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Energy Conservation in China's Road Transport: Policy Analysis

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ABSTRACT

Energy consumption for transport purposes has increased rapidly in China over the past decade. China's transport industry has undergone remarkable developments in energy conservation through structural, technological and managerial measures. The paper analyzes energy-conservation policies and measures related to road transport in China. The paper also identifies constraints for these policies and measures. The transport management authorities face a series of difficulties associated with methods, costs, public awareness, and management systems. Suggestions for improvement are also offered, including promotion of energy-efficient private vehicles, advances in business vehicle energy conservation, exploiting the energy potential of urban traffic and infrastructure development for energy-efficient clean vehicles.

Keywords: Energy Conservation; Road Transport; Policy Analysis; China

1. Introduction

Over the past decade, energy consumption for transport purposes has increased rapidly in China. This escalation is primarily accounted for by growing consumption of gasoline and diesel [1,2]. The freight transport sector has steadily improved its energy efficiency and reduced its energy intensity. The passenger transport sector, however, is likely to see a moderate increase in energy intensity in the near future because of a growing demand in service quality (i.e., speed, convenience, comfort) [3]. With the country's continuing industrialization and urbanization, energy consumption for transport purposes will continue to increase in the foreseeable future, and transport will gradually become a major energy user in the Chinese economy [4].

In recent years, China's transport industry has undergone remarkable developments in energy conservation through structural, technological and managerial measures. Nevertheless, a number of major problems remain to be solved. Through various policies, the local or national governments have actively encouraged public transport, inter-city rail transit construction, green travel, and energy conservation by means of structural and technological optimization. Despite positive initial results, the industry still faces enormous challenges, such as structural defects in the transport sector, inadequate public transport capability, and ineffective energy-management mechanisms and policies [5].

2. Main Measures

Energy conservation can be achieved primarily through two strategies (**Figure 1**): structural adjustment and technological advances. In practice, these strategies are refined into schemes (at a relatively macro-level) and measures (at a relatively micro-level). For these schemes and measures to take effect, governmental policies are required. With the continuing marketization of energy-related sectors, the government regulates the operation of such sectors primarily by three groups of measures: price policies, fiscal and taxation policies, and other managerial policies [6,7].

Government policies take the form of laws and bylaws, governmental plans, and guideline documents. For a new policy to be effectively enforced in China, the government has to consider carefully multiple aspects of the issues at hand. In particular, the following elements need to be clearly defined: 1) the objectives of the policy; 2) the target objects of the policy; 3) the governmental departments responsible for policy enforcement; 4) procedures required to enforce the policy; 5) mechanisms for monitoring policy enforcement; and 6) the relationship between the present policy and preceding and subsequent ones.

Energy conservation in road transport is the key task in

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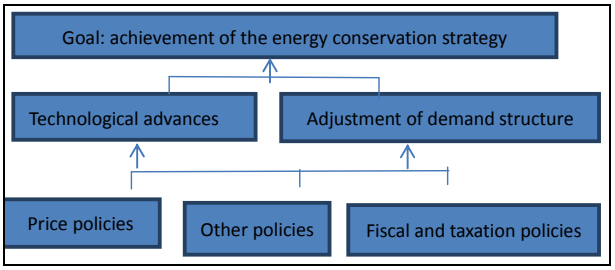

Figure 1. Relationship of the goal, strategies, and schemes (measures) in energy conservation.

transport energy conservation, and numerous policies, schemes, and measures are related to this task. The major ones are listed in **Table 1**.

3. Restraints Analysis

With respect to energy conservation, transport management authorities face a series of difficulties associated with methods, costs, public awareness, and management systems. They can be summarized as follows [8]: Finally, complete content and organizational editing before formatting. Please take note of the following items when proofreading spelling and grammar:

- Technological conditions. Some energy-conservation techniques are under development or at the demonstration stage and require funding support.
- Cost issues. The implementation of energy-conservation schemes involves increased costs and thus requires financial assistance.
- Limited public awareness. The importance of energy conservation and efficiency has not been widely recognized by corporate managers, appliances operators, and the general public.
- Weak management. Current systems for rating energy efficiency, energy conservation, and environmental protection are inadequate. Data are lacking. There are delays in the dissemination of energy conservation-related information. Management measures do not function well.

Table 2 lists the constraints faced by transport management authorities in enforcing energy-conservation policies.

In particular, the impact of these energy policies on non-business (*i.e.*, private-use) vehicles has been unsatisfactory. Achieving further improvement in the outcomes of these policies would appear to be an enormous challenge. The main factors that confine the outcomes of these policies are as follows. First, the ownership of private vehicles has increased rapidly. Correspondingly, the energy consumption by private vehicles has accelerated. Because of changing consumer habits, small vehicles are unlikely to become the first choice of vehicle for most people in the near future. Second, consumers are relatively insensitive to gasoline prices, which impede the transition to choosing more energy-efficient vehicles.

4. Policy Recommendations

4.1. Consistent Promotion of Energy-Efficient Private Vehicles

Motorized vehicles are the leading factor in rising fuel consumption. Experience in developed countries (Europe, Japan, United States) indicates that the most effective economic measures for improving the energy efficiency of vehicles are as follows: 1) issuing energy-efficiency standards and introducing fuel taxes; 2) requiring manufacturers to upgrade production techniques; and 3) encouraging consumers to purchase fuel-efficient vehicles. China should introduce energy-efficiency standards and promote the adoption of energy-conservation behavior and technologies as well as alternative-fuel vehicles.

