



Final Report

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March 2009

PRC: RESOURCE OPTIMIZATION IN THE ROAD SECTOR IN PRC Final Report (Volume I)

Prepared by China Academy of Transportation Sciences
For Ministry of Transport, PRC

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Asian Development Bank

GREEN TRANSPORT Resource Optimization

in the Road Sector in the People's Republic of China

Executive Summary



Asian Development Bank and
Ministry of Transport, People's Republic of China
Collaborative Project



Green Transport

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Foreword

The findings of an in-depth study financed by the Asian Development Bank (ADB) and implemented by the Ministry of Transport (MOT) of the People's Republic of China (PRC) on Resource Optimization in the Road Sector are being published as reference material for those interested in “green transport”. Green transport is a new concept: an initiative to support sustainable economic development without sacrificing the local and global environment. It aims to provide society with a transport system that leaves a smaller physical footprint, uses less energy, and produces less carbon dioxide (CO₂) and other harmful pollutants. Careful planning and sympathetic design are key elements in achieving this. They make it possible to decrease land use, especially farm land, increase energy efficiency through operational improvements, and reduce harmful pollutants by appropriate energy pricing and a socially responsible assessment of alternatives that includes environmental impacts in its economic analysis.

This publication and supporting documents record the results of 1½ years of collaboration between national consultants of the China Academy of Transportation Sciences and international consultants working under the guidance of staff of MOT and ADB. Members of this team worked closely to develop the framework for the study; carry out field surveys, investigations, research, and workshops; and prepare the reports. This intense consultation provided key guidance to the direction and content of the various report documents.

The final output includes an executive summary, a main report with analysis and policy recommendations, three guidelines, a handbook and a technical note. Representatives from MOT, Tsinghua University, Transport Planning and Research Institute, Research Institute of Highway, Anhui Provincial Communications Department (PCD), Henan PCD, Jiangsu PCD, Liaoning PCD, Shaanxi PCD, Xinjiang Autonomous Region PCD, Zhejiang PCD, Beijing Transport Committee, Chongqing Transport Committee, Shanghai Municipal Engineering Administration Bureau, World Bank, and ADB attended workshops held in Beijing, Chongqing, Hangzhou, Nanjing, Shanghai, Xi'an, and Manila and offered comments and suggestions. These were invaluable contributions that helped to ensure the high quality of the final documents.



Klaus Gerhaeusser
Director General
East Asia Department

Preface

This book is the outcome of the collaborative project for “Resource Optimization in the Road Sector” by ADB and MOT of PRC, indicating a continued round of exploration for PRC’s road sector in the energy saving and emission reduction.

The road sector is one of the fundamental pilot and service industries of the national economy, providing services for millions of users and playing an important role in the construction of a successful society. Along with the 30-year implementation of reform and opening-up policy, a great leap forward in development has been achieved in the road infrastructure in PRC. By the end of 2008, the total mileage of the road system reached 3.685 million km, including 60,000 km of expressway built over the past three decades. The improvement of the road system provided firm and substantial support to the rapid growth of social and economic development and the improvement of the living standards.

The PRC is currently in a critical period of developing a successful society in an all-around way while speeding up its socialist modernization. There are expectations and new requirements for the road sector not limited to the quantity of the service, but also the quality of its safety and convenience in continuous growth and sustainability of the development, to succeed in resource conservation and environmental protection. Based on recognition and exploration of the features of PRC’s transport development stage, to further scientific outlook on the development, MOT has set forth its transport development strategy to serve as a blueprint for national social and economic development, rural area development of socialism, and travel demand of the people through the use of modern scientific technology and management techniques to improve transport infrastructure and service operational efficiency in a resource conservative and environmentally friendly manner.

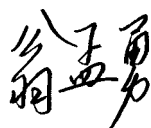
Given the limited land and energy resources, there are great pressures towards maximized resource usage in the road sector. To ensure resource conservation and environmentally friendly development, to use the resources and energy more effectively and efficiently, to enhance comprehensiveness, compatibility, and sustainability of development in the road sector, MOT and ADB jointly launched the TA study project “Resource Optimization in the Road Sector”.

The TA study project lasted a year and a half, with bold innovation and valuable exploration found in many shapes and forms, through incorporation of the relevant domestic study achievements and international experience, comprehensive field survey and workshops under the leadership of MOT and ADB with participants from transport department at different levels, were conducted with experts from relevant departments. In addition to the main report of the TA study project, three guidelines, a handbook and a technical note have been compiled.

The study's report put forth a "green transport" development concept, concentrated mainly in three key areas for the road sector resource optimization, i.e. energy resource saving and CO₂ emission reduction; preservation of land resources and road freight operational efficiency; set forth practical and operable policy recommendations, including the development of multi-modal transport system, the improvement of the road network structure, project decision-making, IT application in freight operations, standardization of the truck, strengthening of transport demand management, financing system innovation, and human resource development. The concept and the policy recommendations will facilitate further in-depth implementation of energy preservation and emission reduction strategies and policies, capable of providing important references and support to decision-making.

As the supplement to the main report, the three guidelines: Advanced Analysis in Road Project Feasibility Study and Environmental Impact Assessment for Energy Saving and CO₂ Reduction, Land-saving in Road Construction – Farmland Protection, Information System Development for Provincial Road Freight Transport Administration; the handbook: Awareness of Climate Change and Eco²-Transport; and the technical note: Options for Freight Terminal Development and Management; provide for the planning, construction, and management of departments of the road sector, as well as for drivers a summary of advanced experiences both at home and abroad, with informative and educational examples and data.

I am sure this publication will be of great significance in disseminating the green transport concept, to help the industry with more effective, efficient measures for resource conservation, emission reduction, and environmentally friendly development, while still facilitating the implementation of a scientific outlook on the development in the road and transport sectors.



Weng Mengyong
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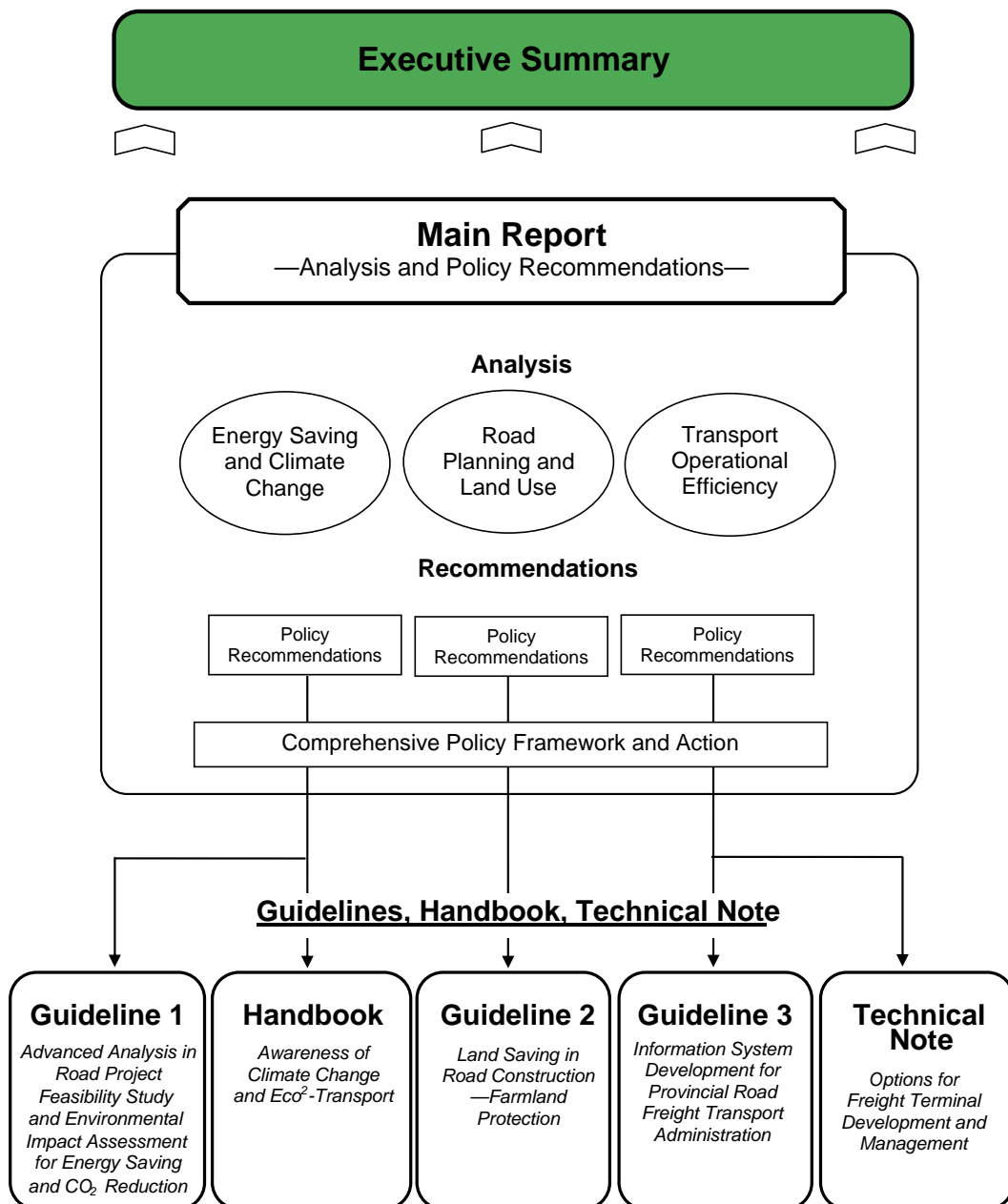
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Document Organization

This technical assistance report comprises a number of documents. It has been organized in a logical sequence that can be seen in the schematic view below.



Abbreviations

ADB	Asian Development Bank
CATS	China Academy of Transportation Sciences
CO ₂	carbon dioxide
EIA	environmental impact assessment
EU	European Union
GDP	gross domestic product
GHG	greenhouse gas
MOHURD	Ministry of Housing and Urban–Rural Development
MOLR	Ministry of Land and Resources
MOR	Ministry of Railways
MOT	Ministry of Transport
NDRC	National Development and Reform Commission
NHN	national highway network
PCD	provincial communications department
PPP	Public Private Partnership
PRC	People's Republic of China
PSB	Public Security Bureau
RTO	Road Transport Ordinance
TA	technical assistance

Currency Equivalents

(as of 14 November 2008)

Currency Unit	=	yuan (CNY)
CNY1.00	=	\$0.1464
\$1.00	=	CNY6.83

Weights and Measures

1 mile	=	1.6093 kilometers
1 gallon (United Kingdom)	=	4.5461 liters
1 gallon (United States)	=	3.7853 liters
1 mile per gallon (United States)	=	0.4250 kilometers per liter
1 liter of diesel	=	2.6300 kilogram (kg) carbon dioxide
1 kg gasoline (or diesel)	=	3.1723 kg carbon dioxide
1 kg coal equivalent	=	29,3076 kilojoules = 7,000 kilocalories
1 kg oil equivalent	=	41,868 kilojoules = 10,000 kilocalories
1 kg coal equivalent	=	0.7 kg oil equivalent
1 mu	=	0.0667 hectares

Introduction

Project Context

Purpose

The purpose of this report was to examine how the development of the road system in the People's Republic of China (PRC) affects the use of land, the use of energy, and the quality of the environment and whether more efficient management of the transport system could limit or reduce those impacts. The outcome of this report is a series of recommended policies and guidelines and a handbook to help better balance the needs of economic growth with the very valid concerns about the use of energy and scarce land resources, and the environmental consequences of that use. This report offers practical tools to help the central and local governments as well as transport operators and other road users turn policy into action.

At the outset, it should be noted that the PRC is a world leader in many of these areas. Much excellent work has already been done, both at the national and provincial levels, to make a coherent policy and take practical steps to limit the negative consequences of road development. Many of these steps have been codified as formal laws and regulations that offer a strong foundation for managing land use and environmental consequences of road development.¹

However, much remains to be done. This report is targeted at those remaining areas of need.

