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LARGE-SCALE PROJECT MANAGEMENT

Zhi-huan Fu, Qing-zhong Luo, Guang-zhi Jia

The Construction of a Green Transportation System of China

Abstract Since the 21st century, the transportation industry in China has achieved rapid growth with a significant increase in the transport capacity; however the development has also greatly impacted the energy saving & environmental conservation. This paper takes into account non-commercial vehicles such as private cars in the statistics of energy consumption and pollution of Chinese transportation system. This method extends on previous methods which solely include commercial vehicles in these statistics. Based on more comprehensive quantitative data, it reviews the progress in the energy saving and environmental conservation efforts by the Chinese transportation industry and points out that the rapid increase of energy consumption and pollution emission and the deterioration of traffic congestion are prominent problems in the development of the Chinese transport industry. The main reasons for theses problems include the unbalanced development of different transport modes, the irrational layout of integrated transport hubs, the inadequate law, regulations and standards, and the use of suboptimal technology. Based on these findings, this paper proposes several goals for the construction of a green transportation system in China including the establishment of a transportation management system, the improvement of transportation energy efficiency, the control of environmental pollution and the alleviating of urban traffic congestion. Additionally, it points out that in order to build a green transportation system in China, multiple aspects should be enhanced, i.e., the formulation of traffic planning, the optimization of transport structure, the development of urban public transport, improvement of integrated hubs, administration of energy saving and environmental conservation, development of intelligent transportation systems, technical innovations, etc..

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Zhi-huan Fu
Chinese Academy of Engineering, Beijing 100088, China

Qing-zhong Luo, Guang-zhi Jia (✉)
China Academy of Railway Sciences, Beijing 100081, China
Email: jiagzh@aliyun.com

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1 Introduction

As the concept of "green development" has gradually gained universal recognition in recent years, the "green development" of transportation is attracting increased attention as a critical component of economic and social development, and quite a few Chinese scholars have conducted relevant research based on the conditions of China. Some scholars who focused their research on urban traffic pointed out that green transportation is one component of sustainable urban traffic and the developing trend of urban traffic, and offered suggestions on the construction of a green urban transport system (Bai, Wei, & Qiu, 2006; Chen, 2006; Lu, 2009; Wang, 2003); some scholars focused on how to develop a specific transport mode such as urban rails, highways, railways or waterways, based on the concept of "green transportation" (Liu, 2006; Luo, 2012; Meng, 2008; Ran, 2008); and other scholars studied the role that policies and planning development played in the construction of a green transportation system (Du, Xiong, & Ding, 2006; Wang, & Shen, 2004; Zhang, Hu, & Huang, 2013). Additionally, there is abundant research relevant to "green transportation" mainly dealing with energy saving, low carbon and sustainable transportation, among which the research group on "Sustainable Urban Mobility" from Tsinghua University analyzed various approaches of sustainable transportation of Chinese cities from the angles of city planning, transport planning, energy system, environmental countermeasures, automotive technologies, management system and policies (Lu, Mao, & Li, 2008; Sustainable Urban Mobility research group of Tsinghua University, 2007). Still other scholars analyzed the energy saving and sustainable development of China's urban transportation and proposed the overall strategy of public transport prioritization, its key tasks and supporting measures (Jiang, Y., 2009; Jiang, Y., & Jiang, K., 2010).

In general, China started relatively late on "green transportation" research, and it has common problems such as:

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(1) focus on only a single transport mode; (2) focus on only some aspects of green transportation, like energy saving, or environmental conservation, or urban traffic congestion; (3) investigating only part of the influencing factors; (4) limitation by official statistics and failure to take into account non-commercial vehicles such as private cars in the statistics of energy consumption and pollution emissions, which resulted in statistics that do not accurately reflect the actual situation. This paper intends to integrate all transport modes, and conclude and analyze the status quo and problems of the construction of a green transportation system of China, and explore the goals and major tasks of the construction of a green transportation system of China with a comprehensive consideration of all the relevant major fields and influencing factors of green transportation. This paper also includes non-commercial vehicles such as private cars, motorcycles and low speed vehicles (agricultural trucks) etc., with an effort to maintain the integrity and accuracy of statistics.

2 An overview of the transportation development in China

The transportation industry in China has maintained substantial growth since 1978 when the reform and opening-up policy was first implemented, and the 21st century has witnessed its historic progress. By the end of 2012, the operating mileage of railroads, highways, civil aviation, pipelines and urban rails had reached 97, 625 km, 4.2375 million km, 3.2801 million km, 90,100 km and 2,064 km respectively, corresponding to the increase of 39.4%, 149.6%, 111.1%, 226.4% and 882.9% respectively since 2001. As for waterborne transportation, some major breakthroughs have been made in the construction of infrastructure for ocean and coastal transport, despite the lack of an obvious increase in the mileage of navigable inland waterways. High-grade infrastructure with immense capacity has been developed swiftly. By the end of 2012, the operating mileage of high-speed rails had amounted to 9,365 km, ranking the first in the world; the mileage of expressways had reached 96,200 km, corresponding to an increase of 394.9% since 2001; and berths with 10,000-ton capacity or above had totaled 1,886 nationwide, corresponding to an increase of 132.8% since 2001 (see Table 1).

