Transport-Related Resource and Environmental Issues in China

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Current Status of Transport-Related Energy Consumption, Land taken and Environment in China

Transport-Related Energy Consumption Status in China

With the rapid development of the Chinese economy, the total amount of energy consumption is rising at a fast rate. Currently, China has become the second largest energy consumer in the world after the U.S. Figure 1 shows the total consumption of primary energy in China from 1980 to 2004. In 2005, China's total primary energy consumption was 2.22 billion tons of standard coal, and the energy consumption per GDP (10,000 US$) was 1.43 tons of standard coal, 11.5 times as much as Japan, 7.7 times as much as France and Germany, and 4 times as much as the US.(Xinhuanet,2006)

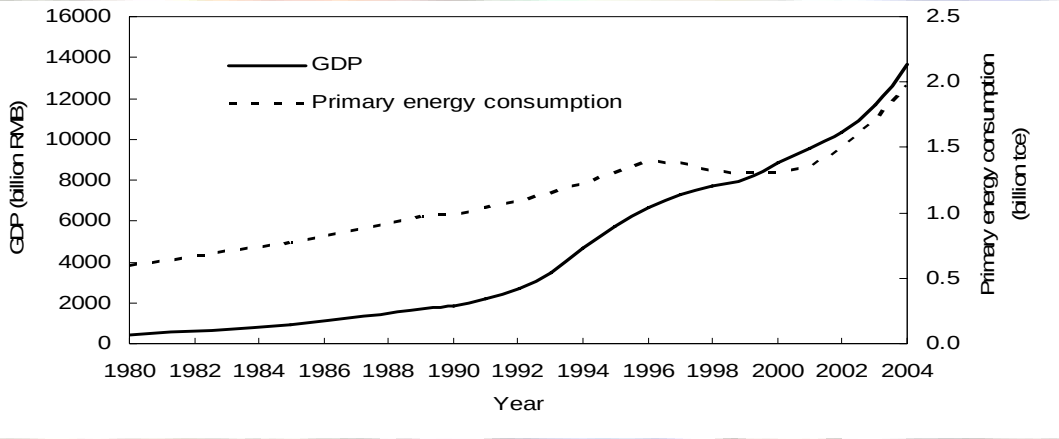

Figure 1: Total Consumption of Primary Energy in China

Sources: China Statistical Yearbook 2003 and data from the official website of China's State Statistical Administration

Fig 2 shows China's oil consumption from 1990 to 2004. It indicates that although China's overall level of resource consumption was not always rising, oil consumption maintained a consistent upward trend, with an annual increase of 9.2%, far higher than the increase in other resource consumption during the same period of time (3.9%). By 2003, China, with its total oil consumption of 240 million tons, overtook Japan and became the second largest oil consumer in the world.

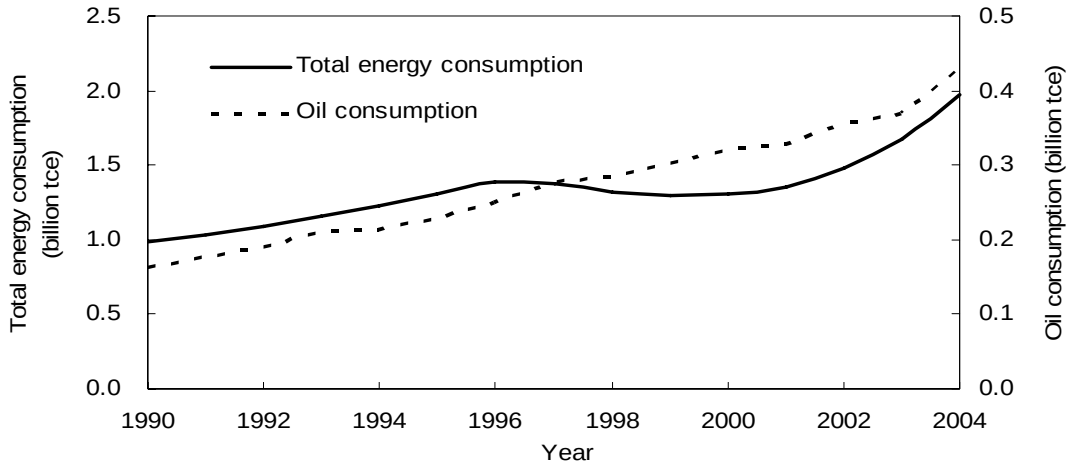

Figure 2: Total Consumption of Oil and Energy in China
Sources: China Statistical Abstract 2005

As is shown in Fig 3, energy consumption in the commercial transport service sector experienced an annual growth rate of 4.5% from 1991 to 1996, and 14.5% from 1996 to 2002, representing an increase of 60.565 million TCE. The share of energy consumption by the commercial transport service sector in the national total energy consumption increased from 4.5% in 1991 to 7.3% in 2002.

