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A Review on Fuel Economy Standards and Labels for Motor Vehicles: Implementation Possibility in Pakistan

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Abstract: This research investigates the possibilities of potential savings and reduction in Green House Gas (GHG) emissions caused by road transport in general and private cars in particular. Private cars use a large share of the transport fuel, thus these are the major and ever increasing contributor to the GHG emissions. An extensive review of international experiences on fuel economy standards and labels, in order to encounter the problem, is carried. The possibilities of the implementation of fuel economy standards and labels for motor vehicles in Pakistan are examined. Based on the studies carried out in developed countries, results have shown that the implementation of fuel economy standards and labels for motor vehicles in developing countries like Pakistan would be beneficial for the society, government as well as environment.

Key words: Fuel economy standards, energy label, motor vehicles, Pakistan

INTRODUCTION

Encouraging consumer preferences towards better fuel economy standard vehicle would also help to reduce GHG emissions. In Pakistan, like many developing countries, the increasing prosperity and population growths are resulting in accelerated growth in vehicle population and vehicle kilometers traveled. Therefore, the risks of increasing of dependence on fossil fuel cannot be avoided. However, it is not the only reason, but there are so many other consequences that need to be taken into account seriously, such as increasing air pollution, global warming, health diseases, etc. It has been observed that one of the reasons of the increase in GHG emissions from passenger motor vehicles is due to the continuing rise in the number of vehicle and kilometers traveled with lower fuel economy. It is estimated that 25% of global CO_2 emissions from fossil fuels can be attributed for transportation and over 30% in the Organization for Economic Co-operation and Development (OECD) countries (Dargay and Gately, 1997). Emissions of CO_2 in OECD countries, far from falling in line with the 1997 Kyoto international agreement on climate change, are in fact expected to increase by a third by 2020 if no major new policies are put in place, largely due to increased transport and energy use (Waller-Hunter, 2001) Air pollution causes respiratory problems, adverse effects on pulmonary function, leading to increased sickness absenteeism, increased use of health care services, premature birth and even mortality (WHO, 2004). It inferes the need of a fuel-efficient, safe and environmentally designed transport systems which may also play an important role in reduction of GHG emissions and national energy consumption. In this regard one of the appropriate, simple and effective strategy adopted is to introduce fuel economy standards and labels, which may provide guidance to consumers in their purchasing decisions on fuel-efficient vehicles. Standards set a fuel economy level of motor vehicles that manufacturers must meet in order to sell their products in market. In this respect, fuel economy standards have some advantages, because manufacturers may appreciate standards, as they reduce the market risk associated with introducing new products. On the other hand, fuel economy labels promote consumer awareness to purchase higher fuel-efficient vehicles and encourage manufacturers to produce more fuel-efficient vehicles.

Automobile fuel economy standards have proven to be one of the most effective tools in controlling oil demand and GHG emissions from the transportation sector in many regions and countries around the world (An and Sauer, 2004). Many countries have introduced fuel economy standards and others are planning to adopt the program. The primary policy for controlling motor-vehicle fuel consumption in the United States has been the imposition of Corporate Average Fuel Economy (CAFÉ) standards, when the USA suffered under the energy crisis created by the OPEC oil embargo of 1973-74.

