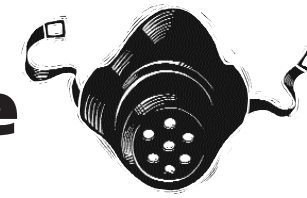
DRAFT FOR COMMENTS

Avert the great guzzle



FUEL ECONOMY REGULATIONS: SETTING THE PRINCIPLES RIGHT

RIGHT TO CLEAN AIR CAMPAIGN

2008

CSE

CENTRE FOR SCIENCE AND ENVIRONMENT, DELHI

CONTENTS

WHY THIS STUDY?

The oil price surge has caught the market watchers and media agog. Expert views war on price insulation, energy security and our vulnerability. But oil price peaks do not make lasting impression on the public memory as the Government either makes generous cuts in petrol and diesel prices and taxes or caps its increase to take the heat off the price rage. Consumers are thus insulated at a huge cost. Vehicle industry is not pushed to innovate to ensure substantial fuel savings through efficiency gains. There are no checks on them as they continue to drift towards bigger and more powerful cars.

Price shocks have not provoked policies to prevent the oil guzzle for a more energy secure and low carbon future.

Transport sector is the largest user of oil – nearly half of the total consumption, and is poised to make India's oil security even more precarious. Asian Development Bank projects that the total fuel consumption of on-road vehicles in India in 2035 can be six times over that of 2005 level. Explosive growth in personal vehicles and steady shift of freight transport from railways to roadways will incite ravenous appetite for energy. The Integrated Energy Policy 2006 estimates that 50 per cent improvement in fuel efficiency can help save nearly 86 million tonnes of fuel by 2030-31, which at current prices amount to more than US $36 billion. Petroleum Conservation Research Association further interprets this to suggest that this amounts to 65 per cent of total current consumption and in terms of carbon dioxide emissions reduction it is equal to removing 7 million of today's four wheeled vehicles.

The Indian car industry however, is celebrating the record sales figures. And the Automotive Mission Plan that aims to expand the auto hub in India does not link the new investments with stringent fuel efficient and clean emissions targets. It is indefensible that the government should be so willing to forego public revenue to support car industry that has no legal obligation to meet fuel efficiency standards.

How fuel efficient, are our cars? Nobody knows. The fuel economy level of Indian car models is confidential. There is no official policy to get carmakers to publish the fuel economy levels of models they make. The valued Indian customer relies on anecdotal information, the car-owner grapevine, car companies' self-proclamations or data the niche car magazines publish. There is no official certification data to back the claim of the car companies.

The fuel economy data for vehicle models that are routinely published in other countries, are not accessible even under the Right To Information Act in India, as the Centre for Science and Environment has found out. They are all on denial mode. The vehicle certification agency, Automotive Research Association of India that certifies vehicles claims that the "numerical value of fuel consumption of each model is of commercial confidence in nature and third party information." The

Union ministry of shipping, road transport and highways that regulates certification of vehicle says it does not maintain the results of type approval tests. The Ministry of Commerce and Industry that has mandated inclusion of the fuel economy data in the procurement policy of government vehicles said individual ministries can give that information. The Union ministry of heavy industries that administers the auto sector, disowned all responsibility regarding the issuance of fuel economy data under the Auto Fuel Policy stating that this is the responsibility of the Ministry of petroleum and natural gas. The Petroleum ministry responsible for the Auto Fuel Policy, that has mandated declaration of fuel economy data of all vehicle models by the auto makers, passed the buck to its research wing PCRA claiming that the matter pertains to that organisation. And PCRA replied, "So far PCRA has not made any Auto Fuel Policy." The buck stops here.

It is reprehensible that such crucial data of public interest is not available either to the consumers or to the regulators for rule making when the country is reeling under severe economic strains from rising cost of crude oil imports.

So far, ironically because of lower level of income thresholds, the Indian market has favoured small cars and two wheelers. As small engines use less fuels the average fleet-wide fuel consumption is expected to be low. But already, with rising income levels there is steady shift towards bigger cars that use more fuels. The share of the mini cars has dropped from 21 per cent in 2001 to 11 per cent in 2004. Taking their place are the bigger cars in compact, mid size and high end segments.

The Indian automobile industry is in a mood of denial. It argues that in the current competitive environment fuel efficiency is the unique sales proposition. Those not meeting the customer expectation lose market. Regulatory intervention on this front is not needed. They are also scared of the customer wrath – what if the on-road performance does not match industry claims.

Worldwide standards are crafted by the governments to benchmark improvement in efficiency levels of the vehicle technologies, provide a level playing field for companies to compete fairly with each other and allow consumers to compare models on the basis of fuel economy levels while shopping.

Standards can make a significant difference in India. The limited fuel efficiency data from the vehicle certification agency Automotive Research Association of India (ARAI) shows that there is wide variation in the efficiency levels of different car models even within the specific group of vehicles classified on the basis of their engine cubic capacity. If in the same class the efficiency level of the laggards can make appreciable improvement to catch up with the efficiency level already achieved by the best in the class, there can be substantial efficiency gains and fuel savings – more than 30 per cent.

Corporate profit can take a hard hit if car companies drift towards oil guzzlers. Studies show that in the US the big Detroit automakers – General Motors, Ford motor company and Daimler Chrysler that relied heavily on fuel inefficient big sport utility vehicles (SUV) have suffered heavy losses as consumer demand shriveled due to soaring oil prices recently. About 75 per cent drop in the sales will lower their profits by US $7 billion.

If the Indian government allows fuel prices to reflect the actual market trends, Indian car companies, producing fuel inefficient big cars and SUVs, stand to face similar risks.

Fuel economy improvement will also help the Indian industry, which is aiming to globalize, to become more competitive. The societal benefits in terms of fuel savings can be enormous. Also the ancillary benefits from the avoidance of green house gas emissions escalation will be significant. Without fuel economy regulations there can be steady increase in size, weight, and power of vehicle fleet as has been noticed in other countries and also in India. While technology is advancing rapidly in other regions, there is huge potential for rapid diffusion of improved technologies if regulatory standards are in place in India.

Learn from others

Regulations in India should be crafted based on the experience and lessons from other countries and the uniqueness of the Indian situation. Nearly nine regions of the world have already enforced fuel economy regulations – Europe, China, Japan, California, USA, Canada, Australia, Taiwan, and South Korea. These together cover a significant proportion of vehicle population around the world. Major technology solutions have begun to configure in these regions. India cannot stand isolated.

However, there is no common strategy that fits all. Widely different regulatory approaches prevail depending on the primary objective of the nations. This can be direct fuel savings in countries that are facing energy crisis and are heavily dependent on oil imports. Or direct regulations of greenhouse gas emissions or carbon-di-oxide emissions if combating global warming is high on the agenda. Both the strategies however, are directly linked with the fuel consumption in the transport sector.

Japan and China regulate fuel economy of vehicles based on fuel consumption per unit of distance traveled. European Union regulates CO_2 emissions from vehicles that is linked to the fuel consumption. Only California controls total green house gas (GHG) emissions from vehicles that include GHG from air conditioning in cars, nitrous oxides from cat converters, methane etc. These countries have not only set fuel economy standards but some of them have also begun to tighten their standards further. The comparison of these standards carried out by the US based International Council on Clean Transportation in 2007 highlights the key elements of this race. Europe had begun with the most ambitious but voluntary target of CO_2 reduction from its car fleet but its car industry has failed to meet the target. It has slipped behind Japan that is on its way to achieve the most stringent and mandatory fuel economy standars for passenger vehicles in 2012. Japan will nearly equal the original target for CO_2 emissions reduction of Europe. The United States that slumbered for more than 20 years is now on the verge of passing new corporate average fuel efficiency standards (CAFÉ) that would raise the standards from about 25 miles per gallon (mpg) today to 35 mpg by 2020. The US Environmental Protection Agency is also working on a GHG emissions standards for passenger vehicles. California has aimed at maximum improvement from the current base levels over the next decade.

In the developing Asia, China has not only set fuel economy regulations but has also implemented taxation measures to promote fuel efficient small vehicles. The Chinese standards are so stringent that the bigger US cars are finding it difficult to enter this market. India which is aspiring to be an auto hub cannot ignore these developments.

However, a lot can go wrong if fuel economy regulations are not properly designed and lead to unintended consequences. We have learnt from other countries that if these regulations are ill designed, efficiency standards can be in conflict with emissions reduction objectives. For example, the US made the mistake of keeping the

standards for SUVs lax initially when their numbers were very small. When the share of SUVs expanded significantly over time the fleet average fuel economy worsened.

Similarly, learn from Europe's mistake. The European Union had entered into a voluntary agreement with the car industry associations to meet the toughest CO_2 emissions reduction target by 2008 on a fleet-wide basis, and expected to make huge fuel savings. But the voluntarism did not work. European Commission did not enforce strong monitoring and compliance system for individual car companies. Over time power and size of the fleet began to increase that impeded fuel economy improvement. Also taking advantage of the flexibility that fleet-wide target provides – (which means not achieve absolute and equally stringent improvement in all individual car models but maintain an average by mixing more efficient models with lesser ones), the European companies resorted to expanding the fleet share of diesel cars that are relatively more fuel efficient but more polluting. The net result today is that the EU has failed miserably to meet the voluntary CO_2 reduction target and at the same time its cities have begun to violate the air quality standards.

This kind of voluntarism and regulations that are hard to monitor will not work in India**.** Like China, India also needs to develop a system that is mandatory, and is easy to monitor and enforce. Both China and India do not have sophisticated tools for monitoring and for assessing compliance. For instance, it is difficult to determine compliance with standards and enforce corporate average target as vehicles sales and registration data are not accurate or verifiable in India. There is also no centralized database available to the regulators to assess the compliance levels.

China provides a good model in which efficiency standards for the heavier vehicles are made more stringent to offset the impact of SUVs and bigger vehicles. Japan and California have taken multi-pronged approach – they have set tight fuel economy and green house gas emissions regulations along with stringent fuel neutral emissions standards. India needs to learn from these roadmaps.

Action in India

Who will set fuel economy standards in India? When this question was raised in early 2007 there was no clarity. The current laws (Central Motor vehicles Act) that also set the emissions and safety standards for vehicles in the country does not have any legal provision for setting of energy efficiency standards for vehicles. However, carbon dioxide measurement method that is needed to estimate fuel economy of vehicles and is collected during vehicle certification and type approval is notified under the Central Motor Vehicles Act.

Finally the solution has been found in the Energy Conservation Act that is the umbrella legislation for energy conservation efforts in all sectors of economy including transportation. Bureau of Energy Efficiency (BEE), a statutory body under the Union ministry of power, administers this act. The very recent agreement, that the Petroleum Conservation and Research Association (PCRA), an autonomous body under the Union Ministry of Petroleum and Natural Gas has signed with BEE to develop and notify the fuel eonomy standards, helps to sort out the legal tangle. Removes the first roadblock.

If we have come this long, it is important that the standards are designed carefully. Comprehensive approach is needed to improve fuel efficiency and emissions from vehicles. It is therefore, important to set the principles right.

Set fuel economy standards: Given the imperative of energy security in India regulating fuel economy levels of the vehicles will help to achieve substantial fuel

savings. This tangible benefit can help to enlist public support for the regulations. Consumers are more sensitive to changes in fuel economy levels of the vehicles in India. Fuel economy regulations will also give ancillary benefit of reducing heat trapping carbon dioxide emissions for climate benefits.

Set mandatory standards: Voluntary efforts make compliance more uncertain especially when industry begins to increase the power and performance of the vehicle that affects overall fuel efficiency of the fleet. Voluntary system has not worked anywhere in the world. Standards should be legally enforceable.

Standards should target key vehicle segments: Separate set of fuel economy standards can be developed for passenger vehicles and heavy-duty vehicles as distinct programmes in phases. Passenger vehicles market are very sensitive to fuel economy changes and thus has a strong potential for fuel savings. Set standards for heavy-duty vehicles given the fact that road based freight transport and also public transport is expected to grow dramatically in the future and these guzzle substantial share of transport fuel. Given the very large number of two-wheelers and growing interest in bigger engines in India standards for these vehciles can be introduced in the next step to protect the baseline. Till that time these vehicles should be brought under labeling and fuel economy related tax measures.

Design standards carefully: There are so many different ways that fuel economy and GHG regulations have been designed across regions. But clear lessons from all of them is that standards should be designed carefully to prevent leakages. If standards do not prevent drift towards heavier vehicles, fuel saving potential of the regulations can be eroded. If efficiency gains are not balanced adequately with emissions conrol strategies countries can get locked in serious efficiency vs emissions trade off. For instance, diesel cars may afford some fuel savings but they can increase toxic emissions manifold if clean diesel emissions standards are not in place. Fuel economy regulations should be designed to maximise fuel savings and GHG emissions reduction benefits without compromising on the safety and emissions requirements. India already has the advantage in its predominantly small car fleet that are relatively more fuel efficient than big cars and SUVs. Standards can help to protect the baseline and then make improvements.

