinct fuel-saving benefits. However, both vehicle fleets and management agencies fail to take advantage of this option.

Road transport is expected to remain the primary mode of transportation in China for the foreseeable future. Online logistics platforms have the potential to greatly increase freight efficiency. Encouraging rail freight, and the large-scale adoption of electric trucks in urban delivery systems could also greatly reduce energy consumption and mitigate the environmental impacts of the sector.

## Terms and definitions

**Heavy-duty vehicle** refers to tractors, trailers and straight trucks with gross vehicle weight of more than 3,500kg (including breast board truck, van truck and stake truck), dump trucks are not included in this report.

**Stage 2 fuel consumption limits** refers to "*Fuel Consumption Limits for Heavy-duty Commercial Vehicles*" (GB 30510-2014).

**Stage 3 fuel consumption limits** refers to "*Fuel Consumption Limits for Heavy-duty Commercial Vehicles*" (Stage 3). Stage 3 limits will be implemented beginning July 1, 2019. Generally, Stage 3 tightens the limits by an average of 10.7% – 17.9% compared to the base of Stage 2.

**GB1589-2016** refers to the enforced national standard "*Limits of dimensions, axle load and masses for motor vehicles, trailers and combination vehicles*" as revised by MIIT (Ministry of Industry and Information Technology) and NTCAS (National Technical Committee of Auto Standardization). The standard prescribes the limits of dimensions and masses for motor vehicles, trailers, and combination vehicles, which apply to all on-road vehicles, and is one of the basic technical standards for the motor vehicle industry. The standard was released by AQSIQ (General Administrative of Quality Supervision Inspection and Quarantine) and SAC (Standardization Administration of China) on July 26, 2016, and was implemented on the date of release. All new production vehicles had to comply with this standard beginning January 1, 2017.

**"9.21" regulations** refer to "*Highway management provisions for over-limit operation vehicles*" that was implemented on September 21, 2016. The MOT (Ministry of Transport), MPS (Ministry of Public Security), and MIIT have unified the standard of determining over-load vehicles (gross vehicle weight limit of 49 tonnes) and have developed a one-year period of joint enforcement action against illegal retrofit trucks and over-load/over-limit trucks, as well as a two-year period of joint enforcement action on vehicle product transport tractor-trailers.

**Truck broker** refers to an intermediate organization between a shipper, who has

a product to be shipped, and a carrier, who owns a truck.

**Vehicle-cargo matching platform** refers to online applications that provide real-time information about cargo owners, drivers, and vehicles so as to optimize the matching of cargo and vehicle information and improve freight efficiency.

**Black cargo and white cargo** refer to Chinese rail cargo classifications. Cargo from Class 1 to Class 14 (coal, oil, ore, fertilizer, grain, etc.) is referred to as "black cargo;" the other Classes (household electrical appliances, motor vehicles, medicine, tobacco, textiles, etc.) are called "white cargo."

**Heavy and light cargo** refer to classification distinctions based on mass. Specifically, cargo that has a mass of over 210 kg/$m^3$ is defined as heavy cargo, whie under 210 kg/$m^3$ is defined as light cargo. Alternately, heavy cargo's actual mass, calculated as length (cm) x width (cm) x height (cm) ÷ 6000, is greater than or equal to its volume mass.

**Long-haul mainline freight/transportation** refers to cross-province transportation lines longer than 1000km, such as the Guangzhou-Beijing, Harbin-Beijing, Xi'an-Beijing, Changsha-Shanghai, and Chengdu-Shanghai freight lines.

**Urban delivery** refers to vehicles that drive primarily on urban roads and deliver cargo to end users in urban areas.

# 1 Overview

Road freight is the most prominent mode of cargo transportation in China, accounting for almost 80% of the nation's total freight.[1] Road freight also accounts for high proportions of both fuel consumption and $CO_2$ emissions from the transportation sector. Reducing the fuel consumption level of the entire road freight industry is the goal of promoting green freight programs.

Currently, the fuel consumption limits for heavy-duty vehicles in China are used to evaluate single vehicle fuel consumption levels. The standard classifies vehicles by gross vehicle weight (GVW) and specifies a unified fuel consumption limit for each bin. Vehicles with fuel consumption levels higher than the limits allowed during comprehensive test cycles are not allowed to be produced. The proposed "*Fuel consumption limits for heavy-duty commercial vehicles*" (Stage 3), released in 2016, tightens the fuel consumption limits by an average of 10.7% – 17.9% compared to Stage 2 (see Footnote 1). In response to the stricter fuel consumption limits, motor vehicle manufacturers are reducing vehicle fuel consumption by optimizing transmission systems, reducing vehicle weight, and developing alternative fuels and new energy vehicles (NEVs). However, because there is a lack of authoritative statistics on fuel-saving effectiveness of related technologies, most freight enterprises – and especially individual private vehicle owners – show very low confidence in their effectiveness. Due to high competition in domestic freight markets, over-load and over-limit operations are quite common, which can discourage freight enterprises and individual vehicle owners from purchasing and applying fuel-saving technologies. Although fuel consumption level is a factor being considered by freight carriers and individual users, it is not the key factor in final purchase decisions.

This report provides an in-depth introduction and analysis of six aspects of the Chinese freight system: the development of the road freight market in China; the current status and trends for trucks in China; truck fuel-saving technologies in China;

the operational characteristics of road freight enterprises in China; the institutional arrangements of related governmental departments in China; and policy recommendations.

Most of the content and views in this report came from in-field surveys.

# 2 Road freight market

This chapter introduces the scale and market share changes of road freight, railway freight, and shipping in China as well as the underlying reasons for these changes. This chapter conducts an in-depth analysis of the impacts of “9.21” regulations on the road freight market, the development of emerging freight organization modes, and the application of pure electric vehicles in urban delivery. To get a thorough understanding of these issues, beyond that provided by desk studies, we also visited research institutes such as the China Federation of Logistics and Purchasing (road freight branch) and the Institute of Comprehensive Transportation of the National Development and Reform Commission (NDRC).

## 2.1 Road freight is the primary mode of cargo transportation in China

Road freight has the characteristics of high mobility, strong adaptability, and requires less facilities at receiving stations; compared to railway, waterway and other modes of transportation, road freight is capable of achieving door-to-door transportation that allows delivery of cargo from the consignor's door directly to the consignee's door without requiring transshipment, thus avoiding repeated loading, unloading, and handling and ensuring the quality of cargo. On the other hand, the railway transportation department in China used to have a relatively strong administrative background, but railway freight capacity was relatively inadequate for a long time. When high-speed trains become available, railway transportation was used mainly for passenger travel and transporting national strategic materials. As a result, road freight has become the primary transportation mode for China’s logistics and transportation system.

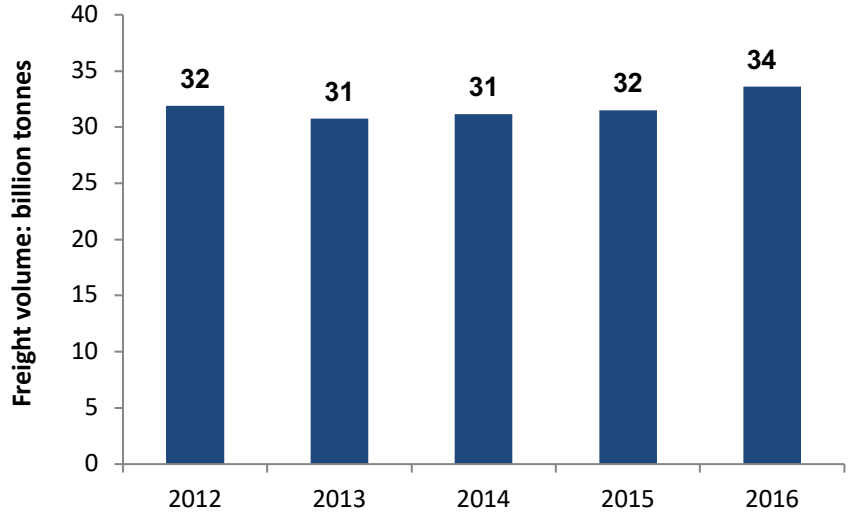



**Figure 1: Freight volume trends, 2012–2016.** 【4】

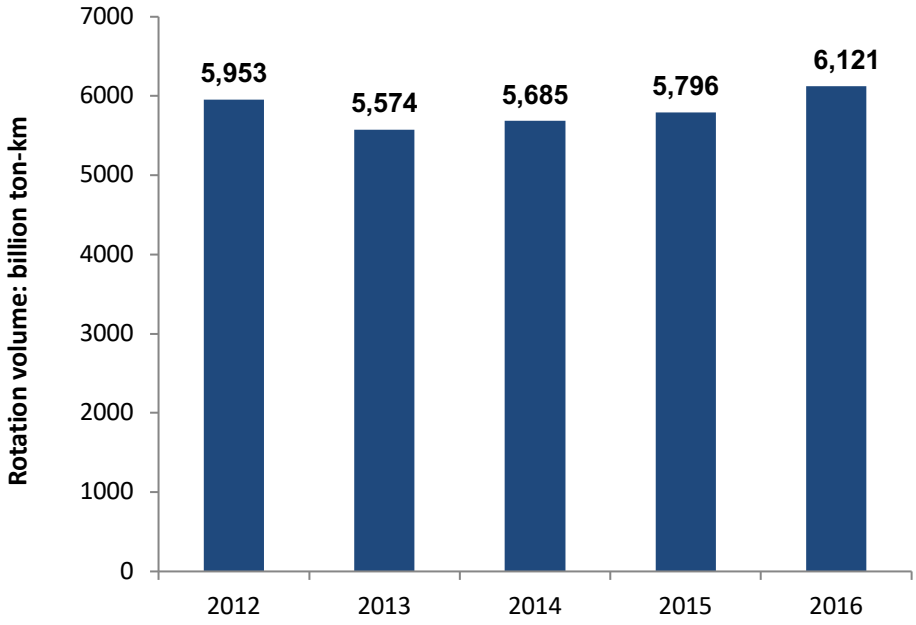



**Figure 2: Freight activity trends, 2012–2016.** 【4】

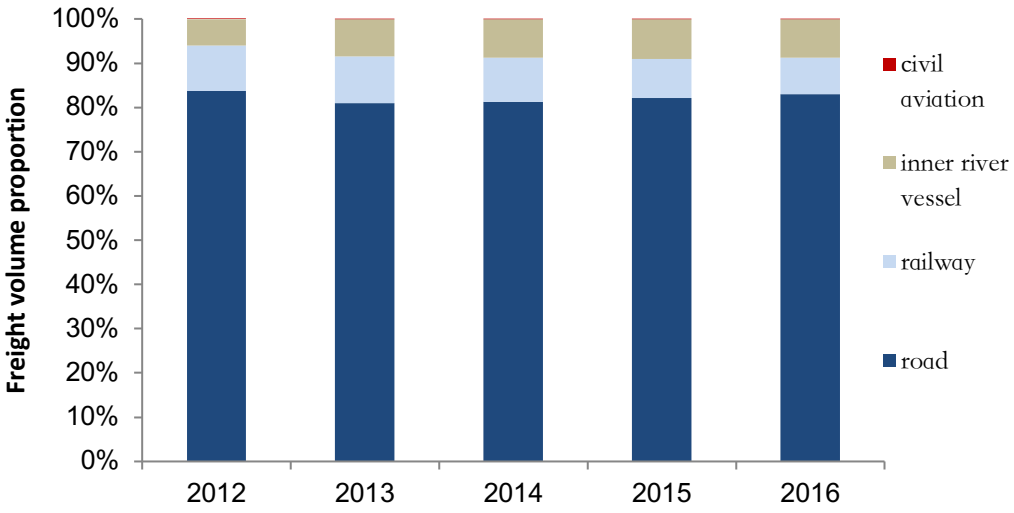



**Figure 3: Freight mode trends, 2012–2016.** [1] [4]

As part of the ongoing reform of the railway system, the operating mileage of high-speed railway is increasing constantly and railway transportation capacity has been released. Tianjin, Weifang, and other harbor cities around Bohai Bay have already banned transporting coal by diesel trucks. All transportation of coal within these harbor cities has been transferred to railway freight, and the proportion of railway freight will increase significantly in the future. Railway freight of white cargo also increased rapidly in 2016. Some 7.5 million 20-foot equivalent units (TEU) of cargo containers, 2.9 million motor vehicles, and 260 million tonnes of bulk cargo have been transported through the national railway system. These are increases of 40%, 53%, and 25% respectively over the previous year. [4]

The operation of high-speed railway express also has had significant impacts on the domestic aviation express market. High-speed railway express service has been operated on a trial basis since October 20, 2016, in 505 cities where high-speed trains stop to provide small goods delivery service. High-speed rail has the advantages of saving time, high quality, high standards, and all-day service. Compared to aviation express, high-speed rail has more frequent departures, is less affected by weather, and has a larger rotation capacity. The rapid development of high-speed railway express will inevitably affect aviation express and command a

greater market share of short distance (below 800km) freight.

Generally speaking, road freight will remain the primary mode to freight in China for a long time. The inevitable development trend for moving high value-added cargo freight in the future will be long-haul transportation through railway freight, then finishing the “last kilometer” of door-to-door service through road freight. With the continuous improvement of high-speed railway express and the traditional railway freight transportation system, the development speed of medium- and long-distance road freight will gradually slow down, and road freight will become a short distance solution to link different transportation modes.

## 2.2 Individual private carriers represent the backbone of China’s road freight market

Currently, there are about 8.1 million road freight carriers in China, among which, nearly 70% are individual private carriers. This large number of individual private carriers caused disorder in competition for a long time, which led to freight rates staying at artificially low levels. In order to increase profit, most truck owners would like to purchase nonstandard vehicle models and operate under over-load conditions, which further lowers the freight rate and leads a vicious cycle. At the same time, individual private carriers remain in a weak position in the negotiation of transportation contracts. They have no effective measure to circumvent the unreasonable loading requirements from the cargo owners, which is also an important reason for over-load and over-limit operation. To some extent, the disorderly competition among the individual private carriers also restricts the development of large-scale fleets. In recent years, along with the rapid development of the express delivery industry as well as its strict requirements for efficiency and service standards, professional transportation fleets have been developed rapidly. Take ZHIHONG Logistics as an example. Since 2013, the enterprise has started to turn its fleet into a large-scale fleet and has provided third-party logistics and professional transportation services for SF EXPRESS, YUNDA EXPRESS, YT EXPRESS and ZTO

EXPRESS. Its transportation network has grown to cover more than 160 domestic cities and has formed a network of more than 20,000 freight vehicles.

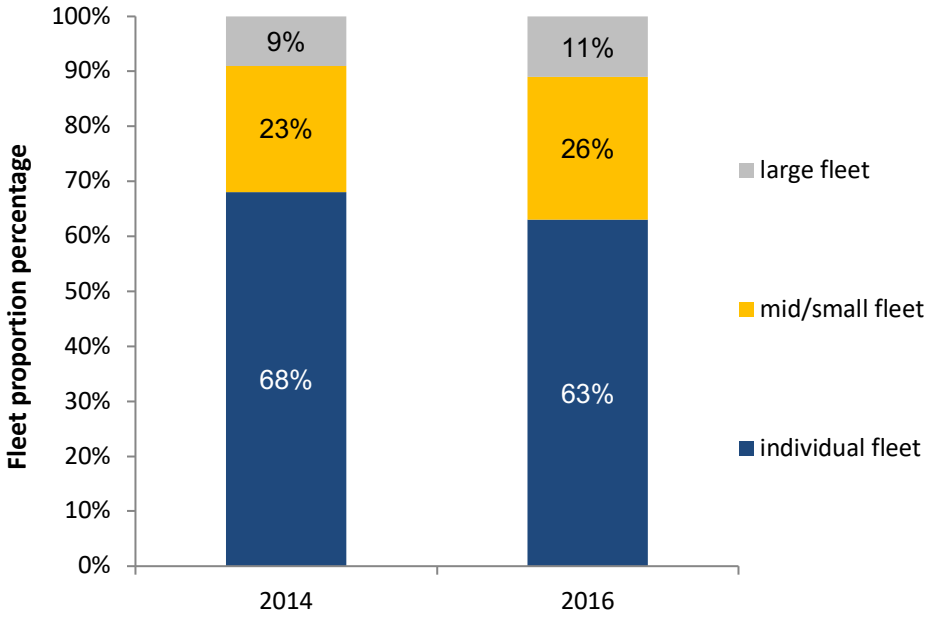


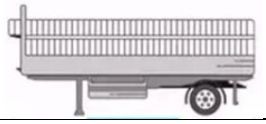
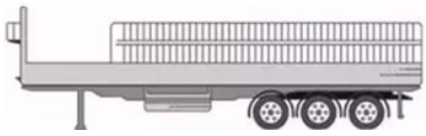

**Figure 4： Proportion of Chinese truck fleets by fleet size.**[3]

## 2.3 Serious truck over-loading was basically eliminated by "9.21" regulations

AQSIQ and SAC issued and enforced the national standard "*Limits of dimensions, axle load and masses for motor vehicles, trailers and combination vehicles*" (GB 1589-2016), which has become the main basis of a new over-load enforcement program. With the implementation of GB1589-2016, a large number of nonstandard vehicles like 17.5m low-platform tractor-trailers and 16.15m and 14.6m container tractor-trailers are facing pressure to be phased out.

[3] Large fleet: 200–500 vehicles, mid fleet: 50–200 vehicles, small fleet: 5–50 vehicles, data source: G7 Networks.

**Table 1：Vehicle length limits in GB1589-2016**

| | Figure | GVW（tonnes） | Vehicle length （m） |
|---|---|---|---|
| Straight truck |  | GVW≤3.5 | 6 |
| | | 3.5＜GVW≤8 | 7 |
| | | 8＜GVW≤12 | 8 |
| | | 12＜GVW | 9 |
| |  | GVW≤20 | 11 |
| | | 20＜GVW | 12 |
| Combination vehicle |  | 20＜GVW≤49 | 17.1[4] |
| Trailer |  | Gross mass limit of 18 tonnes | 8.6 |
| |  | Gross mass limit of 35 tonnes | 10 |
| |  | Gross mass limit of 40 tonnes | 13 |
| |  | | 13.75[5] |

MOT and MPS have developed a one-year period of joint enforcement action against illegal retrofit trucks and over-load/over-limit trucks as well as a two-year period of joint enforcement action on vehicle product transport tractor-trailers, both

[4] The limit for articulated long-haul vehicles is 18.1m.

[5] The limit for semi-trailers used to transport 45-foot containers is 13.95m.

of which began on September 21, 2016. The two joint enforcement actions have greatly influenced the road freight market in three ways. First, the market entrance management was not strict enough in the early stages of its development. Freight trucks that are used for super large cargo freight have entered the field of general cargo freight and have become the major vehicle model for long-haul transportation on mainline roads because they have higher volume capacity. The whole long-haul freight industry faced the issue of violating regulation rules. Therefore, after the enforcement actions began, the industry was not sure about the exact punishment target of the enforcement actions. To avoid violation punishment, some vehicle owners temporarily stopped operating, which resulted in the number of operating freight vehicles falling by nearly one quarter.[6] The freight capacity shortage in the road freight market resulted in freight rate increases of about 30% in short term.[7] Most owners of nonstandard vehicles are medium/small scale enterprises and individual private carriers, to whom the enforcement actions bring huge social influences. In addition, most nonstandard vehicles have official operation approvals and have not reached scrappage limits, so it is difficult to instantaneously ban such vehicles. Therefore, the freight industry has gradually realized that the enforcement actions focused primarily on over-load violations; the freight market has gradually recovered and the freight rate has stabilized.

Second, MPS and MOT have unified enforcement of the over-load standard, which has resulted in a great decrease in single-vehicle freight capacity. Using a 6-axle vehicle as an example, the GVW limit was reduced from 55 tonnes to 46 tonnes for 6x2 vehicles and to 49 tonnes for 6x4 vehicles. Therefore, a distinct freight capacity gap appeared in the freight industry after the implementation of “9.21” regulations, which resulted in a great increase in the heavy-duty vehicle market. The production volume of heavy-duty trucks increased by 36% in 2016, compared to 2015.

[6] Communication with industry experts and fleet operators.
[7] Communication with industry experts and fleet operators.

Third, the over-load enforcement action has encouraged large-volume cargo, like motor vehicles and coal, to change from road freight to railway freight. According to the data from NDRC, the national railway system transported 1.61 billion tonnes of coal from January to September 2017, which was 17.4% higher than the same period in 2016.[8]

Generally speaking, the enforcement actions have had greater influences on heavy cargo freight than on light cargo freight, and have had greater influences on long-haul freight than on short-distance freight.