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It was estimated that this embargo caused the loss of 500,000 jobs and US$35-45 billions to the US gross national product. To determine the effectiveness of the CAFÉ goal it is important to examine the trends in oil importation. In 1973 the USA was importing 6.025 million barrels of oil per day. By 1992 this figure had increased by 15% to 6.938 million barrels per day. During the same time period the number of registered vehicles in the USA increased from 126 to 200 million, an increase of 59% (Kirby, 1995). In Japan, weight-class-based fuel economy standards will result in a 23% improvement in gasoline passenger vehicle fuel economy from 1995 to 2010 and 16% improvement in diesel car fuel economy from 1995 to 2005 (He *et al*., 2005). It is considered to be the easiest way for manufacturers to abide by the fuel economy standards through the reduction in vehicle weight although it raises concerns with regards to vehicle safety. It is commonly reported that 45.45 kg (100 pounds) in weight reduction increase fuel economy by 0.42 km L^{-1} (mpg) (Plourde and Bardis, 1999). In European Union, the forecast growth in fuel consumption by road transport is being a major policy challenge. Opinion surveys also indicate that European citizens consider the amount of road traffic to be the most important local environmental problem (Koopman, 1997). A voluntary agreement has also been signed by the European, Japanese and South Korean automobile manufacturers associations to increase the average fuel efficiency of their vehicles to 17 km L^{-1} (40 mpg) by 2008 and about 21.25 km L^{-1} (50 mpg) by 2012 (Guangzhou, 2003). In Canada fuel economy standards have been set by Transport Canada under voluntary Motor Vehicle Fuel Consumption Standard (MVFCS) program. The program was designed to provide information on fuel consumption rates to vehicles buyers and to improve the fuel efficiency of new vehicle fleet. Under this program manufacturers are committed to meet annual Corporate Average Fuel Consumption (CAFC) standard. The Motor Vehicle Fuel Consumption Standard (MVFCS) Act was passed in 1981 to enforce the CAFCS as part of the government's off-oil policy of the early 1980s (APEC Automotive Dialogue, 1999). As the China has become the world's third largest oil consumer after the USA, Japan and the road transportation has gradually become the dominant part of the transportation system. The Energy Conservation Law was promulgated in 1997 and took effect in 1998. China has not yet implemented any mandatory national standards for vehicle fuel economy, but due to the increased role in China's oil consumption, energy conservation in the transport sector has recently become on the top priority. In this connection, efforts are currently underway to establish fuel economy standards for motor vehicles (He *et al*., 2005).

Pakistan's National Conservation Strategy (NCS) Report in 1992 also railed against lax vehicular emissions regulation in the country, citing vehicular emissions as responsible for 90% of all pollutants in the country. The report identified motor vehicles as the main of urban air pollution in Pakistan and estimated that urban air pollution had resulted in damages worth $370 Million (1992) with 6.4 million people hospitalized annually for pollution related illnesses. In Pakistan, the present and future population of motor vehicles indicates that, there is a need of fuel-efficient, safe and environmentally designed transport systems. As, it promotes consumer demand for efficient vehicles by making comparative specific information of models available to buyers through fuel economy labels. Therefore, it has been found that the technological and design changes in motor vehicles can help to increase GDP, create job opportunities, reduce oil consumption and emissions.

This study is carried to investigate the possibilities to implement the fuel economy standard and labels for motor vehicles in Pakistan. In order, to get verity of comprehensive results to improve fuel economy standards, the advanced technologies (NRC, 2002) are utilized during this study. Therefore, this study also consists of the extensive review of the advanced technologies and their potential savings.

INCREASING FUEL ECONOMY STANDARDS

Only 15% of original energy from the fuel conversion to the wheels provides acceleration, overcome aerodynamic drag and rolling resistance. The rest is lost; therefore because of this the potential to improve fuel economy with advanced technologies is enormous. Energy balance for a vehicle is presented in Fig. 1 (Advanced Technologies, 2006).

All of these steps at which energy is wasted are opportunities for advanced technologies to improve the fuel economy standards for motor vehicles. The technologies available are continually involving and those currently available can be utilized more widely. As emerging Technologies, now in the late stage of development and will like to be introduced over the next several years and advanced technologies in the R and D stage could also become available over the next 10-15 years. A complete study of these technical issues can be