Standards should be enforceable. Define the enforcement structures upfront: Design standards that are easier to enforce and do not have to rely on complicated administrative and enforcement structures. Fuel economy regulations will require appropriate adminstrative structure and data recording system for monitoring, compliance and effective implementation of the standards. Fuel economy or GHG regulations that rely more on giving greater flexibility to the manufacturers to meet standards as in the US CAFE system or in the European CO2 regulations, require sophisticated and complex supervisory structures. In Japan for instance, all registration data including fuel efficiency data are stored in one government server called MOTAS along with data on the tax incentive for each vehicle that are submitted. For judging compliance with the standards, each company submits necessary data to the government annually, and the government checks the data by using the central server. On the other hand, a minimum standard that each model of vehicle needs to comply with as in China is more practical especially when enforcement systems are premature. The degree of sophistication of the enforcement systems can be improved over time as more experience is gathered.

Disincentivise big cars: Tax policies must continue to prevent shift towards heavier vehicles, while also reducing car usage. Yet again China provides a good model in which efficiency standards for the heavier vehicles are made more stringet for that

class of vehicles to offset the impact of SUVs. The argument that India predominantly produces fuel efficient small cars and therefore fuel economy regulations are not needed is not correct. The Japanese standards are more stringent for small cars. When large volumes are produced two small cars combined generally consume more fuel than a large car. Small cars should also achieve durable clean emissions and efficiency performance.

Remove perverse incentive for diesel cars: Fuel efficiency standards should not be traded off for higher harmful emissions. Diesel cars score moderately high on efficiency and lower carbon dioxide emissions per unit of distance, but are high emitters of harmful emissions. Much of its efficiency gains and climate benefits can be lost if more diesel is burnt due to its cheap costs. More carbon dioxide is emitted per litre of diesel than petrol as it has higher carbon content. Therefore, additional tax measures are needed to offset the lower cost of diesel fuel and check dieselisation. At the same time clean diesel standards (diesel fuel with less than 15-10 ppm sulphur used with advanced particulate trap) should be implemented to check toxic emissions. Despite having retail prices of diesel at about two third of petrol Japan has been able to prevent dieselization with stringent emissions and fuel efficiency standards.

Tax measures and fuel economy labelling can activate market: Tax policy and labelling linked to fuel efficiency of vehicles must be enforced along with fuel economy standards for the most effective impact. This has been found to be very effective around the world in influencing consumer demand for fuel efficient vehicles and also check drift towards bigger vehicles.

Technology solutions exist. Standards can enable them: A combination of technical approaches is possible for fuel savings -- weight reduction, drag reduction, rolling resistance reduction and improving engine technologies. The fuel economy regulations should be designed to accelerate innovations and also enable early introduction of advanced technology options such as electric hybrids etc. Fiscal measures are needed to enable rapid commercialisation of these technologies.

The recent policy decision to set the fuel economy standards for vehicles is an important step forward in India. But these need to be designed well and implemented on time to avert the great guzzle.

Anumita Roychowdhury
Vivek Chattopadhyaya
Jayeeta Sen
Priyanka Chandola

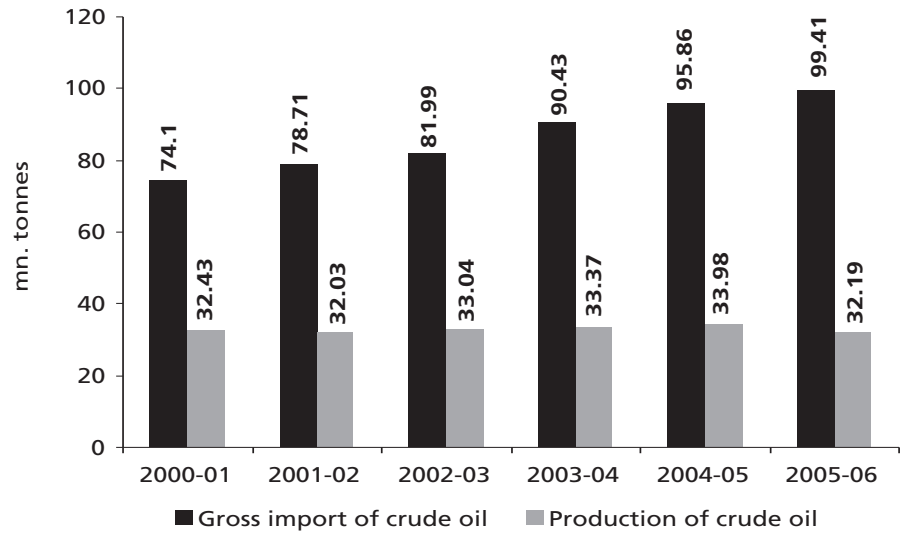
1. TRANSPORT AND ENERGY SECURITY CONCERNS

The *Integrated Energy Policy 2006* released by the Planning Commission, the apex planning body in India, has warned that energy would pose as one of the biggest constraints if India expects to sustain 8 to 10 per cent GDP growth over the next 25 years. Also at this growth rate the oil consumption will more than quadruple over the next two decades.

India's domestic crude oil production will not be able to meet even the smallest fraction of this surging demand. Already, nearly 78 per cent of the crude oil requirement is imported[2]. The total domestic crude oil production in 2006-07 has been around 35.11 million metric tonne, which is a very small fraction of the 111 million metric tonne of crude oil and petroleum products that was imported during 2005-06[1]. According to the projection of the Paris based International Energy Agency (IEA) about 94 per cent — nearly the entire requirement of India will have to be imported by 2030. The oil import bill is more than one fourth of the total import bill of India's foreign trade.

Increased dependence on oil imports has also made India vulnerable to price shocks that the world has witnessed in the recent past. According to the IEA India spent equivalent to 3 per cent of GDP on oil imports in 2003. India can loose 1 per cent of its GDP due to the rising prices.

Figure 1: Energy insecurity: Crude facts



Source: Based on Petroleum and Natural Gas Statistics of Ministry of Petroleum and Natural Gas and Integrated Energy Policy 2006 of Planning Commission of India

Increased dependence on oil imports has made India vulnerable to price shocks

In this scenario the transport sector that already uses up more than 40 per cent of the total oil and oil products in the country[3] threatens to worsen the energy crisis. While as much as 98 per cent of the total petrol stock is used up by the transport sector, nearly 62 per cent of India's total diesel fuel meets road transport needs. Petrol and diesel consumption is rising steadily since 1970s but the growth rate is higher after 1990s when the economy opened up. The trend in demand for petroleum crude closely follows the economic growth curve. (See Figure 2: *Trend in GDP and oil consumption*).

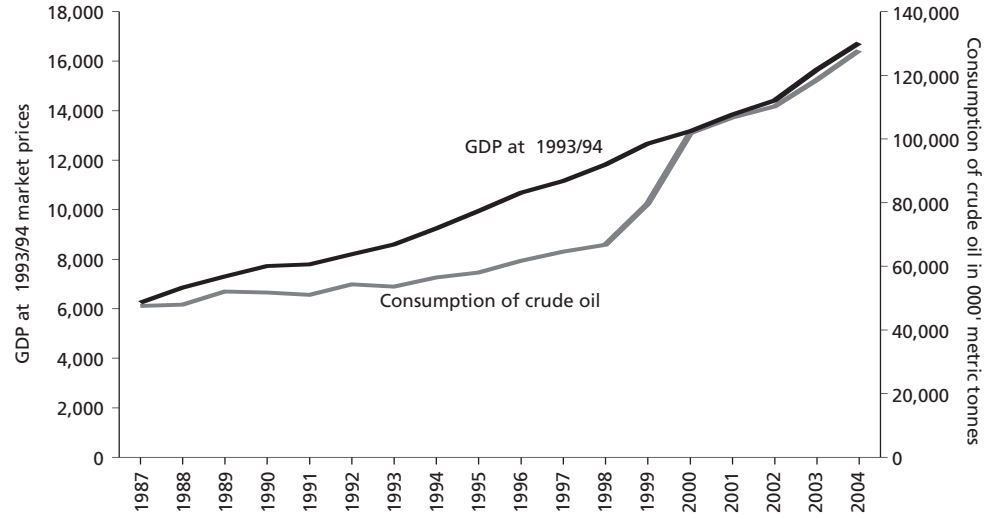
Retail prices of petrol and diesel are on high tide since 2002 but reached a record high when the crude prices peaked last year. Petrol retail prices have increased overall by 60 per cent and diesel prices by 79 per cent since 2002. The prices can rise higher if the public policy do not bar the public sector oil marketing companies from passing on the full increase in prices to the consumers. The transport fuel prices levelled off despite the steady increase in international crude prices in the recent years (See Figure 3: *Trends in international crude oil and retail fuel prices*). In February 2008, prices have been finally revised upwards.

Price caps have led to staggering under recoveries and losses. The total under recovery on account of escalated international prices of crude oil was estimated at Rs. 73,500 crore in 2006. The government along with the public sector oil companies had absorbed nearly 87.5 percent of this burden. Only 12.5 percent of the price escalation was borne by the consumers by way of a modest increase in petrol and diesel prices [4]. According to the estimates by the Petroleum Conservation Research Association the oil bonds floated by the government does not recover even one third of the losses.

This financial turmoil is further complicated by the direct subsidy on oil products (LPG and kerosene for public distribution system) that Indian government has continued to bear. The burden of subsidy increases with the increase in international prices and the Government budget comes under severe pressure.

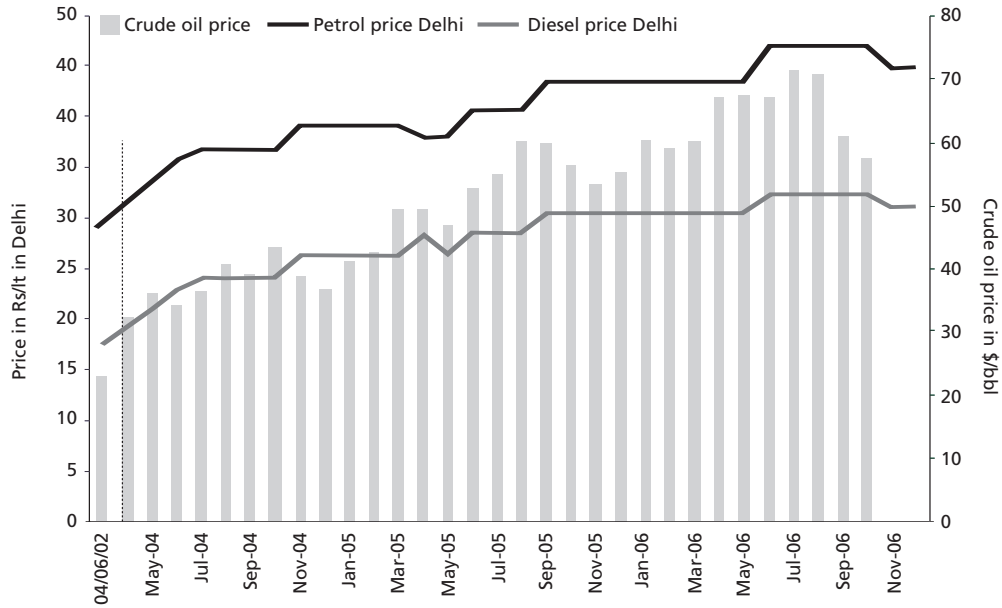
Impending climate cataclysm has further raised the concerns regarding the greenhouse gas (GHG) emissions. The transport sector will pose a serious challenge to GHG emissions reduction. Even globally the rich countries have found it most

Figure 2: Trend in GDP and oil consumption



Source: Based on data published by ADB in *www.adb.org/statisitcs*

Figure 3: Trends in international crude oil and retail fuel prices in Delhi



Note: Crude price: June 2002 crude price is of "All Countries Spot Price FOB Weighted by Estimated Export Volume (Dollars per Barrel)", thereafter the prices are of Indian basket only.

Sources: Indian Oil and US DoE

difficult to lower greenhouse gas emissions from the transport sectors. In fact, in the Annex I countries transport sector has recorded the maximum increase in GHG emissions in the transport sector at 24 per cent between 1990 and 2004 compared to the other sectors of economy.

Even in India transport is expected to complicate the challenge. Contribution of different sectors to the GHG emissions is very poorly assessed in India. Today estimates are largely quoted from a very old inventory prepared in 1994. This shows the contribution of the transport sector is a mere 8 to 12 per cent to the overall CO_2 stock in the country. This is largely because of the low rate of motorisation in the country so far. But this certainly does not account for the massive growth in vehicular stock over the years.

Related information show that growth is expected to be massive in this sector. The study conducted by the Asian Development Bank (ADB) on the *Energy Efficiency and Climate Change Considerations for on road transport in Asia* in 2006, (henceforth ADB study of 2006) on the trend in life cycle emissions of GHG from the transport sector predicts significant increase in India over a period of 2005 and 2035 – by over 90 per cent. The World Energy Outlook 2006 estimates that the share of transport CO_2 emissions in the total CO_2 emissions from oil within India is already around 35 per cent. Any national climate action plan therefore will need to focus on aggressive cuts of GHG emissions from this sector.