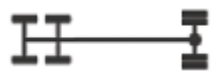
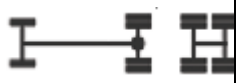
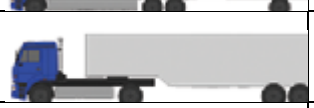
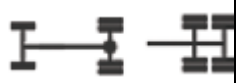
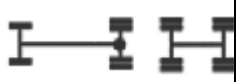
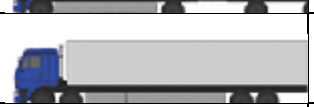
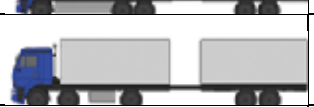
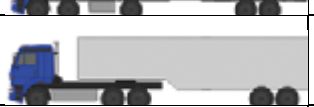
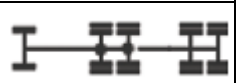
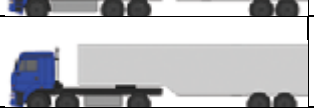
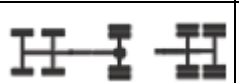
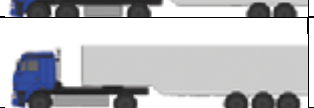
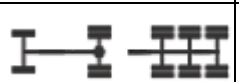
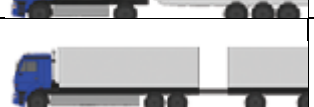
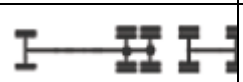
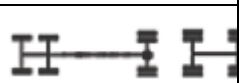
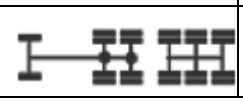
**Table 2：Annual road freight rate index in China**

| | 2014 | 2015 | 2016 | Change % (2016 vs 2015) |
|---|---|---|---|---|
| **Road freight rate index in China** | 109 | 106.3 | 103.4 | -2.7% |
| **Whole vehicle freight rate index** | 104.5 | 101.6 | 95.9 | -5.6% |
| **Sporadic freight transportation rate index (light cargo)** | 115.6 | 112.8 | 116.7 | 3.5% |
| **Sporadic freight transportation rate index (heavy cargo)** | 115.9 | 113.7 | 112.6 | -1.0% |

*Note*: The road freight rate index is surveyed by the China Federation of Logistics and Purchasing and Guangdong Linan Logistics Group. It is an index that reflects the situation and development trend of the road freight market. The road freight rate index of China takes the average freight rate of the last week of December 2012 as the baseline reference and sets the baseline road freight rate index as 100. The index is higher than 100 when the freight rate increases and lower than 100 when the freight rate drops. The indexes in Table 2 are categorized by freight modes.

[8] http://yxj.ndrc.gov.cn/mtzhgl/201710/t20171031_865560.html

**Table 3： Over-load determination standards for road freight vehicles**

| Axle | Vehicle type | Figure | | GVW limit （tonnes） | GVW limit （tonnes） |
|---|---|---|---|---|---|
| 2-axle | Straight truck |  |  | 18 | 20 |
| 3-axle | Center axle tractor-trailer |  |  | 27 | 30 |
| | Articulated vehicle |  |  | | |
| | Straight truck |  |  | 25 | |
| | |  |  | | |
| 4-axle | Center axle tractor-trailer |  |  | 36 | 40 |
| | |  |  | 35 | |
| | Articulated vehicle |  |  | 36 | 40 |
| | Full trailer vehicle |  |  | | |
| | Straight truck |  |  | 31 | |
| 5-axle | Center axle tractor-trailer |  |  | 43 | 50 |
| | |  |  | | |
| | Articulated vehicle |  |  | | |
| 5-axle | Articulated vehicle |  |  | 43 | |
| | |  |  | 42 | |
| | Full trailer vehicle |  |  | 43 | |
| | |  |  | | |
| 6-axle | Center axle tractor-trailer | |  | 49 | 55 |

| Axle | Vehicle type | Figure | | GVW limit （tonnes） | GVW limit （tonnes） |
|---|---|---|---|---|---|
| | |  |  | 46 | |
| | |  |  | 49 | |
| | | |  | 46 | |
| | Articulated vehicle |  |  | 49 | |
| | | |  | 46 | |
| | |  |  | 46 | |
| | Full trailer vehicle |  |  | 49 | |
| | | |  | 46 | |
| Notes | 1．For 2-axle trucks, the total mass of truck and cargo shall not exceed the GVW on the vehicle license.<br>2．Except for driving axle, 2-axle vehicles, 3-axle vehicles, semi and full trailer tractor-trailers, the GVW limits shall decrease by 3 tonnes for decreasing every two tires.<br>3．For trailers and tractor-trailers that install tires with nominal transect width of no less than 425mm and straight trucks and tractor-trailers that install tires with nominal transect width of no less than 445mm, the GVW limit shall not be decreased.<br>4．For vehicles that are equipped with double-wheel and air suspension at each side of the driving axle, the GVW for 3-axle and 4-axle straight trucks shall be increased by 1 tonne; for 4-axle articulated vehicles that are equipped with double-wheel and air suspension at each side of the driving axle and have a distance between the two axles of semi-trailers ≥1800mm, the GVW limit shall be 37 tonnes.<br>5．For vehicles that are not listed in the table, the GVW shall be determined based on the prescriptions of “*Limits of dimensions, axle load and masses for motor vehicles, trailers and combination vehicles*” (GB 1589-2016). | | | | |

## 2.4 Emerging freight strategies

With the road freight industry entering into a stage of integration and adjustment, a series of policies for lowering cost and improving efficiency have been released for the logistics industry. Especially with the rapid development of Internet

technologies in China, some new operation modes have emerged in China's road freight market, and the emerging operation modes have made beneficial attempts to solve the problems existing in China's road freight market, such as asymmetric information, poor timeliness, and low transportation efficiency caused by mismatching between vehicles and cargo.

### 2.4.1 Drop and hook

"*The notice of promoting the development of drop and hook transportation*" was jointly released by MOT and other related management agencies in 2009. Since then, the state has released many supportive policies for promoting drop and hook transportation, but drop and hook is still in the demonstration stage. The major organization mode of China's drop and hook transportation can be described as "one-line and two-point, drop and hook at both ends," or simply to drop and hook at the port or within factories. In general, drop and hook transportation mode is still developing slowly in China. Four factors restrict the development of drop and hook transportation in China. First, wide promotion of drop and hook transportation requires good freight organizing systems, but the freight links are not highly organized in China. Because drop and hook transportation cannot get steady cargo sources without large freight organizing platforms, this mode of transportation cannot develop smoothly. Second, the main body of the domestic road freight market is provided by individual private carriers. Because most tractors and trailers belong to individual private carriers, it is hard for them to accept drop and hook transportation due to safety concerns. Third, "*Level Classification and Construction Requirements of Motor Freight Stations (Yards)*" (T/T402-1999) is still being enforced as the regulation for the level classification and construction requirements of freight stations. However, this regulation has not made sufficient requirements on the functional design of freight stations/yards from the perspective of guaranteeing drop and hook transportation. Fourth, tractors and trailers cannot drop and hook freely because of the lack of standardization, which also restricts the development of drop

and hook transportation overall. Fifth, the available tractors and trailers cannot satisfy the volume of drop and hook transportation needed. The ratio of tractors and trailers in China is about 1:1, which seriously restricts the development of drop and hook transportation.

### 2.4.2 Truck broker

Truck broker refers to road freight operator that serves as a carrier to sign the freight contract and take on the carrier's responsibilities and obligations but entrusts an actual carrier to complete the freight transportation work. Generally speaking, truck brokers do not engage in specific transportation tasks, but only handle transportation organization, cargo distribution, selection of transportation mode and route, etc. The broker's income comes mainly from the freight rate difference between small- and large-scale transportation. Truck brokers have dual identities: To consignors, truck brokers act as carriers, but to actual carriers, they are consignors. Relying on the Internet and other related technologies, truck brokers build logistics information platforms to collect, integrate, and reasonably schedule the scattered resources of vehicles, freight stations, and cargo through an organized and innovative mode, which is able to effectively improve the organizing efficiency of transportation, optimize the structure of the logistics market, normalize the market operation behaviors, and promote the transforming and upgrading of the freight industry.

Although the mode of truck broker is still in the pilot stage, varieties of service modes already have emerged, such as electronic-business + truck broker, logistics platform + truck broker, and traditional freight + truck broker, the pilot of truck brokerage which has received positive achievement. By the end of June 2017, the accumulated population of freight vehicles from the truck broker pilot enterprises reached 100,000 units; pilot enterprises uploaded 1.267 million freight waybills from January to June of 2017, realizing a total freight volume of 13.81 million tonnes. Logistics transportation efficiency continues to improve. By integrating the resources on the truck broker platform, the monthly driving distance of single freight trucks has

reached 12,000km and the average waiting period between cargo transportation has been shortened from 3 days in the past to 8 – 10 hours now.[9]

However, truck brokerage also faces some problems during the process of development. The Ministry of Finance (MOF) and State Administration of Taxation (SAT) released "*The Notice about Fully Promoting the Pilots of Changing Business Tax to Value-added Tax (MOF/SAT [2016] No. 36)*[10] on March 23, 2016, which required truck brokers to "*pay VAT (value added tax) as per traffic transportation service*" with a tax rate of 11%. However, the tax collection and management policies face difficult implementation due to the lack of a detailed implementation program and a qualification certification program. Meanwhile, the decentralized operating individual private carriers cannot provide VAT special invoices with a tax rate of 11% to truck brokers, which breaks the entire VAT deduction chain and makes truck brokers bear higher taxes. It also affects the implementation of truck broker policies.

### 2.4.3 Vehicle-cargo matching platforms

Because of the asymmetric information, poor timeliness, and mismatches between vehicles and cargo inherent in traditional transportation modes, the time that vehicles stop and wait is quite long, which reduces transportation efficiency. Targeting these specific problems, truck-cargo matching platforms have been developing rapidly since 2013 under the push of an "Internet + Logistics" concept. The number of such platforms reached 200 at one time. Traditional truck-cargo matching platforms mainly referred to offline entities, including distribution stations, highway ports, logistics parks, etc. After the introduction of the Internet, virtual truck-cargo matching platforms were established to combine offline trucks with cargoes through logistics apps. Online apps and other systems can be applied to realize information exchange and accurate matching, so as to solve the problem of asymmetric information.

[9] http://www.chinawuliu.com.cn/zixun/201707/31/323457.shtml
[10] http://szs.mof.gov.cn/zhengwuxinxi/zhengcefabu/201603/t20160324_1922515.html

Although the investment and financing fever on Internet platforms have cooled since the second half of 2015 and many Internet platforms have disappeared, the investors were still fond of investing in Internet platforms that have finished self transformation rapidly and have a clear commercial operating mode. Besides releasing vehicle and cargo information, truck-cargo matching platforms also offer aftermarket businesses, including vehicle finance, insurance service, electronic toll collection (ETC) application service, and collection on delivery (COD) service, etc. The latest report of business growth released by www.huochebang.cn indicated that, as of July 31, 2017, 4.5 million trucks and 880,000 cargo owners have registered on the platform (www.huochebang.cn). More than 1 million ETC cards have been issued with the daily recharge amount as high as RMB 90 million and the accumulated value of financial IOUs has reached RMB 1.5 billion.[11] With the pilots of truck brokerage being further promoted, truck-cargo matching platforms will give full play to the value of information integration, gradually transitioning from a matching business model to self-operating businesses and undertaking entire transportation works and responsibilities.

## 2.5 Urban delivery vehicle electrification

Due to the strict restrictions on trucks that operate in cites and the operating permit regulation system, there are various types of urban delivery vehicles in China. A large number of noncompliant vehicles exist, including heavy-duty straight trucks, enclosed vans, light-duty passenger vehicles, crossover type passenger vehicles, multipurpose vehicles (MPV), electric three wheelers, etc.

[11] http://news.sina.com.cn/c/2017-09-05/doc-ifykpuui1084347.shtml

**Table 4： Urban delivery vehicle types**

| Vehicle type | | Figure |
|---|---|---|
| Straight truck | Van |  |
| | Breast board truck |  |
| Enclosed van | Crossover type passenger vehicle |  |
| | Retrofitted European light-duty passenger vehicle |  |
| | Retrofitted Japanese light-duty passenger vehicle |  |

| | | |
|---|---|---|
| Crossover type passenger vehicle | Noncompliant vehicle |  |
| Light-duty passenger vehicle | Noncompliant vehicle |  |
| MPV | Noncompliant vehicle |  |
| Pure electric enclosed van | Retrofitted crossover type passenger vehicle |  |
| Pure electric enclosed van | Retrofitted light-duty passenger vehicle |  |

| | | |
|---|---|---|
| Pure electric van | Truck chassis |  |
| Electric three wheeler | Noncompliant vehicle |  |

As the environmental pressure continues to increase, some cities have introduced restriction policies on diesel straight truck registration. Coupled with the difficulties of getting operation permits for traditional fuel vehicles, new energy vehicles (NEVs) have developed rapidly under supportive policies such as having operation rights on the road, parking fee discounts, easy-to-get operation permits, and governmental subsidies. The application of pure electric delivery vehicles[12] is constantly increasing in urban areas. By the end of 2016, the cumulative production of pure electric delivery vehicles exceeded 100,000 units, which were used in the fields of express delivery, flower/pet market delivery, laundry, and many other types of urban delivery. With the increase in battery energy density and vehicle size, as well as users' pursuit of greater range, the market share of pure electric delivery vehicles of more than 3.5 tonnes shows a substantial increase. In the future, with the further tightening of restrictions on urban operation and registration for diesel vehicles and the increasing range of pure electric delivery vehicles, the limitation of using pure electric delivery vehicles will be greatly reduced, and the application

[12] Pure electric delivery vehicle refers to enclosed vans (mini or light-duty passenger vehicle chassis) and vans (truck chassis) that are used in urban delivery.

scope and proportion of the pure electric delivery vehicles in urban delivery will substantially increase.

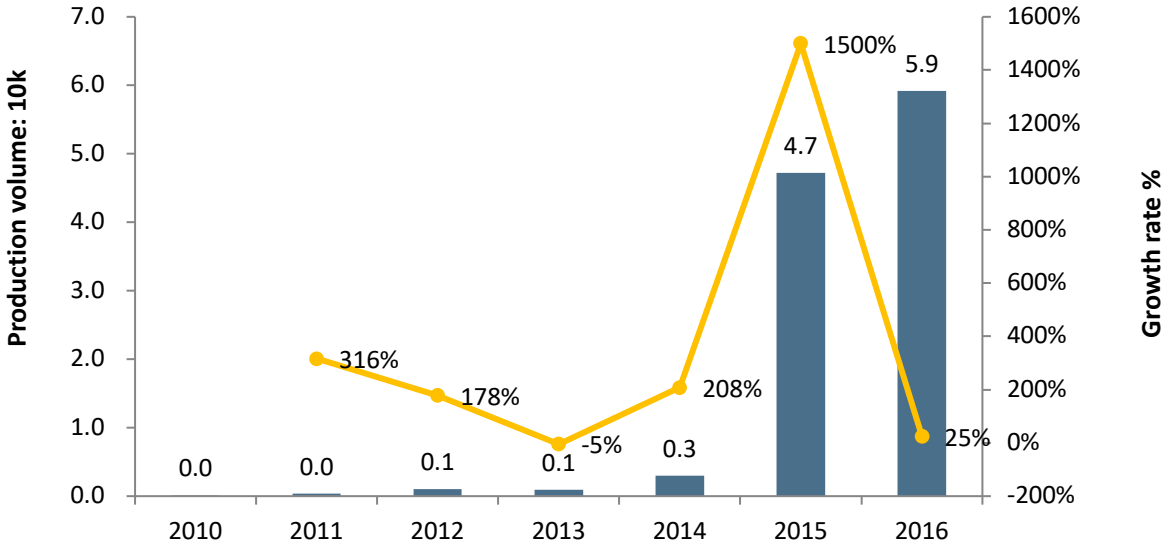



**Figure 5： Pure electric delivery vehicle production in China, 2010–2016.** 【2】

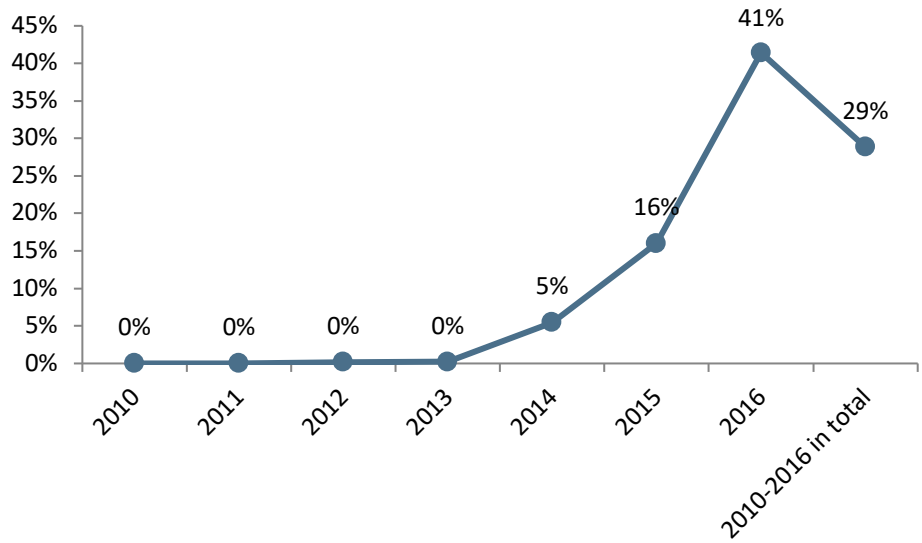



**Figure 6： Share of pure electric delivery vehicles over 3.5 tonnes, 2010–2016.** 【2】

## 2.6 Road freight service types

Currently, according to the service type, the road freight market is categorized into express transportation (below 30kg), sporadic freight express (30kg – 300kg),

specific sporadic freight transportation (300kg – 3,000kg), and truckload transportation (above 3,000kg).

**Table 5: Road freight service types in China**

| Type | Individual delivery weight | Average rate （RMB/kg) | Target client | Cargo composition | Transportation method |
|---|---|---|---|---|---|
| **Express transportation** | Below 30kg | 5–10 | Individuals, enterprise, and e-business | Consumer goods | Distribution from central station |
| **Sporadic freight express** | 30–300kg | 1.5 | Business enterprise, individual businessman and individual | Small batches of products | Transit or direct transportation |
| **Sporadic freight transportation （specific line）** | 300–3,000kg | 0.5 | Business enterprise, logistics contractor | Big batches of products | Direct transportation |
| **Truckload transportation** | Above 3,000kg | 0.5–1.5 | Trade enterprise, logistics contractor, sporadic freight | Big batches of raw materials and products | Direct transportation |

The market share of sporadic freight express rises steadily and appears to be a trend of cross-assortment penetration. In 2013, DEPPON LOGISTICS, which engaged primarily in sporadic freight express, entered the express transportation market and its express business grew rapidly, achieving a growth rate of more than 60% in 2016. On the other hand, many express enterprises have started to enter the sporadic freight express market. Firms such as ZTO Express and Yunda Express have officially announced their entry into the sporadic freight express market, and freight express enterprises like Best Express, SF Express, and Quanfeng Express also have started their businesses in the sporadic freight express field. As the customer demands and operational modes of express transportation and the sporadic express market are

tending to be the same, the integration and penetration between these two assortments of freight are accelerating.

On the other hand, the sporadic freight (specific line) market is experiencing a contraction in demand. With the rapid development of e-business, the traditional freight mode—with the characteristics of big volume per batch and small number of batches—is gradually changing to small volume per batch and a large number of batches. Freight orders are becoming fragmented and personalized; part of the market share of sporadic freight (specific line) is being taken up by sporadic freight express and express transportation. Enterprises engaged in sporadic freight (specific line) have started to transform themselves positively and built regional distribution networks relying on their advantages of mainline transportation, so as to change the operation mode from station-to-station to station-to-door.

The truckload transportation market is polarizing. The small-scale truckload carriers are facing pressures from the freight rate. After the implementation of "9.21" regulations, the rate of outsource transportation capacity increased. However, because the rate of truckload transportation is usually fixed in annual contracts, that resulted in difficulties in completing freight transportation smoothly and loss of profits for small-scale carriers. However, large-scale truckload carriers with greater self-owned freight transportation capacity suffered less impacts from "9.21" regulations. Such large-scale carriers have obvious competitive advantages because they can better control their transportation costs. As customers require more integrative and professional service and lower freight rates, the market is accelerating to be more consolidated with larger-scale carriers. With the trend toward mainline freight transportation outsourcing, truckload carriers with larger fleets have seen their opportunities developing. Small-scale carriers, such as platform-type carriers, are trying to overcome the bottleneck of vehicle management with information technologies, so as to transform their operations from the mode of matching trucks with cargoes to the mode of undertaking full process responsibilities, in effect becoming truck brokers.

# 3 Truck technologies and characteristics

This chapter describes the vehicle models of road freight trucks, market changes in the past 5 years, the market share of top enterprises, and typical vehicle technology characteristics through the analysis of heavy-duty freight truck data (above 3.5 tonnes) and communication with experts and manufacturers in the industry.

## 3.1 Truck production trends

Being influenced by the implementation of China 4 emission standards, consumers purchased a large number of China 3 vehicles in 2013, in order to save on vehicle purchase cost and consequent use cost, which led to a 59% increase in heavy-duty vehicles in 2013. As a result of centralized purchases in 2013, part of the market demand was released in advance. Also, with China's economy beginning to enter a period of slower development, the overall market demand declined. In 2014 and 2015, the heavy-duty truck market fell sharply. The national standard GB1589-2016 was implemented in 2016. Since then, MOT, MPS, MIIT and other related departments have unified the standards of enforcement and carried out joint enforcement actions against over-load issues in the whole country, which caused an interim lack of freight transportation capacity and a rise in freight rates, resulting in enthusiastic vehicle purchasing; heavy-duty truck production increased by 36% in 2016.