The transportation capacity is increasing rapidly with the large-scale expansion of transportation networks, providing the national economic growth with solid transporting support. In passenger transportation in 2012, the volume of passenger traffic of railways, highways, waterways and civil aviation had increased by 80.1%, 153.6%, 38.1%, 324.5% respectively since 2001, and the turnover volume of passenger had increased by 105.9%, 156.2%, –13.8%, 360.5% respectively since 2001 (see *Figure 1*). In freight transportation in 2012, the volume of freight traffic of railways, highways, waterways, civil aviation and oil/gas pipelines had increased by 102.1%, 201.9%, 245.7%, 218.7% and 215% respectively since 2001; and the turnover volume of freight had increased

Table 1 *Comparison of Infrastructure Scale of All Modes of Transport between 2001 and 2012*

	Indicators	Units of Measurement	Year 2001	Year 2012	Increase (%)
Railway	Total mileage	km	70,057	97,625	39.4
	Electric railways	km	16.900	51,028.9	201.9
	High-speed rails	km	0	9,356	-
Highway	Total mileage	Ten-thousand km	169.8	423.75	149.6
	Classified highways	Ten-thousand km	133.6	360.96	170.2
	Expressways	Ten-thousand km	1.9437	9.62	394.9
Water Transport	Total mileage of navigable inland waterways	Ten-thousand km	12.15	12.46	2.5
	Classified waterways	Ten-thousand km	6.36	6.37	0.2
	Static load of ocean transport ships	Ten-thousand tonnage	2,385.7	6,943.79	191
	Passenger capacity of ocean transport	Ten-thousand rated seats	1.4	1.95	39
	Container stowage of ocean transport	Ten-thousand TEU	47.9	115.66	142
	Quay berths for port production		33,441	31,862	-4.7
	berths with 10,000-ton capacity or above		810	1,886	132.8
Civil Aviation	Regular flight routes		1,009	2,457	143.5
	Mileage of regular flight routes	Ten-thousand km	155.36	328.01	111.1
Pipelines	Oil/gas transport mileage	Ten-thousand km	2.76	9.01	226.4
Urban Rails	Cities in service		3	17	466.7
	Length in service	km	210	2,064	882.9

Note. Data is from *Statistical Bulletin of Highway and Waterway Transportation Development, Handbook of Railway Statistical Indices, China Statistical Yearbook, Urban Rail Transport in China, 2012.*

by 98.6%, 840.5%, 214.4%, 274.9% and 386.5% respectively since 2001 (see *Figure 1*).

China will continue to promote the construction of transportation infrastructure in an effort to meet the needs of social and economic growth. The national development plan proposes that by 2015, the total mileage of railways should reach approximately 120,000 km, including 19,000 km of high speed rails; the total mileage of highways should reach 4.5 million km, including 10,800 km of expressways, connecting 90% of cities and towns with population above 200,000; the mileage of high-grade navigation channels should reach 13,000 km; the structure of port terminals should be optimized with 2,214 deep-water berths; civil transportation airports should exceed 230, with the steady advancement in the capability of air traffic control, hence to ensure 10.4 million takeoffs and landings. In the area of urban rail transportation, the mileage should reach 5,790 km as 36 cities have made their construction planning for urban rail transport.

3 Achievements and problems in the construction of a green transportation system of China

3.1 Major achievements

For years, the Chinese transportation industry has taken a series of measures to save energy, reduce emission and conserve the environment, and has obtained significant results.

3.1.1 Development of energy-saving and eco-friendly transport modes

Since the 21st century, compared with other countries, China has attached great importance to the development of energy-saving and eco-friendly transport modes, mainly manifested in the following aspects: accelerated construction of railroads with 30,000 km newly-built railways; full play of waterborne transportation, with the revamped inland waterways and reinforced harbor construction; vigorous development of pipe-line transportation, with strengthened construction of oil and gas networks. Based on this scenario, railroads, water-ways and pipe-lines still account for a relatively large share in the overall social transportation of the Chinese transportation system, though the highway transportation accounts for the biggest share so far. In 2012, railroads passenger transportation accounted for 29.4% of the market share, and the railroads, waterways (ocean transport not included) and pipelines accounted for 24.3%, 23.5% and 2.6% of the overall social freight traffic turnover volume respectively. Hence the average energy consumption of the transportation system was kept at a relatively low level.

In the urban traffic, China attaches importance to public transport system. Besides buses, the construction of urban rail transit such as metro and light rails featuring larger capacity and less pollution have especially been speeded up. So