Project Background and Objectives

Road infrastructure has developed rapidly over the past 20 years. By the end of 2007, the length

of the PRC's highway network had surpassed 3.58 million kilometers (km), of which 53,900 km are expressways. The development of roads together with equally rapid growth of industry and urbanization has resulted in significant conversion of farmland into other uses. Concerned over the pace of that conversion—and the fact that the PRC's farmland per capita is only 42% of the world average—the Government has tightened the land administration policy with the objective of saving as much productive land as possible while not unreasonably limiting economic expansion.

The Ministry of Transport (MOT) challenge under this new policy is to be more vigilant over the use of land for highways. In response, MOT issued land-saving regulations² in 2004. Analysis indicates that the concerns regarding land-take have been identified and that measures have been put in place to ensure a reduced and better use of land for highways in the future. This report sees the need to refine this process and formalize it within the standard evaluation procedures.

With development, the PRC has become the world's second-largest oil consumer, changing from being an exporter of crude oil to importing a third of its fuel. The number of registered vehicles is projected to reach 170 million by 2020, with annual fuel consumption soaring to 200 million tons by that year. Long-term energy consumption and motor vehicle emission impacts have to be taken into account in the national socioeconomic development program.

Rapid economic growth also brings increased freight traffic. Logistical costs are higher in the PRC than in either Europe or in the United States,³ and to maintain competitiveness for

¹ The following are key laws and regulations: Air Pollution Control Law, Noise Pollution Prevention and Control Law, Water and Soil Conservation Law, Environment Protection Law, Environmental Impact Assessment Law, Energy Conservation Law, Land Administration Law, Road Transport Regulation, Regulations on the Protection of Basic Farmland, State Department Notice About Accelerating Saving and Intensive Use of Land, and Directive About Implementing the Strictest Farmland Protection System in Construction of Highways.

² Ministry of Communications. 2004. Notice 164. Directive About Implementing the Strictest Farmland Protection System in Construction of Highways.



PRC industry, the logistics of transport needs to improve. Freight transport in the PRC relies heavily on expressways, but expanding the expressway network is not the only way to increase the efficiency and reliability of freight transport. Supporting measures to increase efficiency in freight and passenger service can also help to bring the logistics costs down.

This Report

In this executive summary, the focus is primarily on the recommendations. The reader is referred to the main report and its annexes for a fuller discussion of the background to the recommendations and their justification. Recommendations are kept practical as much as possible and explain how they

can be implemented. When possible, particularly in the guidelines and the handbook, this points out where and how the specific recommendation is already being implemented by one or more provinces, and examples of the documents or forms used are provided.

In the following sections, a brief outline is given of the issues arising from the increased use of fossil fuel, the increase in greenhouse gases, the use of land, and the scarcity of productive farmland in the PRC. Ways to have increased efficiency in the operation of the transport system are identified to benefit the environment and conserve land.

³ The PRC Confederation of Logistics and Purchasing reports the logistics cost in the PRC as 18.2% of gross domestic product, compared with 9% in the United States, 10% in Europe, and 11% in Japan.

Energy Saving and Climate Change

Status and Challenges in Energy Consumption

The world scientific community recognizes that the earth is getting warmer. The International Panel on Climate Change reached consensus not only that the global climate is changing but that the change is occurring more rapidly than had been thought. Scientists now say that the average surface temperature on earth rose approximately 0.6 degrees Celsius (°C) during the 20th century. A temperature increase of more than 2° or 3°C is very likely after 2050.

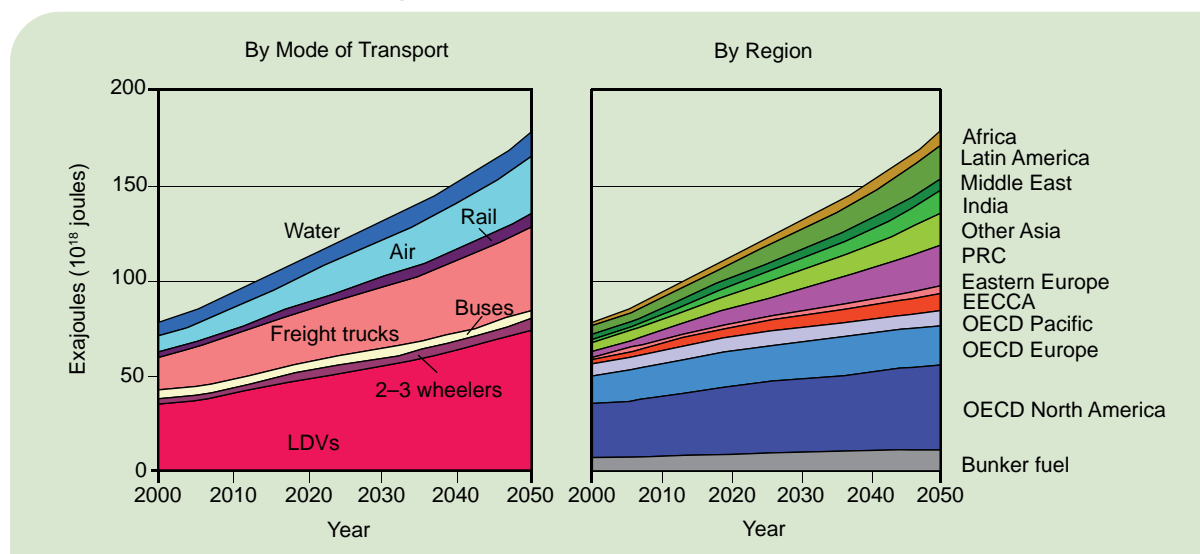
Rising carbon dioxide (CO₂) and other greenhouse gas (GHG) concentrations in the atmosphere, resulting largely from fossil fuel

combustion, contribute to higher global temperatures and changes in climate. Climate variability can cause abrupt disruptions such as floods, droughts, or tropical storms. These disruptions can take a major toll on a country's economy if a significant part of economic activity is sensitive to the weather and climate.

The People's Republic of China (PRC) will account for 42%–52% of the increase in energy-related CO₂ emissions between 2005 and 2030. It is generally agreed that in 2007 the PRC overtook the United States (US) as the world's biggest CO₂ emitter. Increased fossil fuel use is expected to boost annual PRC CO₂ emissions from 5.1 gigatons (Gt) today to 11.4 Gt in 2030.⁴

Although the PRC's transport sector's

Figure 1: Projection of Worldwide Transport Energy Consumption by Mode and Region



EECCA = Eastern Europe, Caucasus, and Central Asia region; LDV = light-duty vehicle; OECD = Organisation for Economic Co-operation and Development; PRC = People's Republic of China.

Source: International Panel on Climate Change Working Group III. 2007. The Fourth Assessment Report: Climate Change 2007—Mitigation of Climate Change.

⁴ 2.1 of the main report, Analysis and Policy Recommendations.

contribution to overall emissions is currently small (about 7% of domestic CO₂ compared with about 30% in the US⁵), the transport system is growing (Figure 1), especially in the urban areas, and is likely to become one of the important sources of CO₂ emissions and air pollution. Road transport in particular, therefore, is a target for policy initiatives intended to curb such emissions.

Available statistics do not permit calculating actual total vehicle fuel consumption in the PRC. There are no official statistics covering all road transport (urban, intercity, rural, agricultural, and military) and fuel used, since responsibility is with different agencies, and data collection and processing are not coordinated. Best available estimates from Tsinghua University show that national intercity commercial fuel consumption is increasing fast, especially diesel oil consumption. From 1999 to 2004, the total fuel consumption volume increased from 28 million tons (t) to 48 million t, an annual growth rate of 13.9%. The diesel oil consumption increased from 13 million t to 32 million t, an annual growth rate of 19.4%.

The PRC's rapid motorization is cause for global and domestic concern as attention focuses increasingly on limiting GHG emissions. The International Energy Agency estimates that CO₂ emissions from the PRC's cars and other light-duty vehicles totaled slightly less than 65 million t in 2005 but will almost triple by 2020. Six percent of all CO₂ emissions from cars worldwide will come from the PRC by mid-century if current trends continue.

The concern is even greater over the PRC's rapidly growing truck transport sector—currently 25% of the vehicle fleet—since it has proven extremely difficult to implement policies that would reduce consumption of diesel fuel, which is now highly subsidized, and use of the cheapest high-sulfur oils. This inaction makes it difficult to adopt more environmentally friendly fuel and engine standards for diesel trucks, currently responsible for more than 90% of the harmful air pollutants in large cities in the PRC and the high GHG emissions.

Without a change in policy, the total fuel consumption by on-road vehicles in the PRC can be expected to grow by 3.5 times over the next

30 years. Correspondingly, the CO₂ emissions can be expected to grow by 3.4 times. However, projections vary depending on the assumptions one makes. Adoption of new fuel and engine technology would affect consumption and emissions, as would a change in the economic growth rate or pursuit of new regimes for managing transport demands. What is clear is that policy is important. The lack of policy or continuance of the status quo is not sustainable.

The PRC is one of the most active among developing countries to adopt developed-country engine standards for maximum fuel use for cars and light vehicles—ahead of the US, Canada, and Australia in terms of fuel efficiency of cars. It is trying to close the time gap for implementing the much tougher European emission standards. However, following this up with stricter fuel quality standards, which are needed to allow the more fuel-efficient engines to function as intended, has been more of a challenge. This is particularly difficult for diesel-engine trucks, where engine standards still lag far behind those of the developed countries. The vehicles used in the PRC run on comparatively poor-quality diesel that emits several hundred times as much harmful pollutants (sulfur, nitrous oxide, and total suspended particulate) as those in developed countries.

Furthermore, while vehicle inspection and emission monitoring are well established in the PRC, drivers of both private cars and commercial trucks need to become much more skillful and educated about fuel efficiency behind the wheel.

Key Issues in Energy Saving and Environment Conservation

The following areas were identified as offering the most opportunity for improvement in setting the agenda and implementation procedures:

- Ensuring that road users face the full costs (including environmental externalities and congestion costs) of their choices to make a trip, and which mode to use. This is most effectively done by means of charges for road use in the form of differentiated fuel prices (to reflect differences in the environmental impact of fuels of various qualities) and congestion charges where appropriate.

⁵ World Bank. 2007. An Overview of China's Transport Sector 2007. EAST Working Paper No. 15.



- Expanding feasibility studies to include a calculation of the proposed project's energy-use consequences. This new information will then form the basis for calculating the associated change in GHG emissions (guideline 1).
- Bringing the road transport fleet into line with the most efficient fleets elsewhere in the world through the Government of the People's Republic of China's adoption and enforcement of engine technology standards and the associated fuel qualities required.
- Raising awareness of the issue of energy use and growing CO₂ emissions. This is a critical component in eco-driver training programs that have been shown in other countries to significantly reduce energy use. Other energy sensitivity training is needed for design institutes and for provincial and municipal planners.
- Managing transport demands by developing a vehicle quota system, pricing restrictions on congested areas, differential licensing fees, parking fees, and fuel taxation. These can all have a significant impact on energy use and GHG emissions in urban areas.
- Expanding the public transport system to continue to provide a high quality of local service at lower pollution and energy consumption levels.

These issues are addressed and discussed in more detail in the policy analysis in section 5 on page 15.