Any national climate action plan will need to focus on aggressive cuts in GHG emissions from the transport sector

There are special reasons to be worried about vehicles. The recently-released World Energy Outlook (WEO), 2007 of the International Energy Agency, has sounded the alert on India crossing the tipping point of per capita GDP of $3000 (on purchasing power parity basis - PPP). This threshold, once crossed, says WEO, vehicle ownership rates begin to escalate rapidly. It further estimates that the per capita GDP will increase to USD 13,000 (on PPP basis) by 2030 which will boost buying power significantly.

Vehicles will guzzle close to half of country's primary oil demand by 2030 says WEO, 2007. This increase will largely be driven by light-duty vehicles, mainly cars - the fastest growing segment — at an annual average growth of 10 per cent by 2030. Cars will burn up nearly the same amounts of total energy consumed by the entire transport sector today, even though heavy-duty vehicles will splurge the most. The rolling stock of vehicles continuously locks up huge amount of energy and carbon.

Both economic and environment cost of this energy lock up is unsustainable. Countries are now largely working with three basic approaches at varying level of progress to reduce fuel consumption and GHG emissions from transportation. These include setting greenhouse emissions or fuel efficiency standards, shifting to lower-carbon fuels and advanced vehicle technologies, and reducing the use of motorized vehicles. Technological development to improve energy efficiency per unit of vehicles remains a critical strategy even as parallel efforts are made to reduce car usage through a public transport strategy and bio-fuels programs.

While India will have to make intereventions in each of these areas for the most effetcive impact, this paper examines the need for fuel economy regulations for vehicles that are increasing at an enormous speed.

2. WHY INDIA NEEDS FUEL ECONOMY STANDARDS FOR MOTOR VEHICLES?

Explosion in vehicle numbers: India is motorizing very rapidly. Transport demand has grown at 1.2 times the GDP growth rate. According to the motor vehicle statistics available from the Union Ministry of Shipping, Road Transport and Highways (MoSRTH), total numbers of registered vehicles have increased dramatically in two decades — from 10.6 million in 1986 to 72.7 million in 2004, a seven fold increase. If two-wheelers are excluded then the total numbers of registered cars, trucks and buses, have increased from 4.3 million to 20.8 million during the same period, a five fold increase. Another projection available from the ADB study of 2006, shows that under a business as usual scenario the active population of cars and SUVs in India can increase from 6.2 million in 2005 to around 80 million in 2035.

The total fuel consumption of on-road vehicles in India can grow siz times over that of 2005 levels over the next 30 years until 2035.

The total fuel consumption of on-road vehicles in India can grow six times over that of 2005 level over the next 30 years until 2035. This will be the direct result of the unprecedented growth in commuting demand — expected to increase by 5 - 8 percent per annum.

Growing travel demand will further inflate this trend. A recent study from the Indian Institute of Technology (Kanpur) has estimated the future mobility trends in India

Table 1: Projected growth in vehicle numbers in India

Vehicle population (million)	2005	2008	2015	2025	2035
Two wheeler	35.8	46.1	87.7	174.1	236.4
Three wheeler	2.3	3.0	5.3	8.8	13.1
Heavy commercial vehicle	2.4	2.9	4.6	9.1	16.2
Light commercial vehicle	2.4	3.2	5.7	12.5	26.9
Car, Sports utility vehicles	6.2	8.8	18.0	41.6	80.1
Grand total	49.1	63.9	121.3	246.1	372.7

Source: ADB 2006, Energy Efficiency and Climate Change Considerations for on road transport in Asia, Asian Development Bank 2006, Manila

for the period of up to 2030-31 and its implications for energy demand and the resultant CO_2 emissions for the country. The estimations show that by 2030-31 on an average Indians will travel thrice as many kilometers as they travelled during the year 2000-01 and the absolute passenger mobility will be more than 12,500 billion km.[5] This increase in passenger mobility will change the modal split towards personal vehicles. As a result, the share of public transport is projected to drop from 75.7 per cent in 2000-01 to 44.7 per cent in 2030-31 and during the same period the aggregate share of private vehicles and para-transit modes is projected to increase from 24.3 per cent to 55.3 per cent respectively.[6] Energy demand will escalate from 954 peta joules (PJ) in 2000-01 to 5,879 PJ by 2030-31.

Easy financing, rising income, and changing consumer preferences will only enhance this trend. During the 1990s motor vehicle ownership in India escalated at roughly 10 per cent each year; about 15 metropolitan cities registered over 15 per cent growth. Delhi, averaging more than 200,000 car registration a year, broke its own record—more than 340,000 cars—in 2006. One in ten families in Bangalore now owns a car, and almost every family owns a two-wheeler. Just two decades ago, one of every 16 families owned a car and one in four, a two-wheeler.

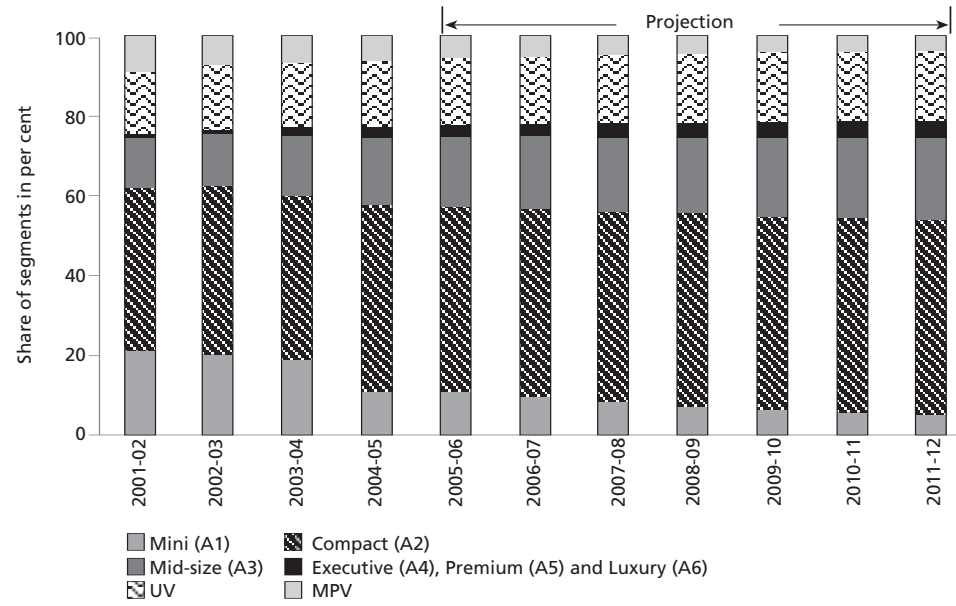
In bigger cities where most of the cars are sold the annual growth rate for cars is higher than two-wheelers. In Delhi for instance, registration of cars is increasing at a rate of nearly 8-9 per cent per annum since 2001 while two-wheelers are increasing at around 6-7 per cent per annum. This is opposite of the national trend in which car registration is increasing at 9.5 per cent per annum and two-wheelers at 11.1 per cent per annum. But even this gap is narrowing overtime.

Mororisation will get an added fillip from the government policy to promote automotive hub in India through Auto Mission Plan and tax support. It foresees huge potential market in a country where the current level of car penetration is as low as 7 cars per 1000 people. Car numbers have the highest growth potential especially as the car manufacturers are now racing to the bottom to cut costs and improve affordability of the masses. The 16 per cent annual growth rate for cars in India is already close to the 18 per cent annual growth rate reported in China. Car is a product of luxury consumption and by that corollary car emissions cannot be allowed to dominate the ecological space in cities. Policies should maximise fuel savings in this sector at the earliest for the sake of social equity and justice.

Market shifts towards heavier cars and SUVs: Perceptible market shifts have begun towards bigger and heavier vehicles that require more fuel per kilometre of travel. The trend in vehicle sales shows that customer preference is shifting steadily towards bigger cars and sport utility vehicles, thus changing the market profile significantly (See Figure 4: *Shift towards bigger vehicles*). If this trend is allowed to continue especially without fuel economy regulations, it will seriously erode the current advantages of small cars that use less fuel.

The finer changes in the car segment are dramatic. Though the overall combined share of mini (sub-compact), and compact cars in the total car sales remains nearly the same - 75 per cent - there is distinct variation in the share of each of these categories. During 2001-02, the compact cars ruled the car market with a share of 54 percent, followed by mini cars at 28 percent and midsize cars at 16 percent. During 2004-05, the share of the mini cars has reduced drastically to 14 percent, compact cars have gained to reach 61 percent. The sales of bigger midsize cars have increased to 22 percent during the same period. The executive, premium and luxury car share has also increased from little less than 1 percent to 3 percent between 2001-02 and 2004-05.

Figure 4: Shift towards bigger vehicles



Source: Computed by CSE based on data provided by SIAM

Perceptibe shifts have begun towards bigger and heavier vehicles that require more fuel per kilometer of travel

These market shifts also reflect the changing trends in market share of the car companies. The mini and compact cars dominate the Indian car market and this market is predominantly shared by three automakers — Maruti Udyog Ltd, Tata Motors and Hyundai. In 2002 Maruti with a niche in small car segment had the highest share of sales at 63 per cent, followed by Hyundai with 17 per cent and Tata Motors with 11 per cent. These together had the largest combined market share of 90.5 per cent in 2002. By 2005 Maruti's share dropped to 50.9 per cent, though it remained the biggest seller in this segment. Hyundai remained stable at 17 per cent and Tata Motors improved to 17.7 per cent. Together the share of the three companies though still the largest dropped to 85.8 per cent.

If the shift towards bigger cars continues the fleet-wide fuel economy average will decline worsening India's oil dependency.

A joint study conducted by the Madras School of Economics along with the National Institute of Public Finance and Policy for the Union Ministry of Environment and Forests in 2004 stated that India was on the throes of worsening fuel economy and losing the advantage of the fuel efficiency of its small car fleet as bigger models were taking over. According to their estimates most of the car models were broadly within the range of 796 cc and 1800 cc, more models were towards the lower end of 796 cc — 1400 cc and in the fuel economy range of 12-16 km/litre. But rapid shift was noticed towards mid engine capacity of 1000-1700 cc and this trend was expected to accelerate in the medium term. The segment now dominates the Indian car market — already the combined share of the total sales in this segment has increased from 44.5 percent in 2001 to 63.3 percent in 2003. [7] The report, therefore, categorically observes, "This is perhaps the right time for improvement in fuel economy of vehicles by sending appropriate signals…."

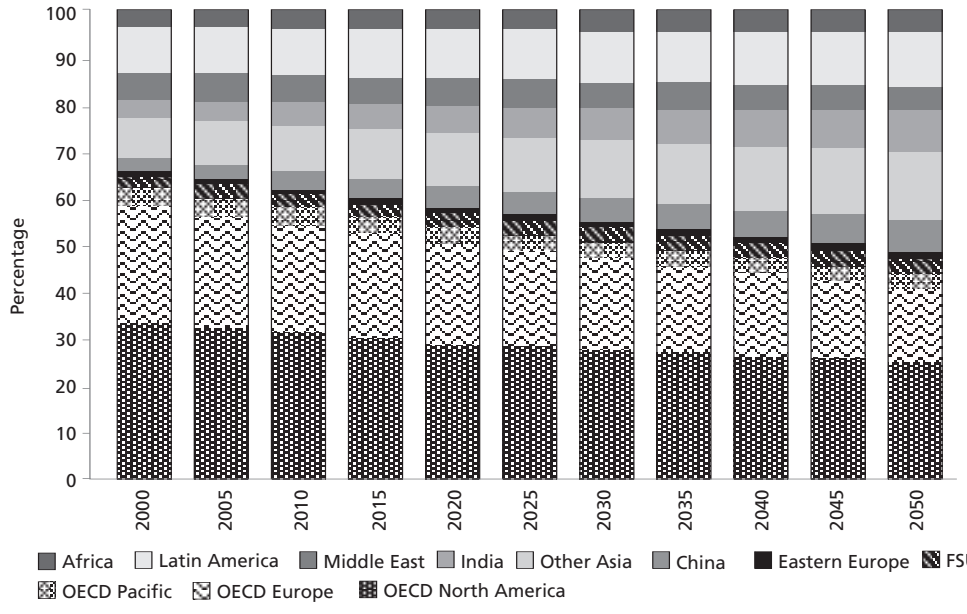
Consistent shift in freight traffic from railways to roadways: Adding to this complex challenge is the continuous shift of freight traffic from railways to the roadways. India reflects the Asia-wide trend. China and India report 12 to 5 goods vehicles per 1000 people respectively and the share of road based freight traffic

increasing rapidly. Railways share in freight traffic in India has come down to 26 per cent whereas share of that of the roadways has gone up to 74 per cent. This competition will get more intense in the coming years as the new highways are being built and refurbished to run parallel to high density railway routes and truck technology is getting better, bigger and more reliable. Truck traffic will increase phenomenally by 2010. The IEA World Energy Outlook 2006 predicts that in India, the transportation energy demand could grow even faster than anticipated, if all of the new highway projects currently under consideration in India are completed.