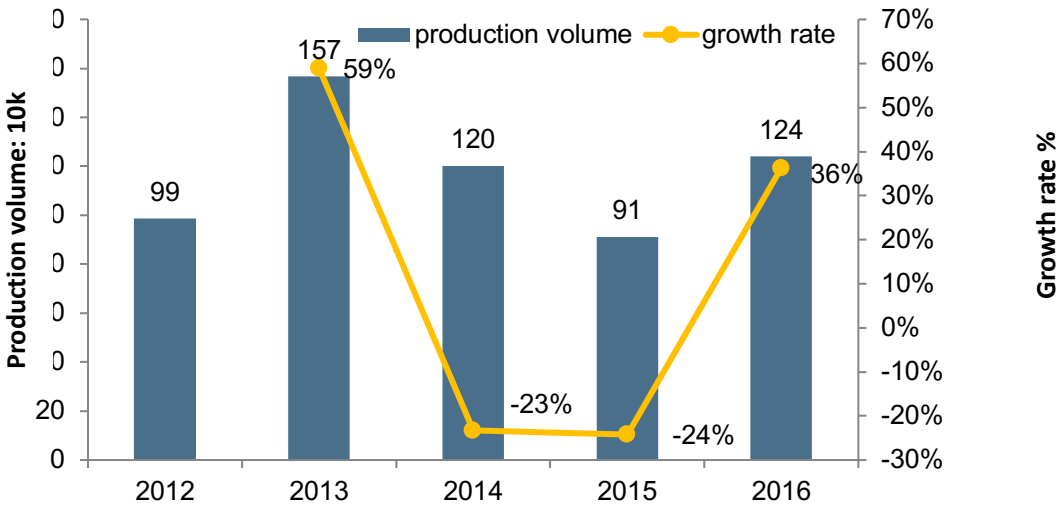



**Figure 7: Heavy-duty freight truck production in China, 2012–2016.** [2]

The straight truck model is the primary type of vehicle used for road freight in China. However, the proportion of tractors to the total number of road freight vehicles is increasing. In recent years, with the rapid development of express transportation and the sporadic freight express market, consumers have placed higher demands on logistics transportation efficiency, which has promoted the development of mainline transportation and increased the proportion of tractors.

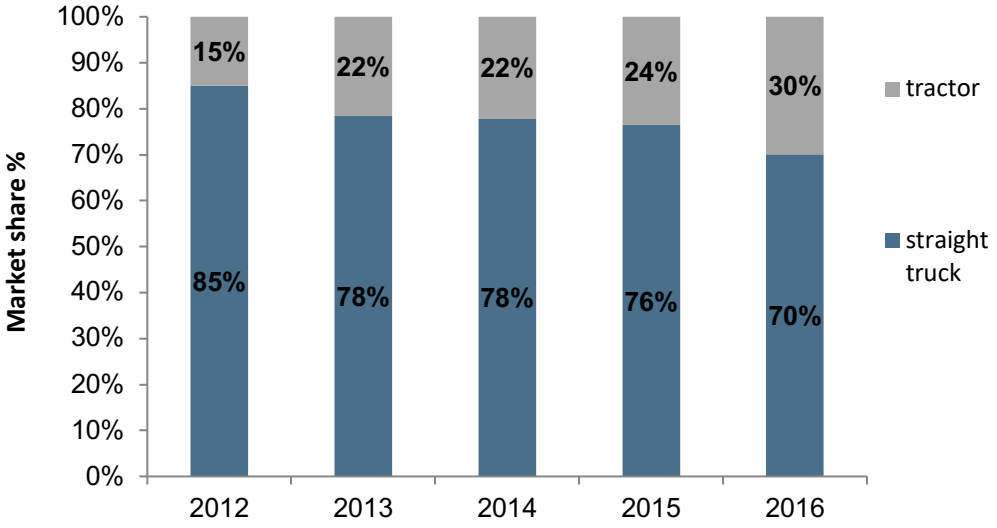



**Figure 8: Share of heavy-duty trucks by vehicle type in China, 2012–2016.** [3]

From the perspective of fuel type, diesel is still the primary fuel used by heavy-

duty freight trucks. With the influences of purchase subsidies and other policies, the population of pure electric trucks grew sharply in 2016, accounting for 2% of the total population of heavy-duty trucks. Being restricted by range and other conditions, the pure electric trucks are widely applied only in urban logistics. Since the second half of 2014, the price of domestic diesel has declined constantly. As a result, the economic advantage of natural gas has fallen sharply, which caused the market share of natural gas heavy-duty trucks to shrink rapidly; the proportion of natural gas heavy-duty trucks decreased from 4% in 2014 to 1% in 2016.

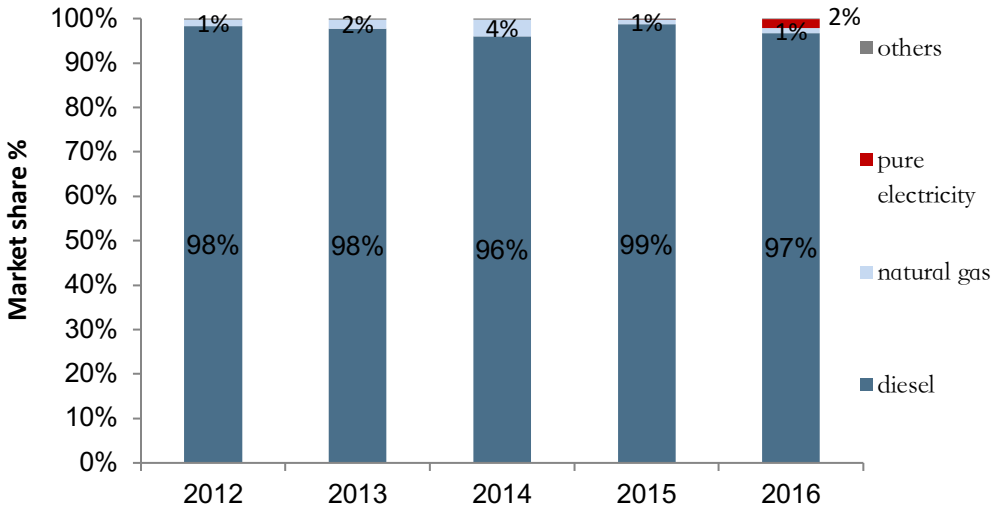



**Figure 9：Share of heavy-duty trucks by fuel type in China, 2012–2016.** [3]

## 3.2 Tractor characteristics

Large populations and large freight demands are the main reasons for the high level of tractor sales in Hebei, Shandong, and Henan provinces. Specifically, Hebei province has a population of more than 70 million and accounts for relatively high proportions of iron/steel, coal, and cement production. Shandong province has a population of nearly 100 million, accounting for relatively high proportions of vegetables, fruits, and pig production. Henan province has a population of nearly 100

million. Zhengzhou, the capital city of Henan, is one of the logistics centers in China with a huge demand for cargo transit. Henan province also accounts for relatively high proportions of coal and food production in China.

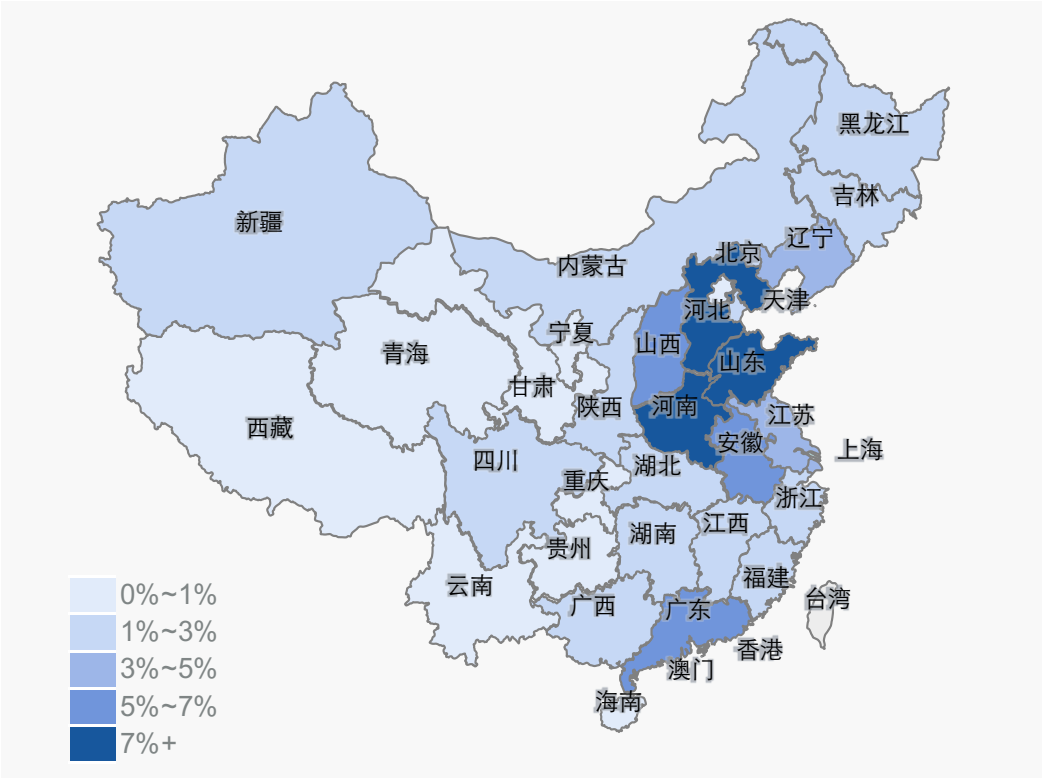



**Figure 10: Share of tractor sales by province in China, 2012–2015.** [3]

FAW, FOTON, DONGFENG, SHAANXI AUTO and CNHTC are the top manufacturers of tractors. The FAW JIEFANG brand has a good reputation, an adequate service network, and an accessories supply chain. At the same time, FAW has its own factories to produce engines, gearboxes, rear axles, and other key components, which results in good vehicle performance and the top sales in the market. With the overall sales increase in 2016, the market share gaps between FOTON, DONGFENG, and SHAANXI AUTO narrowed significantly. Although the market share ranking showed a big change, the market share gaps were less than 1%.

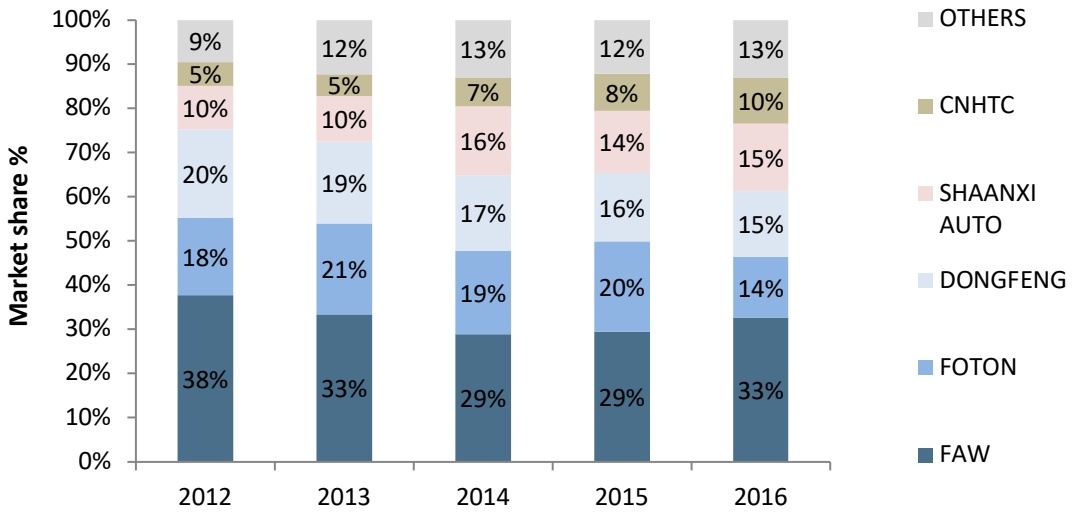



**Figure 11: Market share of tractor manufacturers, 2012–2016.** 【3】

**Table 6: Ranking of tractor manufacturers, 2012–2016** 【3】

| Brand | Annual ranking | | | | | 2012–2016 sales (in ten thousands) | 2012–2016 Market share |
|---|---|---|---|---|---|---|---|
| | 2012 | 2013 | 2014 | 2015 | 2016 | | |
| **FAW** | 1 | 1 | 1 | 1 | 1 | 40 | 32% |
| FOTON | 3 | 2 | 2 | 2 | 4 | 22 | 18% |
| DONG FENG | 2 | 3 | 3 | 3 | 3 | 21 | 17% |
| **SHAANXI AUTO** | 4 | 4 | 4 | 4 | 2 | 16 | 13% |
| **CNHTC** | 5 | 5 | 5 | 5 | 5 | 9 | 8% |
| **Top 5** market share | 91% | 88% | 87% | 88% | 87% | 108 | 87% |

Diesel is still the primary fuel type used in tractors, however there is great potential for development of natural gas tractors in the future. Due to the obvious economic advantages of natural gas, coupled with the domestic diesel supply shortage in wintertime before 2014, some regions issued incentive policies for natural gas vehicles, which resulted in rapid development of natural gas tractors.

Natural gas tractors accounted for 16% of the total tractor market in 2014. With the decline of domestic diesel price in the second half of 2014, the economy of natural gas dropped sharply. Meanwhile, the wintertime shortage of diesel supply basically disappeared and the overall tractor market was declining, so the natural gas tractor market was shrinking rapidly. Being affected by the implementation of China 5 emission standards and the overall growth of the tractor market, the natural gas tractor market began to recover in 2017 and the production of natural gas tractors increased significantly in the last year.

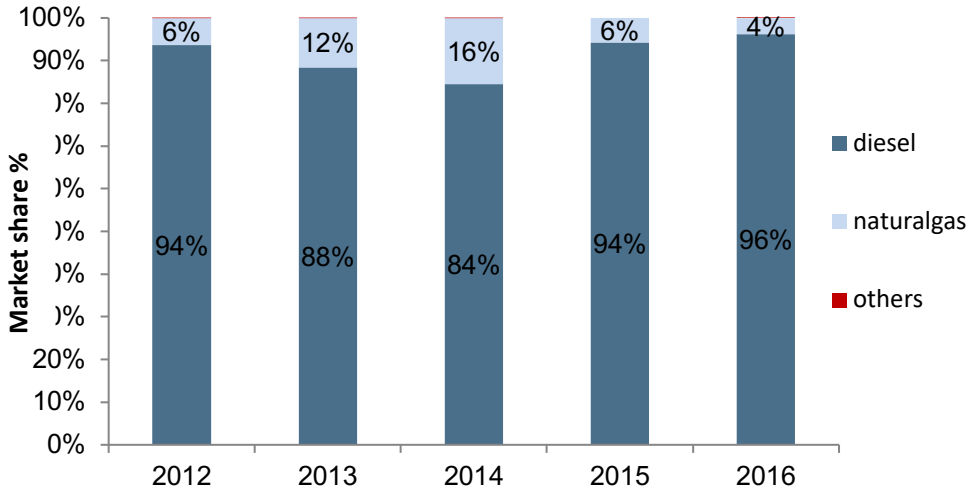



**Figure 12: Market share of tractors by fuel type, 2012–2016.** 【3】

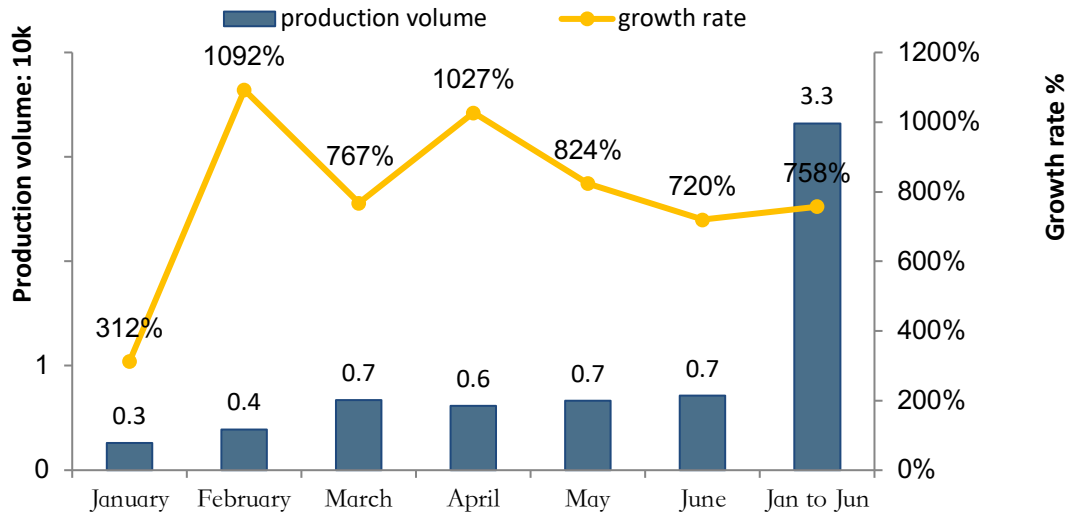


**Figure 13: Production of natural gas tractors, 2017 (Jan to Jun).** [2]

Being influenced by the implementation of GB1589-2016 and "9.21" regulations, the proportion of 6x2 driveline configuration tractors declines significantly and the market share of 6x4 driveline configuration tractors increases significantly. The 6x4 arrangement will become the primary driveline configuration of tractors in the future.

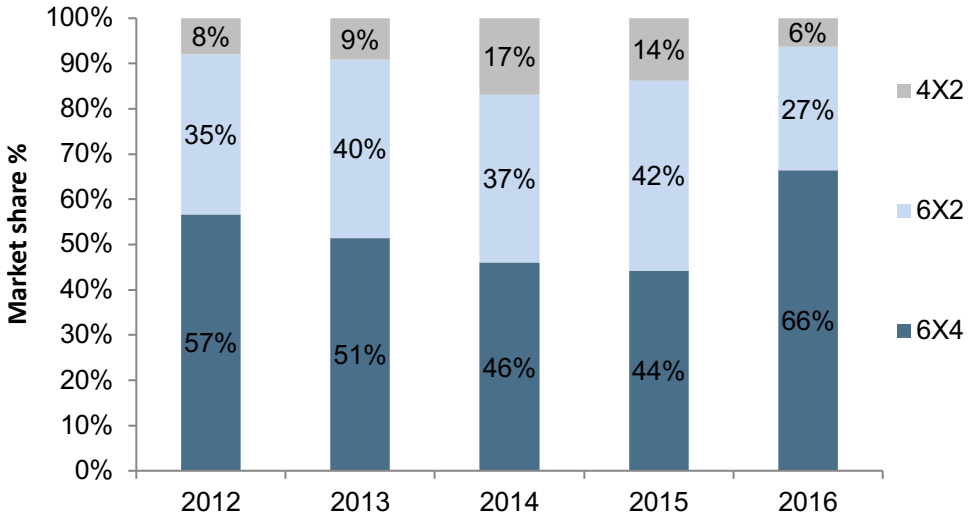



**Figure 14: Market share of tractors by driveline configuration, 2012–2014.** [2]

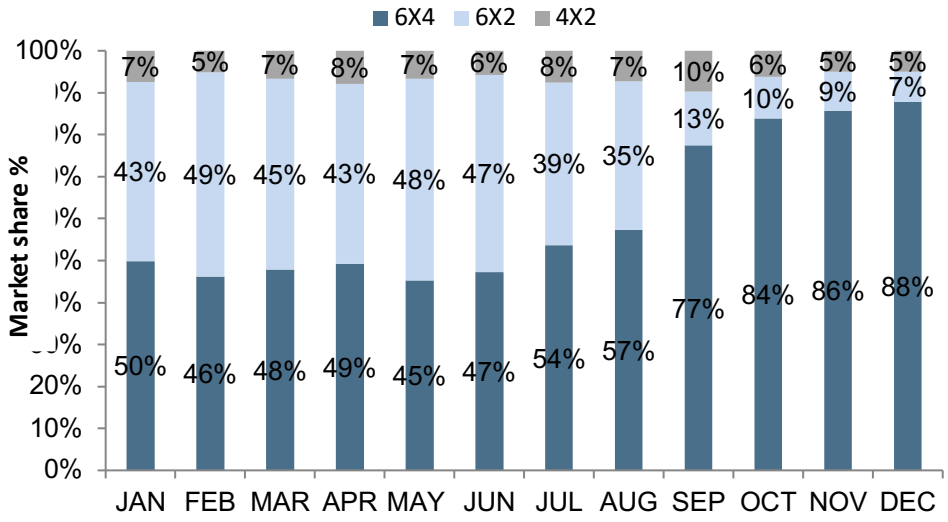



**Figure 15: Market share of tractors by driveline configuration, 2016 (January to December).** [2]

WEICHAI POWER accounts for a relatively large share of the tractor engine market because of its technology advantages, long presence in the market, and good brand reputation. However, almost all FAW heavy-duty trucks are equipped with engines produced by WUXI DIESEL ENGINE WORKS, a wholly-owned subsidiary company of FAW. Benefitting from the development of FAW tractors, the market share of WUXI DIESEL ENGINE WORKS also is relatively large.

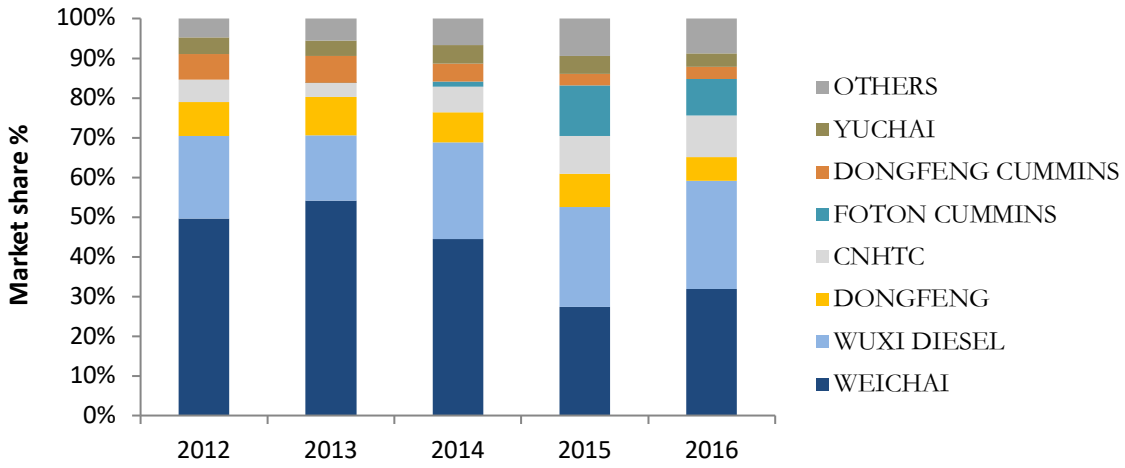



**Figure 16: Engine OEM market share of tractors in China, 2012–2016.** 【2】

**Table 7: Vehicle manufacturers and engine suppliers in China** 【2】

| Vehicle manufacturer | Engine suppliers | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | WEICHAI | WUXI DIESEL | CNHTC | DONG FENG | DONG FENG CUMMINS | FOTON CUMMINS | CUMMINS (IMPORTED) | YUCHAI | OTHERS |
| FAW | 19% | 81% | | | | | | | 1% |
| FOTON | 60% | | | | | 27% | 11% | | 1% |
| DONGFENG | 11% | | | 46% | 27% | | | 14% | 2% |
| SHAANXI AUTO | 96% | | | | | | | | 4% |
| CNHTC | | | 99% | | | | | 1% | |
| DAYUN AUTO | 100% | | | | | | | | |
| JAC | 91% | 2% | 1% | | | | | 6% | |
| CAMC | 60% | | | | | | | | 40% |
| SAIC | 5% | | | | | | | | 95% |
| BEIBEN | 100% | | | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Market share | 41% | 23% | 8% | 8% | 5% | 5% | 2% | 4% | 5% |

*Note:* Totals may not equal 100% due to rounding.