Road Planning and Land Use

Status and Challenges in Land Use

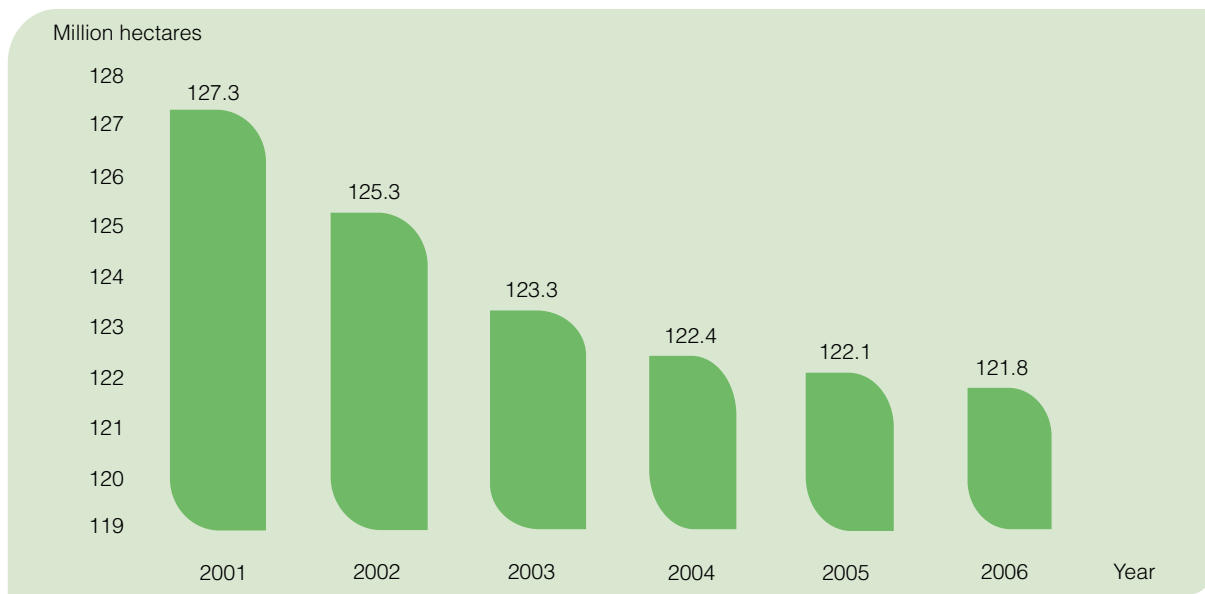
Economic growth and development in recent years of the People's Republic of China (PRC) have led to an increasing demand for the construction of new roads, resulting in the loss of productive agricultural land, particularly in the more developed eastern and central regions of the country. Recent shortfalls in food supply and associated increases in food prices underscore the impact of the chronic shortage of productive agricultural land (Figure 2). The pressure for production of biofuels will only exacerbate the problem.

The rapid expansion of the road network from 1995 to 2006 consumed large amounts of land. Since 2001, new highway construction used about 150,000 hectares (ha) of land per year, including about 70,000 ha of cultivated land. Expressway construction accounted for about 32% of the total land taken and about 45% of the cultivated land.

However, the expansion of the road network is essential for the social and economic development of the country, providing accessibility, mobility, and connectivity. Further expansion and development of the network over the coming years will be required to accommodate the expected growth in traffic demand.

On the one hand, the PRC should be equipped with an advanced highway network to support economic development, which will inevitably consume land resources; on the other hand, land resources are decreasing constantly, and farmland in particular should be protected wherever possible. To ensure effective and intensive use of scarce land resources—especially cultivated land—the PRC's land protection policy has been strengthened and more strictly applied since 2004. The Land Administration Law and the Regulations on the Protection of Basic Farmland are the key foundation laws for the PRC's land administration system. The production of a detailed land analysis report as required by the

Figure 2: Amount of Cultivated Land in the People's Republic of China



Source: MOLR, Communiqué on Land and Resources of China.

Department of Land Resources is now a key component of all major project evaluations.

There is a welcome recognition within the Ministry of Transport (MOT) that land must be conserved. Approximately 30 demonstration projects have been supported in various provinces to examine how land-saving measures can be incorporated into a project's planning, feasibility studies, and design, and determine what impact that will have on both the need for land and the cost of the project.

National policy level. The first group of issues is directed primarily at the central government and falls within the purview of the newly created and enlarged MOT. The new ministry has the potential capability to coordinate policies for different modes of transport and develop strategies that encourage the most efficient and effective allocation between the key competing modes, particularly for longer-distance (and bulk) movements of passengers and freight. These measures will produce efficiencies in transport, which will be reflected in reduced volumes of road traffic that lead to fuel savings, lower emissions, and reductions in land-take requirements.

Improvements in the planning and management of the national road network will also make transport more efficient and, ultimately, reduce the need to use more land for new road construction. In particular, the designation of a core network of strategic interprovincial routes—based on the 7-9-18 National Expressway Network⁶—will allow for improved coordination and integration across the country and the application of a unified system of controls, regulations, and toll charges. This network should become the responsibility of the central government in regard to standards, improvements, and funding.

The amount of land consumed by new road construction has become a major concern to government, resulting in the adoption of strict regulations regarding the area required for individual projects. The production of a detailed land analysis report as required by the Department of Land Resources should form a key component

of all evaluations for project appraisers. The current practice of using standard indicators for the amount of land used per kilometer of new road should be replaced by procedures that encourage land conservation and optimization.

Designers also have a significant impact on how land is used. For instance, designing a road that runs through the middle of a paddy field rather than along the edge will disrupt drainage and water movement and thus reduce the efficiency of the land. A minor change in alignment would yield a large savings in land use.

Project-level design and construction. The second group of issues relating to individual projects focuses on opportunities to conserve land, or minimize land-take, through project development and design. Key to this activity is the existing feasibility study process and associated economic evaluation, which should be expanded and developed to reflect more comprehensively the full range of options. Specifically, the evaluation should be expanded to include a full assessment of the “business-as-usual” or do-minimum scenario, against which the other options should be evaluated, including consideration of upgrading the existing network rather than constructing a new road. These alternatives are likely to have significantly different land-take implications and could result in substantial conservation of land.

Coupled with these evaluations, and to ensure that the value of the land consumed is fully incorporated in the assessment, this report recommends that a realistic market value is used to reflect the scarcity value of different types of land. In this way, productive farmland that is in short supply may be ranked more highly than grassland or forestland. This approach, if applied to alternative alignments, will ensure that preference is given to routes that minimize the impact on high-value farmland and are located on more marginal land. Options involving the use or upgrading of existing roads will also be favored, as the land requirements will be less.

The MOT has conducted a number of demonstration projects to assess the potential land

⁶ The network will be formed by 7 lines emanating from Beijing, 9 running through the country north to south, and 18 going east to west. It will cover an area with a population of 1 billion and connect all towns and cities with populations above 200,000. It will also link all major transport hubs for aviation, railway, shipping, automobiles, and trucks. Asia Times Online. 2006, 9 Aug. China's many roads to prosperity. Available: www.atimes.com/atimes/China_Business/HH09Cb02.html



savings to be achieved from a series of relatively minor adjustments to the current design standards or changes in design philosophy. The design standard changes included reductions to lane, shoulder, and median widths; revised drainage layouts; and steeper cut and fill slopes. Many of these modifications may have a detrimental effect on road capacity. The technical assistance therefore warns against a wholesale reduction in standards, especially since such changes may severely restrict the future capability to upgrade or widen the road on the existing alignment—resulting ultimately in a greater land loss. Further, those design changes may in many cases make the road less safe. Reduction of clearance to the edge of the right-of-way and use of rectangular rather than trapezoidal drains are two examples that should be used only in severe cases. New design approaches that replace high embankments with structures and deep cuts with tunnels, and the adoption of alignments on higher marginal land, are supported.

Operation and management. The third and final group of issues is directed at maximizing the capacity of existing (or newly built) roads so as to defer the need for further new road construction and thus reduce the amount of land taken. The techniques available include conventional traffic management measures (road markings, segregation of vehicle types, junction improvements, signalization, access control, etc.), plus more advanced systems involving variable speed limits, lane control, and automatic toll collection. These measures will all allow a greater volume of traffic and more efficient and intensive use of the existing highway infrastructure.

A central element of any integrated transport policy involves the support and promotion of public transport in preference to the use of individual private cars, as buses are inherently more efficient in terms of road space occupied and passengers carried (as well as energy consumed). The central

government recognizes this and actively promotes the use of public transport services—both bus and rail—although very few measures to curb the ownership or use of private cars have been implemented. This technical assistance supports the further development of public transport in urban and rural areas with the specific objective of restraining the growth in private vehicle ownership and thus the demand and pressure for new road construction.

One further measure available to increase the capacity and efficiency of the existing (and future) road network would be the progressive improvement of standards of driver discipline and behavior. Specifically, the adoption of stricter lane discipline, restrictions on heavy goods vehicles, enforcement of speed limits, and the creation of a more courteous and considerate driving culture will all increase the capacity and safety of existing highways and reduce the need for new construction.

In reflect of most of these recommendations, the PRC is reasonably well advanced and has legislation or procedures in place (e.g., the explicit treatment of land costs and land-take). The main area for improvement is in the implementation of the procedures, including specifically the rigorous application of the detailed processes for evaluating alternatives in the feasibility study analysis.

Key Issues in Land Conservation

The key issues that emerge from this analysis are as follows:

- The way the PRC's transport system has developed has had a significant impact on land use. The slow growth of railways and waterways is especially significant. It has led to overdependence on highways, which are

often used inappropriately because of lack of alternatives.

- The implementation of the 7-9-18 network has not been well coordinated in terms of standards, timing, and prioritization. Individual provinces have pursued their own agendas and priorities—generally focusing on roads serving the provincial capital—with little regard for the overall strategic function of particular routes. Some longer-distance connections between provinces have not been completed in a timely manner, resulting in dead-end roads. This restricts the service capacity of the network, reduces the road functions and road network efficiency, and causes a low utilization of land resources.
- Current feasibility study reports use as a shadow price the “original purpose of land,” not the “best alternative purpose.” This does not show the true value of the land and does not then encourage intensive land use. The real cost of land taken should be reflected in the feasibility study.
- Some provinces have conserved land by implementing flexible designs such as reducing embankment height and replacing high-fill roadbeds and deep-dug road cuts with bridges and tunnels. Flexible designs should be encouraged where they do not compromise safety.
- The application of information technology greatly enhances the serviceability of the existing road network and indirectly saves land resources.

Details of the policy initiatives recommended to address these issues are outlined in section 5.

Freight Transport Operational Efficiency

Status and Challenges

This is the third of the three components of this technical assistance (TA) project and deals with the operational link between the issues of land use, energy use, and environmental impact. Clearly, more efficient use of the existing roadway system is attractive. Similarly, more efficient operation of the nation's fleet will show benefits, both in profitability of the fleet operators and in reducing network demand, cost, and environmental impact of transport service providers. However, in some cases, the goal of increased transport efficiency is contrary to the goal of reduced land use. A less dense network will reduce land use, but a less dense network will increase the unit cost of transport. So ultimately, this analysis is about trade-offs between increased efficiency on the one hand and leaving a smaller land-use footprint on the other.

Rapid economic growth also brings increased freight traffic. Highway freight traffic is increasing at almost the same rate as the gross domestic product (GDP) growth, or about 10% per annum from 2003 to 2006. Logistical costs (transport, warehousing, administration, and inventory) are much higher in PRC than in other countries; the PRC Confederation of Logistics and Purchasing reports that logistics cost 18.2% of GDP compared with 9.0% in the United States (US), 10.0% in Europe, and 11.0% in Japan.

The regular collection and analysis of data is essential for monitoring, evaluating, and managing the transport system. The PRC maintains extensive data files on the extent and condition of the infrastructure, but less information on vehicles and fleet operations. Road transport performance statistics are limited to the volume of intercity

transport, the number of vehicles, the number of for-hire carriers, etc. They do not show revenues, expenditures, or price indexes. Normally, GDP data for transport, telecommunications, and warehousing are lumped together, accounting for about 6% of GDP activity. Although the Ministry of Communications⁷ publishes a statistical digest every year, its statistics yearbook, which contains more detailed data, is still confidential and not available to the public. The Government Information Disclosure Ordinance issued by the State Council in 2007 and effective on 1 May 2008 is a significant step toward a more open system of public institutions.

Under the market economic system, road transport transactions take place not only between the carriers and users but also between and among different carriers and operators or market players. All these players will have a role in eventual energy savings and emission reductions. It's important that the market provides them with environmentally friendly choices and that the public interest be protected by the application of both mandatory and voluntary standards.

The focus of this component is on freight transport. The road freight market is extremely fragmented and lacks effective measures for quality control of trucks and truck operators. The Government has realized the negative effects of this on operational efficiency and has set forth some policy measures to deal with them. This section looks at the key issues affecting road freight and proposes policy recommendations, action plans, and a guideline.