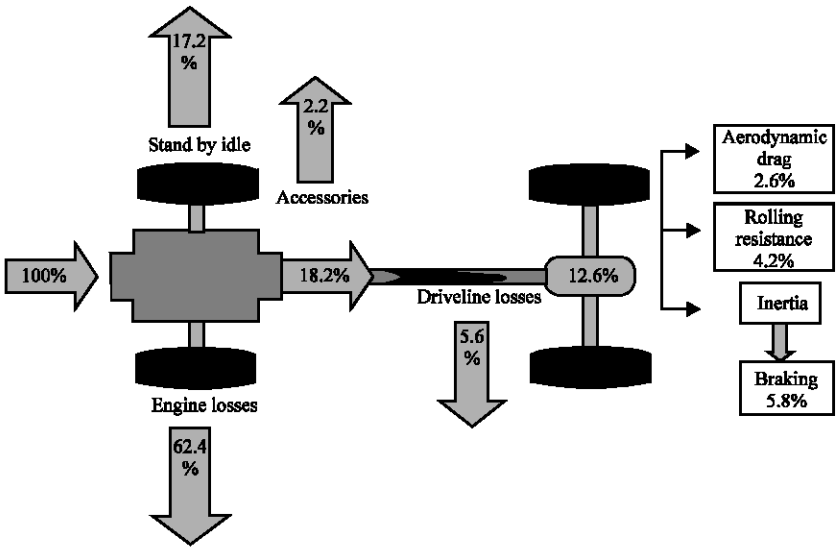

Fig. 1: Energy balance for a vehicle daily

found in NRC (2002), DeCicco *et al.* (2001), DeCicco and Ross (1996) and US Office of Technology Assessment, 1995).

CLASSIFICATION OF TECHNICAL OPTIONS

In order to improve the fuel economy of motor vehicle, the technical options can be classified as followed. These technologies and their associate costs and potential efficiency improvement are summarized in the Table 1 and 2 (NRC, 2002).

Powertrain technologies: Powertrain technologies, which include engines, transmission and the integrated starter-generator. According to the National Research Council (NRC), the engine, transmission and vehicle technologies listed here are likely to be available within the next 15 years (NRC, 2002). Some listed as production intent are already available and are well known to manufacturers and their suppliers and could be incorporated in vehicles once a decision is made to use them, other designated emerging are generally beyond the R and D phase and are under development and are sufficiently will understood that they should be available within 10-15 years.

Load reduction technologies: Load reduction technologies, which include mass reduction, streamlining, tire efficiency and accessory improvements. The Office of Technology Assessment (OTA) study found relatively good agreement among the major US, German and Japanese automakers on potential reduction in tractive loads (Plotkin and Greene, 1997). OTA`s conclusions about reductions, based on both the automakers views and a combination of literature review, interviews with suppliers and examination of prototype, are as given below:

Table 1: Potential increase in fuel economy and price for production intent technologies

Production-intent technology	Fuel economy improvement (%)	Retail price ($) increases
Engine Technologies		
Engine friction and other mechanical/ hydrodynamic loss reduction	1-5	35-140
Application of advanced low friction lubricants	1	8-11
Multi-valve, overhead camshaft valve trains	2-5	105-140
Variable valve timing	2-3	35-140
Variable valve lift and timing	1-2	70-210
Cylinder deactivation	3-6	112-152
Engine accessory improvement	1-2	84-112
Engine downsizing and super charging	5-7	350-560
Transmission Technologies		
Continuously variable transmission (CVT)	4-8	140-350
Five speed automatic transmission	2-3	70-154
Vehicle Technologies		
Aerodynamic drag reduction on vehicle design	1-2	0-140
Improved rolling resistance	1-3.5	14-56

- Drag coefficient from average of 0.33 down to at least 0.25, optimistically to 0.22, will give rise a gain in fuel economy 6-7%.
- Rolling resistance from average of 0.008~0.010, down to about 0.005, will give rise a gain fuel economy up to 8%.
- Regarding the weight, with steel (and aluminum engine), up to 15% reduction in curb weight;