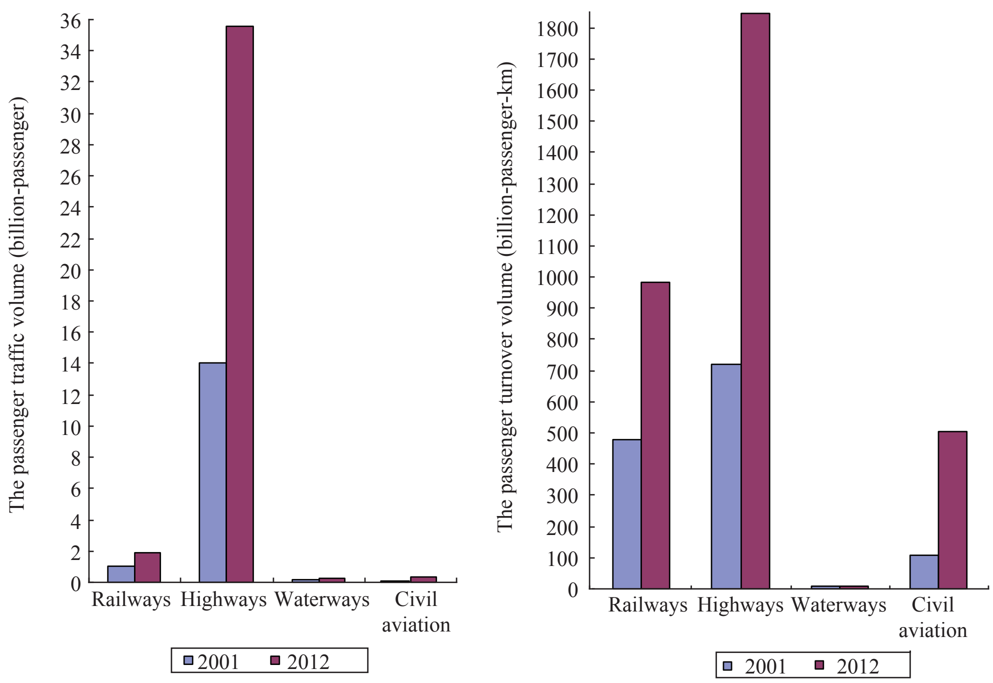

Figure 1. Comparisons of indices of passenger traffic by all modes of transport between 2001 and 2012. Left: the passenger traffic volume (hundred-million-passenger). Right: the passenger turnover volumes (hundred-million-passenger-km). *Figure 1.* Data adapted from *Statistical Bulletin of Highway and Waterway Transportation Development*, *Handbook of Railway Statistical Indices*, and *China Statistical Yearbook*.

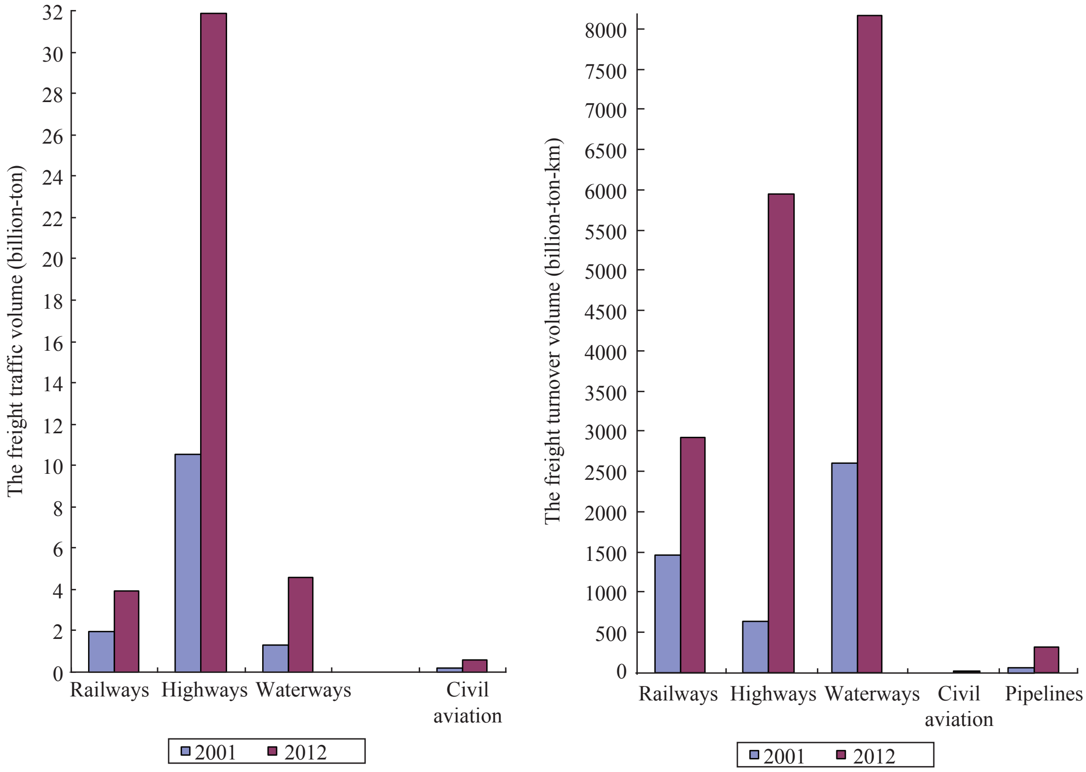

Figure 2. Comparisons of indexes of freight transport by all modes of transportation between 2001 and 2012. Left: the freight traffic volume (hundred-million-ton). Right: the freight traffic turnover volume (hundred-million-ton-km). The waterborne transportation includes navigable inland waterways, coastal waterways and ocean transportation. In 2012, the volume of freight transport of the three increased by 202.9%, 351.9% and 119.3% respectively, accounting for 50.2%, 35.5% and 14.3% of the total volume of waterborne transportation respectively. The turnover volume of freight of the three has increased by 406.3%, 383.9% and 145.8% respectively since 2001, accounting for 9.3%, 25.3% and 65.4% of the total turnover volume of waterborne transportation respectively. Data adapted from *Statistical Bulletin of Highway and Waterway Transportation Development*, *Handbook of Railway Statistical Indices,* and *China Statistical Yearbook*.

far, there are 70 urban rail routes in 17 cities in the mainland, with a total mileage nearly 10 times of 2001. Meanwhile, BRT transport has been promoted in big and medium-sized cities and has been well-received.