The target of the current work is to determine how the PRC can improve the efficiency of freight transport management using the expanding road network. This work flows directly from the work

⁷ The Ministry of Communications was changed to the Ministry of Transport in 2007 through the consolidation of a number of transport-related ministries.

done in previous ADB TA, which considered policy reform in road transport.⁸

Network Effects

Warehousing and freight transport services can be optimized by placing the warehouses at nodes in the network that create the most efficient distribution patterns for the companies involved. National companies will look to national route optimization, and provincial companies may look to provincial optimization. However, the current structure of ownership of the expressways, tolling policy, and toll costs limit the degree of improvement that can result from these changes. This topic has been considered in a number of other projects, some commissioned by ADB and some by the World Bank.⁹

Those projects noted that the current configuration of toll roads—following generally the structure of one road, one company—results in inefficient toll collection and, in some provinces, different toll collection systems. To combat this problem, a number of provinces have instituted their own tolling systems, which are applied province-wide. These include common tolling, which is then distributed to the various companies in the province; network systems, as used in Guangdong; and weight-based systems as used in about 20 provinces. Many of these approaches offer significant benefits to the intraprovincial traffic and help to improve operational efficiency, but they fail to address the issue of efficiency of long-distance movements that cross many provincial boundaries.

Standardized Fleets and Fleet Operations

While this area is very much in flux, it is clear that there is currently very little standardization in the sizes of vehicles, pallets used in warehouses, and equipment used to handle the freight in the vehicles. This leads to inefficient operations and lost productivity. Further, the structure of the fleets does not appear to be evolving in a way that

would optimize operations. Fleet structure is very fragmented and tends to be dominated by smaller owner-operated vehicles. These vehicles rely heavily on overloading for profitability. The need to overload in turn biases many things, including the design of the trucks, their registration, the mode of operation, and the style of ownership. In most other countries, fleet operations improve by balancing the efficiency of owner-operated vehicles with for-hire operations and assessing the trade-off value of ownership of trailers and ownership of trucks. These efficiencies have not yet fully developed in the PRC.

Terminal Operations

Terminal operation has a large impact both within the road transport industry and across modes of transport. In the developed countries, an efficient intermodal structure for freight movement has developed that combines the efficiency of rail freight—particularly the use of containerization—with the logistical distribution efficiency of trucks. While single-mode terminals are becoming common in the PRC, intermodal terminals are still rare. The Government has recently recognized terminal operations as a critical element in the logistics chain by initiating a program of support for 179 new terminals in most of the major cities of the PRC. While 45 terminals have been started, in many cases only the passenger part of the terminal is complete and the freight portion has yet to be finished. This leaves 134 terminals yet to be developed. A recent national logistics survey notes that in the existing 50 logistics parks, the idle rate is greater than 60%.¹⁰ This clearly points to a lack of focus and usefulness in the logistics parks.

Stakeholder Awareness

All the concerns mentioned need to be addressed by each of the stakeholders involved in improving road transport management. Stakeholders need to be accountable for their performance, aiming for constant improvement of the institutional and regulatory system and following best practices.

⁸ ADB and the PRC's Ministry of Communications. 2007. Policy Reform in Road Transport.

⁹ World Bank. 2006. People's Republic of China: China Expressway Retrospective Study, Analytical and Advisory Activity Report; ADB and the PRC's State Development Planning Commission. 2003. The New Frontier, Investing in Toll Roads.

¹⁰ The PRC Confederation of Logistics and Purchasing, National Statistics Bureau. 2007. National Major Enterprise Logistics Survey.



Key Issues in Freight Transport Operational Efficiency

The key areas for attention are

- collection, dissemination, and use of road transport data for monitoring the market and evaluating and managing the transport system;
- training and improved awareness of best-practice standards throughout the industry;
- development and implementation of a national highway network standard;
- increased focus on the development of a more standardized fleet and related standards for terminals and goods handling within terminals; and
- accelerated approach to development of improved intermodal terminals including the use of innovative financing such as public-private partnerships in terminal development and operation.

Comprehensive Policy Framework and Action

A number of good policies already exist and need only systematic application, but in other cases, very high-level and significant policy changes are needed to achieve the targets set for this project. In the main study report, eight major policy initiatives that will make a significant impact on the operational efficiency, land take, and environmental consequences of further developments to the road transport system are laid out. The critical policy initiatives are as follows:

- 1. Comprehensive transport.** Improve overall transport and land-use efficiency through the adoption of an integrated and comprehensive approach to planning within the Ministry of Transport (MOT), so that solutions involving alternative modes are considered, network options including expanding existing facilities are given prominence, maximum use is made of the existing network, and a full costing of the land taken is incorporated in the evaluation procedures.
- 2. Road network structure.** Move gradually toward designation of a national highway system that includes the key corridors as a subset of the 7-9-18 network and begins to establish standards and operating systems, including integrated toll systems, on those routes that lead to efficient network operations in the longer term. Establish appropriate design standards for each class of highway that minimize land take, commensurate with traffic requirements (now and in the future) and road safety.
- 3. Project development and design.** Ensure that the current excellent guideline from the National Development and Reform Commission (NDRC) and Ministry of Communications that calls for including the shadow cost of land in all new road feasibility studies is followed carefully. This will ensure that land is a key component of all investment decisions and

that the trade-off of land value against the need for economic growth will be explicitly recognized. Require that all feasibility studies explicitly consider options involving the use of existing facilities, with minimal land take. Ensure that road user charges reflect the scarcity of the resources used and the environmental externalities that result from their use. As an integral part of this, include a new chapter in feasibility studies that calculates the energy-change impacts of proposed road projects. Similarly, in the environmental impact assessment (EIA), include explicit calculation of the change in greenhouse gas (GHG) emissions the project would cause. Thirty model projects emphasizing land conservation and environmental protection have been supported by MOT since 2004. These have successfully minimized land-take in their design and construction by adjusting engineering standards to the local conditions. MOT should use these experiences to amend the technical standards for highway projects.

- 4. Information technology and fee collection.** Application of information technology to the national road freight transport administration system could allow for identification and tracking of vehicles across provincial boundaries and enforcement of regulations. National standards should be developed for vehicle registration fees, road maintenance charges, and vehicle insurance that would all encourage the development of modern fleets that use a drag-and-drop operating model.
- 5. Vehicle standards.** New standards for vehicles and their operation need to be developed and included in the Road Transport Ordinance (RTO). The PRC should adopt and enforce efficient-engine technology standards and the associated fuel qualities required to bring its vehicles in line with the most efficient fleets in the world. This change would include strict



guidelines for manufacturers, licensing issuing bodies, operators, and enforcement officials to assist with implementation of an information technology system to manage the fleet.

6. Managing demand. The impact of managing transport demand cannot be overstated. While this project did not consider in detail urban transport, this is a fertile area where any steps to improve the management of demand will pay dividends in energy savings, fewer environmental impacts, and efficiency in operations. MOT and the Ministry of Housing and Urban–Rural Development (MOHURD) are urged to focus on the management of transport demands, support for improved public transit systems, and measures to improve the operating efficiency in urban road systems.

7. Innovative financing. Investment by the private sector in road transport infrastructure, particularly those aspects related to logistics, intermodal freight transfer, and passenger interchange, should be encouraged and supported where appropriate. Only if no credible private investors are available to provide the terminals and operating systems

needed by the logistics industry should the Government become involved. The private sector has proven itself to be very responsive and efficient, and that source of improved efficiency should be encouraged.

8. Education. For the industry to accept and support new policies, training will be needed to change the mind-set of the operators. The human element is the most important in the drive for transport efficiency.

Policy: Develop a Comprehensive Transport Planning Approach at National, Provincial, and Local Government Levels

The creation of the MOT clearly indicates the intention of the Government of the People's Republic of China (PRC) to improve coordination and planning among the various modes of transport. The Comprehensive Transport Promotion Law is being drafted by the NDRC to guide future planning initiatives. Planning of the

road network links should carefully consider the following aspects:

- The mode of transport chosen may have a large impact on land-take and the environment. The aim should be to reduce the social cost of the movement of goods and people.
- The density of the network should be matched with the demand. Where expansion of existing roads is a viable response to the estimated demand, that option should be given priority.
- During network planning, agencies should work together to balance the economic benefits with environment and social impacts at a policy and strategic level. A strategic impact analysis should be conducted with the participation of all relevant government agencies (for example, the transport sector, the Land Use Department, the Water Resource Department, the Forest Bureau, the Environment Protection Bureau, and the Agriculture Department). Currently, a land-saving analysis report is required for each major national road project. This should be expanded in line with the proposed revised guidelines for feasibility studies and EIAs to include not only land but also energy, the environment, and alternative modes.
- Where possible, more intensive use of the existing high-capacity road should be considered. In some cases, a smaller facility may be appropriate.
- In the less-developed western or northern regions, consideration should be given to the construction of lower-standard, expressway class roads, with possible allowance for expansion in the future when demand increases.
- In the coastal region or close to the major cities, consideration should be given to the provision of sufficient additional land within the right-of-way to accommodate widening of the road or the construction of additional parallel express lanes to meet the expected increases in demand.
- Integration of planning of network hubs is a priority. Ensuring connections between transport modes at key hubs, particularly between road and rail, will improve service significantly.

Where possible, those hubs may also connect to ports and inland water terminals.

International Experience

The Intermodal Surface Transportation Efficiency Act of 1991 was a major milestone for the United States' (US) combined-transport policies. It recognized the significance of linking the country's ports, railways, highway freight yards, airports, and public transport stations to the country's highway system, and stated that those connections should be encouraged. In May 1996, the US Department of Transport produced a list of through-transport lines totaling over 2,000 kilometers (km), selected by the state departments of transport and urban planning organizations, that link 616 combination freight yards and 99 cargo and passenger airports.

The European Union (EU) has established programs like "smart European combination transport" to develop and help implement a common standard and specification for stations and yards that bring different modes of transport together. These include those of railways, highways, and sea and inland river transport. Such standardization is aimed at accelerating a higher operating efficiency by means of shared information and innovative technological development.

In national comprehensive development planning, emphasis is on developing a comprehensive high-speed traffic network to improve efficiency of land use, especially the joint of different traffic modes such as high-speed railway, freeway, port, and airport.

Impact on Energy and Environment

Ensuring that different modes of transport are considered in the evaluation of major investment decisions together with energy use and environmental consequences will help balance energy and environmental concerns with development needs. The best overall options should result from that consideration. While this area does not deal with the specifics of energy use and environmental impact, the strategic choices made in some ways are the critical ones, and those choices drive much of the remainder of the impact assessment.

Impact on Land Use

The choice of the most appropriate mode may affect land use since roads require 3.5 times the land needed by rail to provide the same capacity. Similarly, expansion of an existing road will reduce land demand by many hectares per kilometer compared with the land required by an entirely new alignment. Proper network planning is therefore critical.

In some cases, while providing additional land for future expansion may take more land initially, the longer-term benefits can be substantial as the need for the construction of a new parallel facility may be avoided. Experience from developed countries has shown short-term savings to be counterproductive in the longer term, as the cost of rectifying the initial decision—especially in regard to the taking of land—can be very high.

At a broader level, the transport sector may cause additional loss of land by moving toward greater use of biofuels. Raising crops for fuel may exacerbate food shortages and lead to price increases.

Impact on Freight Transport Operations

Comprehensive transport planning requires consideration of how to link modes together in a seamless way, how to create terminals in locations that support intermodal linkage, and how to ensure that the different modes are using pricing based on real costs. As a consequence, shippers are able to choose the most cost-effective means of moving their goods, and this in turn should lead to the best socially responsible outcome.

Policy Implementation

Creation of MOT indicates the Government's interest both in improving the coordination of the delivery of transport capacity and service and in being more socially aware in that delivery—considering the full consequences of the choices of where and how to create transport infrastructure. This means that other departments not necessarily directly involved in transport also have a major say in how the network is developed

and operated. Those other departments include those overseeing land, energy, environment, public security, and local government.

