

Study on the Beijing Transportation Energy Saving and Consumption Reduction under the Total Energy Consumption Restriction

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Abstract - Total energy consumption and intensity in transportation industry are the critical factors to the success of future energy safety and greenhouse gas emission control. Total energy consumption in aviation transportation, pollution emission in road transportation, especially the exhaust gas emission from the private vehicles and road freight transport vehicles shall be the most crucial constraints for Beijing transportation industry to reach the energy saving and emission reduction target responsibility and obtain the air pollution governance effect in 13th Five Year Plan (2016-2020). Combining the 12th Five Year Plan period(2010-2015) analysis of transportation industry and study on energy demand prediction of private vehicles in Beijing, and after using the predict technique of an exponential growth model and the moving average method to revise the predicted result, the study predicts a quantitative range of energy consumption demand in Beijing transportation industry for the next five years, meanwhile suggested a three-level estimation of the total control of the energy consumption target in Beijing transportation industry, and proposed policy suggestions for energy saving and consumption reduction in Beijing transportation area.

Keywords: total energy consumption, transportation, energy saving and consumption reduction

1. Introduction

In recent years, the smog problem in Beijing is becoming so serious and frequent, which also badly threatens the public health that this originally extremely professional meteorological word of “smog” is becoming widely known, and the severe situation of pollution is also gets the attention of the government. When President Xi Jinping visited Beijing to assess the works in February 2014, he reinforced three times to prevent and control the air pollution, and clearly pointed out that “prevention and control of atmospheric pollution is one of the most serious problems for development of Beijing”.

The direct reason for the frequent smog problem in Beijing is the extreme adverse weather conditions, but the basic reason lies in the total pollutant amount, which mainly is the coal, fuel, and emissions associated with life. After the APEC, Beijing Environmental Protection Bureau announced an analysis result of source of chemical components that constitute PM_{2.5} (Particles smaller than 2.5 micrometers, PM_{2.5}, tend to penetrate into the gas exchange regions of the lung). in Beijing, i.e 28%-36% of which source from the outside (mainly Hebei province and surrounding area), 64%-72% are from local pollution sources, such as motor vehicles, coal, industrial production, and dust emissions. As present in the data, motor vehicle emission has become the primary air pollution of the local pollution source in Beijing, with contribution rate of PM_{2.5} reached to 32%, volatile organic compounds accounted for about one third of the total in the whole city, nitrogen oxides accounted for more than half the city and presented with progressive tendency^[1]. According to the investigation by “Atmospheric Haze Chase with the Control” Team of Chinese Academy of Science that the emission from the engine cycle is one of the major causes for the smog in Beijing, transportation energy consumption and intensity are key elements to decide future energy security and the success of the greenhouse gas emission control^[2].

2. Energy-Saving and Consumption Reduction are the Important Supports to Complete the National Energy Saving Target.

In order to save energy and reduce consumption from the source, the *Energy Development Strategy Action Plan (2014-2020)* by National Energy Administration precisely proposed to strictly control the increase of the total energy consumption, strive to implement the energy efficiency improvement plan, and promote the energy consuming reform in urban and rural areas. National Development and Reform Commission (NDRC) also clarified that the inspection guide for

provinces and cities energy-saving target responsibility appraisal will be the “double control” of both the total energy consumption and intensity control in the 13th Five Year Plan period. As the transportation industry is one of the four major areas of 13th National Five Year Energy Program, that it greatly support the realization of obligatory indexes of energy saving, carbon emissions, non-fossil energy, and atmospheric pollution prevention.