With the requirement of improving the timeliness of logistics and the change of vehicle purchase preferences from lower power/weight ratios to higher power/weight ratios, the application of larger displacement engines has increased significantly in the tractor fleet. Engines rated at more than 300kW have come to dominate the market. In the future, the proportion of engines rated at more than 350kW will continue to rise, and tractors of more than 500 horsepower (1kW=1.36 horsepower) will become the primary product of whole vehicle manufacturers.

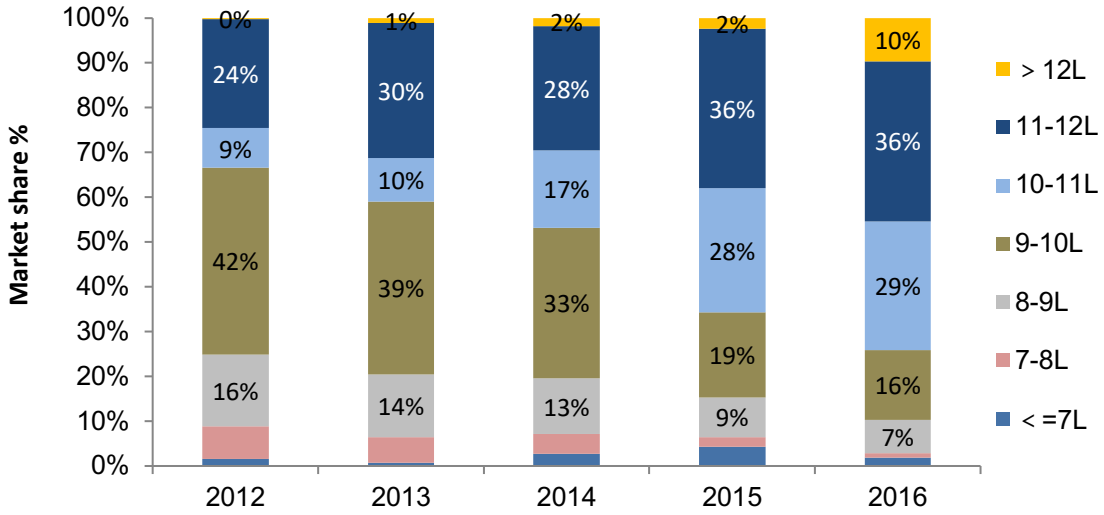



**Figure 17: Engine displacement of tractors in China, 2012–2016.** [2]

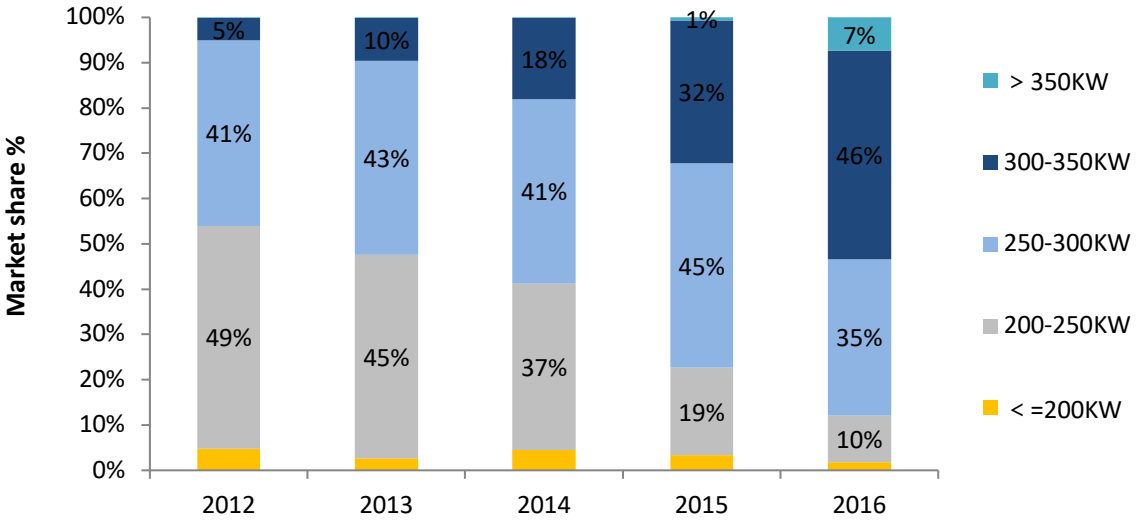



**Figure 18: Engine power of tractors in China, 2012–2016.** [2]

## 3.3 Trailer characteristics

Trailers are classified into eight categories in China, including stake trailer, container trailer, tank trailer, etc. However, most trailers used in the logistics industry are not compliant with the regulation rules. After the implementation of GB1589-2016 and "9.21" regulations, trailer manufacturers were optimistic about the effects of these policies, and the production volume of trailers in 2016 increased significantly.

**Table 8: Trailers and figures**

| Trailer type | Figure |
|---|---|
| Stake trailer |  |

| | |
|---|---|
| Container trailer |  |
| Tank trailer |  |
| General semi trailer |  |
| Low platform trailer |  |
| Box trailer |  |

| | |
|---|---|
| Dump trailer |  |
| Vehicle transport trailer |  |

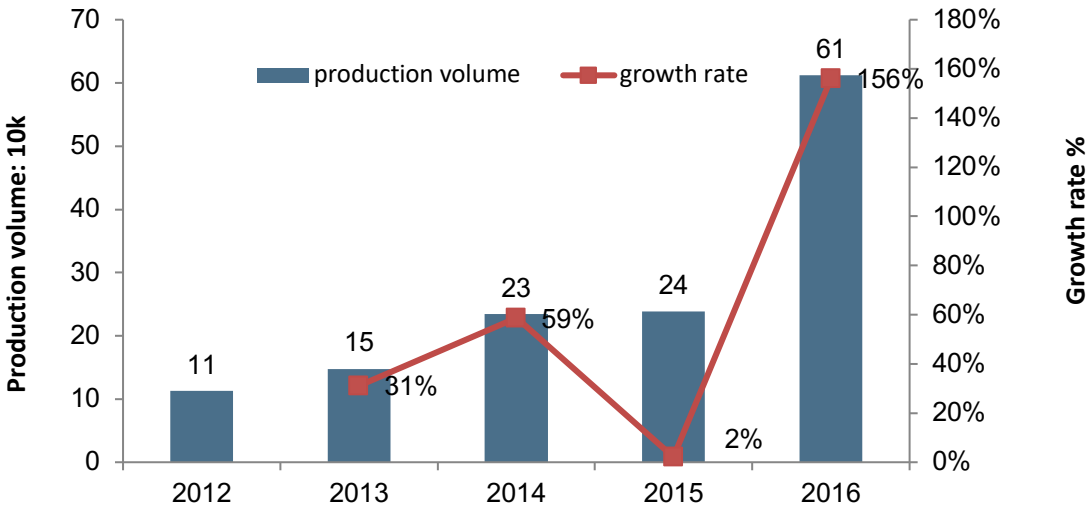



**Figure 19: Trailer production in China, 2012–2016.** 【2】

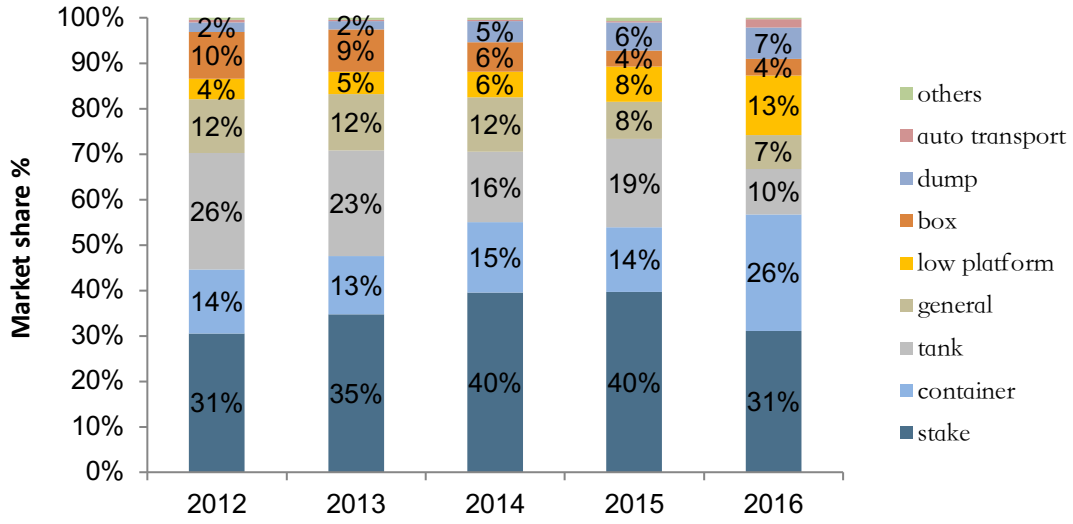



**Figure 20: Market share of trailers by body type in China, 2012–2016.** [2]

The domestic trailer manufacturers must meet production qualifications only for retrofitting. Market entrance requirements and technical requirements for such manufacturers are relative low, with the result that there are a large number of manufacturers with trailer production capabilities. Consolidation of the trailer market is therefore low, and these manufacturers commonly are faced with the problems of scatter, small size, disorder, and poor quality assurance.

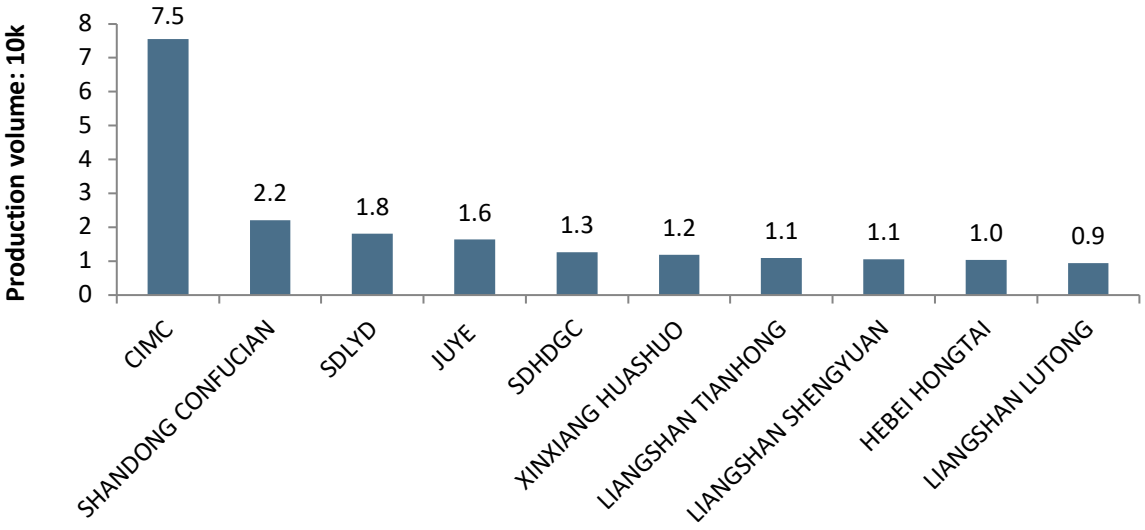



**Figure 21: Production of top 10 trailer manufacturers in China, 2016.** [2]

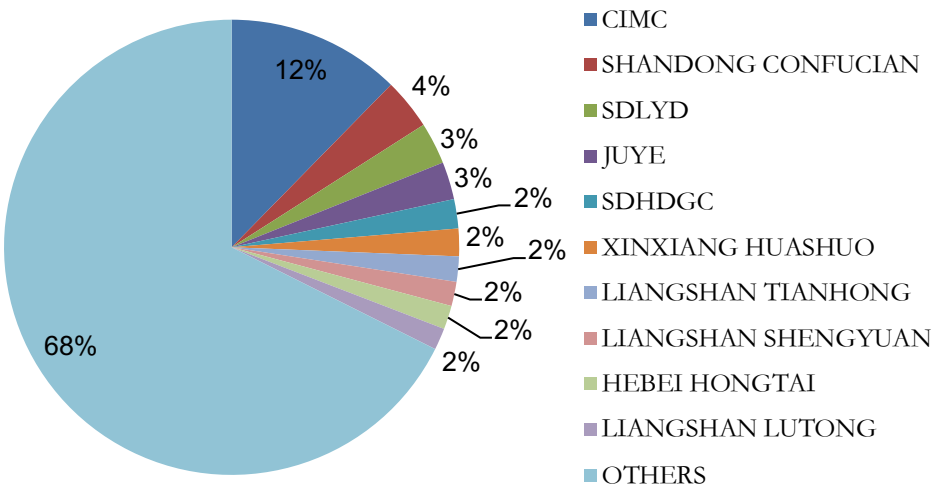



**Figure 22： Market share of the top 10 trailer manufacturers in China, 2016.** 【2】

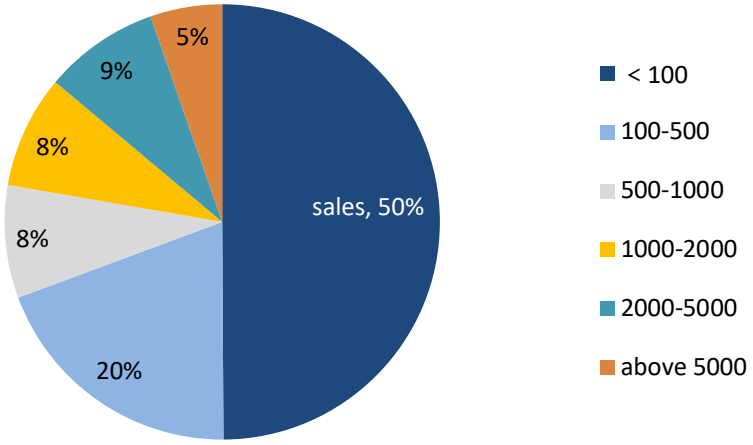



**Figure 23: Market share of trailer manufacturers by sales volume, 2016.** 【2】

## 3.4 Straight truck characteristics

In addition to the provinces of Hebei, Shandong, and Henan that traditionally have large heavy-duty truck sales, Guangdong, Jiangsu, and other economically developed areas are also important sales areas for straight trucks. Specifically, Guangdong and Jiangsu are the top two regions of express delivery in China, especially Guangdong Province, which accounts for more than 25% of the total volume of express delivery in China. The large demand for freight transportation is the main reason for the leading sales volume of straight trucks in this region.

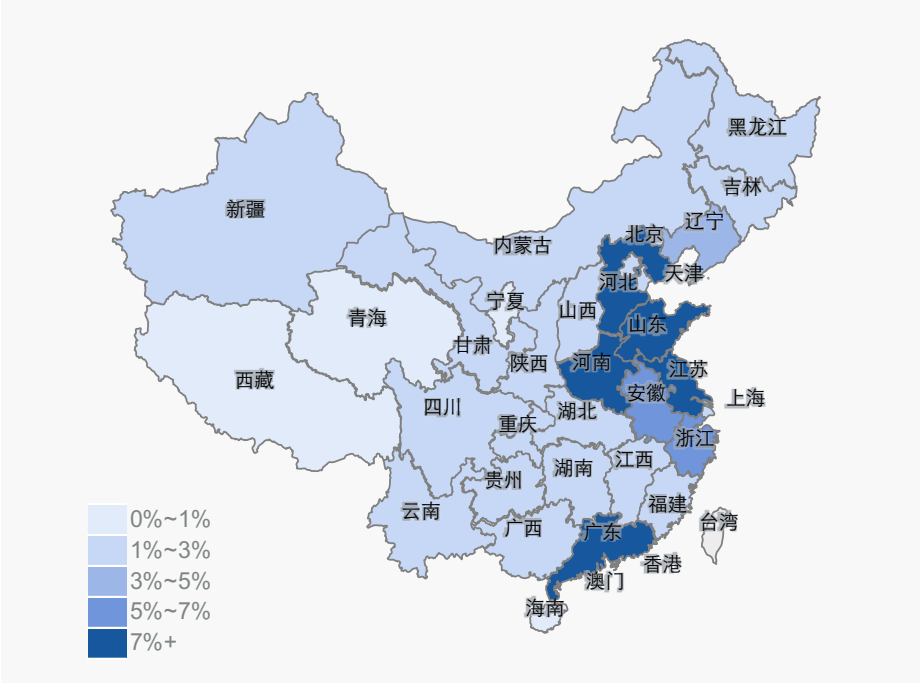



**Figure 24: Share of straight truck sales by province in China, 2012–2015.** 【3】

Both FOTON and JAC have many brands of light-duty and medium-duty trucks. FOTON, for example, has FOTON FORLAND, FOTON OLLIN, and FOTON AUMARK, among others, with each brand focusing on a different sub-market, which results in a higher overall market share in the straight truck field.

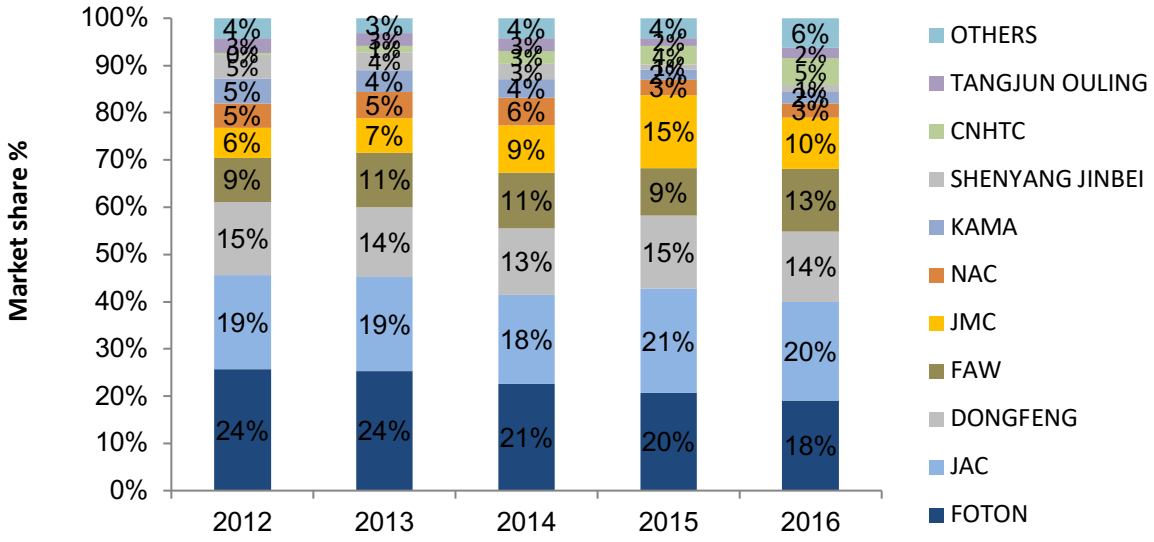



**Figure 25: Market share of straight trucks, 2012–2016.** 【3】

**Table 9: Ranking of straight truck manufacturers, 2012–2016** [3]

| Manufacturer | Annual ranking | | | | | 2012-2016 sales | 2012-2016 market share |
|---|---|---|---|---|---|---|---|
| | 2012 | 2013 | 2014 | 2015 | 2016 | | |
| FOTON | 1 | 1 | 1 | 2 | 2 | 88 | 22% |
| JAC | 2 | 2 | 2 | 1 | 1 | 78 | 19% |
| DONGFENG | 3 | 3 | 3 | 3 | 3 | 58 | 14% |
| FAW | 4 | 4 | 4 | 5 | 4 | 44 | 11% |
| JMC | 5 | 5 | 5 | 4 | 5 | 38 | 9% |
| **NAC** | 6 | 6 | 6 | 7 | 7 | 18 | 4% |
| KAMA | 7 | 7 | 7 | 8 | 8 | 14 | 4% |
| JINBEI | 8 | 8 | 8 | 10 | 10 | 12 | 3% |
| TANGJUN OULING | 9 | 9 | 9 | 9 | 9 | 12 | 3% |
| CNHTC | 10 | 10 | 10 | 6 | 6 | 11 | 3% |
| **Top10** market share | 90 % | 92% | 91% | 93% | 90% | 90% | 92% |

Diesel is the primary fuel used by straight trucks. However, being influenced by the new energy vehicle (NEV) development strategies and large amounts of financial subsidies, pure electric straight trucks increased significantly in 2016.