Table 2: Potential increase in fuel economy and price for emerging technologies

Emerging technology	Fuel economy improvement (%)	Retail price increases ($)
Engine Technologies		
Camless valve actuation	5-10	280-560
Variable compression ratio	2-6	210-490
Intake valve throttling	3-6	210-420
Transmission Technologies		
Automatic shaft/manual transmission	3-5	70-280
Advanced continuously variable transmission	0-2	350-840
Automatic transmission with aggressive shaft logic	1-3	0-70
Six-speed automatic transmission	1-2	140-280
Vehicle Technologies		
42-V electrical system	1-2	70-280
Integrated starter/generator (Idle off-restart)	4-7	210-350
Electric power steering	1.5-2.5	105-150
Vehicle weight reduction (5%)	3-4	210-350

aluminum intensive (not optimized), 20% reduction; optimized aluminum, 30% reduction; with carbon fiber composites, up to 40% reduction, will give rise a gain in fuel economy 9-24%.

TRANSPORT REGULATION

In order to set fuel economy standards for motor vehicles, rules prescribed by government or management are to be developed after passing through a consultative process involving government and industry representatives. Table 3 lists the various international regulations and or guidelines aimed at improving new vehicle fuel efficiency for some selected countries (OECD, 1997).

FUEL ECONOMY LABELING SCHEME

This section provides the information about the existing and planned vehicle fuel economy labeling schemes in several selected countries. A voluntary fuel economy labeling scheme has been in place since 2003 (Singapore Government, 2006). Vehicle labeling schemes have also been in existence for several years in Sweden and the United States since 1975 and in the UK since 1983. The American scheme was amended in 1990 and the Canadian scheme in 1998, in the light of consumer feedback. Summary of fuel economy energy labels for motor vehicle in several selected countries are given in Table 4 (Boardman *et al*., 2000).

IMPLEMENTATION POSSIBILITIES IN PAKISTAN

Like all developing countries, the course of economic development in an increasingly integrated country like

Table 3: Examples of transport regulations in selected countries

Country	Regulation description
Czech Republic	Specific fuel consumption targets agreed and implemented
Japan	Fuel efficiency targets for 2000 set, average 8.5% improvement over fiscal 1992 levels. 5% target for average improvement in fuel efficiency for petrol trucks
Russian Federation	Development of vehicle fuel efficiency standards proposed
Sweden	Target for private car average fuel consumption of 6.3 liters per 100 km by 2005 has been proposed. Since new car fuel economy was 8.4 L per 100km in 1993i, this implies an improvement of 25% over the period 1993 to 2005. Volvo has committed itself to a 25% reduction in average fuel consumption by 2005
Switzerland	Federal Government Ordinance on reducing the specific fuel consumption of cars. Requirement is for a 15% reduction in average fuel consumption in the period 1996 to 2001 (3.2% per year).
United States	Corporate Average Fuel Efficiency (CAFE) standards Implemented in 1975, came into effect for cars in 1978. Last revised in 1992 currently 27.5 mpg (8.55 liters per 100 km).
European Union	Commission Communication COM (95) 689, 20 December 1995, Council Conclusion of 25 June 1996. Objective is to achieve an average of 120 gm km^{-1} CO_2 emissions (approx. 5 l/100km) for new cars by 2005 Target is aimed at European made vehicles, but plans are to extend the targets to imports as well.

Pakistan has generated considerable growth in motor vehicles. The number of vehicles in Pakistan has jumped from 680,000 in 1980 to about 5,200,000 in 2004 showing an overall increase of more than 664%. (Government of Pakistan, 2005). As air pollution is one of the environmental problems in Pakistan and the road transport has been considered one of the major contributors. It is also fact that the amount of CO_2 emitted from distance traveled is directly proportional to fuel economy. In order to protect the environment and to take measures to control emissions, following environmental protection related legislations have also been introduced in the country:

- Pakistan Environmental Protection Ordinance, 1983
- National Environmental Quality Standards (NEQS), 1993
- Pakistan Environmental Protection act, 1997
- National Environmental Quality Standards (NEQS), Revised, 2000