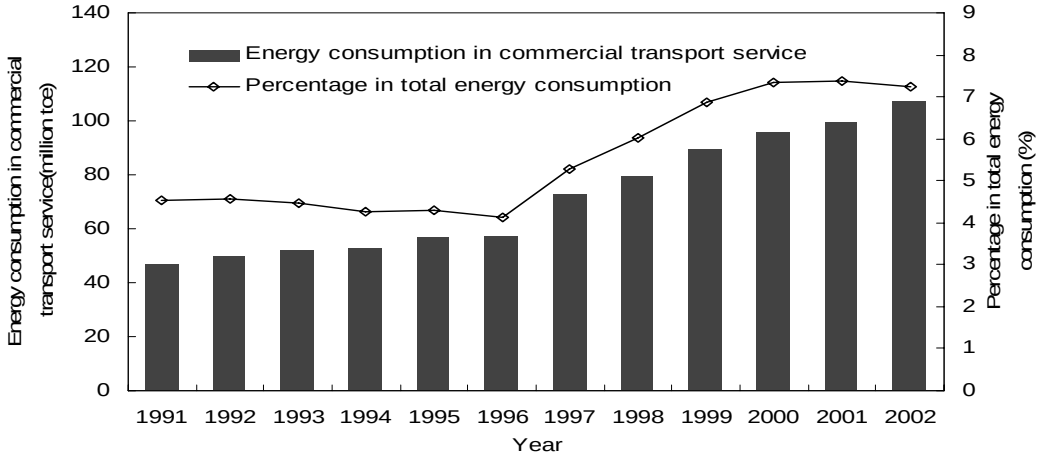

Figure 3: Energy Consumption of Commercial Transport Service Sector
Source: Energy Statistics Yearbook of China

Energy Consumption by Motor Vehicles in China

The share by vehicles in energy consumption has experienced a continuous increase, and has gradually become the dominant part. According to the International Energy Agency, 50% of China's crude oil consumption is consumed by road transport. In 2003, road transport consumed 38.114 million tons of gasoline and 17.096 million tons of diesel, accounting for 87.9% of the national gasoline and 22.1% of the national diesel product volume respectively.

Table 1: Production of Gasoline and Diesel Fuel and Vehicle Consumption of Gasoline and Diesel Fuel from 1990 to 2002 in China (million tons/year)

Year	Crude product	Gasoline			Diesel fuel		
		Production (A)	Vehicle consumption (B)	B/A (%)	Production (C)	Vehicle consumption (D)	D/C (%)
1990	138.3	21.6	19.8	92.0	26.1	4.5	17.3
1991	141.0	24.0	21.9	91.1	28.5	5.1	18.3
1992	141.7	27.3	25.2	92.5	31.7	6.3	19.9
1993	144.9	31.4	27.2	86.5	34.7	7.1	20.3
1994	147.6	28.5	25.8	90.4	34.8	7.1	20.4
1995	149.8	30.5	26.9	88.0	39.7	7.3	18.3
1996	157.3	32.8	28.2	85.9	44.2	8.1	18.3
1997	160.7	35.2	29.8	84.6	49.2	8.7	17.7
1998	161.0	34.7	29.5	85.0	48.8	9.2	18.9
1999	160.0	37.4	32.0	85.5	63.0	12.9	20.4
2000	163.0	41.3	35.5	86.0	70.8	14.5	20.5
2001	164.0	41.5	35.9	86.4	74.9	15.6	20.8
2002	167.0	43.4	38.1	87.9	77.4	17.1	22.1

Source: http://www.cleanauto.com.cn/fenlei/qiyou/tongjiziliao/biao12.htm

Land Resource Consumption by Transport Construction

At present, transport infrastructure in China consumes about 42.09 million km^2, 0.44% of the country's land area. According to the national development plan, the total area for transport infrastructure construction in 2020 will amount to 46.37 million km^2, 0.48% of the whole country's area. From Figure 4 we can see that by 2020, roads will account for 90.2% of land use by transport infrastructure.