India should closely follow the global policy discussion on the need for fuel economy standards for heavy duty vehicles. Estimates show that heavy-duty vehicles are responsible for 30 per cent of worldwide fuel use. Since 1999, commercial truck sales have doubled in India. The total truck sales in China and India surpassed sales in Europe and North America by close to one million units in 2004. (See Figure 5: *Share of energy use in heavy trucks in different regions*). The resultant energy impact and CO_2 emissions follow the same trend.

Greenhouse gas emissions from transport sector: Greenhouse gas estimation is very poor in India. The available information is very limited and dated. An inventory of the Indian emissions from all energy, industrial processes, agriculture activities, land use changes and forestry and waste management practices has been reported in India's Initial National Communication to the UNFCCC in 2004. But the base year for the estimates is 1994[8]. According to this estimate initial national greenhouse gas inventories of anthropogenic emissions by all sources for 1994, 1228 million tonnes of CO_2 equivalent emissions (of this CO_2 is 63 per cent) from all anthropogenic activities in India, accounting for 3 per cent of the total global emissions. The total CO_2 emissions from combustion of fuels are responsible for 679.47 million tonnes of emissions per year. Of this the transport sector contributed 12 per cent of the emissions (79.88 million tonnes per year) and ranks third in the order.[9] This however, does not capture the impact of changes and growth over the recent years.

Figure 5: Share of energy use in heavy trucks in different regions



Source: Michael P. Walsh 2006, Global Efforts To Encourage Heavy Duty Vehicle Fuel Economy Improvements, Presented at the workshop on improving The Fuel Economy of Heavy Duty Fleets, February 22, 2006, ICCT and NESCAUM

Greenhouse gas estimation is very poor in India. The available data does not capture the trend in emissions from the transport sector effectively

Another estimate available from The Energy Research Institute also refers to the same year of 1994-95 and shows that the transportation sector accounted for 16.3 per cent of the total CO_2 emissions from combustion of fossil fuels[10]. For the same period another study carried out by the National Physical Laboratory (NPL) estimated that the total CO_2 emission from motor vehicles in India during 1994-95 was about 69.8 million tons and were predicted to increase at 9.1 per cent per year[11] In May, 2007, the Union Minister of Petroleum & Natural Gas informed at the Ministerial Conference on Energy in a Changing World at UNESCO headquarters in Paris that the transport Sector accounts for about 30 per cent of total Green House Gas emissions. Details of these estimates are not available.

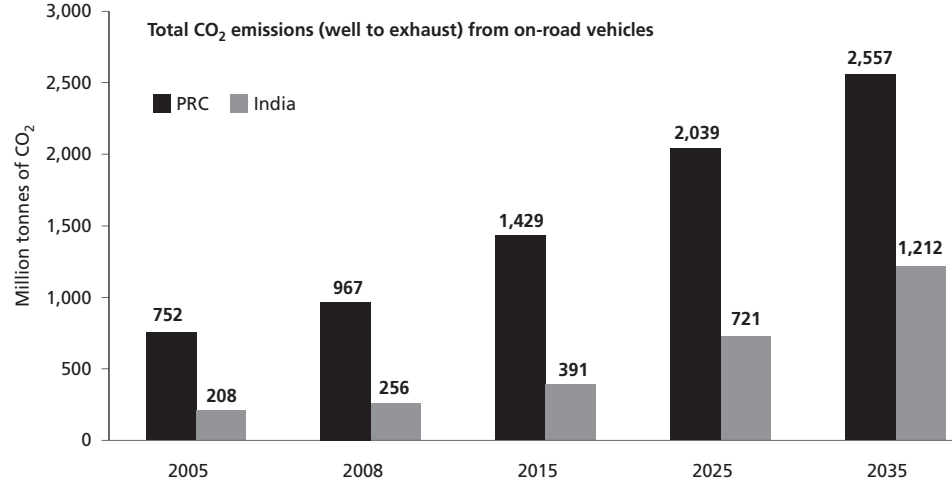
The ADB study of 2006 has estimated the trend in life cycle emissions of GHG from the transport sector in China and India that predicts significant increase in India over a period of 2005 and 2035 –by nearly 90 per cent. (See Figure 6: *Total CO_2 Emissions from On Road Vehicles*)

Limited and imperfect data do indicate the special challenge pose by the vehicles. In the energy sector oil sector will grow quite phenomenally and within that transport's share will always dominate. The WEO 2007 estimates show that out of the total CO_2 emissions from oil consumption in 2005, the transport sector's share that was 37 per cent of the total CO_2 from oil consumption in 2005 will increase to 58 per cent in 2030.

Diesel complicates the trade-off between efficiency and clean emissions: Without stringent emissions standards expansion of diesel car fleet for its higher efficiency levels can adversely affect air pollution levels and public health. Diesel particulates are particularly more hazardous and international health and regulatory agencies have found them to be carcinogenic. Higher NOx emissions are also dangerous in itself while their role in ozone creation can also have serious public health consequences.

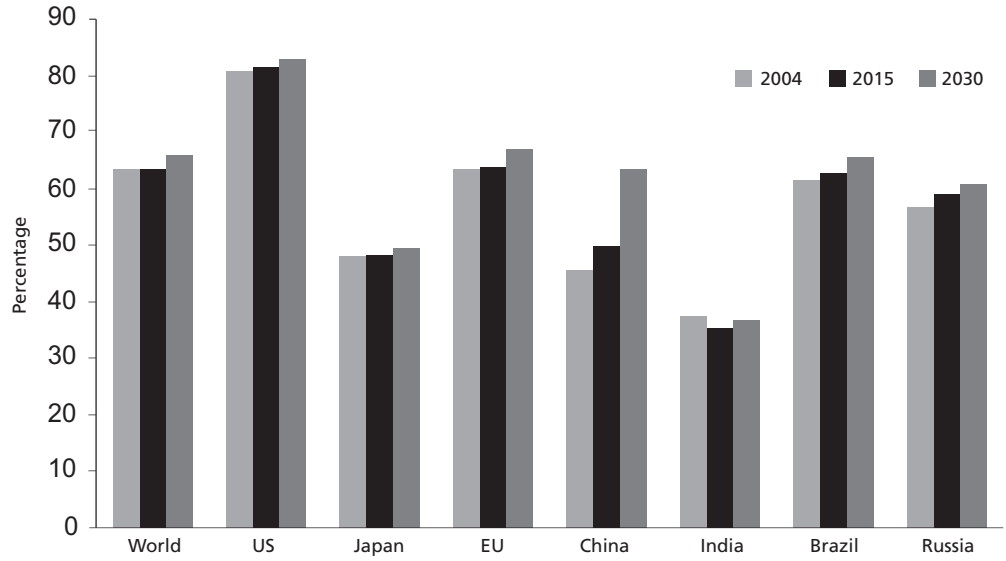
Moreover, diesel's fuel economy gains can be weakened by the rebound effect of the increased use of diesel vehicles due to cheaper diesel fuel prices. Improved fuel-efficiency of cars reduces the fuel cost of motoring per kilometre and encourages increased driving. If the greater energy density of diesel is considered the

Figure 6: Total CO_2 Emissions from On Road Vehicles



Source: Based on ADB — DFID 2006, Energy efficiency and climate change considerations for on road transport in Asia, Published in Philippines

Figure 7: Share of transport CO_2 emissions as a percent to the total CO_2 emissions from oil* in each regions (in per cent)



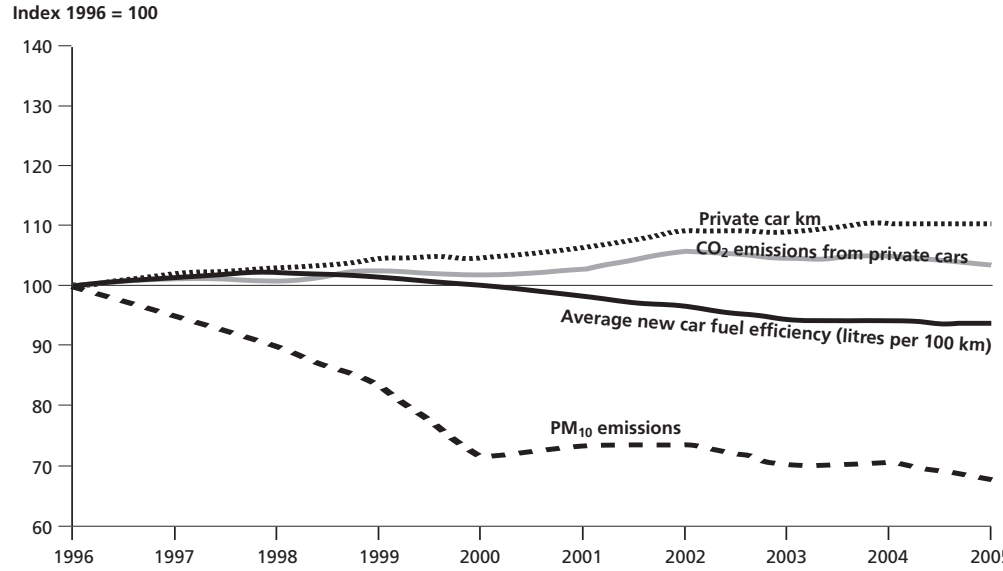
*Reference case only
Source: Computed from the World Energy Outlook 2006

CO_2released per unit of energy in diesel fuel is also higher than petrol. Studies from from EMBARQ, the World Resources Institute Center for Sustainable Transport show that diesel fuel economy values will have to be increased by 12 per cent in energy terms or 18 per cent in CO_2terms before diesel can be compared with gasoline. This reduces the apparent advantage of diesels significantly. The overall CO_2 emissions per litre of fuel can be higher than petrol. If more diesel is allowed to be used in vehicles the net CO_2 emissions will increase and not decrease.

For example in the UK, between 1996 and 2005, and despite improvements in fuel efficiency, CO_2emissions from private cars rose by 4 per cent because of a 10 per cent increase in driving distances. Also PM10 emissions reduction slowed down from 29 per cent initially to only 3 per cent in later years due to increased use of, and emissions from, diesel cars. (See Figure 8: *Rebound effect of diesel in the United Kingdom*) And now science also implicates black carbon emissions from diesel vehicles as a potent greenhouse pollutant. If included then diesel vehicles can have detrimental effect on climate mitigation efforts. Fuel economy regulations should have built in safeguards against conventional diesel.

Strong consumer interest in fuel efficiency: The potential fuel savings from fuel efficiency standards is of compelling consumer interest especially as the cost of transportation imposes enormous burden on individual households. Indians are spending more on conveyance than ever before, especially those in cities, who rely heavily on personal vehicles. According to data collected by the Central Statistical Organisation over the past 10 years, transport accounts for a greater proportion of the household budget in India. In 1993-94, Indian households were spending roughly 56 per cent of their monthly budget on food. By 2003-04, this was down to 45 per cent. During this same period, the single largest increase in expenditure was in transport. In early 1990, the average household spent 11.3 per cent of its monthly budget on transport. By 2003-04, it had gone up to 17.1 per cent. After food, it accounted for the largest part of household budgets. The average household spent more on personal transport — purchase and a lot much more on their operational costs including fuel costs.

Figure 8: Rebound effect of diesel in the United Kingdom



In any given engine size class data shows a great deal of vertical scatter. This means if the laggard in the class catches up with the best in the class there can be significant fuel savings

It is however evident that high fuel prices alone are not strong enough deterrent on commuting demand and the sensitivity to high fuel prices can be moderate although in the longer run it may affect the decision of what size of car to buy. The ADB 2006 report points out that "10 per cent increase in fuel prices may change the litre of fuel sold by less than 6 per cent and vehicles kilometers traveled by even less."[12] While the cumulative fuel savings can be still quite substantial, other measures are needed to stem the tide.

Worldwide, policy focus is now shifting towards improving vehicle energy efficiency to increase distance traveled per liter of fuel, lowering fuel consumption per passenger- or freight-ton km, and improving urban design that reduces the need to travel, modal shifts to lower fuel consumption per passenger- or freight-ton km.

3. WHAT DO WE KNOW ABOUT FUEL ECONOMY OF THE INDIAN VEHICLES?

Fuel economy data of vehicles models is one of the most guarded secrets in India. Customers have to depend on the anecdotal information, self claim by the car companies, or the data published by the specialised auto magazines, for their purchasing decision.

Reporting fuel economy data for vehicle models is not a legal obligation of the auto companies in India. This makes assessment of the fuel economy levels difficult. In the absence of certified data it is not possible to reconstruct a trend line in the fleet-wide fuel economy levels or the trend in vehicle weight and power overtime.

At the time of type approval and certification of the vehicle models for emissions at the Pune based vehicle certification centre Automotive Research Association of India (ARAI), carbon dioxide (CO_2) emissions are measured. Fuel consumption is calculated using the carbon balance method. However, in 2004, the Union ministry of road transport, shipping and highways issued a notification that legally mandates the manufcaturers to get their vehicles tested for fuel consumption manufactured on and after April 1, 2005. This notification succeeds the Auto Fuel Policy released in 2003 that required the manufacturers to declare fuel economy of the models they

make. (See box: *Fuel consumption tests in India*). But neither the manufacturers nor the ARAI share this information. Complete lack of transparency is obstructing policy making in the country (See box: *Right to Information*).