A number of practical steps can be taken to assist in that integration, some of which are under way (Table 1):

- Preparing and passing a new comprehensive transport law to give guidance to MOT and other agencies on how to ensure that the transport system develops and is operated in a comprehensive way. This law is under preparation and is likely to be presented to State Council for consideration within 2 years.¹¹
- Incorporating the principles of the proposed law. While the law is unlikely to be passed until 2011 or 2012, the principles on which it is based can be incorporated now into the planning process. This can be done by establishment of strategic and comprehensive planning committees within MOT and between MOT, Ministry of Railways (MOR), and NDRC and, where necessary, other affected ministries or agencies.
- Developing a similar coordinating committee structure for project review at the provincial level and, in the future, at the municipal level.

Policy: Optimize Road Network Structure

The longer-term efficiency of the PRC's high-capacity highway system depends on smooth, unimpeded flow of traffic throughout the network. This means that the system must become simpler to use and more consistent from province to province. In turn, that means that differences between provinces need to diminish. The national highway network (NHN) should be a subset of the 7-9-18 National Expressway Network but would be designated as serving the national interest, and national standards would apply to all roads in that network. The argument for a national designated highway network revolves around a number of very important issues:

National security. The national high-capacity

¹¹ Comprehensive Transport Promotion Law, sponsored by NDRC.

Table 1: Action Plan to Develop Comprehensive Transport

No.	Action	By Whom	Comment	Related Actions
1	Establish the Comprehensive Transport Promotion Law to guide future comprehensive planning initiatives.	NDRC	Members to include MOT, MOR, and representatives of the transport industry	
2	179 highway transport hubs can be integrated with railway and where practical with airport and port links as comprehensive passenger and freight terminals.	MOT	Members to include NDRC, MOR	
3	Establish comprehensive planning committee within MOT, MOR, NDRC, and other ministries to coordinate project planning.	MOT, MOR, NDRC	The creation of MOT makes such a committee more viable. The current approach is fragmented, and increased coordination is needed.	
4	Encourage development of comprehensive planning committees at provincial and municipal levels.	PCD, NDRC	Much of the practical development of projects takes place at provincial or municipal level. Coordination of planning is also important at those levels.	
5	Allocate sufficient land in a location that balances the need for road access with the need for efficient intermodal operations	PCDs or municipality		2

MOR = Ministry of Railways, MOT = Ministry of Transport, NDRC = National Development and Reform Commission, PCD = provincial communications department.

road network is a PRC strategic resource. To move large numbers of equipment or people in times of strategic concern, the network must be in good condition. This means that the network, including critical bridges, must be designed to a high standard and be well maintained in excellent to good condition at all times. Under the current system, each provincial communications department (PCD) makes critical decisions on the minimum safe condition of the network with no national operating or management standards or assurance that the money needed for that level of maintenance is available.

Emergency preparedness. The snow emergency of 2008 indicated the weakness of the current organizational structure for management of the national road network. Equipment that was needed by one province was located in another province, and no structure existed for pooling of equipment such as snow plows or blowers. The recent national disaster caused

by the earthquake in Sichuan also highlights the need to keep a strategic supply of emergency equipment pooled for use by the nation in times of need. As the climate becomes more variable and the population continues to grow, there will inevitably be cases where rapid response and movement of equipment and resources from one area of the country to the other will be a national priority. The NHN would very much support those requirements.

Operational efficiency. The rapid increase in road capacity over the past 15 years has had limited impact on the 55% of logistics expenses that result from line-haul transport. The future reduction of logistics cost and improvement in efficiency will rely on more effective and rational use of the high-capacity system. One of the impediments to this is the existence of missing links, or dead-end roads. These gaps in the network have the effect of removing the high-capacity roads leading to them from the national

network since they are not connected. This is a high priority for network improvement.

Authority and structure. The national government retains the authority to amend the 1997 Highway Law (the basis for the devolution of responsibility for the road sector to the provinces, counties, and townships), or to add regulations to it. Further, the promulgation of the Toll Road Regulations in 2004 showed how MOT can issue regulations related to the smooth functioning of the national expressway network.

The NHN would include the following:

- standard toll setting and pricing using the same system throughout the network;
- pooling of revenue and costs were appropriate to ensure that operating and maintenance cost on the complete NHN is assured;
- graduated tolling that recognizes the incremental road damage inflicted on the roadway by the loading of the heavy goods vehicles;
- strict enforcement of vehicle standards including loading, dimensions, safety equipment, licensing, and environmental and emission standards;
- stronger pavement design standards on key high-density corridors to limit long-term pavement damage from heavy vehicle traffic;
- data transferability on road condition, operating conditions, and emergency response needs; and
- standard emergency response systems and coordinated equipment supply that can move equipment to the areas of highest need from the reserve depots.

International Experience

The United States Interstate Highway System for which the US Department of Transportation has established national standards in some areas of operation is similar in concept to the proposed NHN.¹² In Europe, the European Community has

outlined a European road network with common standards, ensuring that the overall network is both comprehensive and links all major centers.

Impact on Energy and Environment

A more efficient and effective national network will generate significant operational benefits, in particular in the movement of freight. The aim is to restructure the freight forwarding and management business over the next few years to allow companies to optimize their distribution process and, thereby, reduce logistics cost. This in turn will reduce energy consumption, a major contributor to logistics cost.

Further, the requirement that vehicles using the NHN be carefully inspected, properly registered, and adhere to the high national standard for energy and environmental compliance will also help set a precedent for other parts of the network. This, over time, will have a significant impact on the style and type of vehicle used, and ensure that the energy and environmental impact of those heavy vehicles is minimized.

However, current fuel price regulations prevent the achievement of such energy efficiency and environmental improvement targets in road transport since fuel-efficient vehicles with new technology engines require clean fuels that PRC refineries find unprofitable to produce.

Impact on Land Use

As with the energy and environmental impact, the establishment of an NHN with clear common standards and strict adherence to vehicle and operating standards will improve efficiency. An efficient roadway system is also efficient in its use of land. The high-capacity, targeted corridors will allow for relocation of distribution centers, reduce the vehicle kilometers of travel, and, thereby, increase the efficiency of the system; the higher efficiency will better handle demand and reduce the need for additional capacity.

Along with the establishment of the NHN with consistent and uniform standards, appropriate design standards for lower classes of road should be developed that minimize land-take

¹² The United States Federal Highway Administration sets standards for vehicle operation and safety as a guide to which the states must adhere. Failure to adhere to the national standards leads to loss of part of the national funding for roads directed to the state in the subsequent year. This includes inspection and monitoring of freight operations.

while recognizing the need to retain flexibility for future widening or upgrading within the existing right-of-way and maintain safety standards. Measures should also be introduced to optimize the capacity and use of existing roads through improved traffic management (including “smart” traffic control), increased use of public transport, and improved driver behavior and discipline. In this way, the demand and pressure for new road construction can be deferred (or removed) and losses of agricultural land minimized.

Impact on Freight Transport Operations

As noted above, an NHN will have a number of important impacts on freight operations. It will

- stimulate restructuring of the national distribution chain;
- help to reduce logistics costs;
- ensure that vehicle standards are enforced and provide a working guide for vehicle inspection for loading, safety, and environmental standards;
- ensure high-quality sustainable roads through the NHN corridors by ensuring that operating and maintenance costs are covered by revenue and that the physical condition of the roads is

very good; and

- efficiently handle environmental or safety burdens, such as the heavy snowfall in 2008, by establishing an emergency response system with emergency and safety equipment available to the overall network.

Policy Implementation

Designation of an NHN will require issuance of a new regulation by MOT. That regulation can follow the pattern of the 2004 Toll Road Regulations, or it can be a simple amendment to that regulation. The NHN can take a number of institutional forms, including

- MOT assuming full responsibility for those routes;
- MOT establishing operating, technical, and toll setting standards to which all companies within those designated corridors have to abide; or
- MOT supporting amalgamation of the current operating companies under one interprovincial corporation through each corridor.

Further work will be needed by MOT to develop a viable action plan, but this will be a major strategic initiative (Table 2).

Table 2: Action Plan to Optimize Road Network Structure

No.	Action	By Whom	Comment	Related Actions
1	Review 7-9-18 system and identify the key long-distance routes in that system.	MOT	Members to include MOT, NDRC	
2	Review legislation and regulation to determine practicality of setting up a national highway network.	MOT, NDRC	Members to include MOT, MOLR, and NDRC	1
3	Create action plan for setting standards, revenue and cost sharing, tolling, vehicle inspection, emergency response systems, and national security considerations.	MOT	Members to include MOT, NDRC	1, 2
4	Improve interprovince linkage and dead-end roads by transferring national budget as needed.	MOT	Members to include PCDs, MOF	

MOF = Ministry of Finance, MOLR = Ministry of Land and Resources, MOT = Ministry of Transport, NDRC = National Development and Reform Commission, PCD = provincial communications department.

Policy: Improve Project Development and Design

Land cost, energy cost, and environmental consequences should be incorporated fully in the feasibility study of road transport investment options, and full consideration should be given to land conservation in highway design. Probably the greatest opportunity for land saving in conjunction with new road construction (or upgrading) comes at the feasibility stage of individual projects. An analysis of land taken and land cost should be formally included in the process so that the relative impact of the various options may be explicitly determined. There is a difference between the economic cost of land and the price to be paid to acquire the land. The feasibility study should consider the economic cost of the land as specified in the NDRC Economic Analysis Guidelines—that is, the relative value of the land to the community. If no significant cost of land is included in the feasibility study, often the result is a new road constructed exactly parallel to an existing road.

The land-take (and cost) implications of a do-minimum solution, such as expansion of an existing alignment to four lanes, may require significantly less land with substantial comparative savings over a new alignment. Although the ultimate capacity and design standards may not be exactly the same, it is conceivable in certain circumstances that 80% of the potential benefits may be achieved for 20% of the capital costs and land-take.

The same argument can be made for incorporating full energy costing in the feasibility study, and GHG emissions along with other environmental issues in the EIA. Traditionally, an EIA included issues, such as water and air pollution, and specific concerns related to the construction of the project—but not the global consequences of wasteful energy use and the carbon impact of decisions. As global warming has assumed greater significance worldwide, the need for full consideration of the implications of decisions on GHGs is now urgent. The key to doing so is to change the mind-set of the analyst and decision maker to always incorporate the long-term cost of global warming as a project cost.

This means expanding the feasibility study

with a chapter calculating the project's energy-use consequences (e.g., increased energy use because of generated traffic but possible energy savings from new ways of operating the proposed road and its surrounding infrastructure, such as lighting which is more efficient). The new information will then form the basis for calculating the associated change in GHG emissions. GHGs will still be produced, but the choices that minimize such emissions will become clearer, and the choices made in developing infrastructure will become much more socially and environmentally sound.

In addition to the incorporation of energy costing in the choice of route and mode, a further significant policy is to implement direct user charges that reflect the energy and environmental cost of mode, vehicle, and vehicle condition. This can be done using a number of mechanisms such as

- nationwide graduated vehicle sales taxes and annual license plate taxes that are determined by the factory-declared emission standard of the vehicle's engine; higher fees for more polluting engines (and no interprovincial or intraprovincial variations would be allowed, preventing registrations of gas-guzzlers in vehicular "tax havens");
- a national oil price regime that taxes the sulfur content of oils such that refineries seek to import clean crude to refine into clean diesel fuels for heavy diesel-operated vehicles; and
- fuel taxes, supplemented with congestion charges where locally appropriate, that fully reflect the road use costs.

Thirty model projects about saving land and being environmentally friendly have been developed by MOT since 2004. These model projects provide good case studies of land saving in design and construction by adjusting engineering standards to fit the local conditions. MOT should summarize these land-saving experiences and amend the technical standards for highway projects.

International Experience

In most other countries, land is privately owned and specific procedures are required to allow the compulsory purchase of the land needed for the construction of highways and other public facilities. This in itself imposes a very strict discipline on the

promoter of any scheme and, in effect, transfers the obligation of justifying the change of use of the land to the promoter. The absence of an effective land market in the PRC, and the use of accepted indicators or norms for land-take per kilometer for each class of road, can result in the wasteful and inefficient use of land. In India, concerns and difficulties (and costs) over the acquisition of private land for new roads have led to the adoption of a policy (or strategy) of upgrading the existing national road network from two lanes to four lanes, rather than constructing a new alignment.