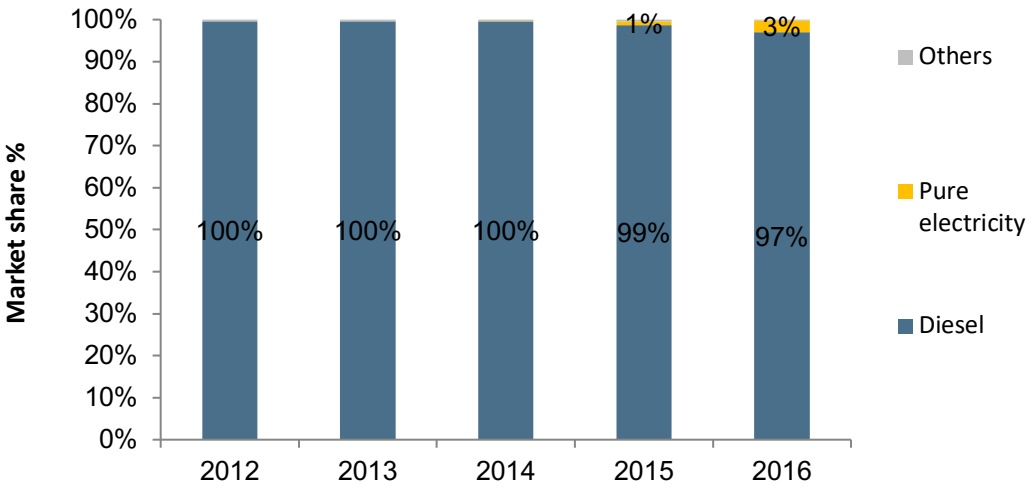



**Figure 26: Proportion of straight trucks by fuel type, 2012–2016.** [3]

According to the provisions of MPS, “straight trucks with length of less than 6,000mm and with gross vehicle weight (GVW) of less than 4,500kg, but does not

include mini commercial vehicles and low-speed vehicles" shall register for blue-color vehicle plate, which only requires the truck driver to obtain a C1 driving license; for driving straight trucks of more than 4.5 tonnes, the driver needs to obtain a B license or above. As a result, 3.5–4.5 tonne straight trucks make up the main body of heavy-duty straight vehicles. Their primary driveline configuration is 4x2, with engine displacement mainly concentrated below 4L and the engine power mainly concentrated below 200kW.

**Table 10: Share of straight trucks by GVW, 2012–2016** 【2】

| **Gross vehicle weight（kg）** | **2012–2016 production volume（10k）** | **Proportion %** |
|---|---|---|
| 3500＜GVW≤4500 | 308 | 67% |
| 4500＜GVW≤5500 | 3 | 1% |
| 5500＜GVW≤7000 | 2 | <1% |
| 7000＜GVW≤8500 | 12 | 3% |
| 8500＜GVW≤10500 | 12 | 3% |
| 10500＜GVW≤12500 | 9 | 2% |
| 12500＜GVW≤16000 | 65 | 14% |
| 16000＜GVW≤20000 | 1 | <1% |
| 20000＜GVW≤25000 | 21 | 5% |
| 25000＜GVW≤31000 | 24 | 5% |
| 31000＜GVW | 0 | 0% |

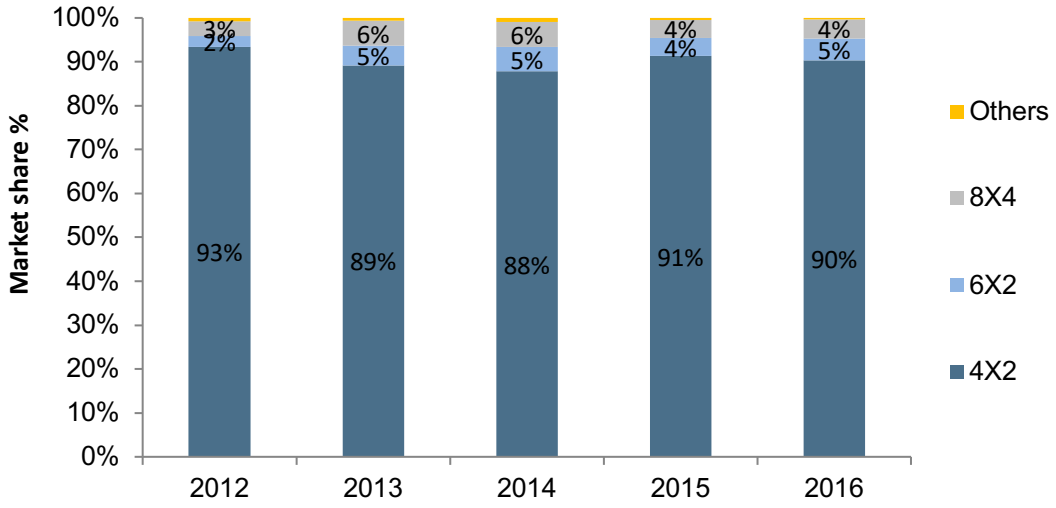



**Figure 27: Driveline configuration of straight trucks, 2012–2016.** [2]

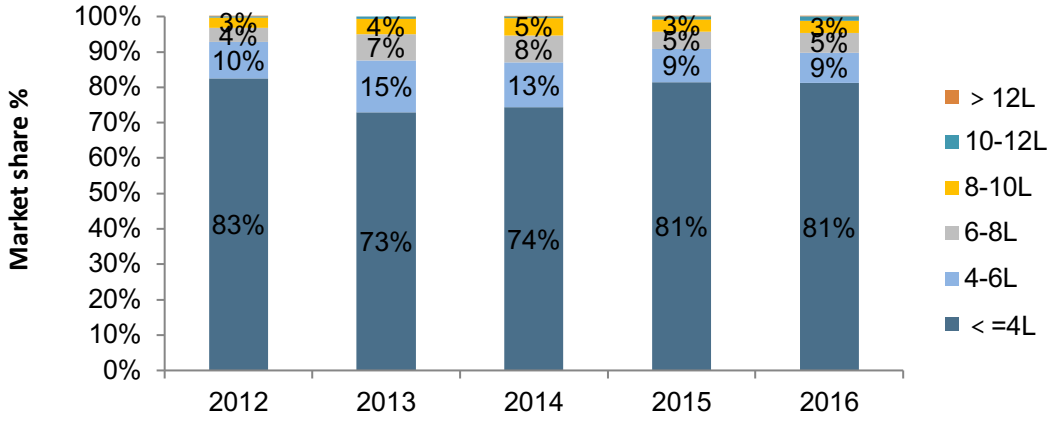



**Figure 28: Engine displacement of straight trucks, 2012–2016.** [2]

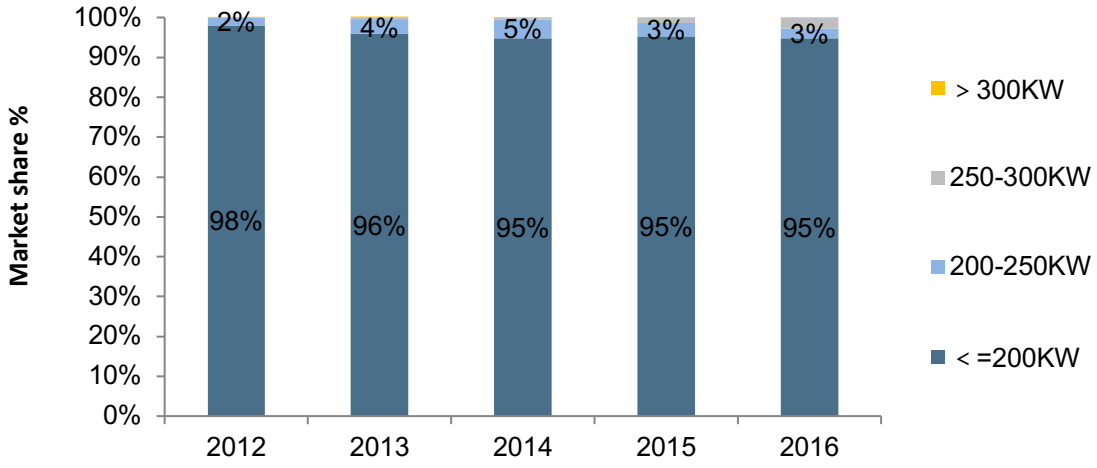



**Figure 29: Engine power of straight trucks, 2012–2016.** [2]

As for engine selection of straight trucks, some manufacturers use self-produced engines for straight trucks, whereas others select engines produced by other engine suppliers. Most straight truck products of DONGFENG, FOTON, and JAC are equipped with engines produced by other suppliers because of the higher market share and variety of vehicle models. Most straight truck products of JMC and FAW are equipped with self-produced engines.

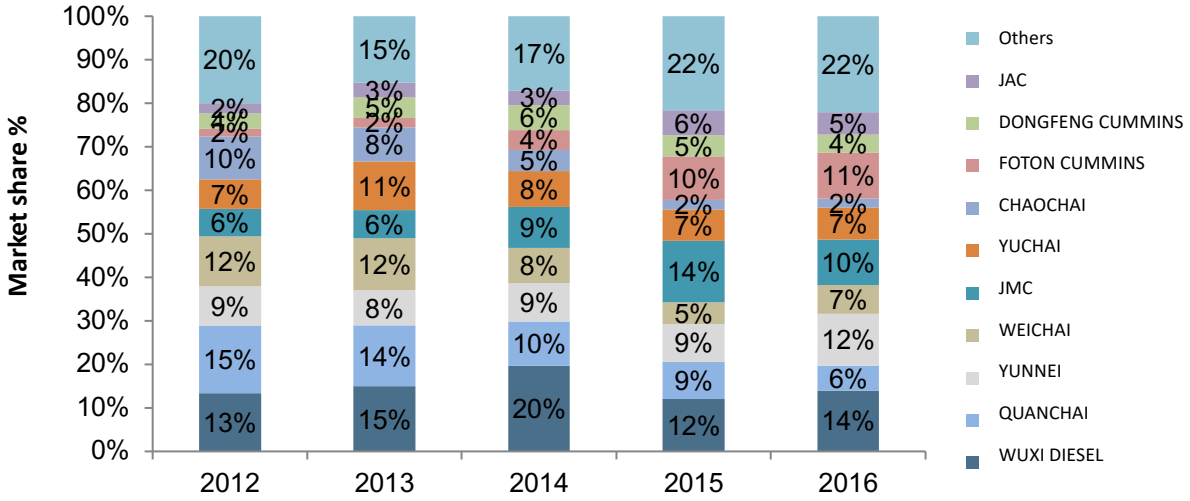



**Figure 30: Share of straight trucks by manufacturer, 2012–2016.** 【2】

**Table 11: Straight truck manufacturers and engine suppliers, 2012–2016** 【2】

| Whole vehicle manufacturer | Engine supplier | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | WUXI DIESEL | QUAN CHAI | YUNNEI | WEICHAI | JMC | YUCHAI | CHAOYANG DIESEL | FOTON CUMMINS | DONGFENG CUMMINS | JAC | Others |
| JAC | 6% | 16% | 11% | 16% | | 14% | 11% | 4% | | 21% | 2% |
| FOTON | 2% | 30% | 6% | 12% | | 4% | 5% | 21% | 1% | | 19% |
| DONGFENG | 1% | | 3% | | | 26% | 7% | | 31% | | 34% |
| FAW | 76% | <1% | 7% | 1% | | 2% | <1% | | | | 13% |
| JMC | | | | | 100% | <1% | | | | | <1% |
| NAC | | 5% | 9% | 40% | | 1% | 15% | <1% | | | 7% |
| SHENYANG JINBEI | 37% | 16% | 6% | | | | 5% | | | | 36% |
| CNHTC | 9% | 1% | 47% | | | 8% | 8% | 12% | | | 16% |
| KAMA | 23% | 1% | 58% | 2% | | 6% | | | | | 10% |
| TANGJUN OULING | 3% | 31% | 10% | 3% | | 1% | 8% | | | | 45% |
| Market share | 15% | 11% | 9% | 9% | 9% | 8% | 6% | 5% | 5% | 4% | 19% |

## 3.5 Typical vehicle technology characteristics

We selected three vehicle models—straight truck with GVW of 4.5 tonnes, straight truck with GVW of 16 tonnes, and tractor-trailer combination with gross combination weight (GCW) of 49 tonnes—as the representative vehicle models of road freight trucks in China.

Tractor-trailers are covered by "9.21" regulations, and MOT, MPS, and MIIT have unified the standards for determining over-loading. The GCW limits of 6x2 and 6x4 tractor-trailers were reduced from 55 tonnes to 46 tonnes and 49 tonnes, respectively. As a result, the proportion of 49-tonne 6x4 tractor-trailers increased significantly in 2016, reaching 66%. Most tractors in China weigh roughly 9 tonnes and the curb weight of a typical trailer is about 7 tonnes, adding up to a tractor-trailer combination curb weight of 16 tonnes. GB1589-2016 was implemented in 2016 and prescribed the maximum allowed dimensions of trailers as 13.75m in length, 2.55m in width, 4m in height and 85$m^3$ in volume capacity (13m*2.5m*2.6m).

**Table 12: Typical technical characteristics of tractor-trailers**

| | 46000＜GCW≤49000 |
|---|---|
| Proportion to total tractor-trailers in 2016 | 66% |
| Gross vehicle weight (tonnes) | 49 |
| Curb weight (tonnes) | 16 |
| Maximum payload (tonnes) | 33 |
| Maximum loading volume ($m^3$) | 85 |
| Driveline configuration | 6x4 |
| Engine displacement (L) | 11 |
| Engine power (kW) | 340 |
| Emission standard | China 5 |
| Fuel consumption standard | Stage 2（47L/100km） |

| | |
|---|---|
| Transmission type | Manual |
| Transmission gears | 12 |
| Transmission gear ratios | 14.8:1 |
| Rear axle ratio | 3.7 |
| Tire type | Radial |
| Tire size | 12R22.5 |
| Aerodynamic drag | 0.75[13] |
| Rolling resistance coefficient （N/kN） | 8.3[14] |

**Table 13：Typical technical characteristics of straight trucks**

| | 3500＜GVW≤4500 | 12500＜GVW≤16000 |
|---|---|---|
| Proportion to total straight trucks in 2016 | 70% | 12% |
| Gross vehicle weight（kg） | 4495 | 16000 |
| Curb weight（kg） | 2500 | 6200 |
| Maximum payload（kg） | 1790 | 9400 |
| Maximum loading volume （$m^3$） | 17 | 45 |
| Driveline configuration | 4x2 | 4x2 |
| Engine displacement（ml） | 2499 | 6060 |
| Engine power （kW） | 105 | 139 |
| Emission standard | China 5 | China 5 |
| Fuel consumption standard | Stage 2 （13L/100km） | Stage 2 （28L/100km） |
| Transmission type | Manual | Manual |

[13] "*Market Analysis and Fuel Efficiency Technology Potential of Heavy-duty Vehicles in China,*" ICCT.

[14] According to *"Fuel consumption test methods for medium and heavy-duty commercial vehicles"* (GB/T 27840-2011), f= 0.0066+0.0000286*V（V=90km/h).

| | | |
|---|---|---|
| Transmission gears | 6 | 8 |
| Transmission gear ratios | 6.314-0.788 | 10.36-0.8 |
| Rear axle ratio | 4.33 | 4.875 |
| Tire type | Radial | Radial |
| Type number | 6 | 6 |
| Tire size | 7.00R16 | 9.00R20 |
| Aerodynamic drag | 0.8[15] | 0.77[16] |
| Rolling resistance coefficient （N/kN） | 7.8[17] | 8.3[18] |

[15] Fixed value prescribed in "*Fuel consumption test methods for medium and heavy-duty commercial vehicles"* (GB/T 27840-2011)
[16] "*Market Analysis and Fuel Efficiency Technology Potential of Heavy-duty Vehicles in China,*" ICCT.
[17] According to GB/T 27840-2011，f= 0.0076+0.0000056*V（V=40km/h）
[18] According to GB/T 27840-2011，f= 0.0066+0.0000286*V（V=60km/h）

# 4 Truck fuel-saving technologies

This chapter introduces the fuel consumption standard system of heavy-duty vehicles in China as well as the technical pathway selected by whole vehicle manufacturers. In order to further understand this information, we visited leading heavy-duty vehicle manufacturers, freight fleets, and the operators of pure electric truck fleets.

## 4.1 Fuel consumption standards/limits for heavy-duty trucks in China

China's fuel consumption standards for heavy-duty vehicles are divided into two categories—fuel consumption standards released by MIIT and fuel consumption standards released by MOT, among which, the MIIT fuel consumption standards are applicable to the all heavy-duty vehicles with GVW of more than 3.5 tonnes, whereas the MOT fuel consumption standards are applicable only to commercial operation vehicles. The MIIT and MOT fuel consumption standards belong to two completely independent management systems; the two sets of standards are not related. The Department of Equipment Manufacturing Industry of the MIIT is responsible for the management of work related to the motor vehicle industry. Compliance with fuel consumption limits is a prerequisite for the vehicles produced to enter the market. Currently, eight testing organizations, including CATARC, are responsible for conducting vehicle fuel consumption tests. The Automotive Transportation Energy Saving Technology Service Center of MOT is responsible for establishing fuel consumption limits for commercial operation vehicles and for conducting vehicle type approval. Meeting the fuel consumption limits is a necessary condition for freight vehicles to get commercial operation approvals. Sixteen testing organizations, including CATARC, are responsible for conducting fuel consumption tests on commercial operation vehicles.

### 4.1.1 MIIT fuel consumption standards

For MIIT, the vehicle fuel consumption level is tested based on the procedures prescribed in "*Fuel consumption test methods for heavy-duty commercial vehicles*" (GBT 27840-2011) and evaluated for compliance based on the national standard "*Fuel consumption limits for heavy-duty commercial vehicles*" (GB 30510-2014). The fuel consumption standard is applicable to gasoline and diesel commercial vehicles with a design GVW of more than 3,500kg, including straight trucks, tractors, coach buses, dump trucks, and city buses. The standard is not applicable to specialized vocational vehicles.

"*Fuel consumption limits for heavy-duty commercial vehicles (Stage 3)*" has already been submitted for approval in 2017 and is expected to take effect about July 1, 2019. In general, Stage 3 will tighten vehicle consumption limits in 2020 by about 15% based on a 2015 baseline.[19] Considering the differences on actual driving cycles and the fuel-saving technology potentials of different vehicle types and vehicle weights, Stage 3 categorizes specific energy-saving goals according to vehicle type and weight. Generally, Stage 3 tightens fuel consumption limits by an average of 10.7% – 17.9% over Stage 2.[20]

**Table 14: Stringency of fuel consumption limits of Stage 3 Vs 2: tractors【2】**

| GCW Bin (tonnes) | Stringency | Stage 3 （L/100km） | Stage 2 （L/100km） | 2012–2016 market share |
|---|---|---|---|---|
| **3.5-18** | 15.20% | 28 | 33 | 0.02% |
| **18-27** | 15.30% | 30.5 | 36 | 0.30% |
| **27-35** | 15.80% | 32 | 38 | 1.04% |
| **35-40** | 15.00% | 34 | 40 | 1.43% |
| **40-43** | 15.50% | 35.5 | 42 | 9.08% |
| **43-46** | 15.60% | 38 | 45 | 34.84% |
| **46-49** | 14.90% | 40 | 47 | 52.74% |
| **>49** | 15.60% | 40.5 | 48 | 0.54% |
| **Weighted average stringency** | 15.10% | | | |

[19] Compiling Instructions of "Fuel consumption limits for heavy-duty commercial vehicles (Stage 3)"

[20] Ditto

**Table 15: Stringency of fuel consumption limits of Stage 3 Vs 2: straight trucks [2]**

| GCW Bin (tonnes) | Stringency | Stage 3 （L/100km） | Stage 2 （L/100km） | 2012–2016 market share |
|---|---|---|---|---|
| **3.5-4.5** | 11.50% | 11.5 | 13 | 67.39% |
| **4.5-5.5** | 12.90% | 12.2 | 14 | 0.71% |
| **5.5-7** | 13.80% | 13.8 | 16 | 0.45% |
| **7-8.5** | 14.20% | 16.3 | 19 | 2.68% |
| **8.5-10.5** | 14.90% | 18.3 | 21.5 | 2.56% |
| **10.5-12.5** | 14.80% | 21.3 | 25 | 1.90% |
| **12.5-16** | 14.30% | 24 | 28 | 14.18% |
| **16-20** | 14.30% | 27 | 31.5 | 0.18% |
| **20-25** | 13.30% | 32.5 | 37.5 | 4.59% |
| **25-31** | 12.80% | 37.5 | 43 | 5.35% |
| **>31** | 15.40% | 38.5 | 43.5 | 0.01% |
| **Weighted average stringency** | 13.80% | | | |

### 4.1.2 MOT fuel consumption standards

Under the MOT fuel consumption standards, fully loaded commercial operation vehicles are tested for fuel consumption levels by running constant speed, acceleration, and idle cycles respectively. Comprehensive fuel consumption of the commercial operation vehicles under full-load conditions are then evaluated through weighted calculations. The tests of MOT fuel consumption level are conducted based on the procedures prescribed in "*Limits and measurement methods of fuel consumption for commercial vehicle for cargoes transportation" (JT/T 719-2016)* (enforcement date: April 1, 2017).