Unfortunately, enforcement of environmental regulation has historically been very lax and vehicle emission regulation is particularly hampered by lack of enforceability. A recent study was carried out by Pakistan Environmental Protection Agency (PEPA) with the assistance of Japan International Cooperation Agency (JICA) to access the pollution level in traffic congested areas in three main cities namely Islamabad; Rawlpindi; and Lahore. Study found that the average Suspended Particulate Matters (SPM) in these cities were 6.4 times

Table 4: Fuel economy labeling schemes in selected countries

	Austria	Australia	Belgium	Canada	Denmark	Netherlands	Sweden	Switzerland	USA
Planned or Existing	Planned	Planned	Planned	Existing	Planned	Planned for attachment to cars -existing on website	Existing	Planned. Temporary label in meantime	Existing
Scope	As directive	Passenger cars, maybe extension to light commercial vehicles, 4×4	As directive	New cars, vans, light duty trucks	As directive	As directive	All passenger cars	As directive	New cars, vans, light duty trucks
Introduction date	As directive	2000	As directive	1998	1 Jan 2000	As directive	1977	As directive but temporary label prior to that	1975
Mandatory?	Yes	Yes	Yes	No	Yes	Yes	No	No: Temporary	Yes
Units of consumption	L/100km	L/100km	L/100km	L/100km mpg	mpg	L/100km	L/100km	Not shown; L/100km in guide	Yes mpg
Comparison by absolute measure or relative scale	Relative by size and sales weighted	Absolute but perhaps label changed to appliance star style (relative)	Relative by size and sales weighted	Absolute	Absolute comparing all cars	Relative by size and sales weighted	Absolute	No scale shown but efficient designation with sales weighted comparison for all same weight	No scale but range of consumption shown for cars of same size
Comparison parameter	width X length	None	width X length	None	None	width X length	None	weight	size class
Other measures of consumption	As directive	None	As directive	Annual fuel cost (focus of label)	Krona/year Krona/ 20000 km Krona/ 60000 km	Cost/ 50000 km Cost/L	None	None	None
CO_2	Intention to include values	No	As directive	No	Yes (g CO_2/km)	Yes (gCO_2/km)	Yes (g CO_2/km)	Not shown but in guide (g/km)	No-intended for the guide
Environmental ranking	No	No	No	No	No	No	Yes, ranking 1 to 3	No	In guide byACEEE
Printed guide	Intended	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Online guide	Intended	Yes	Yes	Yes	Intended	Yes	Yes	Intended	Yes
Fiscal integration	Yes-with fuel consumption tax (No VA)	No	Intended	No	Yes with fuel consumption tax (green owner)	Yes with relative consumption	With enviro. rating	Intended-either to CO_2 or fuel consumption	
New cars sold to fleet buyers	15% maximum	10-15%	-	10%	-	10%	-	< 5%	10%

higher than WHO guidelines and 3.8 times higher than Japanese standards. Presence of such a high levels of SPM in our air is definitely a matter of great concern due to its adverse impacts on human health. Under the provisions of World Trade Organization (WTO) agreement, Pakistan would have difficulty without adequate environmental safeguards (Abedullah, 2006). It is therefore clear that Pakistan needs to place greater emphasis on environmental protection to stem the country's environmental degradation and safeguard citizens` health.

In road transport sector, during year 2001-2002, Pakistan consumed diesel oil 6.96 or 6.88 million tonnes of oil equivalent (84.1%), gasoline 1.09 m tons or 1.12 m TOE (13.8%) and CNG 7369 MMCft or 0.17 m TOE (2.1%). Similarly, during year 2003-2004 (estimated) diesel oil was supposed to be consumed 6.31 m tons or 6.63 m TOE (80.2%), gasoline 1.19 m tons or 1.27 m TOE (15.5%) and CNG 15172 MMCft or 0.35 m TOE (4.3%). The sectoral oil consumption share for 2004-2005 of total 15,124,290 metric tones is shown in Fig. 2 (Year book, 2004-2005).