Transportation is an essential artery of urban economic development, and the subsequent energy consumption, carbon increase, air pollution and deterioration of environmental quality shall not be ignored, moreover, from the aspect to realize the national 13th Five Year targets of energy saving, emission reduction and low carbon, it is especially one of the considerations need to be strictly controlled and managed. According to the Beijing Statistic Yearbook, in Beijing Sector Structure 2012, the Service Sector GDP has accounted for 76.5% of the total GDP, and the energy consumption per unit of GDP is 0.238 tons of standard coal(tce)/10,000 Yuan. Figure 1 below reflects energy consumption per unit of GDP level of 14 major sectors of the Service Sector in Beijing. It can be concluded that energy consumption per unit of GDP of six industries, including transportation, accommodation and catering industry, education and so on, are higher than that of the overall Service Sector level. Among which, the lowest consumer is financial industry, while the transportation is on the top with the consumption of 1.513 tce/10,000 Yuan, and became the highest energy consumer in service sector in Beijing, its energy consumption per unit of GDP is 72 times of the financial industry. Based on the premise of energy consumption per unit of GDP growth remains the same, each 1% of energy consumption reduction in transportation industry can decrease 0.38% of energy consumption per unit of GDP in the Service Sector in Beijing^[3].

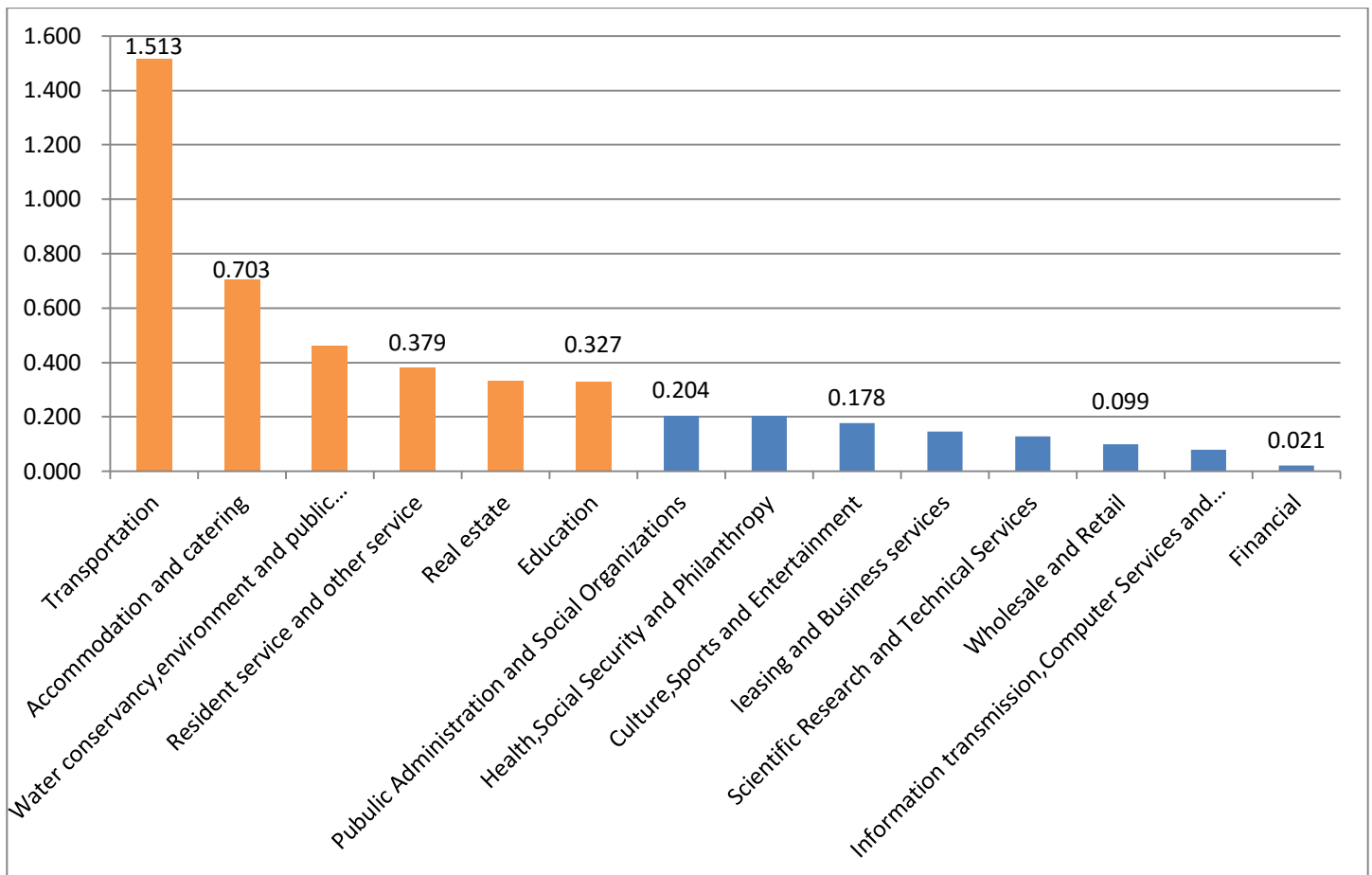


Fig. 1: Comparison of Energy Consumption per unit of GDP of Main industries of the Service Sector in Beijing 2012.

3. The Determination of the Total Energy Consumption Target Range

3.1. The Method of Prediction and Revision

1. The prediction method of total turnover of passenger and freight transport:

$$S_{t+1} = S_t(1+\bar{\alpha}) \quad (1)$$

S_{t+1} : Predictive value of total turnover of passenger and freight transport of year t+1;

S_t : Total turnover of passenger and freight transport of last year;

$\bar{\alpha}$: Average annual rate of change in statistic stage.

2. Calculation method of total energy consumption based on unit turnover of passenger and freight transport:

$$E_T = E_S S_T \quad (2)$$

E_T : Total energy consumption of specific transportation industry within each year;