**Table 16: MOT fuel consumption limits for commercial operation straight vehicles**[21]

| GVW Bin (tonnes) | Stringency | Stage 3 （L/100km） | Stage 4 （L/100km） | 2012–2016 [2] market share |
|---|---|---|---|---|
| **3.5＜GVW≤4.5** | 7.04% | 14.2 | 13.2 | 67.39% |

[21] "Limits and measurement methods of fuel consumption for commercial vehicle for cargoes transportation" (JT/T 719-2016).

| | | | | |
|---|---|---|---|---|
| **4.5＜GVW≤7** | 6.75% | 16.3 | 15.2 | 1.16% |
| **7＜GVW≤9** | 7.22% | 19.4 | 18 | 2.93% |
| **9＜GVW≤12** | 7.08% | 22.6 | 21 | 3.17% |
| **12＜GVW≤18** | 6.90% | 26.1 | 24.3 | 15.36% |
| **18＜GVW≤20** | 7.05% | 29.8 | 27.7 | 0.05% |
| **20＜GVW≤25** | 6.93% | 33.2 | 30.9 | 4.59% |
| **25＜GVW≤31** | 6.93% | 36.1 | 33.6 | 5.35% |

**GVW: Gross vehicle weight**

**Table 17: MOT fuel consumption limits for tractors**[22]

| GCW Bin (tonnes) | Stringency | Stage 3 （L/100km） | Stage 4 （L/100km） | 2012–2016 [2] market share |
|---|---|---|---|---|
| **GCW≤27** | 6.93% | 37.5 | 34.9 | 0.31% |
| **27＜GCW≤36** | 6.98% | 40.1 | 37.3 | 1.14% |
| **36＜GCW≤43** | 6.91% | 43.4 | 40.4 | 10.42% |
| **43＜GCW≤49** | 6.91% | 46.3 | 43.1 | 87.59% |

**GCW: Gross combined weight**

## 4.2 Primary truck fuel-saving technologies and strategies in China

In China, the fuel-saving technologies used on heavy-duty vehicles include optimizing the driveline system, lightweighting, alternative fuels, and pure electric trucks. With the promotion of related policies, developing pure electric vehicles is the primary technical pathway to achieving fuel savings for straight vehicles under 4.5 tonnes. As for tractors and straight vehicles with GVW of more than 12 tonnes, the fuel-saving technology packages are basically selected by the market and include installing aerodynamic drag reduction fairings, reducing vehicle weight, and developing alternative fuel vehicle models.

### 4.2.1 Driveline system

The final drive ratio has significant influence on both dynamic performance and fuel economy. Changing the final ratio can affect engine operating range which also

[22] Ditto.

affects the fuel consumption. Adopting a smaller final drive ratio can help achieve better fuel economy. For vehicles used for express transportation and sporadic express, highway driving mileage accounts for more than 90% of total driving mileage. For such applications, most original equipment manufacturers (OEMs) would like to realize quick start of moving, better climbing performance, and fast acceleration performance through combining a high-powered engine with a small drive-ratio rear axle. With sufficient engine power, the vehicle is able to realize significant fuel-saving results under high-speed conditions. Currently, all J6 Series vehicles of FAW JIEFANG, Dragon Series vehicles of DONGFENG, T7 Series vehicles of CNHTC, GTL Series vehicles of FOTON, and DELONG Series vehicles of SHAANXI AUTO have promoted the tractors with 500kW engines.

**Table 18: Technical characteristics of major tractor brands**[23]

| | FAW JIEFANG J6P | FOTON DAIMLER GTL | DONGFENG DRAGON | SHAANXI AUTO DELONG X3000 | CNHTC SITRAK C7H |
|---|---|---|---|---|---|
| Displacement (L) | 12.52 | 11.8 | 13 | 12.54 | 12.419 |
| Maximum power （kW） | 370 | 360 | 382 | 368 | 397 |
| Maximum horsepower | 500 | 490 | 520 | 500 | 540 |
| Emission standard | China 5 | China 5 | China 5 | China 5 | China 5 |
| Transmission type | Manual | Manual | Manual | Manual | Manual |
| Forward transmission gears | 12 | 12 | 12 | 12 | 16 |
| Reverse | 2 | 2 | 2 | 2 | 2 |

[23] http://www.360che.com/qianyinche/

| | | | | | |
|---|---|---|---|---|---|
| transmission gears | | | | | |
| Rear axle ratio | 3.727 | 3.7 | 3.42 | 2.846 | 3.36 |

### 4.2.2 Lightweighting

Vehicle weight has significant effects on both rolling and accelerating resistance, and is a primary parameter with regard to fuel consumption. Based on the full load condition, when GVW increases by 10%, fuel consumption rises 5.7% on average; when GVW decreases by 10%, fuel consumption drops 5.2% on average. [5] Thus, reducing vehicle weight to the greatest extent possible is an important strategy to improving vehicle fuel efficiency. Currently, manufacturers of heavy-duty vehicles, heavy-duty engines, and other components are working to reduce product weight overall with the goals of reducing vehicle fuel consumption and meeting increasingly stringent fuel consumption limits.

When considering the weight of the whole vehicle, several strategies have obvious weight reducing effects. Replacing the original 10-piece leaf spring with a four- or three-piece leaf spring, as well as using a parabolic leaf spring structure for the front axle, can reduce curb weight by several hundred kilograms while maintaining the same carrying capacity. Today, most of the highway logistics vehicles in China use such components, which are suitable for transporting at top load limits. Second, bellows-type pneumatic suspension can be adopted, reducing total weight by about two thirds compared to using laminated leaf spring suspension. Pneumatic suspensions also improve driving comfort and make it more convenient for cargo handling. Currently, there are three modes of bellows-type pneumatic suspension being adopted in China: 5-airbag, 8-airbag, and 9-airbag. However, due to the higher cost of using airbags, it has not become popular among manufacturers. A third weight reduction tactic is to use a fuel/gas tank made of aluminium alloy, which has become part of the basic configuration. A fourth approach to reducing whole-vehicle weight is to reduce the weight of the engine, gearbox, and rear axle. For example, FAW JIEFANG's current core engine product, the CA4DK, is 10-50kg lighter than

similar engine products and its CA6DK is 110-250kg lighter than similar engine products. Matching those engines with a 12-gear all-aluminium gearbox can lower the weight of whole vehicle by 106kg. A new 435 rear axle—where 435 refers to the diameter of the driven gear, in mm, of the final reduction drive—can reduce weight by about 200kg. The application of aluminium alloy rims can lower weight another 20kg/rim, and so on.

Adopting all-aluminium trailers and cargo tanks is another important method to lower curb weight and reduce fuel consumption. Compared to common steel trailers of the same type, all-aluminium trailers can decrease curb weight by 2-3 tonnes on average and save 2-3L of fuel per 100km. However, due to the higher cost of aluminium trailers, they currently have relatively large-scale application only in the express transportation and oil transportation fields.

**Table 19: Technical characteristics of aluminium alloy trailers** 【2】

| | **Container trailer** | **Box trailer** | **Box trailer** | **Oil transportation trailer** |
|---|---|---|---|---|
| **Length** | 13950 | 14600 | 13600 | 11800 |
| **Width** | 2550 | 2500 | 2550 | 2500 |
| **Height** | 1380 | 4000 | 4000 | 3700 |
| **Curb weight （kg）** | 4100 | 6950 | 6600 | 6500 |

### 4.2.3 Aerodynamic technologies

Drag coefficient, windward area, and vehicle speed determine a vehicle's aerodynamic drag and further influence fuel consumption. With certain windward areas and drag coefficients, aerodynamic drag is directly proportional to the square of speed. Thus, changing the drag coefficient exerts the biggest impact on fuel consumption under the highway cycles that have the highest average speed, but exerts the smallest impact on fuel consumption under urban cycles. For heavy-duty

trucks, and especially for tractors, reducing aerodynamic drag is an important strategy to save fuel. Currently, the aerodynamic drag coefficient of major domestic flat-roof tractors averages about 0.6. Taking FOTON DAIMLER as an example, the drag coefficient at the front side can reach 0.58 through a new profile, which lowers its fuel consumption by 2.5%. However, modifying the profile of the entire vehicle requires a long time and incurs high costs. Therefore, only a small number of manufacturers choose to invest in such modifications.

Currently, installing wind deflectors is the primary method to lower aerodynamic drag of heavy-duty trucks. However, a wind deflector can be installed only on the vehicle roof; side fairings have not been widely applied in China because of road driving conditions and regulations. Although wind deflectors are in wide use, there are no related data to demonstrate this technology's specific fuel-saving results.

#### 4.2.4 Low-resistance tires

The rolling resistance between tires and ground, which is determined by vehicle weight and coefficient of rolling resistance, is an important factor that influences truck fuel consumption. Besides operating conditions, such as speed and tire pressure, the coefficient of rolling resistance also is correlated with tire type and road surface. Single-wide tires and low rolling resistance tires can effectively lower rolling resistance and improve fuel economy.

Today, all large-scale logistics fleets have adopted radial tires instead of bias tires. According to measurements made by Beijing DLD Logistics Co., Ltd., radial tires can help reduce fuel consumption by 5% compared to bias tires under the same loading and working conditions. Individual private drivers choose tires based primarily on price, durability, and purchase convenience of the tires; both radial tires and bias tires are widely used. Low rolling resistance tires are rarely used in China, where most freight fleets and individual private drivers are unfamiliar with this concept.

According to the road test made by Suntown Technology Group Co., Ltd, compared to double-tire trailers, super-single-tire trailers can reduce fuel consumption by 4% on average. However, considering safety issues, super-single-tire trailers are primarily applied in the express transportation field.

### 4.2.5 Alternative fuels

Natural gas vehicles constitute the largest and most mature alternative fuel vehicle type in China, and tractor is the primary vehicle model of natural gas trucks. In addition to the encouragement from the government departments, the economy factor is the most important incentive for developing natural gas vehicles in China. Natural gas tractors are developing rapidly due to their higher annual driving mileage and significant fuel benefits. In 2015 and 2016, natural gas tractor sales fell sharply because of the sharp drop of domestic diesel prices, the rise in the price of vehicles using natural gas, and the downturn of the overall truck market. In 2017, the production volume of natural gas increased significantly. Except for the influences of implementing GB1589-2016 and “9.21” regulations, the population of natural gas tractors has increased significantly relative to the overall truck market. This also has been affected by environmental pressure, driving restrictions on China 3 diesel vehicles in some regions, and the inconvenience of refilling urea solution for China 4/5 vehicles. In the future, with the price of vehicles using natural gas becoming market oriented, the price of natural gas vehicles will likely moderate significantly. At the same time, under the pressures of environmental protection and emission standard upgrades, heavy-duty natural gas trucks will have significant potential for future development.

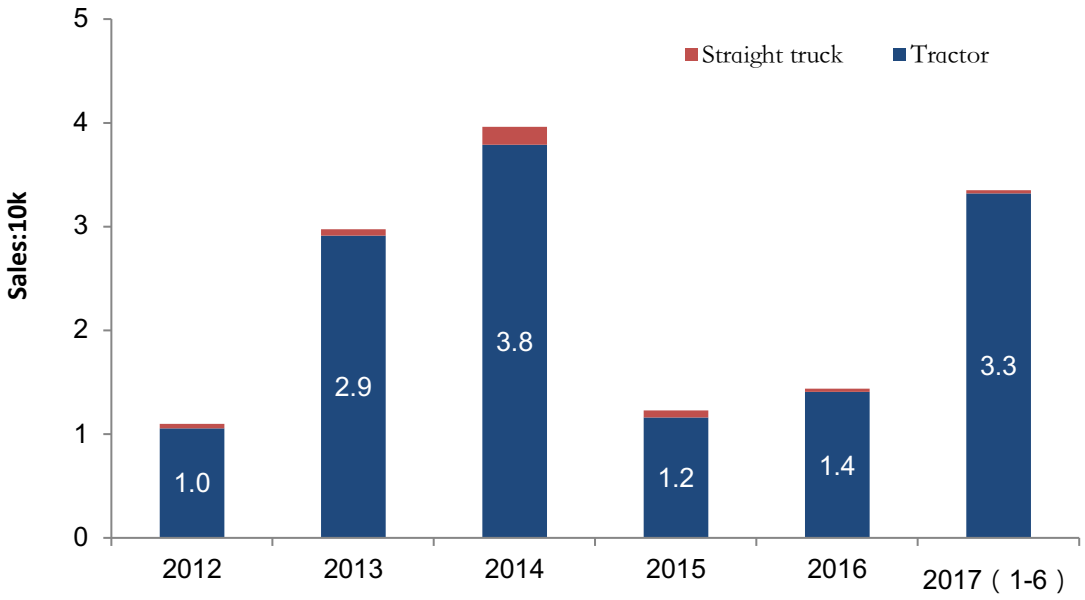



**Figure 31: Sales of heavy-duty natural gas trucks, 2012–2017 (Jan to Jun)** [3]

### 4.2.6 Pure electric drive technologies

The rapid development of pure electric trucks is the result of policy promotion. First, the development of new energy vehicles is a national strategy as well as the only way for China to upgrade its vehicle industry. Second, the development of new energy vehicles is an important measure to take in coping with environmental pressure and fuel consumption. Third, large purchase subsidies are the primary forces driving manufacturers to develop new energy vehicles, especially pure electric trucks. Fourth, the strict driving restrictions on trucks in urban areas is the primary reason for users to buy pure electric trucks. Fifth, policies for pure electric trucks, such as enjoying the right of driving on roads, parking fee waivers, and the installation of free charging poles, also provide conveniences for using pure electric trucks in the urban logistics field.

Currently, pure electric trucks are used mainly for urban logistics delivery, including express delivery, flower delivery, and so on, such that the application is still in a trial stage. The shortage of actual endurance mileage, especially the serious decline of range under high- and low-temperature conditions, is the primary obstacle to large-scale adoption of pure electric trucks.

The daily driving distance for urban logistics delivery vehicles is about 200km. When the driving range of pure electric trucks exceeds 200km, and even more likely after it reaches 230-250km, the government may release policies requiring registration and banning fossil-fueled trucks from going into urban areas. The 3.5- to 4.5-tonne diesel trucks currently used in the urban delivery field will be replaced by pure electric trucks in the future.

**Table 20: Operation and registration restrictions of fossil fuel trucks in certain cities**

| City | Regulation document | Main content |
|---|---|---|
| **Shen-zhen** | "*Notice of banning registration and non-local transfer of light-duty diesel vehicles*" [24] | Shenzhen has banned the registration and non-local transfer of light-duty diesel vehicles since November, 2017. (Light-duty diesel vehicle refers to the light-duty and mini diesel commercial vehicles and small and mini diesel passenger vehicles prescribed in GA802-2014. Among which, the light-duty diesel commercial vehicle refers to vehicles with GVW of no more than 3,500kg). |
| **Cheng-du** | *"Policies of promoting the application of new energy vehicles in Chengdu"* [25] | Chengdu will gradually cease issuance of city entrance approvals to fuel trucks, except for specialized freight vehicles. The regulation was released on July 20, 2017. |

[24] http://www.sz.gov.cn/cn/hdjl/zjdc/201709/t20170901_8359035.htm
[25] http://www.cdwl.gov.cn/index.php?m=content&c=index&a=show&catid=23&id=5932

# 5 Trucking operations

This chapter primarily introduces the annual driving mileage, vehicle load, fuel consumption management, fuel-saving technologies, technology selection, consideration factors of purchasing vehicles, and payback period of freight enterprises. To obtain this information, we have conducted desk studies and have had in-depth communication with related logistics fleets, industry associations, and experts.

## 5.1 Operational characteristics of road freight enterprises

Most road freight enterprises in China are individual private carriers, which results in relatively decentralized management of freight fleets and cargo sources. High stop operating rate and over-load issues are quite common for domestic freight fleets. The monthly driving mileage of a single freight truck is less than 10,000km on average. Non-network medium- and small-scale freight enterprises account for higher proportions in the market; station-to-station transportation is the primary transportation mode of such carriers.

### 5.1.1 Fleet classification

According to the "*Classifications of road freight transportation enterprises*" released by MOT, road freight enterprises in China fall into five classes—Top Class, Class 1, Class 2, Class 3, and Class 4—based on their freight capacity, asset size, vehicle condition, operation performance, and safety status. As a recommended standard for the transportation industry, the class of road freight transportation enterprises is voluntarily applied by the enterprises; the government departments do not make mandatory requirements. According to the statistics of the China Road Transport Associations, by the end of 2011, a total of 42 Class 1 enterprises and 176 Class 2 enterprises have been assessed (note: the standard was revised in 2015; the

original standard has no Top Class classification, so the data here are only used for reference). In addition, according to the general definition of the road freight industry in China, the road freight fleets are divided into three levels according to the vehicle population. Large-scale fleets have 200 – 500 vehicles, medium-scale fleets have 50 – 200 vehicles, and the small-scale fleets have 5 – 50 vehicles.

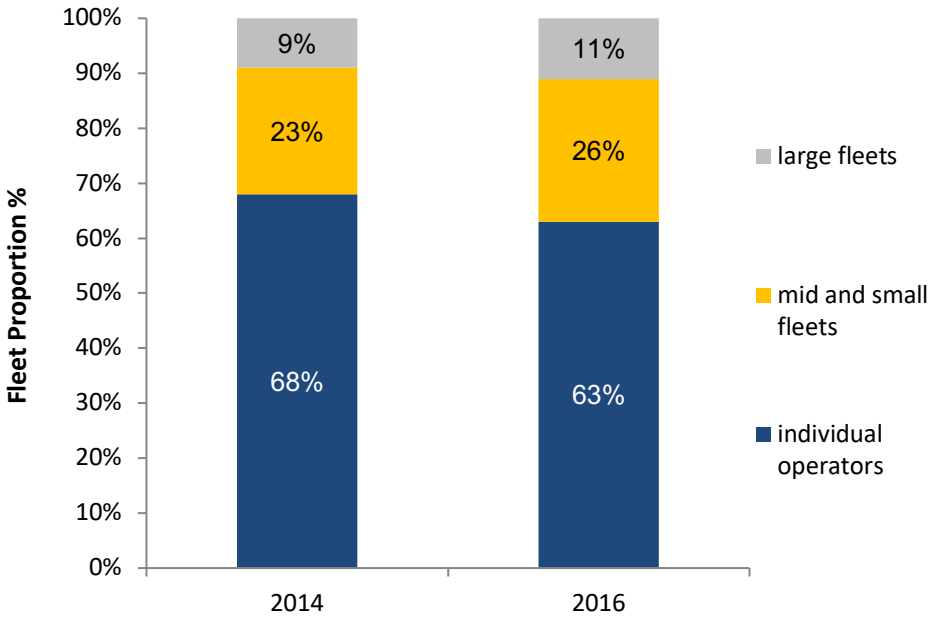



**Figure 32: Proportion of truck fleets in China, by fleet size.**

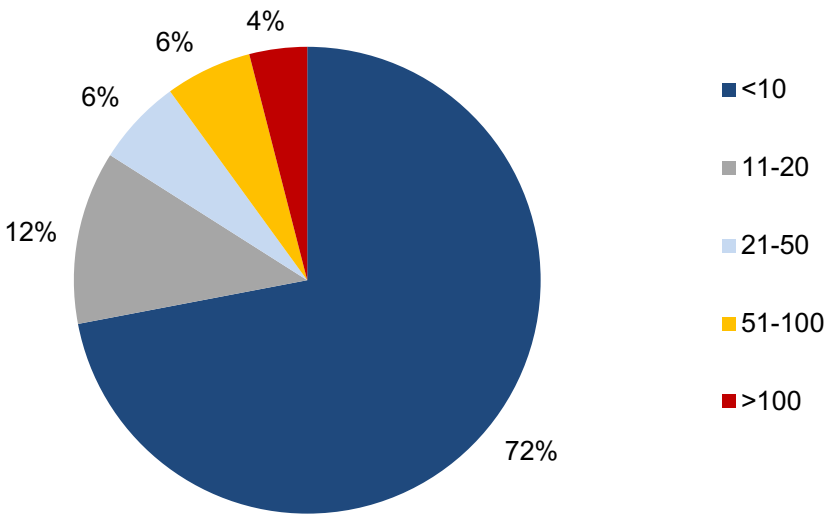



**Figure 33： Vehicle population of medium- and small-scale**

**road freight fleets, 2015.**[26]

**Table 21: Classification of road freight transportation enterprises of MOT**

| | Index | Top Class | Class 1 | Class 2 | Class 3 | Class 4 |
|---|---|---|---|---|---|---|
| | Freight quantity (10k tonnes) | 1000 | 500 | 180 | 50 | 10 |
| Freight capacity | Freight rotation (10k tonnes-km) | 180000 | 90000 | 30000 | 9000 | 1800 |
| Vehicle condition | Freight capacity of self-owned trucks shall be no less than (tonne) | 40000 | 20000 | 7000 | 2000 | 400 |
| Asset size | Total asset (100 millions) | 30 | 10 | 3 | 1 | 0.12 |
| | Net asset (100 millions) | 15 | 5 | 1.5 | 0.5 | 0.06 |
| Operation performance | Total operation income (100 millions) | 16 | 8 | 2.5 | 0.2 | 0.04 |
| | Income of freight transportation (100 millions) | 8 | 4 | 1.5 | 0.15 | 0.03 |
| Safety status | Liable accident rate (number/vehicle) | 0.03 | 0.05 | 0.08 | 0.1 | 0.12 |
| | Liable death rate (person/vehicle) | 0.005 | 0.01 | 0.02 | 0.02 | 0.03 |
| | Liable injury rate (person/vehicle) | 0.015 | 0.025 | 0.05 | 0.05 | 0.08 |
| Technology application | GPS installation rate of dangerous cargo freight trucks, tractors, and vehicles of more than 12 tonnes （%） | 100 | 100 | 100 | 100 | 100 |
| | Vehicle information access rate (through public freight vehicle platforms) of dangerous cargo freight trucks, tractors, and vehicles of more than 12 tonnes （%） | 100 | 100 | 100 | 100 | 100 |
| | Information management system of the enterprises (set) | 5 | 4 | 3 | 2 | 1 |
| | Population of new energy or | 100 | 50 | 20 | - | - |

[26] China Federation of Logistics and Purchasing “Operation Report of Medium and Small Scale Road Transportation Enterprises”.

| | |
|---|---|
| | clean energy freight trucks (number of vehicles) |

Currently, there are huge differences between the management of large fleets and small fleets. This is reflected in the fact that large fleets have a higher rate of self-owned vehicles and are able to make overall arrangements and optimize transportation routes, reducing roundabout routes and shortening stop time to the greatest extent. Large fleets have more constraints on both drivers and non-self-owned vehicles, which require the purchase of uniform vehicles, use of a unified enterprise logo, training the drivers to wear uniforms and follow service standards, as well as requiring better performance on freight transportation timeliness. Large-scale fleets enjoy big advantages on cargo sources and vehicle organization.

