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Forecast on Energy Demand of Road Transportation in China

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Abstract

To some extent, there are some uncertainties factors in forecasting energy demand of road transportation. Scientific forecasting China's energy demand of road transportation is a key for make long-term development plans of the nation's road transportation, and relevant policies of environmental protection and energy-saving. Basing on the energy demand of China's road transportation, considering the factors average fuel consumption of single-automobile and the workload of road transportation, the paper does a comprehensive forecasting for China's energy demand of transportation in the future. The result is that in 2030, the energy demand of road transportation will amount to 250 million tons, which is 1.4 times that of 2020, and 2.3 times that of 2010. The significant increase of energy demand will inevitably bring great pressure to resources of energy and environmental protection, so the implementation of scientific development concept, saving resources and protecting the environment and adopting sustainable development policy will be the objective requirements for highway transportation development of China in the future.

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1. Introduction

With the development of China's economic, road transportation, as an important part of China's comprehensive transportation system, will undertake increasingly transport workloads. At the meantime, with the improvement of people's living standard, family will own private cars gradually, which will increase the vehicle population. While China transportation meets a good development opportunity, it is

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also facing sever challenges of land resource, energy resource and environment protection. Scientific and accurate forecast of energy demand assumed in road transportation and reasonable development plan of highway in short and long term, are the important basis for policies of environment protection and energy resource.

Energy demand prediction of road transportation is uncertainty to some extent. Lots of scholars and institutions have done a wide range of researches, and proposed many prediction methods for energy demand. Since energy demand is restricted by many factors, which have complex relationships with each other, it is difficult to apply causality model or structure proportion to forecast the energy demand. Even though it is, the forecast result is not accurate due to the uncertainty of some factors in future. Accurate forecast of China's road transportation energy demand plays a key role in policy making of transportation and energy.

2. Forecast of Road Transportation Energy Demand

Energy demand of road transportation in future is directly influenced by vehicle population, structure of vehicle population, technical condition and transport workload undertook by all kinds of vehicle. The energy demand of road transportation in the future is forecasted mainly for gasoline and diesel under the condition of without considering the development of alternative energy resource.

2.1. Energy demand analysis by energy consumption of single vehicle

(1) The selected samples

The selected samples include: annual average energy consumption of all kinds of vehicle in the past year and future, annual average energy consumption of typical regions and users (Transport Company) in the past year and future, annual average energy consumption of typical foreign country. Fuel consumption of single vehicle in the future is determined on the basis of comprehensive judgment for analysis of different samples, and then the result is proofread.

(2) Trend analysis of fuel consumption of single vehicle

In the past twenty years, with the increase of large and medium passenger car and big truck, fuel consumption of single vehicle tended upwards, but it tended downwards when the small passenger car population increased rapidly. Fuel consumption of single civil automobile nationwide is shown in table 1.

Table 1. Fuel consumption of single civil automobile nationwide

Year	1990	1995	2000	2003	2004
Fuel consumption of single vehicle (ton per car)	4.5	4.3	3.97	3.06	2.97

Fuel consumption of single vehicle in 2004 decreased by 51.25 percent and 25.19 percent compared with the value in 1990 and 2000. The fuel consumption of single vehicle continues to decline. According to international experience, private cars will begin to enter each family gradually when the per capita GDP exceeds 3000\$. Per capita GDP of Some big cities in China have already reached this level, the tendency of purchase of motor vehicle, especially private car, is began to grow rapidly. It is predicted that private car population in China will increase rapidly during the next twenty years. Fuel consumption of vehicle in China exceeds 10 to 20 percent compared with the same type vehicle in foreign country due to the automobile drive technique gap between China and the international. Fuel consumption of vehicle will decline further with the development of China auto industry and the improvement of auto technology.