3.1.2 Promotion of energy saving and environmental conserving technologies

In the railroads, upgrading for electrifying railways are in progress, and the electrification rate rapidly had increased from 24.1% in 2001 to 52% in 2012. All the newly built locomotives and EMUs have adopted the AC drive systems, with remarkable outcomes in energy efficiency and emission reduction. On highways, a larger percentage of commercial vehicles are using diesel; electric vehicles and petrol-electric hybrid vehicles have been developed; the quality of oil products has been upgraded, energy-saving products such as fuel additives and fuel economizers have been adopted. In waterborne transportation, technologies such as "oil to electricity" in harbor cranes and the use of shore power by anchored ships has been promoted. In the infrastructure construction, new technologies such as energy-saving lighting, pavement material reclamation, and warm-mixing asphalts are largely used.

3.1.3 Enhanced management of energy saving and environmental conservation

In the railroads, a performance assessment system on energy saving and environmental conservation of transport enterprises has been fully implemented. In highways and waterborne transportation, administration offices, specializing in energy saving and environmental conservation have been established at all levels, and a batch of cities, harbors and highways were chosen for trial work on construction of a green, recyclable and low-carbon transportation system and a specific campaign featuring low-carbon transportation by a thousand enterprises of vehicles, ships, roads and harbors was launched. A strict industry access system on fuel consumption of commercial vehicles is now in effect, preventing those failing to meet the criteria from entering into operation (Cai, Liu, & Han, 2006).

As a result of the above measures, great progress has been achieved by the transportation industry of China in energy saving and environmental conservation. Since 2005, the energy consumption per unit and carbon emission intensity of transportation has in general manifested a steady decline (see *Figure 3, 4 and5*). In freight transportation, the energy consumption per unit in highways, waterways, harbors, railroads and civil aviation had dropped by 8.7%, 8.7%, 24.2%, and 15.4% respectively. In passenger traffic, the unit energy consumption in highways, waterways, harbors, railroads and civil aviation had dropped by 8.8%, 4.7%, 24.2%, and 15.3% respectively.

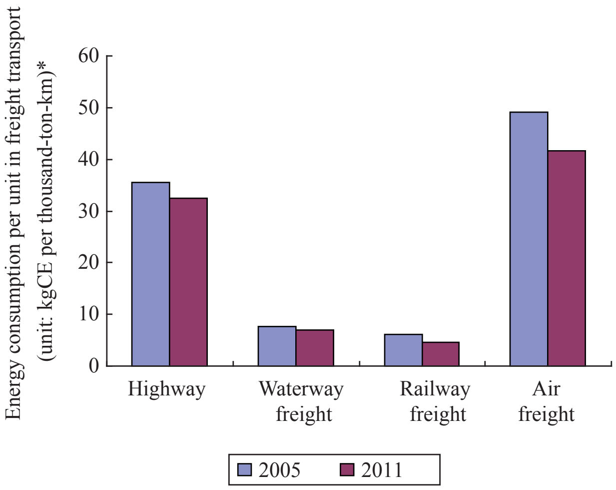

Figure 3. Comparison of energy consumption per unit in freight transportation between 2005 and 2011 by different transport modes. (1) Energy consumption intensity of highway freight adopts that of commercial freight vehicles. (2) The mark * indicates that the energy consumption per unit in air freight adopts kilogram standard coal per hundred ton kilometer.

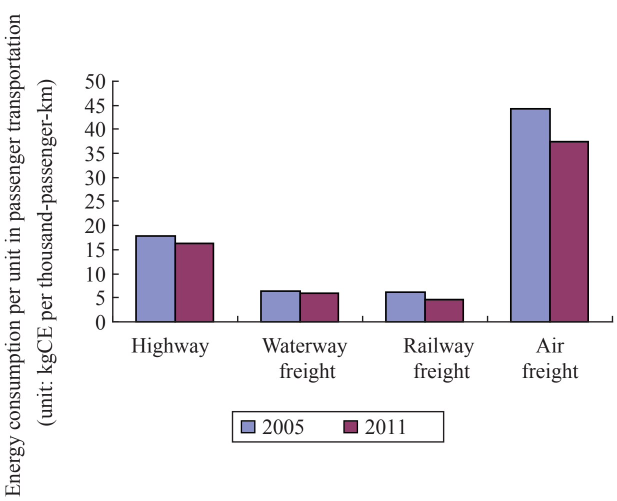

Figure 4. Comparison of energy consumption per unit in passenger transportation between 2005 and 2011 by different transport modes (Part 1). Energy consumption intensity of highway passenger transport adopts that of commercial passenger vehicles.

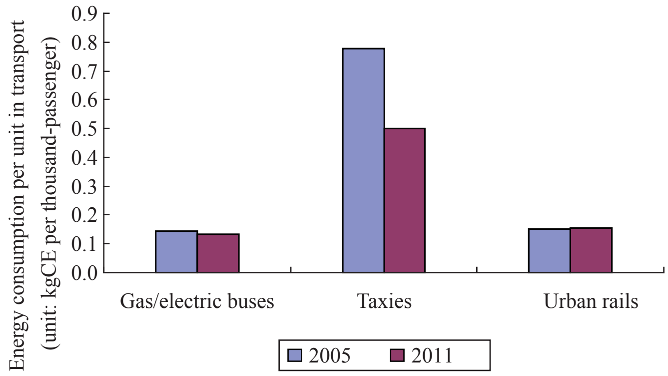

Figure 5. Comparison of energy consumption per unit in passenger transportation between 2005 and 2011 by different transport modes (Part 2). Data adapted from *The Construction a Green Transportation System of China* (Research Report of the Chinese Academy of Engineering).