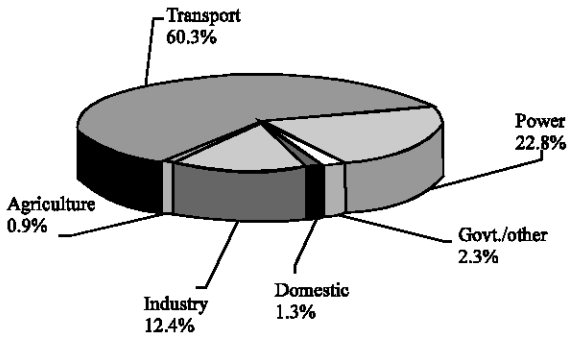

Fig. 2: Sectoral oil consumption 2004-2005

In Pakistan, fuel consumption increased by 65% from 1990 to 2004 (Government of Pakistan, 2005). The import bill of crude oil and petroleum products was approximately $4.53 billion during the 2004-05 (Year book, 2004-2005). This heavy burden of oil import bill on national exchequer is a matter of great concern for the government. Therefore, to minimize the fuel consumption in road transport sector and adverse impacts of motor vehicle emissions on the environment and society, stopping the growth in motor vehicle use is neither feasible nor desirable, given the economic and other benefits of increased mobility. The challenge then is to manage the growth of motor vehicles through fuel economy standards and labels to maximize its benefits in the future. Studies in developed countries have shown that fuel economy standards and labels are being beneficial for the society, government as well as environment. In this regard, by the combination of standards and labels, Pakistan will be able to promote the better fuel economy vehicle and will begin an important market transformation for the vehicle in the country.

Proposed recommendations: The study proposes some recommendations to gain an optimum impact from possible fuel economy standards and labels implementation for motor vehicles in Pakistan. The recommendations are:

- Self-reliance instead of self-sufficiency is the bottom line of Pakistan's industrial policy. Therefore it is the responsibility of the government to implement the fuel economy standards and labels. However government and automotive sectors in Pakistan should cooperate with each other to devise the ways to achieve this target.
- As consumers are crucial to the success of the labelling program, sustained information campaign is needed and the label's design should incorporate consumer feedback simultaneously and once standards and labels have been implemented, it is necessary to evaluate their effectiveness. The evaluation is important to identify the areas of weakness in the program design and implementation so that these can be strengthened.
- An independent laboratory for testing purposes owned by the government or an independent body should be developed as one of the main step to implement the fuel economy standards and labels. This includes the facility to predict traffic behavior, vehicle maintenance and the type of road.
- Setting up of well equipped petrol/diesel/CNG vehicle testing centers in all major cities and ripple effect of current activities by organization like ENERCON, VETS, NTRC and EPA.
- Policy paradigm has to be characterized by continuity, consistency and connectivity.
- Vendor industry in Pakistan should be supported to upgrade its technologies through joint ventures and technology tie-ups.
- Pakistani government should conduct awareness campaign on how to drive efficiently.

CONCLUDING REMARKS

The explosion in demand for the transportation of both people and goods is one of the causes that lead on high rates of growth in demand for oil products and in increasing GHG emissions. Mostly in Asian countries, this growth for oil products may be expected more rapid than the growth of the economy as a whole. Oil consumption growth and GHG emissions can only be reduced when private transportation demands fall or when the fuel efficiency of the motor vehicles strongly improves. In Pakistan, technology used in engines installed has lagged considerably behind prevailing international standards. Manufacturers avoid making efforts to invest more in upgrading production facilities to produce newer models based on more efficient engine designs. As automotive industry is intensely competitive and significantly influences the economic, environmental and human conditions of nearly every nation on the earth. In this regard, due to the increasing number of motor vehicles, a well-planned strategy should be adopted by the government now. Therefore, government should implement the fuel economy standards and labels for motor vehicles and should also encourage the automotive manufacturers to produce more fuel-efficient vehicles. This effort would lead to the preservation of our limited nonrenewable energy resources and our living environment. Through this improvement, hopefully the product can exceed any tough fuel consumption standards set by some countries. Finally, after having very clear understanding of huge economic losses of environmental degradation and oil consumption growth it is easy to conclude that introducing fuel economy standards and labels for motor vehicles in Pakistan is one of the most effective strategies to get the targets of providing economic benefits, better environment and reducing oil consumption growth in road transport sector in the future.