RIGHT TO INFOMATION ACT FAILS TO GET FUEL ECONOMY DATA

It is reprehensible how the official agencies, automobile industry and the vehicle certification agencies hold back fuel economy and carbon dioxide emissions data for vehicle models and make as secret. This information cannot be accessed even under the all powerful Right to Information Act, found out Centre for Science and Environment when its representative attempted to procure the fuel economy data from the concerned agencies. Some of the responses are as follow:

ARAI: "Fuel economy and CO_2 emissions data are not legislated requirements. ...the details about the make and model and the manufacturers are "of commercial nature and third party information," and therefore cannot be shared under the specific clause of 8(d) of RTI Act.

MININSTRY OF SHIPPING, ROAD TRANSPORT AND HIGHWAYS: "The Central government from time to time prescribes standards ...The vehicle manufacturers are required to comply with those standards and the testing agencies are required to ensure its compliance....This department does not maintain the results of type approval tests."

MINISTRY OF HEAVY INDUSTRIES AND PUBLIC ENTERPRISES: "As regards points relating to Auto Fuel Policy and issuing fuel economy data Ministry of Petroleum and Natural Gas, is concerned with the subject and you may approach that ministry directly."

MINISTRY OF PETROLEUM AND NATURAL GAS: This ministry referred the request to Petroleum Conservation and research Association (PCRA). PCRA on its turn replied that "PCRA has not made any Auto Fuel Policy." "Bureau of Energy Efficiency (BEE) ...has taken the initiative to develop fuel efficiency standards in association with PCRA and other stakeholders."

Keeping this crucial data confidential is grossly criminal at a time when the public exhequre is under severe strain due to unprecedented increase in crude prices; people need to make informed choices based on fuel efficiency levels while buying a car; and urgent public policy is needed to set fuel economy standards for vehicles to contain oil guzzling in the transport sector.

Perhaps the auto industry and the concerned departments need to take cue from the recent RTI case on geneticaly modified seeds. In a RTI application to Department of Biotechnology on February 2006 a Greenpeace activist demanded data on toxicity, allergenicity and details of transgenic brinjal, okra, mustard and rice, which were approved for field trials by the Review Committee on Genetic Manipulation (RCGM) for multi-location trials among others.

The concerned agency denied most of the information on grounds that the disclosure of information would harm the competitive position of a third party, in this case, the company testing the GM crop. When the matter was pursued by the Central Information Commission, in April, 2007, the Chief Information Commissioner issued an order saying that request for information on all agricultural products could not be refused under the RTI Act 2005. The order also said that any further grounds for non-disclosure were invalid even if the information was still in the process of development. The order noted that since this was a matter of considerable concern to the educated public, the department may consider its publication in printed form.

The ARAI however has shared a small data set with the Centre for Science and Environment. The data scatter plotted on a chart reflects the changing trends in fuel economy levels of Indian cars and two-wheelers through the successive stages of emissions standards — Bharat Stage (BS) I, II, and III (equivalent of Euro norms — I, II, III) and according to engine displacement size. But ARAI has not disclosed full description of models, actual power, weight and fuel consumption values of each

WHERE ARE THE FUEL CONSUMPTION DATA IN INDIA?

Measurement of fuel consumption of vehicles is technically a legal requirement in India today. In 2004 the Union ministry of road transport shipping and highways had issued a gazette of India notification (S.O.1365 (E) dated 13th Dec 2004) under the Motor Vehicles Act 1988 and CMVR rules 1989, that specifies among others the test methods for fuel consumption for the vehicles manufactured on and after 1st April, 2005. These tests have been made mandatory for all manufacturers. The notification states that fresh type approval/revalidation of the existing type approval would be required for all new items. Notification of fuel consumption tests coincides with enforcement of Bharat Stage III emission norms in 11 cities and Bharat Stage II emissions norms for the rest of India.

In case of two and three wheelers and four wheelers (with GVW less than 3.5 tons) the fuel consumption tests are to be conducted on the same driving cycle on which the emissions are tested on chassis dynamometer. The fuel consumption per kilometer is calculated by carbon balance method using measured emissions of carbon dioxide (CO_2) and other carbon related emissions (hydrocarbons, carbon monoxide).

In case of other heavier four wheelers, the fuel consumption tests are conducted at constant speed, which is, for light motor vehicle 50 km/hour and for medium and heavy motor vehicles 40 km/h and 60 km/h.

The most common source of data for the consumers are the websites and automagazines icluding Autocar India, and Overdrive which carry out road tests of car models on city roads and highways. The road tests invlove driving the vehicles on pre-determined roads through all kinds traffic conditionsin Mumbai. Distance and speed are also recorded. Car fuel tanks are filled completely and tyre pessures are checked as per the manufacturers specifications. The city cycle has a loop of 122 km in South of Mumbai suburb. This circuit is covered twice at an average speed of 21 km/hour and with air conditioners sitched on for 70 per cent fo the distance. The highway run is done on a 241 km loop on the Mumbai-Pune experssway with an average speeed of 55 km/hour.

The on-road data is vastly different from the certification data in lab though the trend corelates. For standards setting process and labelling of car efficiency certification data is used as these are standardised and comparable.

model to help calibrate the information. They have also not divulged the details of the make and model of the vehicles. Only a broad trend can be observed from this data.

PASSENGER VEHICLES

The information available from ARAI with regard to the passenger cars indicates the number of car models with improved fuel economy levels have increased overtime.

Figure 9(i): Trend in the share of petrol car models in different fuel economy ranges

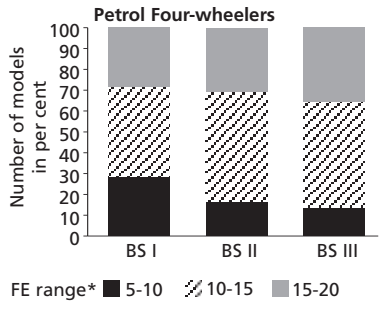
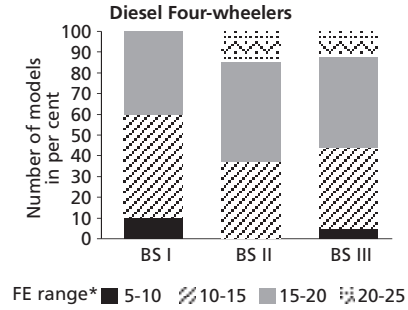


Figure 9(ii): Trend in the share of diesel car models in different fuel economy ranges



Note: *Fuel economy (FE) range in km/lt
Source: Based on data provided by the Automotive Research Association of India (ARAI), 2006

In the petrol car segment while under Euro I regime 29 per cent of all models reported fuel efficiency level in the range of 15 to 20 km/litre, under Euro III the number of models in this fuel economy class increased to 36 per cent of all models reported by ARAI. The number of models with poorer fuel economy (in the range of 5-10 km/litre) decreased from 29 per cent at Euro I stage to around 14 per cent in Euro III stage.

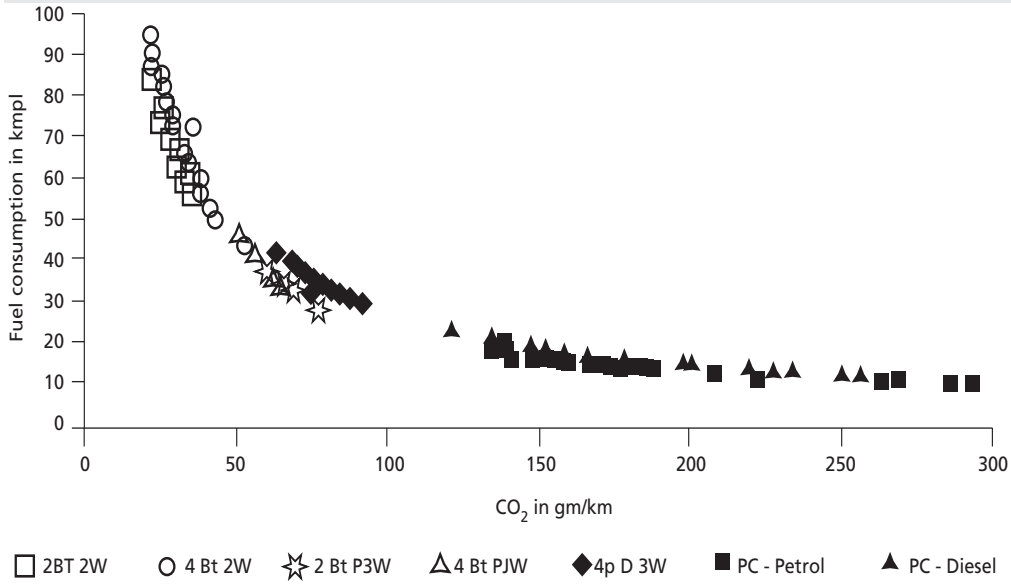
In the diesel car segment the number of models with improved fuel efficiency — in the current best range of 20-25 km/litre shows a slight increase over time. At the Euro I stage 10 per cent of all models were in this range. At Euro III stage about 12 per cent of all models reported are in this range. In the range 15 to 20 km/litre the share of models has increased from 40 to 44 per cent. The share of poorer fuel economy models (in the range of 5-10 km/litre) has decreased from 10 per cent to around 5 per cent.

It is very important to note that in any given engine size class there is a great deal of vertical scatter of models and the difference between the better and poorer model within the same size range is significant. Sometime the difference between the best and worst in the class can be more than 30 per cent. This indicates that there is a considerable scope for improvement in the same size class if the laggards are pushed with standards to match the levels of the leaders. If this maximum front runner approach is taken to set target of improvement for each weight class of vehicles about 30 per cent improvement is possible.

This bears out the importance of setting fuel economy standards to push for improvement. Without the fuel economy regulations India is not being able to diffuse improved technologies across all models and size classes effectively for overall fuel savings.

Predictably, the fuel economy shows deterioration with increase in engine size in both petrol and diesel segments.

Figure 10: Bhanot— CO_2 and fuel consumption of all vehicles



TWO WHEELERS

In the wide spectrum of the passenger vehicles the two-wheeled vehicles that form nearly 60 to 70 per cent of the vehicular fleet in most Indian cities, use the least amount of fuel. This is possible because of very small engine size. Even within this segment the vehicles powered by four-stroke engines are more fuel efficient than conventional two-stroke engines. The best of four-stroke two-wheelers have achieved fuel efficiency in the range of 70 or more km per litre. This amounts to substantial fuel savings over the erstwhile two-stroke dominated fleet as the Indian market has already witnessed significant shift towards four-stroke engines. This

Figure 11(i): Fuel economy according to engine displacement (CC) — petrol passenger cars

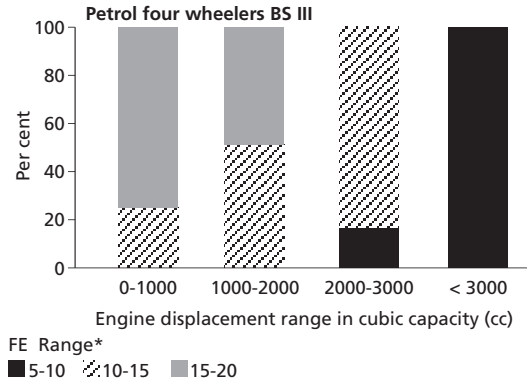
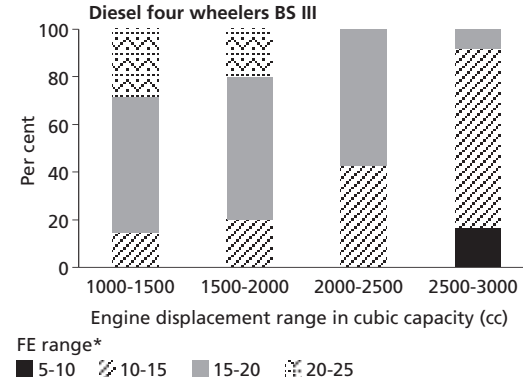


Figure 11(ii): Fuel economy according to engine displacement (CC) — diesel passenger cars

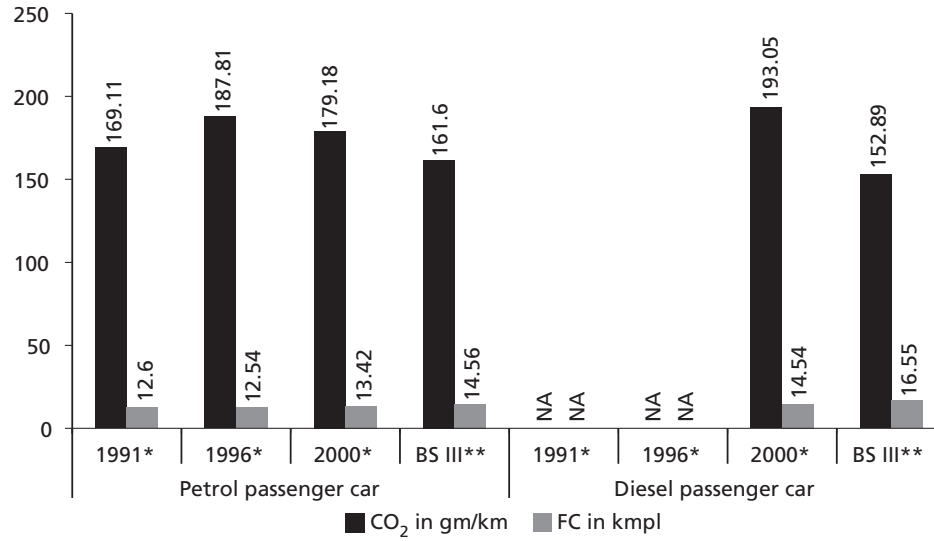


Note: *Fuel economy (FE) range in km/lt
Source: Based on data provided by the Automotive Research Association of India (ARAI), 2006

transition has been largely driven by the fuel economy imperatives in a very price sensitive two-wheeler market in India targeted at middle to low income categories.