3.2 Current problems

The development of Chinese transportation industry has captured the world's attention, yet it has brought immense pressure on energy saving and environment conservation, as the energy consumption and pollutant emission rapidly grow and traffic conditions increasingly deteriorates.

3.2.1 Rapid increase of the total energy consumption

The growth rate of the energy consumption of transportation industry has surpassed that of the entire Chinese society with the rapid increase of passenger and cargo transportation, ranking the first of all the industries. The total amount of Chinese energy consumption had risen from 1504.06 million tCE(Tons of Coal Equivalent) in 2001 to 3,480.02 million tCE in 2012, with a yearly growth rate of 8.8%, while the synchronous growth of the energy consumption of transportation industry had grown from 163.9358 million tCE to 523.2359 million tCE, with a yearly growth rate of 12.3%. The percentage that the energy consumption of transportation accounts for in the total national energy consumption is also on the rise, from 10.9% in 2001 to 15% in 2012 (see *Figure 6*). Among the energy consumption of transportation, the ratio of highways had risen relatively fast, rising from 34.8% in 2001 to 37.1% in 2012, composing a main force in the boost of the energy consumption of transportation.

3.2.2 Rapid increase in pollutant emission

Judging from the CO_2 emission, the CO_2 emission of the transportation industry had risen from 0.362 billion tons in 2001 to 1.157 billion tons in 2012, with a rise of 219%. Highway transport is the chief sector contributing to the rise, as its ratio of the CO_2 emission had increased comparatively rapidly, from 34% in 2001 to 36.3% in 2012. Besides, the

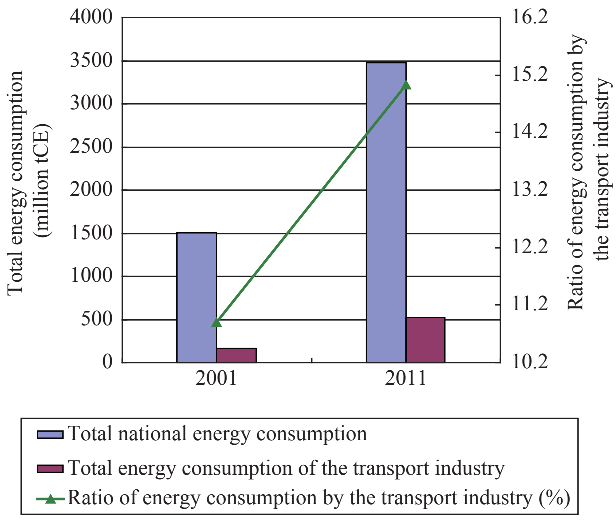

Figure 6. Energy consumption and its ratio of transpiration. Data adapted from *The Construction a Green Transportation System of China* (Research Report of the Chinese Academy of Engineering).

ratio of the CO_2 emission by the civil aviation which consumes mainly aviation kerosene had also increased a bit (see *Figure 7*).

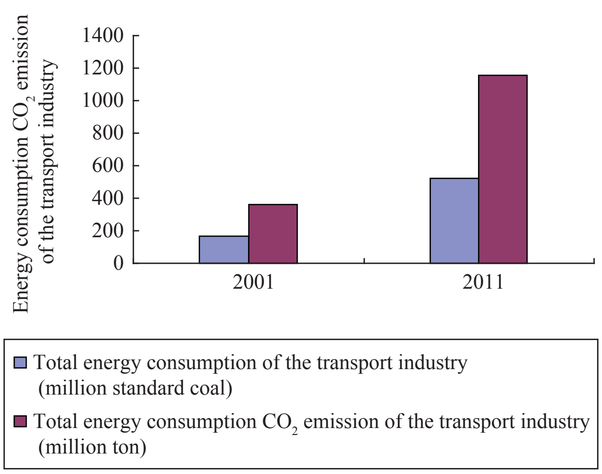

Figure 7. Energy consumption and CO_2 emission of transport industry. Color blue: total energy consumption of the transportation industry (million standard coal); color purple: total energy consumption CO_2 emission of the transportation industry million ton). Data adapted from *The Construction a Green Transportation System of China* (Research Report of the Chinese Academy of Engineering).

The motor vehicle exhaust is a major source of urban air pollution. Between 2005 and 2012, the number of motor vehicles in China had risen from 0.118 billion to 0.2 billion, of which 20.2% failed to meet emission standards, thus increasing urban pollution. According to the survey by Beijing Environmental Protection Bureau, PM2.5 from the motor vehicle exhaust accounts for 22.2% of the total PM2.5 pollution of Beijing (see *Figure 8*).

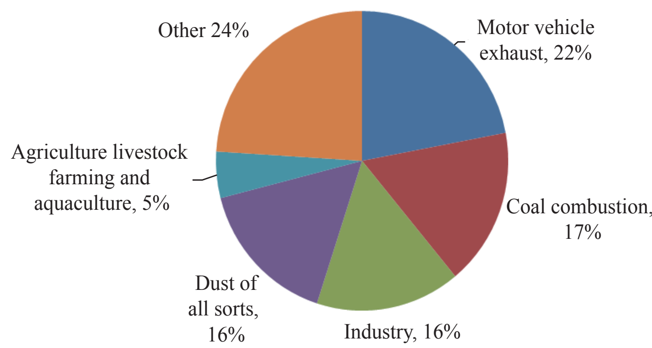

Figure 8. Ratios of sources of PM 2.5 in Beijing. Data adapted from *The 2012 Annual Report of Prevention and Control of Motor Vehicle Pollution*.