In Thailand, the government acquires a full generous right-of-way, but the land not required for highway construction remains in agricultural use and is leased back to adjacent owners until such time as it may be required. In some areas of the PRC, the size of the right-of-way varies from 40 meters (m) to over 100 m. It is common to cooperate with local landholders to plant trees along the right-of-way, and these are available to the local landholders as an independent source of revenue. This conserves the larger unused right-of-way for agricultural use, but it also allows for flexibility in the future expansion of the road if demand warrants. It is an excellent balance between reducing the land-use footprint and maintaining flexibility.

Impact on Energy and Environment

The most effective way to influence the use of energy and GHG emissions in transport is to ensure that road users face the full costs (and congestion costs) of their choices to make a trip, and which mode to use. Such pricing policies lead to energy savings through affecting the modal choice of travelers and through improving the trucking fleet and the associated choice of fuel quality. The latter of course requires that refineries produce and supply the clean fuels that less-polluting engines require. Such pricing policy is the most important of the suggested policies to address the need to conserve energy and limit environmental consequences of energy use.

Impact on Land Use

Incorporating the real economic cost of land in the feasibility study process will have the largest impact on land conservation of any of the recommended policies. If the cost is not included, there is no incentive to save land. When the price of land becomes a major issue, then limiting land-

take becomes a priority. This will have a number of beneficial impacts: schemes that involve upgrading or using an existing alignment will be preferred, as the amount of land taken will be minimized; and route alignments that consume marginal or “waste” land will be favored over those that take scarce agricultural farmland.

Using flexible and land-aware design and construction standards for new roads is also likely to have a beneficial impact, reducing the amount of land needed.

Impact on Freight Transport Operations

The pricing of land-use and energy impacts into transport service decisions will not have any significant negative impacts on freight operations. Over time, some positive changes are likely, including a move toward more efficient equipment and also more efficient fleet structure. This will reduce the logistics cost.

Policy Implementation

Ensuring that land cost is incorporated as a key component in the feasibility study must be a priority of MOT. Changes to the pricing of fuel and vehicle registration charges are more complicated. These will require coordination and negotiation between the central government and the provinces and municipalities (Table 3, see page 24). One change that can be made is to recognize the polluting effect of bad diesel fuel by increasing the fuel tax on that category of diesel and reducing the tax on the higher-quality diesel. Experience in other countries is promising. In Sweden, for example, this kind of progressive taxing has had a strong impact on the choice of vehicle and type of fuel.

Policy: Stimulate the Development of Modern Fleet by Application of Information Technology and Reform of Maintenance Fee Collection

MOT should establish a road transport vehicle database system to include all registration and physical information about the vehicle to be available to all provincial, municipal, and Public Security Bureau (PSB) officials across the PRC. Provinces and municipalities should be encouraged to

Table 3: Action Plan to Improve Project Development and Design

No.	Action	By Whom	Comment	Related Actions
1	Recommend a methodology to estimate CO ₂ emission for feasibility study and EIA of a new highway project (guideline1).	MOT	Members to include MEP	
2	Add a new energy-saving evaluation chapter in highway project–feasibility study report (guideline 1).	MOT		1
3	Review the energy-saving evaluation chapter of all projects with a total annual energy consumption of 1,400 tons or more of standard oil.	MOT		1, 2
4	Implement the new version of land-use indicators for highway construction projects	MOT	Members to include MOLR	
5	Evaluate land saving of a new highway project by using this TA project's guideline 2	PCDs		
6	Establish an independent land-saving analysis report of highway project in the feasibility study.	PCDs		5
7	Review the land-saving analysis report of a national highway project.	MOLR	Members to include MOT	5,6
8	Identify shadow price and the real economic cost of land taken for a new highway project	PCDs	Members to include MOT, MOLR	
9	Set the area and economic cost of farmland taken by a new highway project as the index to evaluate options in the feasibility study.	MOT	Members to include PCDs	8
10	Prompt good experiences of land saving from MOT model projects by application of this TA project's guideline 2.	MOT	Members to include PCDs	
11	Organize research on road design standards, especially on the lane widths and sectional forms, and evaluate their safety before putting forward new design standards.	MOT	Members to include PCDs, MPS	

CO₂ = carbon dioxide, EIA = environmental impact assessment, MEP = Ministry of Environmental Protection, MOLR = Ministry of Land and Resources, MOT = Ministry of Transport, MPS = Ministry of Public Security, NDRC = National Development and Reform Commission, PCD = provincial communications department, TA = technical assistance.

collect maintenance fees only on the truck, not on the trailers based on the average maximum load of the trailers in a fleet. Regulations should require operating insurance only on the moving truck/trailer, not on stationary or unconnected trailers. A national vehicle registration and maintenance fee sharing system should be established similar to the one used in North America.

National database of road vehicles. The current process of vehicle registration, payment of maintenance fees, and payment of insurance leads to inefficient truck fleets. Truck registration now occurs at the county level. Once registered in any county, the trucks can then travel freely anywhere in the PRC. This level of registration and monitoring is not adequate for a modern transport system.



Owners will routinely find the cheapest place to register but may not conduct any of their business in that county. Under the current system, MOT has no ability to control this area of transport. Further, the data on the vehicle may be fragmented. Control of vehicles is difficult because they may be operating overloaded in one province, registered in another province, and be based in a third province. No common database exists to allow for appropriate monitoring and legal enforcement of fines and restrictions across provincial boundaries.

Maintenance fee setting and collection.¹³ The existing method of road maintenance fee collection is based on the Provisions on Administration of Road Maintenance Fee Collection effective since 1 January 1992: “The trailer with license should pay road maintenance fee.”

A trailer is defined as a motor vehicle and a license must be applied for in the relevant documents released by the Ministry of Public Security.¹⁴ The PCDs link the collection of the road maintenance fee with the issuance of the vehicle license plate. The collection of the road maintenance fee on each trailer restrains the development of drag-and-drop transport, because the truck company does not want to incur the additional—and unfair—cost. This in turn reduces the incremental benefits gained by using drag-and-drop transport and deviates from the goal of encouraging and promoting this advanced transport organization.

The current system allows jurisdictions to modify the setting of the maintenance fees. This leads to “shopping” for the most attractive fee and registration of the fleets in that jurisdiction. The

¹³ In January 2009, fuel prices in the PRC will be changed to reflect the downward movement of the world crude oil prices. The Government of the People's Republic of China has decided to take this opportunity to also increase fuel taxes for petrol from CNY0.2/liter (l) to CNY1.0/l and for diesel to CNY0.8/l. The revenue collected from this fuel tax increase on the maintenance fee collection system is still not clear. The allocation mechanism for the fuel tax collected to the provinces and agencies responsible for maintenance is also still not clear. This report has therefore left the above recommendation as it is for the moment, pending clarification of how the new tax will be allocated.

¹⁴ Announcement on Adoption of New Motor Vehicle License Plates, Announcement on Adoption of 92 Motor Vehicle License Plate and Driving License, and Method of Motor Vehicle Registration of the People's Republic of China.

operation of the fleet and the damage to the road may occur in an entirely different jurisdiction. This is illogical and causes problems.

Insurance. By 2003, before the issuance of the Law of the People's Republic of China on Road Traffic Safety, most semitrailer container vehicles had no license plates. The insurance responsibility was on the tractor, and the trailer had no dependent insurance policy and premium. In 2004, after the promulgation of the Law of Road Traffic Safety, the trailer was required to be registered for license plates, and the insurance responsibility for the trailer was separated from that of the tractor, with the cost at about CNY1,300. At that time, the requirement was that only one trailer needed to have the insurance premium paid for it, no matter how many trailers a tractor might have. With the promulgation of compulsory traffic insurance, the insurance premiums now include compulsory traffic insurance (CNY2,240, as a common freight vehicle) and vehicle damage insurance (CNY1,200, a standard effective since 1 July 2007), totaling CNY3,440. The cost to each business has increased by CNY2,140.

International Experience

The North American system of 48 US states and 13 Canadian provinces and territories has overcome this problem. A corporation was set up in 1973 with a board of directors chosen by the provinces and states. This corporation allocates the registration fees and maintenance fees (fuel tax) collected by each jurisdiction based on the estimated percentage of vehicle-kilometers traveled in each jurisdiction by each fleet or individual operator.¹⁵ The operator is required to fill in a form as part of the annual registration indicating an estimate of the vehicle-kilometers to be traveled in each of the states or provinces. Some travel only in one area, but some travel in a number of jurisdictions. The corporation then automatically allocates the registration fees and the maintenance fees based on where the vehicle is actually working. This removes the current incentive to lower the registration fees, since much of the benefit of that will be given to the other jurisdictions. Compliance with the provisions of this agreement is assured by annual audits by independent auditors.

Impact on Energy and Environment

A common database that covers the truck and bus fleets and allows for national monitoring of the vehicle safety, energy efficiency, and environmental condition can have a significant beneficial impact on energy use and carbon dioxide (CO₂) emissions. The rationalization of the truck fleet to move toward a more normal international truck-trailer ratio of 1:4 will not dramatically affect energy use. But the longer-term effect of improving logistics efficiency by reducing transport cost will have a modest energy and environmental benefit.

Impact on Land Use

As with energy, there will be little impact on land use other than in the design and operation of the drag-and-drop terminals. The indirect impact on land use of increasing operating efficiency will be felt only through the longer-term reduction in the growth of demand.

Impact on Freight Transport Operations

Compliance with vehicle size and weight regulations will improve dramatically with a national database available to all PSBs and PCDs. This will have a large impact on the road network and reduce agency costs. The development of a common vehicle licensing and maintenance fee allocation system will also have a large impact on the fairness of maintenance fee allocation, and it will eradicate the current imbalance between where the vehicle is registered and where it conducts its business. Vehicles registered in Beijing but working in Hebei, for instance, would have much of their registration fee allocated to Hebei. Further, the current truck to trailer ratio of 1.3:1 is inherently inefficient. In cases where the loading, unloading, or inspection of the trailers may take 1–2 days, the truck must remain with the trailer. Therefore, policies that encourage a move to widespread use of a drag-and-drop operation will dramatically reduce costs and increase utilization of the truck fleet.

Policy Implementation

Data are essential for monitoring, evaluating, and managing the transport system. The PRC maintains quite extensive data on the extent and condition of

¹⁵ International Registration Plan, Inc. website (www.irponline.org/) and International Fuel Tax Association, Inc. website (www.iftach.org/)

the infrastructure but less information on the vehicles and fleet operations. Three levels of data appear to be most important for this purpose:

- **National statistics on the vehicle fleet based on the vehicle identification number.** These would include the key physical characteristics and specifications of the vehicle. The information would be available to all monitoring and control agencies, including MOT, PCDs, PSBs, and local transportation administration departments. Availability of this national data would simplify enforcement and make infractions such as illegal modification of the vehicles much more difficult. It would enable interprovincial tracking of noncompliant vehicles and allow public security and provincial officials to place a restriction on vehicles from other jurisdictions for nonpayment of fines or safety violations. This recommendation is expanded in guideline 3.
- **Provincial statistics for monitoring operator safety.** This database would follow the general guidelines of the Guangdong database, with the objective of monitoring the safety behavior of the specific vehicles in the fleet and their operators and enabling the responsible departments to track accidents and liability.

MOT has considered setting up a national database for tracking vehicle safety-related issues for some time. This report supports that concept. A number of international examples exist. Canada, for instance, has “national” insurance systems in some provinces, which in turn maintain province-wide safety information on registration, accidents, and liabilities. That information is shared with Canada’s Ministry of Transport and with the police departments, and is similar in concept to what is envisaged here.

- **Local terminal management information.** At a local level, terminal operators need competent management information to track operational efficiency and cost, and ensure that the service that they are offering is as good as it can be. This includes helping to ensure that backhauls are available in the shortest amount of time possible, that dwell time for goods in transit is reduced, and that trucks and trailers are processed in the shortest time possible. But these systems will evolve naturally, and it is not necessary for the government to become involved in specifying what form they should take or how they should be developed. This area is further discussed in the handbook.