Among the land occupied by transport infrastructure, 63.1% of it is farm land, about 29.1 thousand km^2, 3.06% of the country's farm land; 15.2% of it is forest land, about 7 thousand km^2; and 21.7% of it is land used in other ways, about 10 thousand km^2. Thus the loss of farming land is quite serious. It is calculated that construction of highways, railways, and civil aviation airports from 2004 to 2020 will consume 270 thousand km^2 of farming land. This will result in 3.7 million farmers losing their land (0.07 ha. /person).

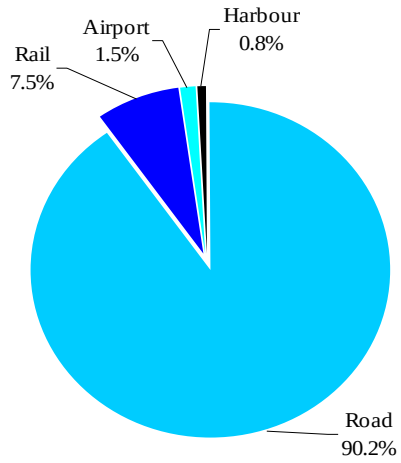

Figure 4: Projection of Land Occupation of Various Transport Infrastructures in 2020
Source: China Statistic Yearbook

Transport-Related Environment Status in China

In recent years, with the rapid transport development, environmental problems have become increasingly serious and hinder economic development and adversely impact social stability and public health. Now, pollution in many cities is changing from stationary source emissions to mobile source emissions. Table 2 shows the results of some studies regarding the emission and concentration shares of vehicles in Chinese cities. The emission and concentration shares of CO and HC are higher than 60%, even reaching 90% in some large cities. In Beijing, Shanghai, and Guangzhou, where vehicle population grows most rapidly, vehicle emissions have become the dominant pollution source, and their pollution characteristics and control progress is typical of other cities as well.

Table 2: Share of Vehicle Air Pollution in Chinese Cities

	City	Year	CO (%)	HC (%)	NO_x (%)
Emissions	Beijing	1989	39	75	46
Emissions	Beijing	1995	77		40
Emissions	Beijing	1998	83		43
Emissions	Guangzhou	1995	85		42
Emissions	Shanghai	1995	76	93	44
Emissions	Shanghai	1996	86		56
Emissions	Chongqing	1999	86	37	86
Emissions	Jinan	2000	79	63	19
Emissions	Nanjing	2001			46
Emissions	Shanghai (within the inner ring)	2002			81
Emissions	Shanghai (urban area)	2002			21

Concentration	Guangzhou	1988	87		67
Concentration	Beijing (total urban)	1995	77		68
Concentration	Beijing (urban area)	1995	86		72
Concentration	Beijing (urban area)	1998	84		73
Concentration	Beijing (urban area)	2000	82		71
Concentration	Shenzhen	2000			92
Concentration	Nanjing	2001			89

At present, the total emissions of CO_2 in China ranks second in the world. The emissions of other greenhouse gases such as methane and nitrous oxide are also very high. The net increase of CO_2 emissions in China totals 823 million tons and it is estimated that by 2020, CO_2 emissions in China will be 2.32 times the current level. Currently, CO_2 emissions per capita in China are below the world's average level. The transport system is a major source of CO_2 emissions, especially in the road and aviation transport sector. Thus, it is crucial to reduce the CO_2 emissions to keep the concentration of GHGs in the atmosphere at a stable level.

Challenges of Transport Energy and Environmental Protection in China

Challenges of Energy Supply in China - Limited Energy Reserves

According to the June 2003 Statistical Review of World Energy published by the BP Company, given technology and cost limitations, the ratio of oil reserves to annual oil production (R/P ratio) was about 40.6 years; for natural gas, the R/P ratio was 60.7 years; for coal, R/P ratio was 204 years. The coal reserves in China total 1002.49 billon tons, but the part that can be mined is only 89.3 billon tons. The gasoline and natural gas reserves are estimated to be 93 billon tons and 38,000 billon cubic meters, but the proven parts represent only 20% and 6% of the total amount respectively and will last for a few decades. Coal mine methane reserves are 35,000 billion cubic meters (equivalent to 45 billion tons of standard coal), ranks 3rd of the world. However, the coal mine methane reserve has not been developed well. Table 3 lists how long the world's proven energy reserves will last, according to the 1996 report of the U.S. Department of Energy.