REFERENCES

Abedullah, 2006. Sources and consequences of environmental pollution and institution's role, in Pakistan. J. Applied Sci., 6: 3134-3139.

Advanced Technology, 2006. Energy Technologies and Fuel Efficiency. www.fueleconomy.gov

An, F. and A. Sauer, 2004. Comparison of Passenger Vehicle Fuel Economy and Greenhouse Gas Emission Standards around the World. Pew Centre on Global Climate Change, 2101 Wilson Boulevard, Suite 550, Arlington, VA 22201.

APEC Automotive Dialogue, 1999. Automotive Industry profile, Canada.

Boardman, B., Nick Banks, R. Howard Kirby, Sarah Keay-Bright, J. Barry Hutton and G. Stephen Stradling, 2000. Choosing Cleaner Cars: The Role of Labels and Guides. Environmental Change Institute, University of Oxford, UK.

Dargay, J. and D. Gately, 1997. Vehicle ownership to 2015: Implication for Energy Use and Emissions. Energy Policy, 25: 1121-1127.

DeCicco, J. and M. Ross, 1996. Recent advances in automotive technology and the cost-effectiveness of fuel economy improvement. Trans. Res., 1: 79-96.

DeCicco, J., F. An and M. Ross, 2001. Technical Options for Improving the Fuel Economy of Us Cars and Light Trucks by 2010-2015. American Council for an Energy Efficient Technology, July 2001.

Government of Pakistan, 2005. Economic survey of Pakistan 2002-2003. Finance Division, Islamabad.

Guangzhou, 2003. Beijing Prepares S Tough Fuel Economy Standards for Cars. The New York Times, November 19.

He, K., H. Huo, Q. Zhang, D. He, F. An, M. Wang and M.P. Walish, 2005. Oil consumption and CO_2 emissions in China's road transport: Current status, future trends and policy implication. Energy Policy, 33: 1499-1507.

Kirby, E.G., 1995. An evaluation of the effectiveness of US CAFÉ policy. Energy Policy, 23: 107-109.

Koopman, G.J., 1997. Long term challenges for inland transport in the European Union: 1997-2020. Consequences for transport fuel economy and use. Energy Policy, 25: 1151-1161.

NRC, 2002. National Research Council, National Academy of Sciences. Effectiveness and Impact of Corporate Average Fuel Economy (CAFÉ) Standards. National Acad. Press, Washington, DC.

OECD, 1997. Organization for Economic Co-operation and Development, Ministers of Transport. CO_2 Emissions from Transport, European Conference of Ministers of Transport, OECD.

Plotkin, S.E. and D. Greene, 1997. Prospects for improving the fuel economy of light-duty vehicles. Energy Policy, 25: 1179-1188.

Plourde, C. and V. Bardis, 1999. Fuel Economy Standards in a Model of Automobile Quality. Energy Economics, 21: 309-319.

Singapore Government, 2006. Voluntary Fuel Economy Label. Ministry of the Environment and Water Resourecs. Also available at (http://www.mewr.gov.sg/nccs/transport.htm).

US Office of Technology Assessment, 1995. Advanced automotive technology: Visions of a super-efficient car. OTA-ETI-638, September 1995.

Waller-Hunter, J., 2001. The environment: From words to action. OECD Environment Directorate. Published in OECD Observer, June 2001. Also available at (www.oecdobserver.org/news/fullstory.php/aid/490/The-environment:-From-words-to-action.html)

WHO, 2004. World Health Organization. Health Aspects of Air Pollution Results from the WHO Project. WHO Regional Office for Europe. DK 2100. Copenhagen Denmark.

Yearbook, 2004-2005. Government of Pakistan, Ministry of Petroleum and Natural Resources, Islamabad.