4.2. Comprehensive Advances in Business Vehicle Energy Conservation

Energy conservation for business vehicles should proceed in terms of three aspects: vehicles, roads, and transport organization. First, it is necessary to reduce the energy consumption of vehicles. This can be achieved in two ways: energy-conservation techniques for new vehicles and the maintenance of existing vehicles. The former approach requires the regulation of manufacturers through relevant standards and policies. The latter approach is within the scope of transport management authorities and can be achieved in several ways: forced retirement of old energy-intensive vehicles; encouraging structural improvement for vehicles by means of economic incentives; rigorous monitoring of vehicle maintenance; and appropriate driver training.

Second, energy consumption can be attained by improving the road network structure and road conditions. It can also be achieved by optimizing transport organization and increasing transportation efficiency by improving the load efficiency.

Moreover, to ensure the long-term success of energy conservation in road transport, it is necessary to promote the inherent energy-conservation capacity in the transport sector and make energy conservation a customary procedure in this industry.

4.3. Exploiting the Energy Potential of Urban Traffic

Urban traffic involves many complex factors, such as management, policies and laws, planning, technology, operation management, and finance. Improvement in one or more of these factors can lead to advances in the traffic environment and efficiency, thereby contributing directly or indirectly to energy conservation. Thus, there is

Table 1. Measures relevant to energy conservation in road transport.

No	Energy conservation policies/measures	Objectives
1	Recommend vehicle types for freight transport	Promote the use of energy-efficient vehicles
2	Encourage the use of heavy-load vehicles and van-type vehicles.	
3	Promote diesel-fueled vehicles	
4	Eliminate old vehicles	Eliminate energy-intensive vehicles from the transport market
5	Upgrade vehicle maintenance and tests	Improve the energy efficiency of vehicles in operation
6	Recommend energy-efficient products	
7	Encourage corporatization of passenger transport organizations	Increase the transport efficiency
8	Promote the use of information technology in freight and passenger transport	
9	Quota management of energy use and reward/punishment	Increase the awareness of energy conservation in staff working in the transport sector
10	Driver training	
11	Construct national expressway networks	Improve the road network structure, road conditions, and its traffic capacity
12	Construct high-grade roads	
13	Improve the pavement of roads	
14	Control overweight and oversize in road transport	
15	Offer toll discounts for heavy-load vehicles	Encourage the use of energy efficient vehicles

Table 2. Energy-conservation measures and constraints for enforcement in transportation sector.

Scheme	Policy	Actual constraint	Type
Adjustment of transport structure	Ensure the proportion of non-motorized vehicles in traffic	Local bylaws discouraging electric bikes; inconvenience of traditional bikes	Public awareness
	Increase the proportion of train and water transport in total transport load	Unavailability of train passes; low speed of water transport	Cost
	Increase the adoption of public transit in traffic	Crowdedness and lack of comfort in buses; road congestion	Public awareness
	Increase the ratio of energy efficient vehicles in passenger vehicles	Energy benefit of small vehicles not necessarily predominant relative to their advantages (e.g., lack of impressive appearances)	Public awareness
	Increase the ratio of energy efficient vehicles in business vehicles	Energy benefit of large vehicles not necessarily predominant relative to their advantages (high costs)	Cost
Improvement of fuel economics of vehicles	Improve the energy standard of new vehicles	Differences in technological statuses of vehicle manufacturers	Technological factors
	Eliminate energy intensive in-use vehicles from the market	Vehicle owners unwilling to abandon existing vehicles	Cost
	Increase the proportion of diesel-fueled vehicles	Limited diesel availability; emission of black smoke and exhaust from diesel-fueled vehicles	Cost
	Increase the proportion of hybrid electric vehicles (HEVs)	High costs of HEVs	Cost
Promotion of alternative fuels	Increase the proportion of alternative-fuel vehicles such as electric vehicles (EVs)	Technological defects of alternative-fuel vehicles; inconvenience in recharging	Cost
Improvement of road networks	Improve the road network structure	Road congestion	Weak management
	Improve the road conditions	Road surface damage	Weak management
	Improve the traffic capability	Too many tolling points	Weak management
Other managerial measures	Control energy use in subsectors	Lack of clear goals	Weak management
	Upgrade energy conservation-related monitoring and examination	Lack of a clear system	Weak management
	Encourage the use of energy conserving products and techniques	Lack of motivation	Cost
	Perform comprehensive management of energy policies	Current laws need revisions	Weak management
	Improve the public concept of vehicle use	Lack of leaders	Public awareness

enormous potential for energy conservation in urban traffic.

Fuel use by urban vehicles accounts for over half of total vehicular energy consumption. Additionally, urban vehicles feature high spatial density, and there is a large proportion of small urban vehicles. As a result, urban vehicles represent a vast market potential for the application of alternative fuels.

Global experience has shown that the operation efficiency of urban traffic can be improved by such approaches as managing transport demand and improving the traffic supply. More specifically, improvements can be achieved by the following practices: limiting the use of private vehicles; introducing (or increasing) the fuel tax, exhaust emission tax, parking fees, and extra fees for traffic during peak hours and in those regions congested usually; creating bus-only lanes; using automatic traffic control systems; and developing rail transit networks. All these practices can contribute to improved energy efficiency.

4.4. Infrastructure Development for Energy-Efficient Clean Vehicles

The government needs to expedite the infrastructure development for clean vehicles. The infrastructure provides the essential conditions and support for growth of the alternative-fuel vehicle industry. Cleaner vehicles can reduce the emission of greenhouse gases and pollutants. Charging stations (or posts) and natural-gas fueling stations can be constructed in cities selected for the promotion of alternative-fuel vehicles, such as hybrid electric vehicles, electric vehicles, and vehicles fueled by compressed or liquefied natural gas. Moreover, intensive research should focus on the development of high-performance batteries and energy-storage devices. Efforts need to be made to develop technical capabilities and standard systems for the manufacture, licensing, and quality control of energy-supplying equipment.

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