S_T : Total turnover of passenger and freight transport of specific transportation industry within each year;

E_S : Total energy consumption of specific transportation industry to complete unit turnover of passenger and freight transport.

3. The double moving average method of revision:

$$M_t^{(1)} = \frac{Y_t + Y_{t-1} + \dots + Y_{t-n+1}}{n} \quad (3)$$

$$M_t^{(2)} = \frac{M_t^{(1)} + M_{t-1}^{(1)} + \dots + M_{t-n+1}^{(1)}}{n} \quad (4)$$

$M_t^{(1)}$: A moving average of No.t phrase;

$M_t^{(2)}$: A double average of No.t phrase;

n: Crossed phrase for moving average values.

3.2. The Prediction and Determination of the Total Energy Consumption Target Range of Transportation Industry

From 2012 to 2015, Beijing municipal government required the total energy consumption target tasks for Beijing transportation industry, respectively the average growth rate is 7.16%, much higher than the city's average energy consumption growth. The industrial restructuring of Beijing approximately trends to be stable during the 13th Five Year Plan Period (2016-2020), and the growth of GDP will decrease from the former high-speed to a new normal rate, the demand for improving the energy efficiency to reduce the energy consumption is becoming more urgent, as well as the constraint targets for energy consumption increase and emission in transportation industry will be more strict. In view of the study on the transportation growth and energy consumption demand in Beijing in the 12th Five Year Plan period (2010-2015), and the 13th Five Year Transportation Development Plan of Beijing, as well as on the basis of the growth rate of 6.0%-7.5% to set up the total energy consumption target range in Transportation Industry as showed in following Table 1.

The scheduled targets in Table 1 during 2016-2020 are designed for ideal transport conditions. However, according to professional advisers opinion^[3], for several uncertainties, such as emergency activities, extremely adverse weather, heavy traffic jam, etc, the practical energy consumption demand for transportation industry in Beijing will be higher about 3%-5% than designed targets under the ideal transport situation. Overall, it will be expected to between 22.5 to 23.1 million tce in 2020.

Table 1: Design of the Energy Consumption Target Range in Transportation Industry.