3.2.3 Deterioration of urban traffic congestion

With the swift increase of motor vehicles, urban traffic congestion has expanded from peak hours to non-peak hours, from city centers to peri-urban areas, from a few cities like Beijing, Shanghai, Shenzhen and Guangzhou to other province capitals. Driving speed during peak hours in city centers of megalopolises and big cities has dropped from formerly 40 km per hour to currently 15-20 km per hour. Surveys in 2009 show that in the center areas of Shanghai, of the 204 major intersections, 44% were congested (90 of them), 40% were comparatively congested (81 of them), and only 16% (33 of them) were unimpeded; the arterial roads of the Inner Loop Road were mostly congested during morning peak hours, as shown in Figure 9. Traffic congestion makes the city travel inconvenient, and aggravates energy consumption and pollutant emission, and has become a prominent issue for China's city development.

3.3 Factors contributing to the above problems

3.3.1 Unbalanced development of different transport modes

Unbalanced construction of transportation infrastructure (Li, Z., Ouyang, Chen, Li, Z., & Huang, 2007) and poor transportation structure contributed to the unreasonable transportation phenomena and increased the energy consumption and pollution emission. As for freight transport, one prominent phenomenon is that highways took up large quantities of long distance transportation of bulk cargo featuring low added value and low efficiency due to reasons such as the insufficiency of railway capacity of coal and the low proportion of high-grade waterways along some rivers. As for passenger transport, prominent phenomena include the rapid expansion of private car transport, a low proportion of public transport and the continuous contraction of bicycle

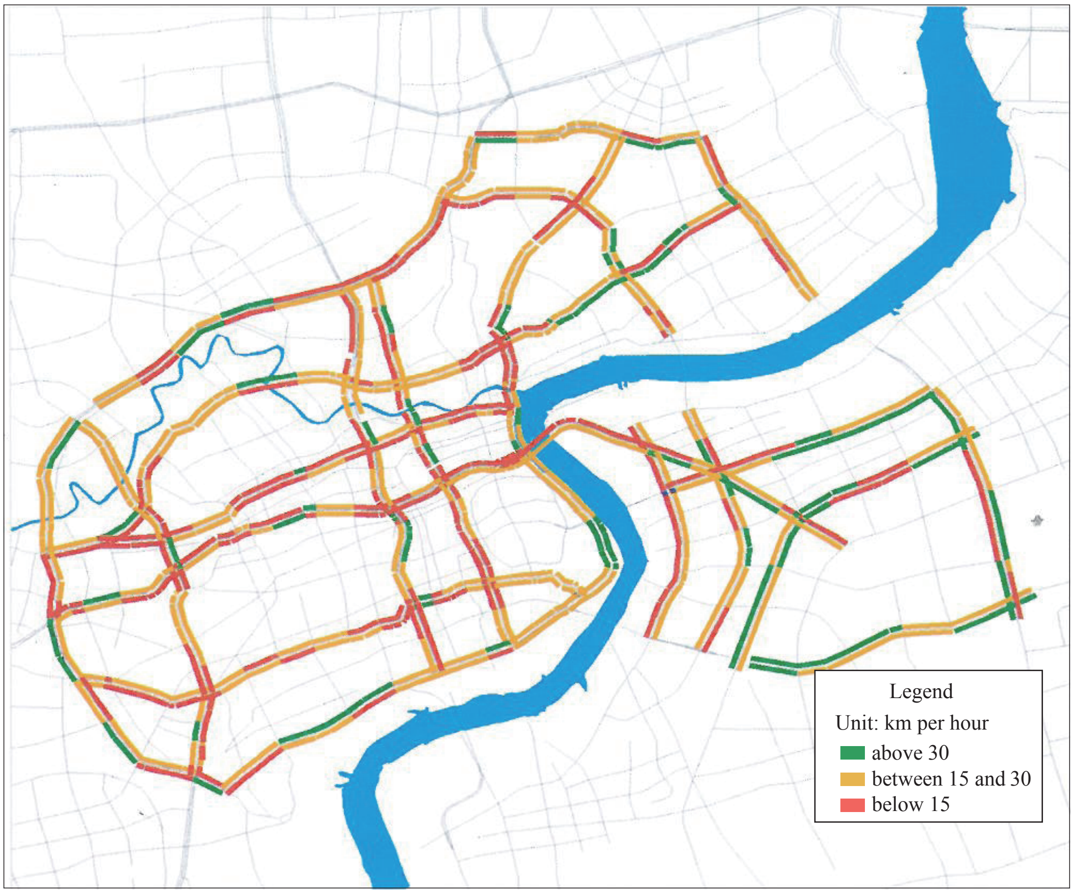

Figure 9. Driving speed on trunk roads of the inner loop road during morning peak hours in Shanghai, 2009. Data adapted from *The Construction a Green Transportation System of China* (The Research Report of the Chinese Academy of Engineering).

transport. In urban traffic, except for a small number of cities such Beijing whose public transport accounts for 30% or above in all the transport modes (walking excluded), the public transport of all the other big cities accounts for approximately 20%, and some province capitals less than 10%; besides, some cities with a high proportion of public transport have a retrogressive tendency in recently years (Fu, Quan, & Lu, 2013) (see Table 2).