Table 4: Action Plan for Information Technology Database and Modern Fleet Development

No.	Action	By Whom	Comment	Related Actions
1	Speed up formulating information exchange standards on basis of the MOT demonstration projects of information technology application.	MOT	MOT, MPS	
2	Establish integrated vehicle and fleet database available to provinces, state security, and MOT.	PCDs	Members to include MOT and PCDs, MPS	1
3	Examine feasibility of setting up North American standard maintenance and registration fee—sharing system based on vehicle-kilometers of travel of the fleet.	MOT, PCD	Members to include MOT and a select number of PCDs	1
4	Review regulations on vehicle maintenance fee and vehicle insurance. Ensure that maintenance fee is paid only on the tractor and not on the trailers for a fleet. Ensure that insurance is paid only on an equivalent number of trailers to match the number of tractors in a fleet.	MOT, PCDs	Members to include NDRC, MOT, PCDs, CIS, and MPS	1

CIS = Commission of Insurance Supervision of the People’s Republic of China, MOT = Ministry of Transport, MPS = Ministry of Public Security, NDRC = National Development and Reform Commissions, PCD = provincial communications department.

From the viewpoint of fostering improved fleet operations, the following practical steps are needed (Table 4, see page 27):

- Develop a system for sharing vehicle registration and maintenance fees among provinces based on the vehicle-kilometers of travel that carriers and individual truckers estimate. The model for such an organization is the North American one, which allocates both registration fees and maintenance fees (fuel tax) among this region's provinces and states.
- Ensure that the regulations covering the application of the maintenance fee allow for registration of the truck and trailer separately and that the maintenance fee is collected based only on the number of trucks in the fleet and the average size of the trailers hauled by those trucks.
- Review and modify the regulations governing insurance of trailers. Insurance of trailers should be adjusted to average the insurance by the number of trucks in the fleet. The aim is to reduce the cost of trailer insurance to reflect the percentage of time that the trailer is actually being hauled by a truck.

Policy: Update and Enforce Standards for Vehicle Size, Engine Specifications, Configuration, and Operation

The current rule under the Highway Law of 1997 issued by the Ministry of Communications to control weight and size of vehicles should be amended. The earlier report, *Policy Reform in Road Transport*, gave a number of arguments for amending the law, primarily addressing the load exerted by the current truck configurations on the road. Further, this report also have concerns over the lack of standardization of the truck bodies and the impact of that lack of standardization on efficient logistics. This concern is further complicated by the National Standard GB1589 of 2004, which governs the configuration of the

vehicles for manufacturers.¹⁶

Equally or perhaps even more important is the need to set national engine standards for mandatory fuel efficiency and emissions in effect by certain deadlines. However, such requirements cannot be put in place without simultaneously providing the necessary incentives for refineries to produce and deliver the clean fuels that such engines require for efficient and economic operation. This calls for coordinated policy and actions.

Regular roadside inspection of road transport vehicles is one of the most effective ways to control overloading as well as to enhance vehicle safety and roadworthiness. At the moment, the PRC has too few roadside vehicle inspection stations, although some provinces have fitted toll booths with weight scales that enable those provinces to charge overweight vehicles for the damage caused to the roads.

The concerns this report has are as follows:

- The height of the trailer bed above the road should be specified. This allows for standardization of the height of the loading docks at terminals and minimization of trailer turn-around time.
- The maximum height of the trailer box above the bed should be specified exactly. This helps control overloading, and it further allows for standardization of pallets and efficient loading of the trailer when in the terminal. The current rules specify that the maximum height of the trailer above the road should be 4 m. But the rules do not specify the height of the trailer bed above the road.
- The trailer bed should be restricted to one level. Currently, the trailer floor may be stepped with two levels. This impedes efficient loading and packing of the trailer and smooth operation of forklift trucks inside the trailer.
- Enforcement of the current legal load limits is extremely poor. The PSB does not have much incentive to ensure vehicle compliance, and provinces look to MOT to solve the problem. Some provinces with weight scales at toll booths

¹⁶ GB1589 defines the overall configuration of the vehicle, including the axle loading and the gross size dimensions, but not the details that are needed to maximize efficiency. GB1589 is relatively new, and it will take at least 10 years for all the vehicles to comply with its provisions.



charge overloaded trucks on the basis of the percent overloaded. Up to 50% overloaded and a higher toll is charged; above 50% overloaded and the truck is detained and the load removed until the permissible level of overloading is achieved. In other provinces, there is no system for dealing with overloading.

- Vehicle weight scales should include a three-step inspection: (i) compliance with axle loading limits; (ii) a visual inspection of the condition of the vehicle and its legal documents, including the annual inspection certificate to ensure that the vehicle still complies with the exhaust pollution standards; and (iii) for those where there is a violation or concern raised in step 2, a full safety and environmental inspection.

International Experience

In the EU, a voluntary agreement with the association of vehicle manufacturers set a GHG standard for 2002 of 165 grams (g)/km CO₂. This was achieved because diesel-fueled vehicles on average emit 10% less GHGs than gasoline

(155 g/km CO₂ compared with 172 g/km CO₂). The agreement set a standard of 140 g/km CO₂ for 2008, with a possible extension to 120 g/km CO₂ for 2012. Between 1995 and 2002, Japan also made a significant improvement in its fleet's average fuel economy to tighter levels than the EU, and it is now in the process of proposing stricter fuel efficiency standards. Assuming no change in the vehicle mix, these targets imply a 23% improvement in 2010 in gasoline passenger-vehicle fuel economy and a 14% improvement in diesel fuel economy, compared with the 1995 fleet average of 14.6 km/liter (l). According to the Government of Japan, this improvement will result in an average fleet fuel economy of Japanese vehicles of 15.1 km/l by 2010.

The EU in particular requires that member states enforce standards by carrying out annual compliance checks. Member states must organize regular checks at the roadside and at operators' premises, covering each year a large and representative cross-section of drivers and vehicles. Each year, checks must cover at least 1% of days worked by drivers subject to driver

Table 5: Action Plan to Modify Vehicle Standards

No.	Action	By Whom	Comment	Related Actions
1	Execute the fuel consumption limit standard of commercial passenger vehicles.	MOT		
2	Establish the fuel consumption limit standard of commercial freight vehicles.	MOT		
3	Implement strict annual inspections of all commercial vehicles for safety and pollution control.	PCDs		1, 2
4	Launch research and development programs in clean technology.	MOST	Members to include NDRC, MOT, MEP	
5	Recommend commercial vehicle operational modal	MOT	Members to include NDRC	
6	Update the RTO to provide more clarity in compliance requirements and accountability for vehicle weight and size limits.	MOT		
7	Ensure that all manufacturers include a fixed plate on the side of the trailer noting the manufacturer's name, tare weight of the trailer, and maximum permissible weight based on the axle configuration and the overall dimensions.	NDRC		
8	Require all manufacturers to produce trailers either with closed boxes or with side panels and hoops that limit the height of the loaded vehicle.	NDRC	Members to include MOT, representatives of industry associations and freight terminals	
9	Implement three-stage inspection at roadside inspection stations.	PCD		

MEP = Ministry of Environmental Protection, MOST = Ministry of Science and Technology, MOT = Ministry of Transport, NDRC = National Development and Reform Commission, PCD = provincial communications department, RTO = Road Transport Ordinance.

working hours law, and at least 15% of the days checked must be at the roadside and at least 25% at the operators' premises. Member states must exchange information every year about breaches of the hours and tachograph regulations and the penalties imposed on nonresidents and, for offences committed in another member state, on their own residents.

Impact on Energy and Environment

While the regulation requires all vehicles to undergo an annual inspection for safety and pollution control, compliance in many cases is very lax. Many trucks in particular are registered and continue to operate with unsafe equipment

and poor exhaust condition. A rigorous program of inspection, compliance, and fines to poorly performing companies would have a significant beneficial impact on the environment, energy use, and the production of GHG.

Impact on Land Use

There will be no direct impact on land use. But the change of the vehicle configuration standards will have an impact on the design of terminals. All terminal docks should be at a standard height that corresponds to the height of the trailer bed of the trucks. This will allow for more optimal use of the terminals and more efficient use of space.

This will again allow for more output from each terminal.

Impact on Freight Transport Operations

Revision to the vehicles' weight and other dimensions and subsequent monitoring of the vehicles will have a dramatic impact on the operations of the fleet. Together with other changes in licensing, maintenance fees, and vehicle insurance, this change in vehicle standards and more rigorous inspection will improve the truck fleet. As the truck fleet becomes more standardized and trailers become more interchangeable, operating efficiency will improve, costs will drop, and shipping time will shrink.

Policy Implementation

The following steps are required (Table 5):

- Update the Road Transport Ordinance (RTO) to provide more clarity in terms of compliance requirements and accountability related to vehicle weights and size limits.
- As a supplement to the vehicle identification number, ensure that all manufacturers include a fixed plate on the side of the trailer noting the manufacturer's name, the tare weight of the trailer, and the maximum permissible weight based on the axle configuration and the overall dimensions.
- Require all manufacturers to produce trailers either with closed boxes or with side panels and hoops that limit the height of the loaded vehicle.
- Establish an overloading and safety compliance management information system with database and continuous data collection, processing, statistics, analysis, evaluation, and report mechanism for the purpose of continuous improvement.
- Work with industry associations and freight terminals to ensure that regulations fit with industry needs.
- Implement a full three-step inspection capability at the roadside weigh scales, following the guidelines provided in the appendix to the main

report.

Policy: Manage Transport Demands

This report suggests that MOT and MOHURD put more effort into advocating management of transport demands, focus on developing public traffic systems, and further improve the operating efficiency in urban road systems. The options include a wide variety of measures used in some cities to control demand. Singapore and London are perhaps the most well-known cities that have instituted strict rules to control access to the city by personal vehicles.

While this project did not delve heavily into urban transport, as MOT now has responsibility for urban as well as intercity transport, this area will become more important.

International Experience

The most impressive examples of managed transport demands are Singapore and London. In both cases, the improvement in traffic flow inside the city was accompanied by the availability of a high-class public transport system. This trade-off of road use for public transport is now becoming a possibility for the larger cities in the PRC, and many of the lessons from Singapore and London may become viable in cities such as Beijing, Shanghai, and Shenzhen.

Numerous cities worldwide are modernizing their urban public transport systems. The most prominent measures taken include the establishment of bus rapid transit systems and investment in rail-based systems such as light-duty rail or metro lines. The GHG reductions achieved by such investments can be captured through the Clean Development Mechanism, thus making these investments economically more viable and reducing barriers towards their implementation.

Impact on Energy and Environment

Managing demand is one of the most effective ways to limit the impact of transport on the use of



energy and on the environment. The shift of travel from personal cars to public transport is a very important objective for all PRC cities.

Impact on Land Use

Managing demand is also one of the most effective ways to reduce the need to use more land. As cities sprawl outward, they exert a lot of pressure on the surrounding land. Concentrating development in the center of the city and serving that development with high-capacity transit solutions markedly reduces the need for ever larger city footprints.

Impact on Freight Transport Operations

Any method that reduces the traffic level in cities will have a beneficial impact on operations. As delivery vehicles can move around the city easier, the cost of that delivery will drop.

Policy Implementation

It is impossible to be definitive in recommending the appropriate range of transport demand measures that can be implemented by any city or

region (Table 6). MOT can, however, encourage those measures by providing subsidies for development of innovative approaches and by setting up a cost-sharing system with the provinces and the municipalities to implement traffic control and demand-limiting measures. These will pay for themselves through increased economic performance by the cities and reduced time and direct cost of congestion.

Policy: Support Innovative Financing Opportunities to Develop Transport Infrastructure

The private sector should be encouraged to provide transport infrastructure and services when possible. It should be supported by the public sector in public-private partnerships.