Total Energy Consumption		2015 (issued)	Scheduled Target (Unit: million tce)				
			2016	2017	2018	2019	2020
Average Annual Growth Rate	6.0% (The rate of strict control)	16.00	16.96	18.06	19.24	20.49	21.82
	6.5% (The rate of median control)		17.08	18.15	19.32	20.58	21.92
	7.5% (The rate of general control)		17.20	18.23	19.42	20.68	22.02

In 13th Five Year Plan period, if the energy consumption in transportation industry evaluated on the basis of growth rate of 6.0%-7.5%, the corresponding target control line will lower than the practical energy demand suggestion of the sector. The transportation industry shall both guarantee the proper operation of society economy progress, meanwhile to stand the challenge of rigid energy consumption obligatory targets like climate change and air quality improvement. Therefore, it should be highly valued, to exploit its potentialities, to promote energy saving and emission reduction work in all aspects, and contribute to the harmonious, healthy and sustainable development of the whole society.

4. Conclusion and Policy suggestions

Since from the 11th Five Year Plan Period(2005-2010), with the rapid development of infrastructure construction such as the rail transit and BRT(Bus Rapid Transit), the share rate of urban public transportation is constantly promoted, remarkable achievements of energy saving and consumption reduction having been made in Beijing transportation industry. However, there are also some weakness needed to be improved. For example, through the energy saving targets assessment carried out in Beijing in past few years, it was found that the cross-departmental coordination is bad in the sub-industries like aviation and railway, and the understanding of energy saving target management is limited to the department or the industry category, supporting to the Beijing's energy saving target management decision is not strong enough, and management efficiency in the freight, the taxi industry need to improve, there is deviation between the advance efforts, budget and schedule in part of the transportation energy conservation and environmental protection measures, and that did not achieve the desired effect, and so on. As for the aspects of reduce congestion and emissions, governance haze weather, we should especially focus on the serious impact from the private vehicles. In the 13th Five Year Plan period, to accomplish the transportation energy saving and emission reduction target, as well as the clean air quality and the economy quality and efficiency should both be guaranteed improving. Legal means, economic means and necessary administrative means must cooperate with each other, none is dispensable. Works mainly from the following five aspects: (1) lay equal stress on the head of source control and the end of consumption governance, and pays special attention to the head of source control; (2) equally stressed on the development mode and technical progress, strengthen the transformation development mode, and pay special attention to the major low carbon energy saving technology revolution; (3) attach equal importance to the measures and effect, and make great efforts to the actual effect; (4) regard both the incentive and constraint as equally important, reinforcing the resources, environment and carbon emissions constraints, and change the incentives for energy conservation and low carbon; (5) pay equal attention to the administrative means and market and legal means, intensify the market means and legal means to decode the resources and environment constraints.

According to the actual development of a new historical stage, there are following suggestions for energy-saving and consumption reducing in transportation industry in Beijing:

First, to incorporate with the target of Beijing population size control, to deepen the reform, continue to strictly control the growth of private cars, reasonably guide the consumption demand for private vehicles, adopting variety of policies and measures to decrease the number and utilization intensity of private vehicles.

Travel of the private vehicles has become the source of problems like serious road traffic congestion, huge gasoline consumption and severe environmental pollution. The growth trend of private vehicles has been largely dominated the city's overall vehicle amount development trend. As the investigation showed under the current lottery buyer policy