Most small fleets rely on affiliation operation, suffering relatively decentralized management and limited control over drivers. Such fleets collect only management fees, cargo information fees, and other related fees but do not participate in the specific freight business of individual drivers. The stop operating rate of individual drivers is high, with the average interval between two cargo deliveries of more than 3 days. Freight rate competition is also fierce.

### 5.1.2 Annual driving mileage

In view of the characteristics of "large vehicle population, high proportion of small operators, decentralized organization and disorderly operation" in the freight industry, the “National Road Freight Vehicle Supervision and Service Platform” is operated by MPS, MOT and the State Administration of Work Safety (SAWS) as the governmental management platform to conduct automatic supervision on heavy-duty trucks, which is to say freight trucks with GVW of more than 12 tonnes, and tractors. The platform can make real-time statistics on the track and mileage of the vehicles, but the related data are not open to the public. The purpose of the platform is to prevent and reduce the occurrence of road traffic accidents as well as to prevent over-speed and fatigue driving so as to improve the driving safety of freight vehicles

and promote the development of BeiDou-related industries.[27]

Being influenced by the factors of transportation distance and cargo organizing conditions, the annual driving mileages of freight vehicles engaged in different sub-markets are also quite different. The annual driving mileage of long-haul freight truck is about 100,000 – 150,000km; the annual driving mileage of delivery vehicles owned by express enterprises can reach 250,000 – 300,000km; the annual driving mileage of urban logistics distribution vehicle is generally about 50,000km. According to the survey conducted by the China Federation of Logistics and Purchasing, the freight enterprises with single-vehicle monthly average driving mileage of 3,000 – 6,000km account for a proportion of 30.3%, whereas those with monthly average driving mileage of 6,000 – 9,000km account for a proportion of 21.2%. Those with single-vehicle monthly average driving mileage of 9,000 – 12,000km account for a proportion of 24.2%, and those with single-vehicle monthly average driving mileage above 12,000km account for a proportion of 19.7%.

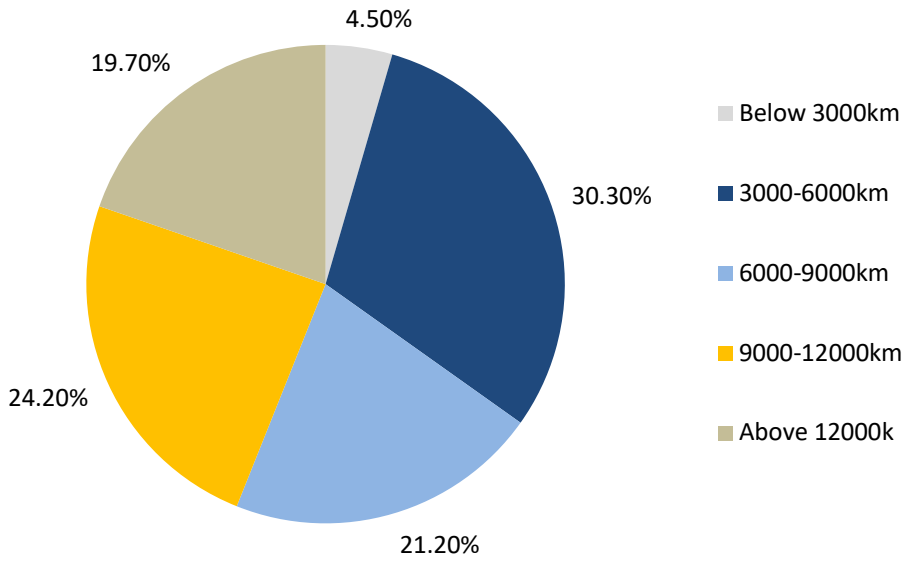



**Figure 34: Monthly average driving mileage of road freight enterprises, 2016.**

From the perspective of single-vehicle operating time, large-scale fleets have an

[27]BeiDou is China's satellite navigation system.

obvious advantage in operational efficiency. The daily average operating time is 10.2 hours, which is far longer than that of individual private carriers and small-scale fleets.

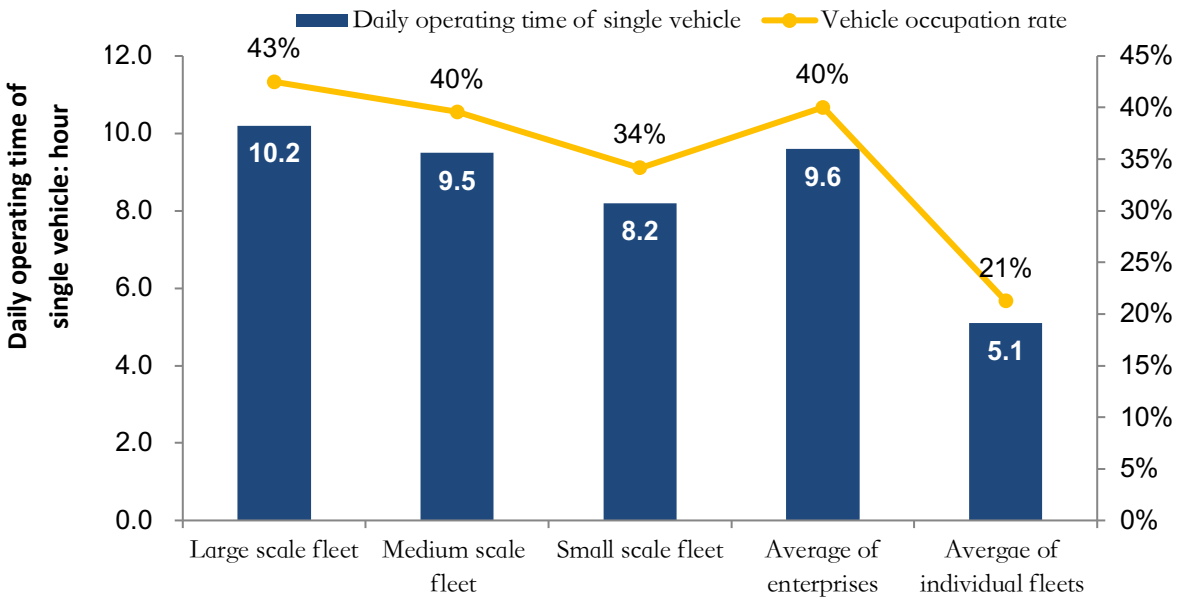



**Figure 35: Daily operating time and vehicle occupation rate of road freight enterprises, 2016.**[28]

### 5.1.3 Vehicle loading

After "9.21" regulations, MOT, and MPS developed jointly enforcement actions on over-load and over-limit operation in the road freight field, over-load operation basically disappeared in mid- and long-distance road transportation, but over-limit operation still existed. Both over-load and over-limit operations are still quite common in the field of heavy cargo transportation between cities.

From the perspective of urban logistics, because there are no weight-calculating toll collection stations in urban areas, freight vehicles only need to meet the driving restrictions of cities. Therefore, the overloaded operation of 4.5-tonne trucks in the urban logistics field is a serious problem, especially in the transportation of barreled water, beer, and similar goods. For example, a 4.5-tonne GVW truck with maximum

[28] Vehicle occupation rate=daily operating time of single vehicle/24 hours; data source: G7 Networks.

payload 1.8 tonne can transport 300 barrels of 18.9-litre/barrel water at one time, making the load more than 5 tonnes, an overloading of more than 200%. Meanwhile, the urban delivery vehicles mainly drive on the urban roads, where the speed is limited by the urban traffic conditions and averages 30 – 40 km/hour.

As for the long-haul transportation, tractors with 17.5m low platform trailers and 16.15m and 14.6m box trailers are the major tractor-trailer combinations of mainline transportation in China, accounting for a high proportion of mainline transportation vehicles. With the implementation of GB1589-2016, a large number of nonstandard vehicles are facing the pressure of being phased out. In order to ensure the normal operation of road logistics transportation, the management agency decided to regulate the low platform and box tractor-trailers by separate deployment, but only proposed a control plan for vehicle transport tractor-trailers. "*Control Plan for Vehicle Transport Tractor-trailers*" prescribes that operation of "double-row vehicles" is totally prohibited since September 21, 2016. "Double-row vehicles" refer to vehicles that violate national standards by loading two rows of cargo on both layers or loading two rows of cargo on the upper layer and one row on the lower layer.[29]

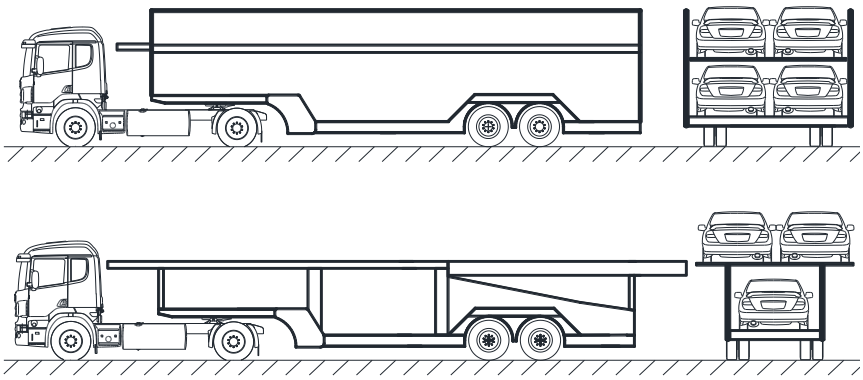


**Figure 33: Violation loading methods of vehicle transport tractor-trailers.**

With the control plan for the vehicle transport tractor-trailers, the freight capacity of the single tractor-trailer is reduced from 21 – 24 units of vehicles to 8 – 9

[29] http://zfxxgk.weihai.gov.cn/xxgk/jcms_files/jcms1/web16/site/art/2016/8/18/art_831_176149.html

units of vehicles under standard loading, which greatly increases the transportation cost of vehicles. In the future, the main approach of vehicle transportation will gradually shift from road freight to intermodal transportation by railway and waterway freight. The proportion of railway and waterway freight for vehicle product transportation will be greatly increased. As the professional main body of transporting vehicle product by railway, China Railway Special Cargo Service Co., Ltd. (CRSCSC) proposed to increase the 7,000 trains that it used for vehicle product transportation, increasing the freight capacity to 5 million units of vehicles in 2017, an increase of 72% over the same period in 2016.

Currently, the driving speed of road freight vehicles in China is relative low. Besides the traffic regulation limit of 90km/hour for freight vehicles on expressways, the congestion caused by traffic accidents and toll stations between provincial boundaries also results in the low driving speed of road freight vehicles.

**Table 22: Driving cycle and load of major freight trucks**

| | | Tractor-trailer | Straight truck | |
|---|---|---|---|---|
| **GVW (tonne)** | | 49 | 4.5 | 16 |
| **Average speed（km/h）** | | 60 | 30–40 | 60 |
| **Driving cycle** | Urban | —— | 80% | 10% |
| | Highway | 10% | 10% | 10% |
| | Express way | 90% | 10% | 80% |
| **Load capacity (tonne)** | | 31–33 | 4 | 9 |
| **Load volume（$m^3$）** | | 200[30] | 13–15 | 35–40 |
| **Over-load situation（%）** | | More than 200% overload (v%)[31] | More than 200% overload(m%) | Standard load |

### 5.1.4 Fuel consumption management

Fuel consumption of road freight trucks is closely related to vehicle model, driving condition, and the type of transported cargo, etc. As for the fuel consumption

[30] Nonstandardized 14.6m and 17.5m vehicles operating in long-haul mainlines.
[31] Mainly transporting light cargo, like potato chips.

of the entire road freight truck fleet, no government departments or industry associations are yet specialized in collecting and summarizing related data throughout the country. According to a survey by the China Federation of Logistics and Purchasing in 2017, fuel consumption cost is one of the primary costs of road freight enterprises, accounting for 25.2% of total expenses. As a result, both transportation fleets and individual private carriers are concerned about vehicle fuel consumption.

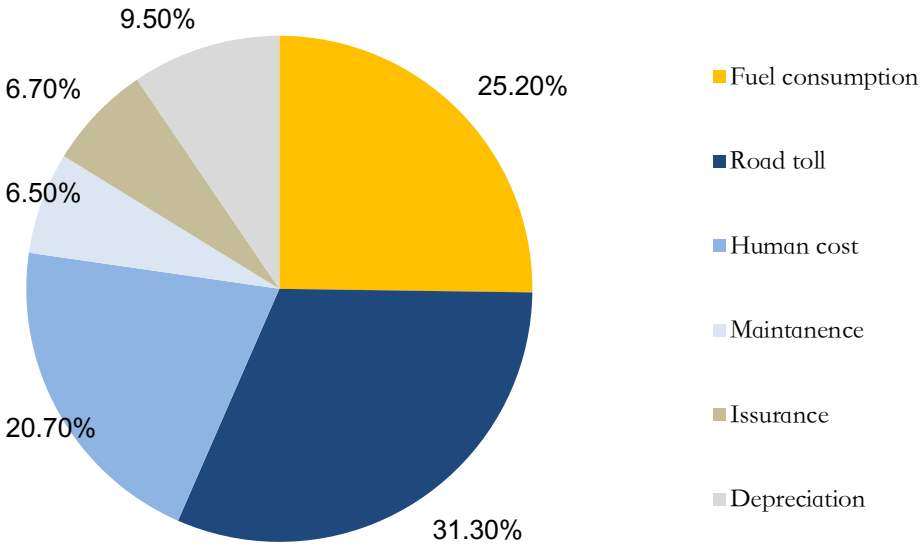



**Figure 36: Cost of road freight enterprises (self-owned freight capacity), 2016**

Currently, larger-scale logistics transportation fleets in China have installed intelligent vehicle management systems on their self-owned vehicles. Such systems can realize all-around monitoring of driving behavior, vehicle performance, fuel consumption, and how the driver handles the demands of the enterprise. Fleet managers can clearly see the driver's location and route information through mobile phone connectivity and detect abnormal operations. As for fuel consumption management, the intelligent vehicle management system can (1) monitor fuel consumption by detecting the fuel injection quantity of the engine nozzle and analyzing high fuel consumption conditions, and (2) set up an ultrasonic sensor in the fuel tank to monitor real-time liquid level changes in the fuel tank; when the liquid

level in the tank obviously drops, the management system will record the condition automatically. Through intelligent vehicle management systems, the operator can analyze the vehicle fuel consumption, effectively maintain vehicles, and correct driver behavior to reduce vehicle fuel consumption and reduce fuel cost.

Small and medium fleets mainly adopt some mode of fuel consumption quota or driver contract to manage fuel consumption of their self-owned vehicles. By setting up a maximum oil consumption limit, the enterprise provides fuel based on a fuel quota or establishes a reward and punishment program according to fuel consumption. The maximum fuel consumption limit is usually set according to experience. Setting fuel consumption quotas can easily cause antagonism between the fleets and the drivers. To get higher fuel consumption quotas, drivers often form an alliance and adopt various measures to demand increases in fuel consumption quotas from fleet operators.

Because individual private carriers operate their businesses under affiliation mode, limited only by their own conditions and other factors, there are no detailed statistics available for vehicle fuel consumption. Fuel consumption levels are estimated primarily based on experience or fuel refilling volume and approximate mileage.

Regardless of fleet size, in theory, all freight truck operators must bear the risk of rising oil prices. The period of most transportation contracts is relatively short, especially for the main body of the road freight industry. For individual private carriers, a contract usually is signed for one-time delivery. In addition, the domestic price of oil is adjusted by NDRC with an adjustment period of 15 days, so the price of product oil in China is relatively stable in the short term.

### 5.1.5 Fuel-saving technology selection

Because the cost of fuel is one of the most important costs of fleet operation, both the logistics fleets and individual private carriers are interested in the new fuel-saving technologies and strategies. Currently, aftermarket installation of wind

deflectors and the use of radial tires are the primary fuel-saving technologies being widely applied among logistic transportation fleets and individual private carriers. These are preferred because of their relatively low price and high user acceptance. The price of a roof wind deflector is about RMB 500–1,000 in China, whereas an air deflector for a wide-body vehicle is about RMB 2,000. Almost all vehicles—from long haul trucks operating on the mainline roads to delivery vehicles operating on urban roads—have been equipped with wind deflecting devices. Under the conditions of high temperature and cold weather, the drivers always feel ambivalent between body comfort and fuel consumption during the periods of traffic congestion and cargo loading/unloading. Some truck models in China have started to install no-idle air conditioners, or parking coolers, for which an independent battery is installed on the vehicle as the auxiliary power supply device for the no-idle air-conditioning system. During the truck operating period, the engine charges the battery and the battery supplies power to the no-idle air-conditioning system during parking time. This not only reduces the fuel consumption while idling, such as during vehicle parking time, but also improves comfort. Taking the truck home is common, so this device is very popular among drivers.

In the selection of fuel-saving strategies and strategies, there are obvious differences among the large fleets, the small and medium fleets, and the individual private carriers. Large fleets are equipped with intelligent vehicle management systems for monitoring fuel consumption and conducting vehicle maintenance in a timely fashion. They tend to have a team dedicated to optimizing vehicle driving routes and pay more attention to reducing the overall fuel consumption level. The business condition and cargo sources of small- and medium-scale logistics fleets are unstable. Most fleet operators prefer to manage fuel consumption through fuel consumption quotas or establish reward and punishment mechanisms based on fuel consumption. Because of high management costs, small- and medium-scale enterprises are more willing to operate under affiliation mode, whereby individual carriers basically achieve fuel savings from their own experience and from

exchanging driving experiences with other truck drivers.

Driver training is a strategy to lower fuel consumption with low investment and obvious cost effectiveness. However, this type of driver training has not attracted much attention from fleet operators or related administrative agencies. From the perspective of governmental agencies, the management of truck drivers concentrates primarily on driving qualification and safety education. In addition to the insufficient attention of the relevant administrative agencies, the lack of professional training organizations to train road freight truck drivers is also a main reason for the lack of driver training.

### 5.1.6 Vehicle management modes

The management programs of freight vehicles are not exactly the same in different regions. Generally, all freight enterprises can apply for commercial operation approval regardless of enterprise scale. However, individual private carriers or individually purchased freight trucks are not allowed to apply for approval. Individual private carriers can develop their businesses only through affiliating with the freight transportation enterprises. As a result, vehicle ownership of the freight industry can be divided roughly into the following two types: vehicles purchased by freight transportation enterprises themselves and vehicles purchased by individuals and affiliated with freight transportation enterprises.

According to a survey by the China Federation of Logistics and Purchasing of more than 3,000 truck drivers nationwide, 74% operate self-owned vehicles and 61% have affiliated their vehicles with freight transportation enterprises.

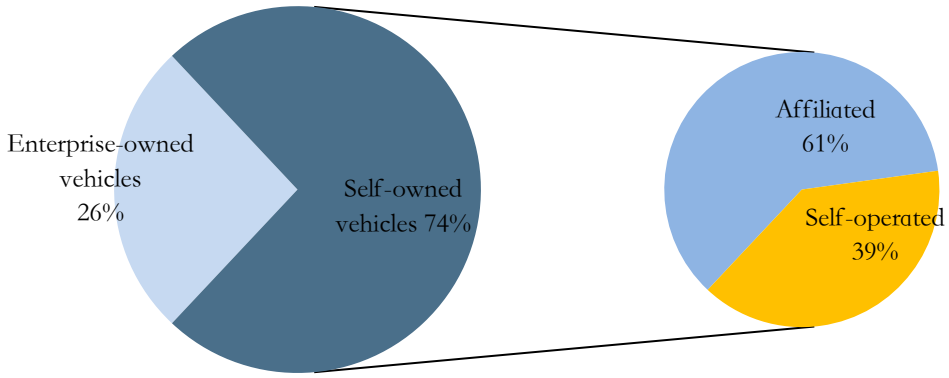



**Figure 37: Ownership of road freight vehicles.** [5]

There are some disadvantages both in the mode of self-owned vehicle (heavy asset) and in the mode of affiliation (light asset). Under the heavy asset mode, due to high investment and expenditure, the enterprises will face more cash flow challenges if cargo sources cannot be guaranteed. Under the light asset mode, the enterprises have limited control over the drivers or the mobility of drivers. Such loose management is not conducive to the improvement of fleet transportation efficiency and the competitiveness of transportation services. Therefore, vehicle partnership is the trend of vehicle management for freight transportation enterprises. Vehicle partnership means the freight vehicles are jointly invested in by the freight transportation enterprises and the drivers. Both sides allocate profits and risks according to the proportion of their investments. In this type of arrangement, fleet managers focus on freight marketing so as to ensure more stable cargo sources. Drivers are responsible for the freight transportation and focus on safety issues and driving efficiency. Vehicle partnership helps effectively control the cost and the overall profit level of the fleets under the premise of safety. It also solves the problems of the high mobility of drivers, the large investment required from the enterprises, and high operational costs.

## 5.2 Characteristics of vehicle purchase and operation

Logistics transportation fleets and individual private carriers focus on different factors when purchasing vehicles. Considering the comprehensive operational cost of the entire vehicle's useful life, fuel consumption is only one of the factors that goes into purchasing vehicles for the logistics transportation fleets. The freight transportation fleets usually pay more attention to the occupation rate of the vehicles, the ability to guarantee after-sales service, and the unity of the vehicle brand. Although individual carriers are concerned about vehicle fuel consumption, saving fuel is not the key factor when individual private carriers make purchase decisions.