Table 3: Lasting Period of Fossil Fuels (years)

	Coal	Natural gas	Oil
Global	221	80	39
China	85	62	19

In China, the oil reserve per capita is even lower, only 2.6 tons/person. Table 4 provides the reserves of coal, oil, and natural gas per capita. The population of China accounts for 21% of the world's total, while its oil resources account for

only 2.3% of the world's total. Since late 1990s, China's oil supply has been experiencing severe difficulty, making China a net oil importer with imports increasing every year. In 2002, China's net import of oil was over 70 million tons, and it increased to 97.41million tons in 2003. In 2004, China's oil consumption totalled 290 million tons; including 140 million tons of imported oil, indicating a dependence rate of almost 50% on imported oil (see Figure 6).

Table 4: Reserves of Coal, Petroleum, and Natural Gas per Capita in 2000

	China	World Average	US	Ratio: China to world average (%)
Coal (ton)	89.8	162.5	876.4	55.4
Oil (ton)	2.6	23.5	13.1	11.1
Natural gas (m^3)	1074	24796	16843	4.3

Source: China statistical yearbook 2000

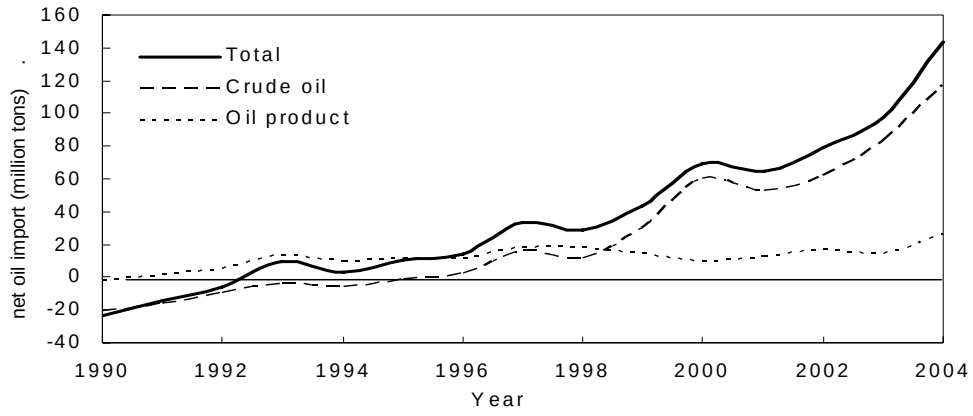

Figure 6: Variation of Net Import Volume of Total Oil Products
Source: China statistical yearbook 1990-2004

Future Energy Consumption

Table 5 demonstrates the projected energy demands of China according to many research institutions and all projects that China's total energy consumption will keep growing.

Table 5: Comparisons of Projections of Energy Demand

Prediction organization	Time	Base year		Prediction result, volume of energy demand (million)			
	Year			2000	2010	2020	2050
IEA	2002	2000		12.1	18.6		30.47 (2030)
Tsinghua University	1994	1990		14.4-15.3		23.8-26.8	34.8-44.0
				13.9-17.1		22.0-27.8	33.0-42.0
Former Ministry of Energy	1994	1990		14.4-15.3		23.8-26.8	34.8-44.1
ERI	2003	1998	Low scenario	14.75	21.69	31.00	
			Medium scenario	14.62	20.33	27.62	
			High scenario	14.48	18.60	23.19	
Chinese Academy of Engineering	1996	1990		16.6-17.0	22.7-24.0	29.0-31.5	35.7-41.3

According to the predictions by the NDRC, China's import of oil will reach 80-120 million tons by 2010, and 150-220 million tons by 2020, and in 2020 when 50% of China's oil demand will be imported. The growing amount of imported oil will greatly threaten the security of China's energy system and influence China's economic development.

Future Vehicle Oil Consumption

According to the DRC, if effective measures are not taken, the oil consumption by the road transport sector will reach 256 million tons, accounting for 57% of the national total, with the increased amount and rate of increase far exceeding those of other sectors. The Study on China's Vehicle Fuel Economy Standards and Policies conducted by Tsinghua University concluded that the oil demand of vehicles are 65.6 million, 119 million, 208 million and 379 million in 2000, 2010, 2020, and 2030, respectively. This means that the oil consumption of vehicles by 2030 will be 5 times that of 2000. This study also projected that the oil demand of the transport sector in 2020 will account for 58-71% of the national oil demand.