constraint that proportion of the private vehicle buyers averagely is accounted for about 72.4% of new additional vehicles of each year. It is estimated that in 2020, the vehicle amount in Beijing will reach to 6.84 million, 5.28 million of which will for the private owners. The gasoline consumption by private vehicle travel will reach to 4.08 million tons, which cover around 1/3 of the citizens total household energy consumption, equivalently of 6 million tons of standard coal, and approximate to 2 times of the total energy consumption in Beijing public traffic system^[3]. For the moment, the enormous vehicle amount base has been formed in Beijing, private vehicles travelled frequently every day, especially with the contribution from the internet car service platform like “DIDI” that the utilization numbers and frequency of the private vehicle has greatly increased. Therefore, the increase of the private vehicles shall be strictly controlled, and the consumption demand for private vehicles should be rationally guide; adopting measures like central congestion charge, time limit for in and out in particular area; creatively link the utilization of private vehicle with the carbon emission to charge for the carbon emission according to the emission quantity, or allow to sell the saved carbon emission rights by reducing the utilization of private vehicles in the carbon trading market to get cash profit, by setting up the regulation from the aspect of economic management to raise the cost of the private vehicle utilization, meanwhile to reward the owners who none or rarely use the private vehicles so as to encourage more private vehicle owners to choose public transportation. Through a variety of policies and measures to reduce the private vehicle use intensity and frequency, to strengthen the publicity and guide to change the travel concept, and to reduce petrol consumption and emissions of private vehicle from the source.

Secondly, taking the chance of integration development of the Beijing-Tianjin-Hebei region to establish a sustainable comprehensive transportation system, and improve the energy conservation and environmental protection in transportation industry.

The integration of the Beijing-Tianjin-Hebei region put forward a development strategy of "transit first", by seizing this opportunity, during the 13th Five Year Plan to achieve the regional coordination, establish and perfect a comprehensive transportation system with complementary advantages, reasonable structure, and meet the demand of different characteristics to achieve the purpose of energy saving and emission reduction. According to the economic and technical characteristics of all kinds of transport means, and focus on the Beijing new airport construction, four levels of rail transportation network construction, “3 hour traffic cycle” of highway construction to rationally allocate the transport resources, and optimize the structure of transportation; by the gradual improvement of planning and the collaborative guidance to achieve "Pareto Optimality" in transportation structure resources. As for the railway transportation, it should speed up the construction of electrified lines and electrification of existing railways; The highway transportation should keep accelerate the road network construction scale and improve arterial level, at the same time to improve the structure of the transportation vehicles and operation management, and improve the intensive level of transportation; Air transportation should improve the utilization efficiency of navigation position through optimization of transportation lines, and forming the shaft radial multi-polar route network. Strive to develop the multimodal transport, and improve the overall efficiency of comprehensive transportation system and energy utilization efficiency.

Thirdly, to deepen the adjustment of transportation system structure, enhance the share rate of railway transport and urban public transportation, and by way of transport intensification to construct a green transportation system with high efficiency and low emission.

From the perspective of saving energy consumption, Beijing should follow the policy guidance of promote and encourage the development of railway transportation, moderate the development of air transport and road freight transport. The study indicated that energy consumption of unit traffic turnover of aviation transportation industry is 10.6 times of that of railway. Air transportation energy consumption in 2015 will account for 53.2% of the whole industry transportation, in 2020, will be less, but still be up to 47.8%. From 2015 to 2020, every 1% of air transport turnover (about 163 ~ 231 million ton-km) transfer to the railway transport, can save energy consumption of 90,000 ~ 94,000 tce^[3]. Energy saving potential from the transportation structure optimization adjustment is considerable, and should rapidly develop the railway passenger and cargo transportation; relevant business travel policies should be complied to increase the green travel allowance, encourage travel on train and the high-speed rail. Encourage the air transport industry to optimizes the operating line, reduce or eliminate some short or less passenger flow flights which can be instead by railway to complete, and try to bypass the corresponding passenger flow to railway transport department.

In the urban transportation structure, rail transit and low carbon travels such as bicycle, walk should be increasingly developed, further optimize and adjust the ground bus operating lines, so as to form a low-carbon transport network which is given priority to the rail transit, clean energy ground public charge as complementary, and cycling and walking as the

supplement. NDRC approved of Beijing second period orbit transportation construction program clarified that in 2020, Beijing will add 12 new rail transit lines of 262.9 km, the city's rail transit total mileage will reach 998.5 kilometers, the passenger transport sharing rate will be 67%, and that plays a very significant role in the structure optimization of urban public transport.