### 5.2.1 Vehicle purchasing criteria

From the perspective of logistics transportation fleets, the enterprises usually like to consider the comprehensive operational cost of the entire vehicle's useful life. Their concerns focus primarily on vehicle availability, including such things as failure rate, time necessary for overhaul, vehicle engine reliability, period of oil change of gearbox, etc., and the ability to guarantee after-sales service. Obviously, fuel consumption level is only one factor and is less influential in purchasing decisions. Consider an express enterprise with a relatively high proportion of self-owned vehicles as an example. The key factor in making vehicle purchase decisions is the comprehensive cost of 5 years/1.5 million kilometers of operation, requiring 1 million kilometers operation without an overhaul.

From the perspective of individual private carriers, however, individual private carriers pay the most attention to fuel economy when purchasing trucks, according to a survey of more than 3,000 truck drivers nationwide made by China Federation of Logistics and Purchasing. However, although fuel consumption is the most concerning factor, individual carriers are influenced by other external factors when purchasing vehicles. These include financial services, recommendations from other truck drivers, living performance of the vehicle (wide sleeping berth, independent

220v power outlet) and sale discount activities, etc. Limited by financial conditions, individual private carriers are sensitive to one-time purchase cost, and they often overlook fuel consumption due to the price. Besides, as trucks are the drivers' second living place, living performance of the vehicle also influences purchasing decisions. Drivers often choose to add livability devices that increase fuel consumption. For example, a small diesel generator may be installed to support the living facilities inside, such as a household air conditioner and electric kettle.

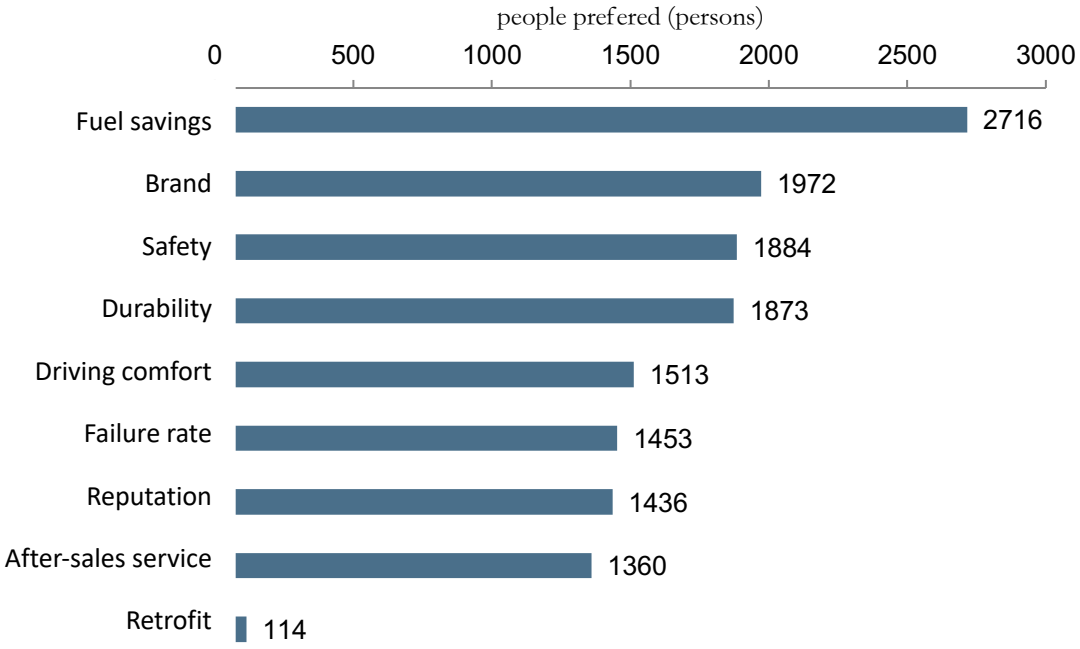



**Figure 38: Truck purchasing criteria** 【5】

### 5.2.2 Vehicle use life/mileage

"*The Standards for Compulsory Scrapping of Motor Vehicles*" prescribes that "heavy-duty commercial vehicles (including tractors) shall be guided to scrap after operating for 700,000km." From the perspective of useful life, "full trailers and semi-trailers for dangerous cargo transportation can operate for 10 years, container semi-trailers can operate for 20 years, other semi-trailers can operate for 15 years, and other freight trucks (including semi-trailer tractors and full-trailer tractors) can

operate for 15 years."[32]

From the perspective of actual operational situations, different transportation sectors have different requirements on vehicle renewal terms. The users of coal freighting industry generally renew vehicles for every 2 years, whereas users engaged in transporting industrial consumer goods generally renew vehicles for every 4 years, and users in the delivery and express industries generally renew vehicles for every 5 years. Common trailers often are renewed every 5 years and aluminium-alloy trailers are often renewed every 8–10 years. From the perspective of scrap value, the two-year depreciation rate of a coal freighting vehicle is 25%–35%, the depreciation rate of an industrial consuming merchandise freighting vehicle is 40%–50%, and the depreciation rate of express vehicles is 60%–70%.

Currently, China's secondhand truck market is experiencing an immature development period. The emission standards and enforcement programs are not unified in different regions, restricting non-local secondhand vehicles from registration while also impeding the overall development of secondhand vehicle market in China, especially in the field of commercial vehicles. So far, there is no authorized research data about secondhand freight trucks in China. The results of the research for this study indicate that secondhand trucks are primarily distributed in three ways: in undeveloped remote areas, in short-distance branch line transportation, and for the private use of individual carriers, with a primary focus on the vehicles below 6 tonnes.

Currently, domestic secondhand trucks are primarily China 3 vehicles. Limited by constant upgrading of vehicle emission policies in different regions and unclear expectations on the use restriction policies for China 3 vehicles, there has been basically no market for secondhand trucks since the second half of 2016. In Hangzhou, for example, the government encourages scrapping China 3 diesel trucks in advance, granting a maximum subsidy of RMB 40,000 for the trucks scrapped within the deadline set by the government. Shandong Province has required not

[32] http://www.mofcom.gov.cn/article/swfg/swfgbh/201303/20130300062947.shtml

conducting environmental inspection for China 3 diesel trucks without diesel particulate filters (DPF) since August 1, 2017. Shandong also required canceling the commercial operation approvals of heavy-duty diesel trucks that didn't meet emission standards and heavy-duty China 3 diesel vehicles that were operating without DPF or stopped running DPF privately.

### 5.2.3 Vehicle payback period

The payback period of operating vehicles is influenced by the interactions among key parameters, such as the vehicle condition, operation mode and operational expenditures. The implementation of GB1589-2016 and the enforcement actions against over-load transportation also significantly affected the payback period, for a time. The enforcement actions had a relatively greater impact on the payback period of vehicles engaged in coal transportation. Calculated with the coal transportation line of Fugu-Fuping, the benefit to the operator decreased by more than RMB 100,000 and the payback period return has been extended from the original 1.9 years to 5.1 years after the enforcement actions. In the field of industrial consumable merchandise transportation, the vehicle payback period before the enforcement actions was 2.9 years. After the enforcement actions were instituted, the payback period was extended to 5.4 years. In the field of express transportation, which does not require much loading capacity, average vehicle loading is about 10–15 tonnes and there has been no change in vehicle payback period before or after the enforcement actions. Express transportation is the most profitable segment of the freight market, in which the vehicle payback period is only 0.5 year. In the field of sporadic freight express, where the average vehicle loading is about 25 tonnes, the vehicle payback period has not changed as a result of the enforcement actions. The payback period remains at 2.6 years.

**Table 23: Vehicle payback period for coal transportation before and after "9-21"**

| Fugu-Fuping | Expenditure/ Income |
|---|---|

| | | | After enforcement actions | Before enforcement actions |
|---|---|---|---|---|
| Operational mode | Loading mode | Go with heavy load and return with no load | — | |
| | Transportation mileage | 500km | — | |
| | Freight charge | RMB 0.3 yuan/tonne-km | — | |
| | Transportation frequency | 15 times/month | — | |
| | Vehicle renewal term | 2 years | — | |
| | Depreciation rate | 25%–35% | — | |
| | Labor cost | None (owner drives himself) | — | |
| | Fuel consumption | | No load：33L<br>Full load：40L | No load：33L<br>Full load：42L |
| Operational cost | Fuel charge | RMB 5 yuan/L | 164250 | 168750 |
| | Toll fee | GVW≤15T（RMB 0.09 yuan/tonne-km）<br>15＜GVW≤55T（RMB 0.04 yuan/tonne-km） | 108000 | 124200 |
| | Maintenance fee | RMB 25,000 /year | 25000 | 25000 |
| | Tire cost | RMB 0.2–0.25 /km | 22500 | 22500 |
| | Other expenditures | RMB 20,000/year | 20000 | 20000 |
| | Affiliated relationship service fee | RMB 2,000/year | 2000 | 2000 |
| | Vehicle insurance | Vehicle purchase price * 9% (compulsory insurance against traffic accidents of vehicles, motor vehicle passenger insurance, etc.) | 31500 | 31500 |
| Acquisition cost | Vehicle price (including tax) | Purchase price under standard purchase tax *10%/117% | 298000 | 298000 |
| | Curb weight of chassis | 7.3 | | |
| | Curb weight of trailer | 6.3 | | |
| | Driveline configuration | 6x2 | | |
| | Power | 380 | | |
| Total expenditure | | | 373250 | 393950 |

| | | | | |
|---|---|---|---|---|
| Operating income | | | 432000 | 553500 |
| Operating profit | | | 58750 | 159550 |
| Payback period (years) | | | 5.1 | 1.9 |

**Table 24：Vehicle payback period for industrial consumer goods transportation before and after "9-21"**

| Guangzhou-Kunming | | | Expenditure/ Income | |
|---|---|---|---|---|
| | | | After enforcement actions | Before enforcement actions |
| Operational mode | Loading mode | Go with full load and return with full load | — | |
| | Transportation mileage | 1,350km | — | |
| | Freight charge | Go：RMB 0.21/ton-km；<br>Return：RMB 0.15 /ton-km | — | |
| | Transportation frequency | 5 times/month | — | |
| | Vehicle renewal term | 4 years | — | |
| | Depreciation rate | 40%–50% | — | |
| | Labor cost | None (owner drives himself) | — | |
| Operational cost | Fuel consumption | | 36L | 38L |
| | Fuel charge | RMB 5/L | 145800 | 153900 |
| | Toll fee | GVW≤15T（RMB 0.09 /ton-km）<br>15＜GVW≤55T（RMB 0.04/ton-km） | 158760 | 178200 |
| | Maintenance fee | RMB 25,000/year | 25000 | 25000 |
| | Tire cost | RMB 0.2–0.25/km | 20250 | 20250 |

| | | | | |
|---|---|---|---|---|
| | Other expenditures | RMB 20,000/year | 20000 | 20000 |
| | Affiliated relationship service fee | RMB 2,000/year | 2000 | 2000 |
| | Vehicle insurance | Vehicle purchase price * 9% (compulsory insurance against traffic accidents of vehicles, motor vehicle passenger insurance, etc.) | 41130 | 41130 |
| Acquisition cost | Vehicle price (including tax) | Purchase price under standard purchase tax *10%/117% | 370000 | 370000 |
| | Curb weight of chassis | 9.2 | | |
| | Curb weight of trailer | 6.8 | | |
| | Driveline configuration | 6x4 | | |
| | Power | 460 | | |
| Total expenditure | | | 412940 | 440480 |
| Operating income | | | 481140 | 568620 |
| Operating profit | | | 68200 | 128140 |
| Payback period (years) | | | 5.4 | 2.9 |

**Table 25: Vehicle payback period for sporadic express transportation before and after "9-21"**

| Dongguang-Jiangxi | | | Expenditure/ Income | |
|---|---|---|---|---|
| | | | After enforcement actions | Before enforcement actions |
| Operational mode | Loading mode | Go with full load and return with full load | — | |
| | Transportation mileage | 500km | — | |
| | Freight charge | 5500/delivery | — | |
| | Transportation frequency | 15 times/month | — | |

| | | | | |
|---|---|---|---|---|
| | Vehicle renewal term | 5 years | — | |
| | Depreciation rate | 60%–70% | — | |
| | Labor cost | 10000/month/person | 120000 | 120000 |
| Operational cost | Fuel consumption | | 28L | 28L |
| | Fuel charge | RMB 5/L | 126000 | 126000 |
| | Toll fee | GVW≤15T（RMB 0.09 /ton-km） 15＜GVW≤55T（RMB 0.04/ton-km） | 108000 | 108000 |
| | Maintenance fee | RMB 25,000/year | 25000 | 25000 |
| | Tire cost | RMB 0.2–0.25/km | 18000 | 18000 |
| | Other expenditures | RMB 20,000/year | 20000 | 20000 |
| | Affiliated relationship service fee | RMB 2,000/year | 2000 | 2000 |
| | Vehicle insurance | Vehicle purchase price * 9% (compulsory insurance against traffic accidents of vehicles, motor vehicle passenger insurance, etc.) | 23850 | 23850 |
| Acquisition cost | Vehicle price (including tax) | Purchase price under standard purchase tax *10%/117% | 288000 | 288000 |
| | Curb weight of chassis | 7.4 | | |
| | Curb weight of trailer | 7 | | |
| | Driveline configuration | 4x2 | | |
| | Power | 380 | | |
| Total expenditure | | | 442850 | 442850 |
| Operating income | | | 990000 | 990000 |
| Operating profit | | | 547150 | 547150 |
| Payback period (years) | | | 0.5 | 0.5 |

**Table 26: Vehicle payback period for sporadic freight express before and after "9-21"**

| Beijing-Shenyang | | | Expenditure/ Income | |
|---|---|---|---|---|
| | | | After enforcement actions | Before enforcement actions |
| Operation mode | Loading mode | Go with full load and return with full load | — | |
| | Transportation mileage | 700km | — | |
| | Freight charge | RMB 7/km | — | |
| | Transportation intensity | 12 times/month | — | |
| | Vehicle renewal term | 5 years | — | |
| | Depreciation rate | 60%–70% | — | |
| | Labor cost | 10000/month/person | 120000 | 120000 |
| Operation cost | Fuel consumption | | 34L | 34L |
| | Fuel charge | RMB 5/L | 171360 | 171360 |
| | Toll fee | GVW≤15T（RMB 0.09 /ton-km） 15＜GVW≤55T（RMB 0.04/ton-km） | 173376 | 173376 |
| | Maintenance fee | 25000 yuan/year | 25000 | 25000 |
| | Tire cost | RMB 25,000/year | 20160 | 20160 |
| | Other expenditures | RMB 0.2–0.25/km | 20000 | 20000 |
| | Affiliated relationship service fee | RMB 20,000/year | 2000 | 2000 |
| | Vehicle insurance | Vehicle purchase price * 9% (compulsory insurance against traffic accidents of vehicles, motor vehicle passenger insurance, etc.) | 30600 | 30600 |

| | | | | |
|---|---|---|---|---|
| Acquisition cost | Vehicle price (including tax) | Purchase price under standard purchase tax *10%/117% | 370000 | 370000 |
| | Curb weight of chassis | 9 | | |
| | Curb weight of trailer | 9 | | |
| | Driveline configuration | 4x2 | | |
| | Power | 380 | | |
| Total expenditure | | | 562496 | 562496 |
| Operating income | | | 705600 | 705600 |
| Operating profit | | | 143104 | 143104 |
| Payback period (years) | | | 2.6 | 2.6 |

Compared to common trailers, the advantages of all-aluminium trailers primarily include low fuel charges, low toll fees, and long useful life; other items of operational cost are basically the same. Calculated with a 14.6m box semi-trailer, its payback period is 4.1 years. The useful life of an all-aluminium trailer is more than 8 years, but the useful life of a common trailer is only 5 years. Additionally, the scrappage value of all-aluminium trailers is relatively high, as the price of aluminium is more than RMB 10,000/tonne and the price of steel is only about RMB 2,000/tonne, resulting in a scrappage value difference of about RMB 46,000. As a result, the application of all-aluminium trailers keeps increasing in recent years in the fields of express, sporadic express and oil transportation.

**Table 27: Payback period for all-aluminium trailers**

| | **All-aluminium trailer** | **Common trailer** |
|---|---|---|
| **Curb weight** | 6.7 tonnes | 10 tonnes |
| **Annual operating mileage** | 150000km | 150000km |
| **Fuel charge** | RMB 5/L | RMB 5/L |
| **Fuel consumption** | Fuel savings: 2-3L/100km | — |
| **Fuel charge saving** | RMB 18,750 | — |
| **Toll fee** | RMB 40,200 | RMB 60,600 |
| **Toll fee saving** | RMB 20,400 | — |

| | | |
|---|---|---|
| **Acquisition cost** | RMB 280,000 | RMB 120,000 |
| **Acquisition cost difference** | RMB 160,000 | |
| **Annual expenditure saving** | RMB 39,150 | |
| **Payback period (years)** | 4.1 | |

# 6 Trucking institutional framework

MOT is the primary administrative department for the road freight market in China, taking charge of road construction and maintenance, establishing highway toll fee collection standards and management, and conducting market entrance and fuel consumption management of road freight trucks as well as management of road freight enterprises and road transportation employees.

In order to improve the overall freight efficiency of the domestic market and reduce energy consumption and emissions from the transportation industry, MOT has carried out a series of programs including the promotion of a drop and hook program, developing truck broker pilots, enforcement actions on over-load and over-limit transportation, promoting and encouraging liquefied natural gas vehicles, promoting the application of new energy vehicles as well as developing the China Green Freight Initiative (CGFI), which have been very effective.

The China Green Freight Initiative (CGFI) is a large-scale public service campaign sponsored by the China Road Transport Associations. The Research Institute of Highway of MOT and Clean Air Asia (CAA) have joined the campaign and CGFI is supported by the Energy Foundation China (EFC). By advocating the concepts of "green management, green technology and green driving," CGFI will achieve the goals of improving transport efficiency, reducing transportation costs, saving energy, and reducing emissions as well as promoting the transformation and upgrade of the industry. Through CGFI, China Road Transport Associations have actively participated in drop and hook pilot programs, promoted natural gas vehicles, and organized activities like a driving skills contest, designed to introduce the concepts of “green management, green technology, and green driving” into the daily work of the freight industry and assist management agencies in implementing national emission reduction policies in practice.

CGFI has developed a series of activities including creating green cargo owners, creating green freight enterprises, recruiting green freight technology, and carbon

footprint management exploration. CGFI has certified six green cargo owners and 15 green freight enterprises. Meanwhile, CGFI has released "The List of CGFI Recommended Green Freight Technology," which describes the scope and category of "green freight technology," including key energy consumption products and key energy consumption equipment of the industry, such as green vehicles and green trailers; aftermarket energy-saving products, such as green tires, aftermarket-installed fuel-saving devices and auxiliary purifying devices; vehicle- and vessel-used fuel-saving additives, such as lubrication oil and detergent; as well as intelligent information technology.

As a whole, the transportation method of the road freight industry in China is relatively backward, the cargo sources are not well organized, the overall energy consumption of road freight is high, emission pollutants from freight vehicles account for high proportion of total pollution, and the problems of scatter, small, disorder and poor quality assurance" of the road freight industry have not been fundamentally solved.

**Table 28: Administrative responsibilities of road freight vehicle management departments**

| | Department | Main administrative responsibility |
|---|---|---|
| **Production** | NDRC | Investment qualification approval of motor vehicle industry |
| | MIIT | Approvals of production qualification, type approval, fuel consumption and conformity of production (COP) |
| | MEP | Establishing vehicle emission standards and vehicle pollution prevention and control |
| **Operation** | SAT | Collecting vehicle purchase tax and setting tax rate; management of freight enterprises' qualification of issuing VAT invoice |
| | MPS | Vehicle registration, violation determination and enforcement, driving qualification of drivers, traffic accident prevention and liability determination. |

| | | |
|---|---|---|
| | MOT | Freight enterprise assessment, road transportation operation approval, vehicle operation approval, determination and enforcement of the actions of freight vehicles and freight enterprises for violating freight transportation regulations, determination and enforcement of the actions of freight vehicles for violating road regulations, fuel consumption management on business operation vehicles. |
| **Scrappage** | MOC | Vehicle circulation and scrappage (including secondhand vehicles) |

# 7 Policy recommendations

Based on the in-depth analysis of freight systems in China, we make the following recommendations:

## 7.1 High-efficiency transportation mode

"*The notice of promoting the development of drop and hook transportation*" was jointly released by the MOT and four additional management agencies in 2009. Since then, the government has issued many supportive policies for promoting drop and hook transportation. However, compared with other countries, the development of drop and hook is still slow. In order to hasten the development of drop and hook freight transport, we recommend: (1) the establishment of cargo matching platforms to match shippers and carriers; (2) the development of trailer rental platforms to dispel safety concerns as well as to reduce purchase cost for both fleets and drivers; and (3) the development of electronic matching platforms between truck brokers and cargo companies.

The market share of rail freight should be increased through policies aimed at raising the proportion railway transport used in transporting coal, large size commodities, and vehicle products.

## 7.2 Fuel-saving technology and promotion

The government should continue to promote the use of natural gas and electric vehicles in road freight transportation to reduce the energy consumption and emissions in the freight industry. Natural gas vehicles are the most mature alternative fuel vehicles in China. Compared with diesel trucks, liquefied natural gas trucks can significantly reduce carbon dioxide and particulate matter emission levels. Electric vehicles should also be promoted to replace diesel trucks below 4.5 tonnes in urban areas.

To promote energy-saving training for drivers China should apply best practices of training programs established in other countries, and develop energy-saving driver assessment programs.

In order to ensure the continued development of the green freight industry in China, the government should continue to carry out enforcement actions on over-load and over-limit operations, propose enforcement programs for 17.5m low platform tractor-trailers and 14.6m box tractor-trailers as soon as possible, and continue to encourage overall efficiency in the freight industry.

# 8 References

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*"Statistic Communique on the Development of Freight Industry, 2016"*

【2】 CATARC 自有产量数据库

Production volume data from database of CATARC

【3】 公安部车辆注册数据（2015 年后车辆注册数据暂停，因此 2016 年销量数据用产量代替）

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