High Energy Intensity in Transport Sector

From 1990s, the energy consumption rate of transport in China increased gradually, from 2.71 kg standard coal /100 ton-km in 1990 to 3.28 kg standard coal /100 ton-km in 1998 (Table 6). At present, the vehicle fuel efficiency is 10-15% lower than that in European countries, 5-20% lower than in USA, and 20-25% lower than in Japan (see Figure 7)..

Table 6: Comparison of Energy Efficiency* of the Energy System (%)

China	ECE		
1997	The beginning of the 1970s	The actual possibility at the beginning of the 1990s	the utmost possibility at the beginning of the 1990s
10.3	15	20	30

** Energy efficiency = energy mining efficiency * process efficiency * end-use efficiency.*

Challenges of Transport Environmental Protection

The vehicle population in China will be 45-50 million in 2010 and 0.1-0.13 billion in 2020.

According to the State Environmental Protection Administration (SEPA), the CO and NOx emission of vehicles in China in 2005 were nearly 3,500 tons and 500 tons respectively, accounting for about 79% of total urban pollution emissions. The CO and NOx released by vehicles will represent 85% and 45-50% of the total pollutant emissions respectively in 2010. It is projected that in Shanghai, 75% of the NOx, 94% of the CO and 98% of the HC will come from vehicles in 2010. The annual financial loss caused by air pollution amounts to 5% of China's GDP. Illness and the death rate caused by air pollution has increased gradually but even if the vehicle population increases at a medium rate, the problems caused by emissions will further deteriorate or remain at a very serious level. Figure 8 shows the expected increase in vehicle emissions. If a proper system of control and regulation is not established, public health, the environment, the quality of life and economic development will all be seriously affected.

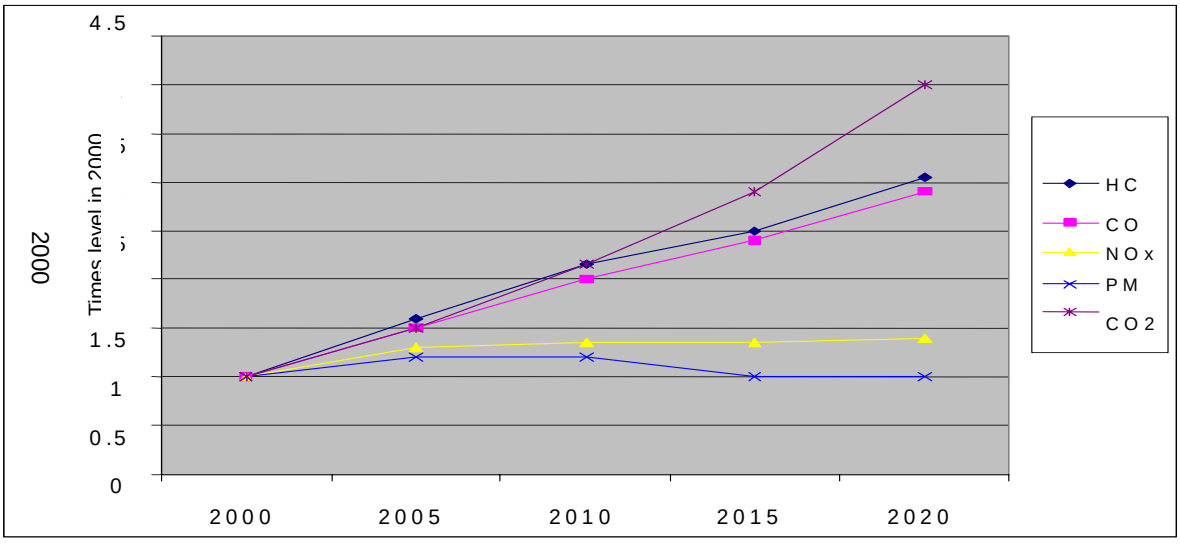

Figure 8: Predictions of Vehicle Emissions from 2000 to 2020

Source: Financial Policy to promote the sustainable transportation development in China

Policy Recommendations

A. For Sustainable Transport Energy Development

1). Establish Fuel Economy Standards for Motor Vehicles and promote new technologies

The fuel economy standards for commercial light trucks, heavy-duty vehicles, and motorcycles should be established as early as possible. Standards for steamships, trains, and other transport vehicles should be established as well.