Fourth, to strengthen the promotion of road transportation energy saving technologies and products application, enhance the vehicle energy conservation and emissions reduction technology research, development and scientific research, improve the transportation efficiency and management level, increase the update and elimination of old vehicles.

Road traffic (including highway and urban road) is the biggest transportation industry that influences the air quality and urban residential environment, and is the main discharge area. For private cars, policies and measures should be drafted to encourage the use of new energy vehicles, intensify the social charging pile planning and construction, introduce the corresponding measures for the administration of charging pile, etc., to ensure the private vehicle owners can use without any problem. For the discarded private cars, certain economic support should be given in order to encourage its update to electric vehicles and other new energy vehicles. Moreover, to take comprehensive measures to improve the quality of road network, and optimize highway network grade structure, meanwhile from the motor vehicle development, research and development of alternative fuel and new type of power and technology promotion, vehicle monitoring, maintenance and elimination, traffic demand management, and many other aspects, to multi-pronged and severely improve the overall level of automobile energy saving and emission reduction. Strictly implement the standard for *Passenger Vehicle Fuel Consumption Limits*, and on the basis of improving the fuel quality, to implement the motor vehicle fuel consumption identification, authentication system and improve the emission standards step-by-step, and improve the vehicle energy consumption identification system and inspection system. Refer to the "Leading" system in developed country to develop leading benchmarking and certification system in the transportation industry, promote the clean and diversification of motor vehicle fuel, through economic and administrative measures to encourage the relevant research and development institutions and production enterprises to develop and apply the advanced fuel and oil replacement technology, from the design and production origin to improve the energy saving technology, and reduce pollutant emission. At the same time of continually speed up the construction of transportation infrastructure network, shall also to develop, promote and apply the modern information network on the basis of intelligent transportation system, such as urban traffic mobility management system, vehicle navigation system, vehicle tracking system, cargo stowage information system, vehicle emissions monitoring system, and gradually improve the efficiency of transportation system, to achieve the goal of energy saving.

Fifth, to strengthen the traffic energy conservation and emissions reduction basic capacity, with statistical investigation, monitoring measurement, monitoring and evaluation, standard specification as the core part, adequately develop the role of regulating of the legal and standards to achieve the laws to follow, and governance according to the laws.

Promote the amendment of Energy Conservation Law, and Air Pollution Prevention Law, to accelerate the establishment of supporting laws, regulations, standards and policy system, which proper to the transportation industry management characteristics and managing scope. Formulate and revise energy conservation standards and vehicle emission standards. Attaches great importance to the traffic law enforcement and supervision, and intensify the penalty for illegal traffic behaviors. Urban traffic is a system engineering, often caused a series of problems when certain supervision does not reach the designated requirement. For example, obstacles to promote bicycle travel are the lack of specifications for bicycle lane design, construction is discontinuity, and bicycle lane is occupied by a roadside parking etc, consequently collaboration with urban planning department is needed to revise specifications and standards as soon as possible, and cooperation with traffic management department is needed for construction of a safety, coherent system of bicycle lanes In conditional area, so that the bike lanes and motor vehicle completely separated, with strict monitoring and traffic law enforcement to guarantee the bicycle lanes will not be occupied by the roadside parking, meanwhile to renew the signal lamp control system, and promise the left turn bicycle can have proprietary green light to ensure the safety of the riding and continuity.

Last, to increase the energy conservation and environmental protection education, propagate the low carbon, clean, safe and sustainable urban transport operation concept, persistently advocate green travel, and improve the bicycle and pedestrian travel proportion to rise steadily.

Any social organizations and individual citizens are both the users of transport system, and trouble makers for traffic congestion, pollution, noise and other problems, nobody can escape the responsibility. The low-carbon transport and concept of sustainable development should be vigorously promoted and encouraging people to choose green travel, such as public transport, cycling, and walking, etc. Therefore, we must change the travel concept, vigorously promote green travel, low carbon travel, reduce utilization intensity and frequency of the private vehicles, so as to reduce gasoline consumption, emissions and pollution.

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