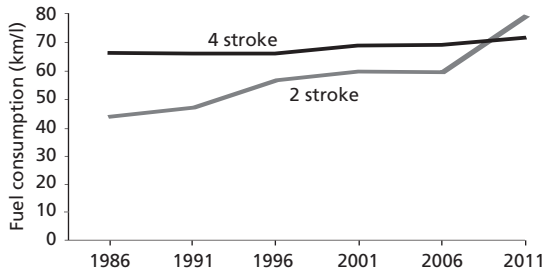
Fuel economy benefit of two-wheeled vehicle is so significant that with replacement of one four-stroke two-wheeler with one compact car of model can lead to increase in fuel consumption by 5.4 times per kilometer travel and CO_2 emissions by 6.4 times. The most fuel efficient car model persently in market is Maruti 800 that has achieved efficiency level as high 22-23 km/litre in India. But this is several times lower than the best levels achieved by the two-wheelers which is more than 70 km/litre. This means if the two-wheeled vehicles can also be made to achieve tight emissions standards then both energy and pollution gains can be significant for the country. IEA projects decline in two-wheeler growth by 2030. This trend can worsen

Figure 12: Average CO_2 and fuel economy of passenger cars



Note: averages of type approval data
Sources:
*Based on data provided by the Automotive Research Association of India (ARAI) to Centre for Science and Environment, 2002
**Srikant R Marathe et al 2007, "Overview of fuel efficiency of Indian fleet" International Seminar on "Setting fuel economy standards and labeling of transport vehicles," 6-7th December 2007, Chennai

Figure 13: Projected trends in two-wheeler fuel economy



Source: N V Iyer

fuel consumption in the sector.

Other countries including China and Taiwan have begun to craft fuel efficiency standards for two-wheelers along with tightening of the emissions standards to maximise the benefits of fuel savings and emissions gains. Even in India fuel economy regulations will be needed because of the large numbers and the emerging trend towards bigger engines.

However, at the current level of technology the trend in fuel economy is levelling off. Further improvement will require major technology breakthrough.

HEAVY-DUTY VEHICLES

In India heavy-duty vehicle sector is the most neglected. Even the emissions standards for these vehicles have lagged behind that of the passenger vehicles. This is largely because of the long haul country-wide scope of their operations and lack of uniform norms across the country.

In 2004 the country had 37.5 lakh (3.7 million) goods vehicles. The sales data of Society of Indian Automobile Manufacturers (SIAM) shows that manufacturers in India sold 3.5 lakh (0.35 million) commercial vehicles in 2005-06. Nearly 60 per cent of these were medium and heavy commercial vehicles. India lacks good truck technology. The Ministry of Shipping Road Transport and Highways (MoSRTH) has assessed some of the constraints in draft *National Road Transport Policy.* This admits that while there has been substantial induction of new technology in the personal motor vehicles sector the advancement in the trucks and buses has been somewhat slow.

A wide gamut of factors including low diesel prices, lax implementation of rules related to overloading, unsupportive tax regime and congested roads have worsened fuel economy in this sector. These have also delayed induction of new technology. The MoSRTH cites the example of slow penetration of multi-axle vehicles that have the potential to save fuel up to the tune of 50 per cent per tonne km. Fuel economy data for heavy trucks are not available. The truckers association is known to be demanding improvement in fuel economy levels of trucks. Given the long haul nature of operations there is strong consumer interest in fuel efficiency improvement.

Bus operation agencies have shown strong interest in fuel economy levels. Standardised vehicle certification data on fuel consumption is not available for comparison or to understand the current baseline of the fuel eocnomy of the fleet produced. Thus, it is difficult to construct a trend in fuel economy of buses and trucks in India.

However, some operational data is available for buses from the bus transit agencies in the country (both city and state level). These data emerge from the operational statistics of the agencies and depict an indicative trend. One such data set has been compiled by the apex planning agency the Planning Commission of India. The data includes fuel economy performance of both city based transit agencies and state transit agencies that ply largely on highway routes. The data shows that the average

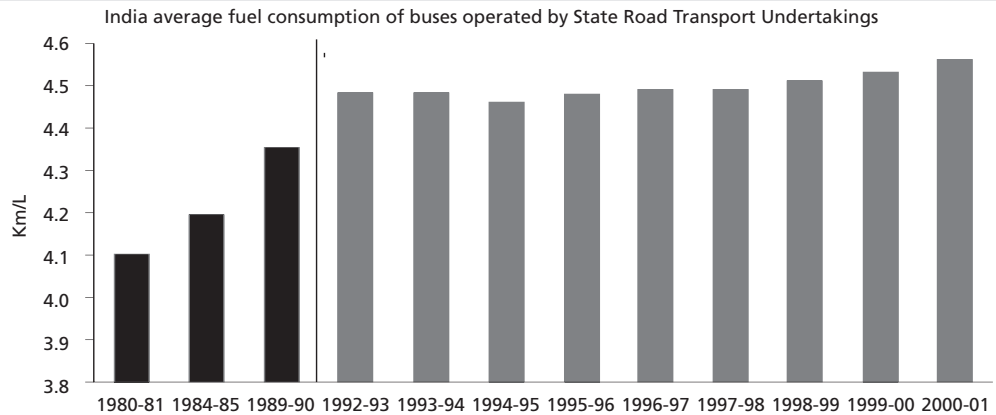
fuel economy for the metro cities of Delhi, Mumbai and Kolkata that have dedicated city bus services is lower than the highway based state transit agencies. This is expected as frequent start stop, longer idling, that are characteristic of city driving influence fuel consumption levels of the buses. More smooth driving on highways give better mileage.

The experience of some of the bus operating agencies indicate worsening of the fuel economy at the operational levels. Bangalore Metropolitan Transport Corporation has carried out detailed assessment of the trend in fuel economy over time. Their analysis shows fuel economy penalty while moving from Euro II to Euro III technologies. Increase in power and performance may have caused some fuel economy penalty as there was no fuel economy improvement target. But this costs huge money to the bus company (See box: *Fuel economy: declining with progress*).

Globally, fuel economy regulations have found acceptance as a near term strategy to ensure significant fuel savings in the transport sector. Its effectiveness stems from the fact that by coordinating with a handful of vehicle manufacturer immediate nation-wide impact is possible. As fuel economy is already an important marketing strategy of the vehicle manufacturers, efficiency standards can improve competitiveness, help to compare models in the market, and create a level playing field for all. Moreover, standards can help to speed up technology development and close gap with the advanced technologies that are developing globally to improve fuel efficiency of vehicles and minimise greenhouse gas emissions. Nearly the same automakers, who are operating in the major regions of the world that have fuel economy regulations are also producing vehicles in India. Even the Indian companies are aiming to globalise. India will have to leverage this capacity for its own benefit.

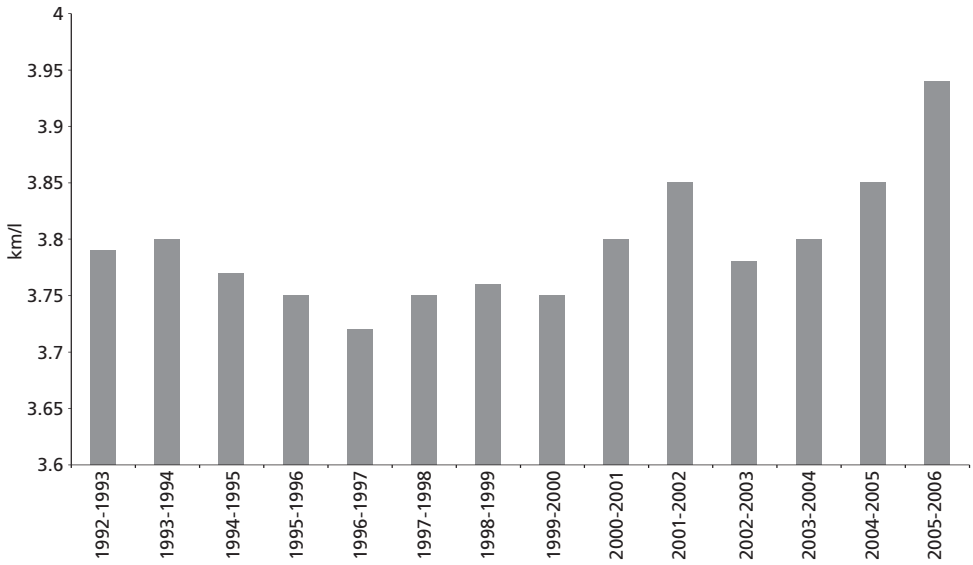
If India continues to ignore fuel economy regulations especially when the country is experiencing spurt in economic growth and income, motorisation, steady increase in mass and power of vehicles, energy crisis will worsen in the future.

Figure 14: National average of fuel efficiency of buses operated by the State Road Transport Undertakings (Km/L)



Source: Based on Anon (undated), India Planning Experience A statistical profile, Planning Commission, Government of India, Section — IV Infrastructure, Table — 9.13, pp — 126-127

Figure 15: Fuel efficiency of buses operated by the Delhi Transport Corporation (km/L)



Note: Data refers to diesel bus fleet.
Source: Based on Operational statistics, Delhi Transport Corporation New Delhi

FUEL ECONOMY: DECLINING WITH PROGRESS

The certification data for fuel economy for buses is not readily available. But Bangalore Metropolitan Transport Corporation (BMTC) has analysed the operational data on fuel consumption for its bus fleet. This shows that when Euro III bus was introduced in 2005, its fuel consumption level in km/l was lower than the levels recorded for buses of Euro 0 vintage (Bharat Stage 0). The Euro 0 base line is said to be 4.80 km/l which is higher than the 4.57 km/l recorded for Euro III buses when new. It is said that power and performance have increased during this period. Moreover, the details of the operational parameters incluing the speed of the bus, maintenance status etc are not available. But these factors may have influenced and reduced the fuel economy of the fleet overtime further. The BMTC estimates that on account of this decline in fuel economy the losses from fuel cost has mounted to Rs 428.82 lakhs in 2007.

Figure 16a: HSD KMPL

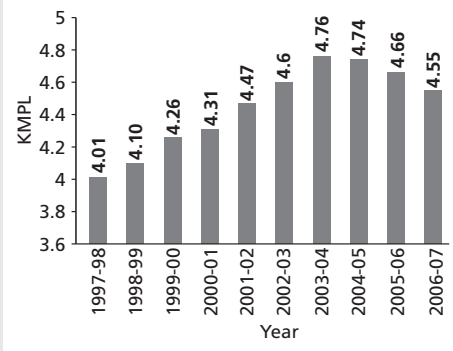
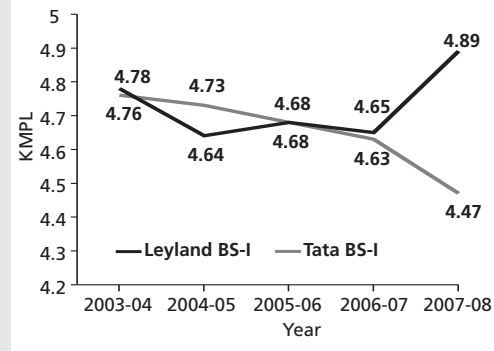


Figure 16b: KMPL comparision of Leyland and Tata BS-I vehicles



4. POLICY DISCUSSIONS ON FUEL ECONOMY REGULATIONS IN INDIA

Early beginning: India was among the leaders to set fuel economy regulations for vehicles but it backtracked. Following the oil crisis of the seventies the government of India had begun to offer fiscal incentives for fuel efficient vehicles in India. During

the eighties the Indian automobile industry was heavily dependent on imported components. The government of India therefore offered custom duty concession conditional to meeting fuel economy standards. For this purpose fuel economy standards were laid down (See Table 2: *Begining of the fuel economy norms in India 1981-1989*). The attarction of the custom duty concession prompted vehicle manufacturers to advertise widely the fuel efficiency values achieved as per tests conducted by testing agencies.[xiii]

Table 2: Begining of the fuel economy norms in India 1981-1989

A. TWO WHEELERS

Engine CC	**Test speed (kph)**	**Fuel economy norm (kmpl)**
Up to 35	20	95
35-75	30	87 (variable transmission) 83 (fixed transmission)
75-200	40	60
>200	50	55

B. PASSENGER CARS

Engine CC	**Test speed (kph)**	**Fuel economy norm (kmpl)**
Up to 600	50	24
600-800	50	22
800-1000	50	20
1000-1400	50	18
> 1400	50	16

C. COMMERCIAL VEHICLES

Payload tons	**Ntkmpl (payload*kmpl)**		**Engine type**
	40 kph	**60 kph**	
Upto 2.5 tons	21-11.5 (1t-5.4t GVW)	22.2-12.1 (1 t – 4.5 t GVW)	IDI
2.5 t – 4.0t	31.6-38.4	26.6-30.2	IDI
	36.3-44.1	30.6-34.7	DI
4.0 t – 14.0 t	47.1-74.5	37.4-64.2	DI
> 14.0 t	75	66	DI

Source: Srikant R Marathe et al 2007, "Overview of fuel efficiency of Indian fleet" International Seminar on "Setting fuel economy standards and labeling of transport vehicles," 6-7th December 2007, Chennai

But subsequently, due to lack of policy clarity this practice was abandoned during the nineties. It was thought erroneously that the new emissions standards will help to achieve technology improvement that will help to improve moth emissions and fuel savings. The other reason was that the tests for fuel economy were not designed appropriately. The norms were tested on one constant speed that did not provide for any variability that normally influence the fuel economy levels. As a result, there was a considerable divergence between certification data and the actual on-roads performance of vehicles. This led to a lot of litigation between the car companies and the consumers.