Transport policies and regulatory measures should consider market principles. From the field visits, this report found strong evidence of private sector enthusiasm for development of a number of the components of a modern transport logistics chain including terminals, freight-forwarding companies, information systems

Table 6: Action Plan to Manage Transport Demands

No.	Action	By Whom	Comment	Related Actions
1	Promote management in large and medium cities.	Municipality	Members to include MOT, MOHURD	
2	Execute a differentiated-fee collection for parking in urban areas; attempt to collect jam fees in large urban centers.	Municipality	Members to include NDRC, MOT	1
3	Set up exclusive high-occupancy lanes for intercity transport.	PCDs		1
4	Provide discount of toll fees for ETC users.	PCDs		1
5	Implement a public transport priority strategy.	Municipality	Members to include MOT, MOHURD	
6	Plan and build large-capacity public traffic facilities like the bus rapid transit and rail lines.	Municipality	Members to include MOT, MOHURD	5

ETC = electronic toll collection, MOHURD = Ministry of Housing and Urban–Rural Development, MOT = Ministry of Transport, NDRC = National Development and Reform Commission, PCD = provincial communications department.

for load matching, and the early stages of fleet development. However, there was also a sense of confusion within the municipalities and PCDs over the correct role of the private sector versus the state sector. The market is an effective way to allocate resources by maximizing productivity, innovation, opportunity, and consumer benefit. To be efficient and fair, markets must reflect certain principles, including consumer choice, competition, efficient pricing, and technical neutral public policies. Violation of these principles would result in unfair outcomes. The resource allocation and consumption patterns in a distorted market cannot be considered optimal.

The appropriate role for the state in the improvement of logistics is to not impede the energetic development of the logistics chain by the private sector. The government will play a role in systems to facilitate logistics efficiency and information exchange, but private sector investment should be encouraged where possible, particularly in the development and operation of modern logistics terminals. The encouragement includes access to subsidy payments that are part of the program to develop national freight and passenger terminals.

The private sector is strongly linked to the needs of the shipping and freight logistics community. The market is dynamic, and significant

capacity and interest have been demonstrated by companies in the PRC and overseas. In developing the 134 new terminals, if it can be shown that the capacity exists within the private sector to develop the terminals, then the private sector should be given first chance to do so. Only if the private sector does not have the capacity to develop the terminals should municipalities take the lead. The subsidy provided by the central government should be available to the private sector.

International Experience

Public–private development of terminals is common around the world for both passenger and in some cases for freight facilities. In many cases, land can be more easily acquired by the government, while development, operation, and management can be carried out by the private sector. Examples of this merging of interest are the major international railway stations in Europe and North America, and development of freight interchange facilities adjacent to major rail and road facilities in most transport hub cities around the world. Because hubs generate a lot of traffic and that traffic brings in lots of customers, development of the terminal generally costs the government very little; most of the cost is carried by the private sector.

Impact on Energy and Environment

The provision of transport infrastructure by the private sector will have no impact on the environment or the use of energy.

Impact on Land Use

The provision of transport infrastructure by the private sector may have a beneficial impact on land use. Currently, private companies set up ad hoc terminals wherever they can secure land. In Chongqing, for instance, there are about seven private terminals located around the city. Allowing the private sector to invest in and develop a large multimodal terminal with allocation of sufficient appropriate land will remove much of the incentive to develop the unofficial terminals that now exist, and thereby reduce the overall demand on municipal land resources.

Impact on Freight Transport Operations

Private sector provision of infrastructure—particularly terminals—can have a significant beneficial impact on operational efficiency. The Transfar Logistics Terminal for instance, was able to reduce the back-loading time for trucks using the terminal from 3 days to 7 hours. While this level of benefit is unlikely to be achieved in most cases, it is also clear that the private sector is more in tune with the demands of the industry, and many of the services offered through a privately operated terminal are therefore more efficient and effective than the equivalent services offered by a public sector terminal.

Policy Implementation

To develop the new terminals, this report recommends the following (Table 7):

- Municipality allocates sufficient land in a location that balances the need for road access with the need to have efficient intermodal links—either road to rail or, in some cases, road to water.
- A functional specification of the required terminal is developed. This would include requirements for physical space, warehousing, and information systems such as electronic load-matching. However, the timing of the development of these facilities and services should remain open.
- Advertise that expressions of interest in the right to develop and operate the terminal should be submitted to the municipal government.
- Based on the financial strength of the companies or consortia planning to bid for the terminal, the municipality can determine if sufficient strength exists in the private sector to undertake development of the terminal on a competitive basis or whether the municipal government will need to take the lead.
- If there is sufficient strength in the private sector, then the municipality can develop a competitive bid for the right to develop the terminal.

Policy: Enhance Human Resource Training

Table 7: Action Plan to Innovate Financing

No.	Action	By Whom	Comment	Related Actions
1	Locate appropriate land for new intermodal terminal.	Municipality	Members to include PCDs	
2	Canvass interest in the private sector for developing the terminal.	Municipality	Members to include PCDs	
3	Prepare bidding documents for terminal development, construction, and operation.	Municipality	Members to include PCDs	2
4	Issue bidding documents and select winning bidder.	Municipality	Members to include PCDs	3

PCD = provincial communications department.

Improving human resources in the road transport sector will require a way to certify each of the professional careers involved, such as commercial driver and truck inspector. It is essential to have professional training courses, a code of conduct, and a code of ethics for enterprises and government agencies. All drivers—commercial and private—must learn about the link between CO₂ emissions and global warming, and they must practice how to drive in a more fuel-efficient and less polluting way. MOT should issue “eco-driving” guidelines, require use of the guidelines by driver training schools, and encourage road transport companies to use them. In addition, information should be shared in a timely fashion among government departments and with the public.

Guidelines on the feasibility study application, development of a national database, and improvements to land use are also critical tools for training. MOT should ensure that all guidelines are widely distributed and should encourage local authorities to use them in the development of their professional training programs.

International Experience

Eco-driving was launched in Europe as the new environmentally friendly way to drive. Research has established that drivers who have taken eco-driving training courses reduce their fuel

consumption, and therefore CO₂ emissions, by 15% compared with drivers who have not taken such a course. They save energy primarily by the efficient use of the gears when the vehicle has a manual gearbox and by learning to read the traffic situation they are in. Driving with a lower engine speed than most people are accustomed to can also save energy.

Impact on Energy and Environment

Raising awareness of the issues of energy use, CO₂ emissions, and the growth in GHGs is a critical component of improving energy efficiency. The guidelines produced by this TA include an eco-driver training program that has been shown in other countries to significantly reduce energy use. Other energy sensitivity training is needed for design institutes and for provincial and municipal planners.

Impact on Land Use

Training in better land use is of the most critical concern to the design institutes and the system planners and evaluators. As land value is incorporated into the feasibility study, the choice of route option may change. Further, as design institutes become more aware, key changes in the physical design as well as the location of the alignment can take place that will lead to large savings in land. The key to this saving will

Table 8: Action Plan to Enhance Human Resources

No.	Action	By Whom	Comment	Related Actions
1	Add class hours of eco-driving to the driver training course.	MOT		
2	Improve eco-driving handbook established by this technical assistance.	MOT	Members to include PCDs	1
3	Encourage application of simulation training devices in driver training schools.	MOT, PCDs		
4	Urge transport enterprises to enhance eco-driving training for their drivers by means of qualification certificates.	PCDs		2
5	Promote knowledge transfer by the help of international organizations such as the World Bank and Asian Development Bank.	MOT	Members to include MOF and international organization	

MOF = Ministry of Finance, MOT = Ministry of Transport, PCD = provincial communications department.

Table 9: Policy Recommendations and Implementation Responsibility

No.	Recommendation	Responsible Agency	Ease of Implementation	Action Priority
1	Comprehensive transport planning	MOT, MOR, other agencies	Easy to do but difficult to arrange	Early to medium-term initiative
2	National highway network	MOT	Easy; MOT can implement immediately.	High priority
3	Project development and design	MOT, PCDs	Easy; part of the process is already complete.	Short-term initiative
4	Development of modern fleet by application of information technology and reform of maintenance fee collection	MOT, all PCDs	Data-based development is easy; implementation of the revenue-sharing system, while conceptually easy, may be institutionally more difficult..	High priority for database and medium priority for revenue sharing
5	Better vehicle and engine design standards	MOT, NDRC, MEP	Difficult but important. This will require coordination of a number of ministries	Longer-term priority
6	Management of transport demand	MOT, municipalities	Easy; MOT and municipalities can implement immediately	High priority
7	Innovative financing	MOT, PCDs, municipalities	Easy; MOT can indicate that terminal subsidies are available to public-private partnerships. PCDs and municipalities can implement immediately.	High priority
8	Training and human resource development	MOT, PCDs, municipalities	Immediate implementation is possible.	High priority

MOE = Ministry of Energy, MOR = Ministry of Railways, MOT = Ministry of Transport, NDRC = National Development and Reform Commission, PCD = provincial communications department.

be education and training of the professionals responsible for the designs.

encouraging training for drivers to become more environmentally aware (Table 8, see page 35).

Impact on Freight Transport Operations

Terminal operations, fleet management, and management of the legal and regulatory system are all in a state of flux. The changes that are taking place have the potential to make a big impact on the operations of the system. Many levels of training are needed, from on-the-job training to international study tours.

Policy Implementation

The MOT will play a central role in devising and

Priority for Implementation

The recommendations are not all equally easy to implement. They are prioritized in terms of which ones fall within the mandate of MOT and which ones, while equally important, will require more effort and time to achieve (Table 9).

Guidelines, Handbook and Technical Note

To help the People's Republic of China (PRC) implement the recommended policies in practical ways, three guidelines, one handbook, and one technical note under a policy reform framework are provided (Table 10).

The first guideline is Advanced Analysis in Road Project Feasibility Study and Environmental Impact Assessment for Energy Saving and CO₂ Reduction. The estimation methodology of energy savings and carbon dioxide (CO₂) emissions was established in this guideline. The other suggested analysis in the feasibility study is also discussed in guideline 1. It will be a practical tool for provincial communications departments (PCDs) and designers. This guideline can be integrated into current feasibility studies of highway projects.

The second guideline is Land Saving in Road Construction—Farmland Protection. This guideline introduces a series of land-saving measures and contains typical cases with data

and diagrams to assist the user's understanding. It also cites the relevant laws and regulations on land conservation. The format of a land-saving report provided by this guideline can help PCDs establish an official report for approval by the Ministry of Land and Resources. This guideline can be used as a practical manual for PCDs and designers.

The third guideline is Information System Development for Provincial Road Freight Transport Administration. The Ministry of Transport (MOT) and PCDs will be the target readers. This guideline gives a framework to help PCDs format data and establish information systems.

The handbook is called Awareness of Climate Change and Eco²-Transport. As the “eco-squared” part of the title suggests, it provides ideas for “eco-nomical” and “eco-logical” transport (road), including suggestions on economical driving and presentation slides for

Table 10: Guideline/Handbook/Technical Note for Policy Implementation

Guideline/Handbook/Technical Note	Policy Supported
1. Guideline 1: Advanced Analysis in Road Project Feasibility Study and Environmental Impact Assessment for Energy Saving and CO ₂ Reduction	Improve project development and design.
2. Guideline 2: Land Saving in Road Construction—Farmland Protection	
3. Guideline 3: Information System Development for Provincial Road Freight Transport Administration	Stimulate development of modern fleets by application of information technology.
4. Handbook: Awareness of Climate Change and Eco ² -Transport	Enhance human resource training.
5. Technical Note: Options for Freight Terminal Development and Management	Support innovative financing opportunities to develop transportation infrastructure.

a training program. The potential readers of this handbook are either road users (or potential road users)—such as motor vehicle drivers, students, and trainers in a driving school, and road transport company's fleet operators—or members of the public learning about greenhouse gases and global warming.

The technical note, *Options for Freight Terminal Development and Management*, targets the development of intermodal freight terminals,

advocating where possible the use of the private sector in partnership with the municipal governments, and suggests ways of setting up the bidding process and selecting the preferred bidder. It also offers recommendations in terminal operation, specifically reducing the time of delay for trucks waiting for a back-load. This can be done either using electronic bulletin boards at terminals or by streamlining the communication system within the terminal.

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Green Transport: Resource Optimization in the Road Sector in the People's Republic of China

The purpose of the in-depth study on Resource Optimization in the Road Sector was to examine how the development of the road system in the People's Republic of China affects the use of land, the use of energy, and the quality of the environment, and whether more efficient management of the transportation system could limit or reduce those impacts. The outcome of the study is a series of recommended policies, guidelines, a handbook and a technical note to help better balance the needs of economic growth with the valid concerns about the use of energy and scarce resources and the environmental impacts.

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