Table 2 *The Proportion of Public Transport in Some Chinese Cities*

City	Year	Proportion of Public Transport	Increase
Beijing	2005	24.1%	19.9%
	2012	44.0%	
Shanghai	2004	24.6%	0.6%
	2009	25.2%	
Changsha	2002	42.3%	-6.5%
	2009	35.8%	
Shenzhen	2005	44.3%	-4.0%
	2010	40.3%	

Note. Statistics of Shanghai include pedestrians. Data adapted from *Research on Issues of Comprehensive Transportation in Urbanization with Chinese Characteristics* (Research Report of the Chinese Academy of Engineering).

3.3.2 Irrational layout of integrated transportation hubs

A large number of integrated transport hubs lack adequate coordination with adjacent land use or among different transport modes in phases like planning, construction and service, as a result, the advantage of integrated transport resources can not be fully realized and the hubs run with relatively low efficiency (Li, Ouyang, & Chen, 2008). Besides, the plane and spatial layout of quite a few hubs was not well planned for different transport modes, leading to the increase in both distance and times of transfer (Liu, 2013). In freight hubs, problems such as the lack of smooth links between different transport modes, the lack of transport capacity matching and frequent transshipment are ubiquitous, directly affecting the efficiency of the comprehensive transportation

3.3.3 Inadequate laws, regulations and standards of green transportation

The system of laws, regulations and standards of energy saving and environmental conservation in the area of transportation is still inadequate, unable to adapt to the current development. Besides, the measures of environmental regulations, environmental monitoring, environmental statistics and environmental supervision are relatively weak, and have no strong restraining force on enterprises.

3.3.4 Inadequate improvement in green transportation technologies

The development of energy-saving transport equipments and clean-energy-fueled transport equipments and the research on the application of key technologies needs to be strengthened; the fuel quality of vehicles needs improvement and the role of intelligent transport technology has not been effectively integrated. As far as intelligent transportation systems are concerned, the platform of information collection, processing and application that covers the whole range of transportation planning and decision-making, systematic construction methods and systematic operational service has not been established in most Chinese cities. Besides, the information sharing is poor and the level of system application is not advanced due to the lack of a top-level design (Fu et al., 2013).

4 Development goals and key tasks to build a green transportation system of China

4.1 Development goals

In the near future, the scale of infrastructure of Chinese transportation will be further expanded, the comprehensive transport capacity will be significantly improved, and the goal of "convenient trips of passengers, smooth flow of goods" will eventually be realized as the disparities between supply and demand in transportation gradually narrow. Accordingly, both the stock and incremental amounts of infrastructure and equipment of transportation will retain their large scale, the energy consumption and pollution emission are bound to increase continuously, and the urban traffic congestion can not be relieved in a short term.

The chief goals of the green transportation system of China include: to establish an administrative system of green transportation, to significantly improve the efficiency of energy use in transportation, to effectively control environmental pollution, and to effectively alleviate the traffic congestion.

4.1.1 The primary establishment of an administrative system of green transportation.

Optimizing the institutional administrative system of environmental protection agencies at all levels will help in clarifying the range of duties and supervision modes. Gradually raising the law and regulation system and technical standards system that cover all the links such as transportation planning, construction and maintenance of infrastructure and transport operation service, as well as the supervision, statistics and evaluation systems for energy savings and conservation in transport.

4.1.2 Significant improvement in the efficiency of energy use in transportation, and effective control of environmental pollution

Increasing the efficiency of energy use by stages, and decreasing environmental pollution in transportation.

The following objectives will be realized before 2015:

(1) The energy consumption per unit transportation turnover by commercial vehicles will be 10% lower than 2005, among which commercial passenger vehicles, commercial freight vehicles will be 6% and 12% lower, respectively; the CO_2 emission per unit transportation turnover by commercial vehicles will be 11% lower than 2005, among which commercial passenger vehicles, commercial freight vehicles will be 7% and 13% lower, respectively.

(2) The comprehensive energy consumption per unit transportation workload by national railways will be 27% lower, decreasing from 6.48 tCE coal/million converted ton km in 2005 to 4.76 tCE coal/ million converted ton km in 2015, and the emission of COD and SO_2 will be controlled within 2,280 tons and 40,298 tons.

(3) The energy consumption per unit transportation turnover by commercial ships will be 15% lower than 2005, among which ocean and inland waterway ships will be 16% and 14% lower, respectively; the CO_2 emission per unit transportation turnover by commercial ships will be 16% lower than 2005, among which ocean and inland waterway ships will be 17% and 15% lower, respectively. The comprehensive energy consumption per unit transportation workload of port throughput capacity will be 8% lower, and its CO_2 emission per unit will be 10% lower than 2005.

(4) In the aviation industry, the energy consumption per ton-km and CO_2 emission per ton-km will be 15% lower than 2005, and the harmless treatment rate of garbage and the rate of sewage treatment of new airports will reach 75%.

Based on the above objectives, the energy consumption per unit will further decrease and the emission intensity of major pollutants will be reduced continuously.

4.1.3 The effective alleviation of urban traffic congestion

The system of urban public transport will be further optimized, the growth rate of private cars will gradually decelerate, the congestion of major cities will be relieved, and the congestion of other cities will gradually be eliminated.