Fuel economy vehicles will be regulated wihin the scope of The Energy Conservation Act. This resolves the legal tangle.

Auto Fuel Policy: The issue of fuel economy regulations came up for discussions once again during 2002-03, when the Auto Fuel Policy was framed to set emissions standards roadmap for vehicles. The committee in charge of framing this policy reviewed some international fuel economy regulations especially the Corporate Average Fuel Economy regulations of the US. The Auto Fuel Policy that was finally adopted by the government in 2003 recommended: "Declaration of fuel economy standards by automobile manufactures should be made mandatory, who should publish the fuel economy standards (km/litre or km/kg) for each model in the documents that are supplied with each vehicle. In the case of heavy duty vehicles, fuel efficiency will be reported in terms of g/kWh at present. Subsequently, after establishing test procedure on heavy-duty chassis dynamometer, reporting may be done in terms of km/litre."

This has not been implemented.

Integrated Energy Policy: The Integrated Energy Policy announced by the Planning Commission in 2006 provides the enabling framework for fuel economy regulations in

India. It states that since no economic substitutes are obvious for the transport sector at least till 2031-32, energy efficiency of vehicles and use of mass transport must have a high priority. The policy has estimated that if the energy efficiency of all motorised vehicles is increased by 50 per cent our oil requirement will go down by some 86 Mt by 2031-32. In other words, this amounts to fuel saving of 630 million barrels, and monetary saving of US$ 36 billion at current prices. PCRA estimates that this improvement target represents 65 per cent of total current consumption. And in terms of carbon dioxide emissions this is equivalent to removing 7 million of today's four wheeled vehicles.

At the same time, if railways are able to win the freight traffic that they have lost to trucks manage to carry 50 per cent of the freight then oil requirement can go down by 38 Mt. These together can reduce oil requirement by over 25 per cent in most oil intensive scenario in 2030 -31. But the energy policy has not discussed the possible regulatory structure for fuel economy standards to achieve the target of 50 per cent improvement in efficiency. The policy provides the framework for policy action. The concerned agencies and the ministries are now expected to work out the detailed regulations.

Major countries with substantial share of the vehicle market have established or poposed fuel economy regulations or GHG emissions standards. Widely different approaches prevail

Report of the Working Group on Petroleum & Natural Gas Sector for the eleventh fiver year plan (2007-12): The prospective plan for the Union Ministry of Petroleum and Natural gas for the forthcoming eleventh five year plan has proposed in its report of 2006 that the current fuel economy levels "be averaged for each category and set, and, then tightened by 8 percent annually during the eleventh plan and 5 percent beyond that. The average fuel economy of all new cars, commercial vehicles and two wheelers would increase by about 45 percent by 2012." There are no further details on the ways to do it.

Ministry of Finance and the tax policy for small cars: Currently the only strategy that is working in favour of fuel efficiency of the fleet is the policy to keep taxes lower on small cars than the heavier categories. The Union Budget of 2006 has cut excise duty from 24 per cent to 16 per cent on small cars. This tax has already made an impact as the car sales in this segment have picked up after the tax cut. But this tax strategy alone cannot be effective if additional deterrents are not available to prevent the shift towards bigger cars, improve fuel efficiency of the fleet and also control usage of cars.

Ministry of Environment and Forests proposal on tax measures linked with fuel efficiency: The Union ministry of environment and forests has proposed to the Finance Ministry to impose a cess on passenger cars, jeeps and two-wheelers based on information provided by the SIAM on the fuel economy of different categories of vehicles. The vehicle with the worst fuel efficiency is likely to be hit the most. Earlier in 2004 based on a joint study of the Madras School of Economics and National Institute of Public Finance and Policy the environment ministry had submitted proposal for a tax system linked with the fuel efficiency of the vehicles. The study has proposed a resource tax to be directly linked with the fuel consumption of vehicles. While the vehicles with fuel economy specified as acceptable will not pay any tax, those with fuel economy levels lower than the acceptable slab will pay a resource tax and this will keep increasing with decreasing fuel economy levels.

Who can regulate fuel economy of vehicles in India?

When public demand for fuel economy regulations got stronger during the early parts of the year 2007, there was little policy clarity with regard to the agency that could take the lead in setting the fuel economy standards in India.

The Union Ministry of Shipping, Road transport Highways that administers emissions regulations under the Motor Vehicle Act 1988 (MV Act) and Central Motor Vehicle Rules 1989 (CMVR) held that fuel economy regulations do not fall within the purview of the act. The Chapter VII of The MV Act states that the central government may make rules … with respect to …"the emissions of smoke, visible vapour, spark, ashes, grit or oil" and "standards for emission of air pollutants." This Act does not require regulations of fuel economy or CO_2 emissions from vehicles. However, for type approval certification ARAI incidentally measures the fuel consumption of vehicles and for that test procedures for CO_2 emissions have been laid down. But there are no legal requirements to report the fuel consumption of vehicles or CO_2 values for the purpose of rule making and enforcement.

Finally, the solution was found within the ambit of The Energy Conservation Act 2001. The Bureau of Energy Efficiency (BEE), is the statutory authority under the Union Ministry of Power that administers this Act. The BEE has been established under the provisions of the Energy Conservation Act 2001 and it has powers to specify the norms for processes and energy consumption standards for any equipment, appliances, which consumes, generates, transmits or supplies energy. Its overarching scope includes fuel conservation measures in all sectors of economy and by virtue of this fuel economy of vehicles also fall within the scope of this Act.

In view of this a policy decision has been taken to develop and enforce fuel efficiency standards under this Act. The Petroleum Conservation and Research Association (PCRA), which is an autonomous body under the Union Ministry of Petroleum and Natural Gas is responsible for the fuel conservation measures in different sectors of the economy, has initiated the process to develop fuel efficiency standards along with BEE under this act. Both PCRA and BEE have signed a memorandum of understanding to develop these standards. This now clears the way for starting the technical process of setting the standards.

India must not delay adoption of fuel economy regulations any further. Three key complementary strategies are expected to provide the foundation of these regulations — fuel economy standards, tax policies linked with the fuel economy of vehicles, and in some measure labelling of vehicles based on fuel economy of vehicles . But structure of each of these strategies will require careful designing for maximum effective impact and avoid loopholes that might weaken the impact of these strategies.

Review of the international experiences will provide useful insights for developing regulations in India. It is proposed to set regulations based on three key complementary strategies — i) Fuel economy standards that will set benchmark for vehicle technology improvement to promote efficiency. This is essential to push the manufacturers to bring in more fuel efficient technologies and not to offset efficiency gains by increasing power and weight of the vehicle fleet, ii) develop tax policy linked with the fuel economy perfomance of vehicles to help activate the market for rapid diffusion of the fuel efficient and clean technologies, and iii) Fuel economy labelling of vehicles to influence consumer demand for fuel efficient vehicles

5. FUEL ECONOMY REGULATIONS IN OTHER COUNTRIES: LEARNING FROM OTHERS

Other governments have already taken steps to enforce fuel economy regulations. But there is no common strategy that fits all. Fuel economy regulations are as diverse as the countries are and the national priorities and uniqueness of local challenges and imperatives determine the structure of these regulations. Widely different approaches broadly include:

i) **Regulation of fuel consumption or fuel economy of vehicles**: This is done either by setting a standard based on fuel consumption per unit of distance travelled by a vehicle (litre per 100 km); or, regulate miles or kilometres per unit of fuel used (km/l); Japan, and China have set fuel economy regulations.

ii) **Regulation of carbon dioxide emissions on a fleet wide basis (CO_2):** CO_2 emissions are the dominant source of GHG emissions from vehicles. This is also linked to the fuel consumption. EU directly regulates CO_2 emissions from its fleet.

iii) **Regulation of greenhouse gas (GHG) emissions:** This is a much broader concept as in addition to controlling tailpipe CO_2 equivalent GHG emissions it also controls GHG emissions from car air conditioning, nitrous oxides from cat converters, methane etc. California is the only region in the world to have adopted GHG emissions standards for vehicles.

These regulations are set largely for direct fuel savings or to achieve direct reduction of GHG emissions. However, both are directly linked with fuel consumption levels of the vehicles. Only California programme goes beyond to regulate other GHG emissions from total vehicle operations.

Major countries with substantial share of the vehicle market have established or proposed their own motor vehicle fuel economy or GHG emission standards. These include the United States, European Union, Japan, Canada, and Australia and California as a state in the US, China, South Korea and Taiwan. Some of these programmes are quite old. The US programme was initiated in 1975 while Taiwan has had its own fuel economy standards for over a decade. The structure of the standard also varies widely across regions (See Table 3: *Summary highlight of fuel economy and GHG standards for vehicles around the world*).

Table 3: Summary highlight of fuel economy and GHG standards for vehicles around the world

Countries/regions	Type of regulations	Measures of fuel economy	Structure of regulations	Test method
The United States	Corporate average fuel economy	Miles per gallon	Fleet average of cars and light trucks	US CAFÉ
European Union	Fleet average CO_2 emissions to be met by the industry associations	Gm/km	Overall light duty fleet	EU New European Drive Cycle (NEDC)
Japan	Fuel economy standards	Km/l	Standards for 16 weight based vehicle classes	JC08
China	Fuel economy standards	L/100-km	Standards for 16 weight based vehicle classes	EU NEDC
California	Greenhouse gas emissions standards	G/mile	Car/ light duty trucks (LDT1 and LDT2)	USCAFE
Canada	Fuel economy standards GHG emissions reduction target	L/100-km	Cars and light trucks	USCAFE
Australia	Fuel economy	L/100-km	Overall light duty fleet	EU NEDC
Taiwan, South Korea	Fuel economy	Km/l	Engine size	USCAFE

Source: Based on Feng An and Amanda Sauer 2004, Comparison of Passenger Vehicle Fuel Economy and GHG Emission Standards around the World, Prepared for: the Pew Center on Global Climate Change, October

It is not possible to make direct comparison of fuel economy standards of different regions as these are based on different test methods. The test cycles that are different in terms of average speed, duration, distance, acceleration and deceleration characteristics and frequencies of starts and stops, have strong influence on the fuel economy and GHG emissions of vehicles. Feng An of the US based Energy and Transportation Technologies and Amanda Sauer have developed a method for comparing the relative stringency of different standards.

The recent assessment carried out by Feng An and a team of experts for the US based International Council on Clean Transportation in 2007 has found that not only the major regions have set fuel economy standards but some of them have also begun to tighten the standards. The key highlights of these trends are as follow:

- Japan has increased the stringency of its fuel economy standards. Japan's standards are expected to lead to meet the lowest fleet average greenhouse gas emissions for new passenger vehicles in the world (125 g CO_2/km) in 2015.

- Europe slips from its top position and falls behind Japan as it is in the process of diluting its CO_2 standards. For poor compliance with the original targets of 140 gm/km in 2008 and 120 gm/km in 2012, European Commission has revised the target for 2012 at 130 g/km.

- California that begins from comparatively much poorer baseline compared to either Japan or Europe has planned most aggressive overall improvement compared to all other countries by 2016 — by as much as 30 per cent. Japan has planned 19 per cent improvement by 2015, EU about 16 per cent by 2012. But both Japan and EU have achieved higher level of average fleet efficiency.

- Canada has established the world's only active "feebate" program with significant incentives and levies for vehicles based on fuel consumption. At the same time, Canada plans to issue an attribute-based fuel economy regulation this fall to take effect in 2011, while it continues to implement its voluntary agreement with automakers.