Establish Mechanisms for Research, Industrialisation, Commercialisation, and Innovation for Advanced Vehicle Technologies. The focus of advanced technology development in China in the near future should be industrialisation/commercialisation of HEVs and, in the long term, on FCV and EV technology research and development.

Facilitate market entry mechanism for advanced vehicle technologies as quickly as possible so that marketing of advanced vehicle technologies can be ensured.

The government should make full use of policy measures to promote the demonstration, production, and the use of hybrid electric technologies in cars, passenger vehicles and trucks. Such policies should encourage the introduction of HEVs and encourage or require auto manufacturers to establish new vehicle assembly lines for HEV production.

Compulsory and incentive requirements should be established to encourage car manufacturers to provide HEV technologies to achieve energy efficiency levels in their vehicle products.

2) Formulate Policies to Encourage Use of Alternative Fuels

Make a comprehensive evaluation of product performance, oil saving potential, life-cycle environment, energy, and economic impacts of different alternative fuels to determine the potential of different alternative fuels on oil saving and environmental protection. Because coal is the main energy source in China, we should strengthen the analysis and evaluation of coal-based alternative fuels in particular by investigating environmental, energy, and economic impacts of coal-based methanol, DME, and coal-based liquid fuels in the near term.

3) Fiscal Polices

To set up fiscal and taxation policies such as vehicle and ship tax, insurance tax, and fuel tax, to help reduce use of vehicles and to increase use of energy efficient vehicles. The government should increase its investment in the research and development of energy resources to solve the problem of insufficient energy supply in China and to meet the demand for clean and efficient energy in achieving the goal of a well-off society in China. To provide governmental subsidies for use of clean alternative fuels. The government should offer certain subsidy to clean alternative fuels in terms of fiscal tax to assure that alternative fuels can be accepted by the market smoothly.

B. Policy Recommendations for Land saving in Transport

1). Rationalise Planning

Insist on resource-saving transportation development as the criterion for planning and implementation of all transportation development projects. The specific planning of resource saving and recycling including land, coastline and energy, etc., and circular economy development needs to be initialized and carried out. It is also imperative to accelerate the organisation, development and coordination of the planning of roads, ports and integrated transportation hubs.

2) Innovative Designing

Planning and design should give attention to the entire process of construction, operation and maintenance. The implementation of mandatory and recommended standards should be differentiated. It is necessary to utilise proper technical guidelines according to the situations and development demands of different regions and geographic areas. Properly using strip corridors and central controls can save lands and protect agriculture. Digging and filling should be carried out in a balanced manner, avoiding deep digging and large blocks.

3) Construction maintenance

Road construction should explore the maximum utilisation of existing road resources and avoid large-scale changes and rebuilding. The mechanism of land recovering and rebuilding should be implemented through such measures as: recultivating temporary used lands, rationally selecting fields to be used, reclaim abandoned lands, and so on. The principle of “deep water goes to deep, lower water goes to lower”, should be intensively used when constructing ports. Moreover, it is possible to begin to charge for using coastline resources.

C. Policy Recommendations for Transport Environment Protection

1.) Improving Pollution Control Level of Conventional Motor Vehicles

To deal with increasingly serious transport air pollution in cities, pollution control levels of conventional gasoline and diesel vehicles should be further improved. Rapid implementation of the strict standards on new vehicles will greatly reduce pollution by the Chinese transport sector.

2) Promoting Use of Clean Alternative Fuels

Some special vehicle types, such as buses and fleet vehicles, should be the first users of clean alternative fuels. Meanwhile, fuel production and vehicles technologies using clean alternative fuels should be constantly improved to promote the rapid development of alternative fuels in China.

3) Establishment of Enforcement Systems

Effective environmental certification and management systems need to be established. The inspection and maintenance system for motor vehicle emission control needs to be strengthened and effective centralised inspection administrative programs should be established.

4) Fiscal policy Recommendations for Sustainable Transport Environmental

development

Fiscal policies should be established to reflect the environmental impacts of different transport modes. That is, the external costs of different transport modes in terms of their environmental pollution should be reflected in the form of taxes or prices to ensure social equity and the most efficient and equitable allocation of transport resources. China should set up a tax reduction or exemption system for vehicles with low emissions and energy use. Meanwhile, it is suggested that environmental tax policy, tailored to Chinese conditions, should be formulated to control heavily polluting vehicles.

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