4.2 Key tasks

4.2.1 Making the overall plan for the development of green transport, curbing the excessive growth of total transport demand

Tasks in this regard include: to enhance the overall coordination of the planning of the development plan of transport and the city layout, the industrial strategic layout, the land utilization and the eco-environmental protection; to establish a development strategy of transportation compatible with the carrying capacity of resources and environment, to reduce circuitous transport as far as possible, to lower the transport intensity and thus to reduce the excessive utilization of transport resources (Li, Zh., Li, N., Guo, & Bi, et al., 2014). To try to change the mono-centric layout of cities and form a multi-centric layout in the city development planning (Niu, 2008). To plan each center as a relatively independent modern comprehensive functional region with abundant job opportunities and good service facilities, thus to reduce the demand of trans-regional transport and relieve the pressure of traffic.

4.2.2 Optimizing transport structure, promoting the transport volume's shift to eco-friendly transport modes

Tasks in this regard include: to adjust step by step the structure of investment in infrastructure of transportation, tilting towards the transport modes with big capacity, low energy consumption and low pollution, promoting the sustainable development of eco-friendly transport modes (Li et al., 2014). To enhance the construction of major network of railways, waterways and pipelines, to elaborate the structure of transport infrastructure, to optimize transport products, and to promote the shift of the undue transport volume of highways to railways and waterways. To enhance the coordination of different transport modes, and to form a highly efficient transport system with a close linking between all transport modes and the distribution of duties according to respective advantages.

4.2.3 Priority development of public transport, advocating green transportation

Tasks in this regard include: to implement the policy of public transport priority, to accelerate the development of an urban public transportation system with big capacity, low pollution, low energy consumption that provides fast and easy transportation, to expand the service network, to improve the capacity configuration and transfer conditions, and to increase the accessibility and service level of ground public transport. To significantly improve the transport environment for pedestrians and cyclists, providing safe and continuous routes, and solve their problem of transfer with public transport. To promote rail transport construction in major cities, bringing into full play its advantage in long-distance trips.

4.2.4 Improvement of the allocation plans of integrated transport hubs, enhancement of effective linking between different transport modes

Tasks in this regard include: to bring into full play the core role that the integrated transport hubs have in coordinating all transport modes and increasing the overall efficiency of transportation. To allocate reasonable passenger hubs of different levels and functions, to enhance the effective linking between urban railway transport, ground public transport and private transport and their linking with main line railways, main line highways and airports according to different characteristics of urban spatial forms and passenger trips. To plan as a whole the spatial layout of freight hubs as well as industrial parks and logistics parks; to improve the collecting and distributing functions of freight hubs for a "seamless linking" as requested, and to increase the convenience, compatibility and safety of goods transshipment.

4.2.5 Enhancement in administration of energy saving and environmental conservation, promotion of green transportation

Tasks in this regard include: to elaborate relevant managing norms and technical standards, and to enhance the institutional building in the development of a green transportation system. To raise the vehicle emission criteria, to improve fuel quality, and to accelerate the implement of the national standard of vehicle fuels. To enhance the management of transport demands in major cities, curbing the overuse of cars by means of total quantity control, raising the purchase threshold, traffic controls and raising the cost; to improve the environmental evaluation system of transportation and the engineering environmental supervision system, thus to form a regulatory system that covers the whole range of transport planning, construction and operation; to enhance the network construction of transport environment supervision and to form a nationwide statistics and information sharing system for transport environment, thus to provide a solid basis for green transportation policy making.

4.2.6 Acceleration of intelligent transportation, increase in the efficiency and service level of the infrastructure system of transportation

Tasks in this regard include: to promote the development and application of key technologies of intelligent transportation and to improve the efficiency and service level of the transport system by intelligent means. To especially speed up the construction of urban intelligent traffic systems, and to comprehensively increase intelligence of the operation supervision, alarms, analysis, decision-making as well as traffic organizing and service induction. To increase the operating efficiency and capacity by using the intelligent traffic management system and the intelligent operating vehicle management system; to improve the time-space distribution of traffic needs, to shave the peak loads, to narrow the disparities between supply and demand by speeding up the application of traffic information system and congestion fees. In the near future, to focus on the problem of "information barriers" and realize the full information sharing across regions and industries.

4.2.7 Promotion of technological innovations, increase in the comprehensive level of energy conservation and emission reduction in transportation

Tasks in this regard include: to increase the investment in technological innovations of energy saving and environmental conservation, to encourage enterprises and research institutes to increase relevant input; and to reinforce the development of eco-friendly transport devices and key technologies as well as the application of new materials, new energies and new techniques in transport construction, operation, management and service. To establish a mechanism to evaluate and promote innovative new products, and to promote advanced and practical innovative products such as electric vehicles, hybrid vehicles, alternative fuel vehicles and natural gas vehicles by comprehensive means such as energy subsidies.

It is a realistic choice for Chinese transportation industry to persist in the ideal of green development and to vigorously promote the construction of a green transportation system, in order to transform developing modes and adapt to the sustainable development of Chinese economy. It is a long-term project that needs in-depth innovation of the system, the management and the technology, as well as the preferential policies in tax, eco-compensation etc., and the support of governments of all levels and the whole society.

Through all the strenuous efforts, the goal of a green transportation system of China is bound to be achieved.

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