(3) transport demand analysis

China's basic national condition is large population, rare land and oil resource. China's eleven coastal provinces, municipalities and autonomous region are the most developed regions in China with land area of 200 kilometers and a population of 0.8 billion, and the population density of these area exceeded developed countries in the world. Per capita petroleum resource is only 20 percent of the world average, and under this background, how to give full play to the advantages of each model of transport has become a key question that China government pays attention to. because of the advantages of railway: small land use per unite capacity, low fuel consumption, less pollution and less consumption of oil resource, China government has already made the transport development policy that no matter inside or outside the city, railway transport and water transport should be constructed priority if the external condition permit. The twelfth five-year plan has decided to accelerate the construction of railway, water transport and urban public transport facilities, the construction of high-speed railway between cities, and the construction of railway transit system and public transit system between massive cities and big cities, all of which will lead to that more and more vehicle transit turn to railway transit, the frequency of using private car will decrease and the fuel consumption of single vehicle will decrease too. The fuel consumption prediction of single civil automobile nationwide in 2020 and 2030 is shown in table 2.

The fuel consumption of civil automobile nationwide in 2015, 2020 and 2030 are 100 to 110 million tons, 170 to 200 million tons and 270 to 300 million tons respectively.

2.2. Energy consumption prediction by transport workload

Freight transport amount (ton kilometer) in China is mainly accomplished by the employing vehicle. In 2003, highway passenger turnover is 769.56 billion person-kilometer, freight turnover is 709.95 billion ton-kilometer, and the converted turnover is 786.91 billion ton-kilometer. Fuel consumption of vehicles all over the society is 7.3 billion ton and the fuel consumption of vehicle per converted ton-kilometer is 0.94 kg. According to *automotive industry policy*, the automotive industry and the relevant industries should focus on the development and implement of the new technology, and improve the economy of vehicles' fuel consumption. At the same time, fuel consumption per kilometer of single person will increase.

Table 2. Fuel consumption prediction of single civil automobile nationwide

Year	2015	2020	2030
Fuel consumption of single vehicle (ton per car)	2	1.4	1

(1) Passenger transport amount and turnover prediction

With China's economic development, passenger transport shows a stable growing trend. From 1990 to 2004, average annual passenger transport amount grew by the speed of 6.5 percent. Under the background that stable growth of economic, acceleration of urbanization progress and growth of economic and trade, the trips number of business, official business, school and work. Especially with the improvement of people's income, the change of consumption structure and the arrival of ageing society, tourism consumption of resident will grow gradually and volume of domestic travel and abroad travel will increase gradually too. Tourists, as the key part of passenger volume, are the best factor that increases the passenger volume. Highway passenger transport amount and highway passenger turn are predicted in table 3 and table 4.

Table 3. Highway passenger transport amount prediction (100 million persons)

Prediction method	2004	2010	2020	2030
Elastic coefficient method	—	242.5	418.6	548.7
Regression analysis	—	244.5	403.9	530.7
Exponential smoothing method	—	206.0	290.7	480.8
Average trip method	—	227.5	347.3	497.4
Comprehensive prediction	162.45	240	365	520

Table 4. Highway passenger turnovers prediction (100 million person-kilometer)

Prediction method	2004	2010	2020	2030
Elastic coefficient method	8748.4	15305	31809	39865
Regression analysis	8748.4	14123	26417	38472
Exponential smoothing method	8748.4	13035	21936	36984

The passenger volume and passenger turnover are: 36 billion persons and 2500 billion person-kilometers in 2020, 52 billion persons and 3700 billion person-kilometers respectively. The growth speed of passenger volume and passenger turnover is: 6.72 percent and 7.3 percent from 2004 to 2010, 4.14 percent and 5.8 percent from 2010 to 2030, 3.8 percent and 4.0 percent from 2020 to 2030 respectively.

(2) Freight transport amount and freight turnover prediction

After the reform and opening-up, the highway freight transport amount grew stably, and it grew 4 percent every year from 1990 to 2004. The freight volume and freight turnover were 12.45 billion tons and 784.09 billion ton-kilometer at 2004. With the growth of China's economic, the adjustment of China's industry structure and the development of Industrialization of agriculture and rural economic, the highway freight transport amount will grow continuously. The prediction of highway freight transport amount and freight turnover is shown in table 5 and table 6.

Table 5. Highway freight transport amount prediction (100 millions ton)

Prediction method	2004	2010	2020	2030
Elastic coefficient method	—	143.4	203.9	280.7
Regression analysis	—	151.3	208.0	260.5
Exponential smoothing method	—	158.5	179.9	235.2
Freight intensity analysis method	—	161.5	198.0	254.3
Comprehensive prediction	124.5	152	199	260

Table 6. Highway freight turnover prediction (100 millions ton-kilometer)

Prediction method	2004	2010	2020	2030
Elastic coefficient method	7840.9	10822	15369	23594
Regression analysis	7840.9	11876	19045	22719
Exponential smoothing method	7840.9	11122	15773	21859

According to the prediction results, the freight transport volume and freight turnover are: 20 billion tons and 1600 billion ton-kilometer in 2020, 26 billion tons and 2200 billion ton-kilometer respectively.

The growth speed of freight transport volume and freight turnover is: 3.38 percent and 5.8 percent from 2004 to 2010, 2.73 percent and 3.82 percent from 2010 to 2030, 2.64 percent and 3.24 percent from 2020 to 2030 respectively. The transport workload of freight vehicle is predicted in table 7.

Table 7. Transport workload prediction of freight vehicle (100 million person-kilometers)

Passenger and freight turnover	2020	2030
Passenger turnover	25000	37000
Freight turnover (100 million ton-kilometer)	16000	22000
Converted ton-kilometer(100 million ton-kilometer)	18500	25700

Transport workload of freight vehicle all the nation – thousand converted ton-kilometer fuel consumption index: 0.85 kg per thousand converted ton-kilometer in 2020, 0.9 kg per thousand converted ton-kilometer in 2030. According to the prediction of in the next 3 years, the fuel consumption amount is: 160 million tons in 2020, 230 million tons in 2030.

3. Energy Demand Prediction Analysis of Road Transportation

Fuel consumption of motor transport in the future is predicted on the basis of fuel consumption of single vehicle and fuel consumption of transport workload, shown in table 8.

Table 8. Energy consumption prediction of road transport (100 million ton)

Prediction method	2020	2030
Average energy consumption of single vehicle method	1.7-2.0	2.7-3.0
Transport workload method	1.6	2.3

Judging from the results predicted by the two methods above, the second result is smaller, which is caused by the incompleteness of existing statistical data and lower workload prediction assumed by small car, so it is necessary to proofread the prediction result.

During the next ten to twenty years, small car in China will develop rapidly. To implement the scientific development and enhance the transportation demand management, public transport system construction, especially rail transport, should be accelerated. With the improvement of automobile drive technology, Low-emission, high-efficiency private cars will be used more and the frequency of using private cars will decrease gradually, though the private car population will still increase.

Taking both average fuel consumption of single vehicle and transport work energy consumption into consideration, it is predicted that energy consumption of vehicle transport in China in 2020 and 2030 will be 180 million tons and 250 million ton respectively.

4. Conclusion

With economic development of China, road transportation, an important part of China's comprehensive transportation system, will consume a large amount of oil. So resource constraints will be major issues which China has to face in the future. In order to meet the requirements of social economic development to road transport, we must keep road transport in a rapid development next 20 years, but it will also bring many new problems, such as making the shortage of oil resources more serious and occupying a lot of land to build roads, car parks and other transport facilities.

Facing the huge demands to road transport, the transport of lower pollution and lower energy consumption should be spread rapidly and resources should be saved and used more effectively. Implementing the scientific development, saving resources, protecting our environment and keeping sustainable development will be the objective requirements to road transport in the future.

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