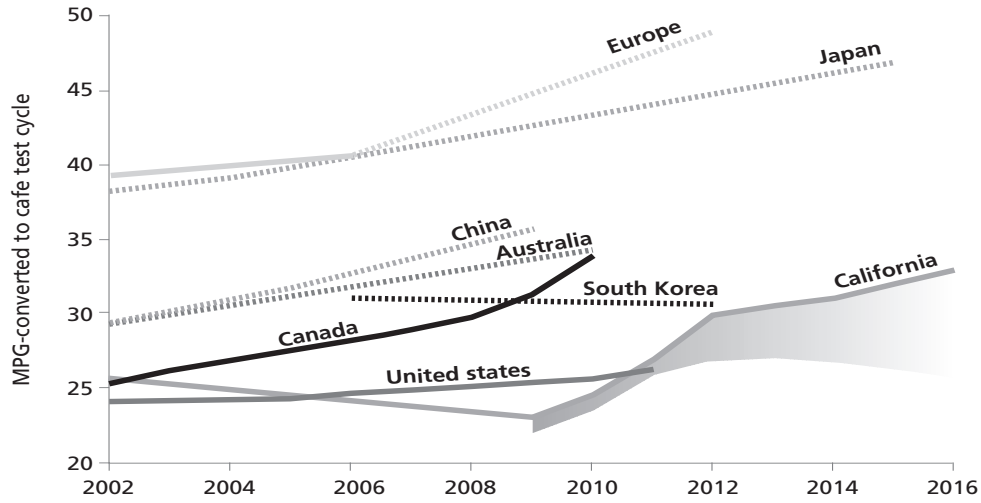
- The US despite the recent revision will continue to lag behind the most industrialised world.

- The Chinese government has reformed the passenger vehicle excise tax to encourage the production and purchase of smaller-engine vehicles, and to eliminate the preferential tax rate that applied to sport utility vehicles (SUVs). China continues to remain at the third position after Japan and EU and ahead of all other countries.

- South Korea is the only nation in the world with fuel economy standards for new passenger cars are projected to decline over the next five years. The South Korean government is considering policy options to address this negative trend.

Other countries are setting fuel economy standards to constantly reduce the energy intensity of the vehicular fleet. Different regional regulations across the world have distinct character of their own in terms of structure, coverage, limit values, enforcement and monitoring strategies and also their limitations. These regulations also represent a learning curve that can help India to design its own regulations.

Figure 17: Comparison of Current Fuel Economy Standards: values normalized by US CAFE-converted mpg 2007



Note: Shaded area shows CA A/C credit.
Source: Feng An. Deborah Gordon, Hui He, 2007, Passenger Vehicle CO_2 and Fuel Economy Standards, A Global Update, Prepared for International Council on Clean Transportation, Draft, June, US.

EUROPEAN UNION: VICTIM OF INDUSTRY'S VOLUNTARISM

Voluntary agreement with the vehicle industry[14]

The European Union had started by setting the most ambitious target for CO_2 emissions reduction from vehicles. Though this has helped to lower CO_2 emissions from new cars in the EU-15 countries by 12.4 per cent from 1995 through 2004, the car makers cannot meet the 2008/9 CO_2 emission target of 140 g/km.

The automobile manufacturers associations in Europe, the European Automobile Manufacturers' Association (ACEA), the Japan Automobile Manufacturers' Association (JAMA) and the Korean Automobile Manufacturers' Association (KAMA), have made a voluntary commitment to the European Commission to reduce the CO_2 emissions from new light-duty passenger vehicles, with fleet-wide targets. According to this agreement each manufacturing association will collectively achieve the target at the European level.

The target represents about a 25 percent reduction from the 1995 average fleet-wide CO_2 level of 187 g/km. It was originally agreed that the fleet-wide sales weighted average target of CO_2 emissions will be reduced to 140 gm/km by 2008 and 120 gm/km by 2012. This voluntary agreement if implemented was expected to improve fuel economy by 33 per cent in 2008 and also reduce CO_2 emissions substantially.

During 2005-06 it became clear that the industry would not be able to meet the target of 140 g/km in 2008. In fact, the current fleet wide average attained in the EU15 countries is still above 160 g CO_2/km. It is likely to reach only 155 g/km by 2008. During this time new cars sold in the EU have become significantly bigger and more powerful. In the meantime, CO_2emissions from road transport have risen by 22 per cent since 1990, notably due to increases both in the number of cars and in the distances driven annually.

Disturbed by these trends European Commission has therefore proposed to

VOLUNTARY STANDARDS HAVE NOT WORKED IN EUROPE

In order to meet the target of 140 g CO_2/km in 2008 the average annual reduction rates of all three vehicle manufacturers associations need to be improved significantly. In the years remaining until 2008-9 the annual reduction rates must reach an average of 3.3 per cent for ACEA, 3.5 per cent for JAMA and 3.3 per cent for KAMA. The Commission emphasized that if industry did not honor its commitments, the Commission would have to consider taking measures, including legislative ones, to ensure that the necessary CO_2 reductions were achieved.

The European commission has now tabled draft legislation that would force carmakers to reduce average carbon dioxide (CO_2) emissions from Europe's new car fleet to 130 grams per kilometer (g/km) by 2012. The target must be achieved through improvements in engine technology alone. Compliance would be encouraged by establishing increasingly severe financial penalties from 2012 to 2015 for carmakers that miss their targets. The proposed legislation is expected to deliver fuel savings of around E2,700 over its lifetime. The measures should cut CO_2 emissions from new cars by 19 per cent.

The main elements of the proposal are as follows:
-- An average emission target for all newly registered cars in the EU of 130 grams per kilometer (g/km) by 2012.
-- Individual targets for each manufacturer based on the average mass of their EU car fleet, established through an emission limit curve. An average mass of 1,400kg gives a target of roughly 130g/km, 700kg gives 100g/km and 3,000kg gives 200g/km.
-- An option for manufacturers to form a "pool" with other carmakers to allow them to jointly meet their combined target. For example, companies expecting to miss their target could pool with others expecting to beat their combined target in return for financial incentives. All such arrangements must respect EU competition rules.
-- The commission's impact assessment says the proposals will lead to average purchase price increases of around six per cent per car. This will be offset by average lifetime fuel savings of E2,700.
-- Independent manufacturers that sell fewer than 10,000 vehicles per year may apply to the commission for a special individual target. Such targets may be set above the emission limit curve (that is, they could be more lenient), but would still require a "fair reduction effort" from the company concerned, according to the commission.
-- Special purpose vehicles, including those built for wheelchair access would be exempt.
-- "Complementary measures" to deliver a further 10g/km reduction by 2012 will be proposed next year, aimed at achieving the overall EU target of 120g/km. These will include minimum efficiency requirements for car components such as tires and airconditioning systems, as well as separate legislative proposals to encourage a greater use of biofuels.
-- The binding limits for average emissions apply to all new cars sold in the European Union from 2012, whether produced in Europe or elsewhere. That means American, Japanese, South Korean and Chinese companies will also be affected. No cars will have to be taken off the market or off the road.
-- The limit for vans is 175 g/km in 2012 and 160 g/km by 2015.
-- Carmakers will have to pay an "emissions premium" for every gram/km by which their fleet exceeds the EU limit, multiplied by the number of cars sold. The fines will be phased in over four years, starting at 20 Euros (US$28.81) per km/g in 2012, 30 Euros in 2013, 60 Euros in 2014 and rising to 95 Euros per g/km in 2015 and thereafter.

The proposal now goes to the Council of EU member governments and the European Parliament. The regulation must be approved by a qualified majority of member states and a simple majority in parliament.

convert the voluntary standards into mandatory standards. In June 2007, the Council of Environment Ministers has approved the shift to mandatory standards and diverse approach to achieve 120 g/km by 2012. Accordingly, the auto makers wil achieve 130 g/km through technical improvements and the remaining 10 g/km with measures such as efficient tires and air conditioners, gear shift indicators, improvements in light-commercial vehicles, and increased use of biofuels. (See box: *Voluntary standards have not worked in Europe*).

Limitations of the European approach

Volantarism does not work: The voluntary agreement does not specify individual corporate targets for companies, or any mechanism to guarantee meeting of the fleet target. There are no specific company-by-company targets it is difficult to hold individual companies accountable if they fail to meet the commitments. Without regulatory action there will be greater propensity to meet consumer preferences for

more powerful cars and undermine efficiency gains. In Europe the average power of the fleet has increased gradually by 30 per cent since 1990.

Originally, the absence of individual target was expected to provide flexibility to the companies to find efficient market solution and if the companies agree among themselves to attain improvement levels. But such processes were not followed effectively among the companies to define their individual targets.

Ineffective monitoring system: There is no monitoring system to demonstrate that each manufacturer has made efforts to meet their common commitment. Such a system would need assessment of the current average sales weighted fuel consumption of each manufacturer to demonstrate improvement over the base year for each manufacturer. This was not done. The European Commission has not yet released any data on the progress or lack of progress of individual manufacturers. Such a system of monitoring is also very complex. The current monitoring system reports annual CO_2 emissions and fuel consumption values only for the total ACEA fleet and for each EU country's fleet and not report values for individual manufacturers. There is no deterrent for the manufacturers except for the reputational risk.

Trade-off with harmful emissions: European industry relied more on the expansion of diesel car fleet for compliance and got caught in efficiency vs emissions trade off. The European industry had hoped that increasing the share of diesel car sales that are moderately more fuel efficienct would help to meet fleet-wide fuel economy target. In fact, diesel has grown from 14 per cent in 1990 to 44 per cent in 2003, and is expected to be 52 per cent of market share by 2007. Lower taxes on diesel fuel and lower import taxes on diesel cars in some EU countries, have further aided in dieselisation of car fleet. But this has not helped Europe to meet its CO_2 target.

On the contrary, expansion of diesel car fleet has resulted in violation of the EU air quality targets for NOx, PM and ozone in cities. Even though Europe has begun to get the world's cleanest fuel with 10 ppm sulphur, its emissions standards have lagged behind the global best. The particulate norms for diesel cars in Europe will close gaps with the US and Japan only in 2009 when Euro V will be enforced. But the NOx norms will catch up with Japan in 2014 when Euro VI norms will be enforced. But even then it will trail behind the US Tier 2 NOx norms by at least 43 per cent. Euro V standards allow diesels to emit 3 times the NOx levels than petrol vehicles. Thus, the dieselization which in many ways is a fall out of the CO_2 reduction strategy has also proven to be counter productive from the air quality and public health perspective. At the same time dieselisation of car fleet is also obstructing rapid improvement in emissions standards in Europe.

Moreover, the average diesel car is driven 40-70 per cent more than the average petrol car in Europe that also negates the CO_2 reduction benefits.

Diesel's contribution to the improvement in fuel economy can be considerably weakened by the rebound effect of the increased use of diesel. Improved fuel-efficiency of cars reduces the fuel cost of motoring per kilometre and encourages increased driving. Moreover, diesel fuel contains approximately 10 per cent more carbon per litre than petrol. As a result, the overall CO_2 emissions can be high if diesel vehicles are driven more. The average diesel car is driven 40-70 per cent more than the average petrol car in Europe. But this has not been adequately factored into the calculations of diesel's "greenhouse" advantage over gasoline.

JAPAN: WINNING THE RACE

The top runner model

Japan has taken early steps to set fuel economy standards for vehicles and also moved rapidly ahead to be the front runner. The Japanese government had set the fuel economy standards for petrol and diesel light-duty passenger and commercial vehicles in 1999 with capacity of 10 passengers or less and freight vehicles with a gross vehicles weight of 2.5 tonnes or less. The "Top Runner" programme that Japan follows is based on a simple principle. It sets standards according to the most fuel efficient vehicle model in the respective weight classes that are already in the market. and pushes the rest to follow the top runner. It works on the potential of the other producers to meet those levels.

The Japanese standards are corporate fuel economy standards, (km/L), and each vehicle manufacturer has to meet the standard for their weight category for each target fiscal year. Fuel economy of diesel vehicles is discounted by 10 per cent to account for the higher energy content of diesel fuel. Each manufacturer will have its own unique fuel economy standard based on its sales mix. Changes in the weight of vehicles sold, either by individual companies or by the industry as a whole, will shift the projected compliance level for the industry as a whole to meet the targeted improvement.

In 2003 the standards for LPG vehicles were introduced in 2003.[15]

The Japanese standards have been revised and tightened in 2006 much before the revision was due. This is because most of the vehicles had already met the standards in force. So a proactive move was made to make the standards a notch tighter. The new standards are amount to fleet-wide average of 125 gCO_2/km in an EU equivalent test cycle.

The number of vehicle weight categories has been increased from 9 to 16. For the first time in the world, fuel economy standards have been introduced for the heavy duty vehicles. Standards for heavier freight vehicles with a gross vehicle weight over 3.5 tonnes and passenger vehicles with a capacity of 11 or more passengers were (more than 3.5 tonnes or small buses) introduced in 2006. Currently, all light duty vehicles (passenger cars and light freight vehicles or vans) and diesel heavy duty vehicles are covered by the regulations.

In 2010 Japan will introduce a new test cycle, the JC08, to replace the previous 10-15 test cycle. This with quicker acceleration, slightly increased speed, and new cold start increase the stringency of the test by 9 percent. But the average speed is still low and in sharp contrast to the high speed cycles of the US.[16]

The standards in the Top Runner Program are used in the Green Purchasing law and the green automobile tax scheme. The taxes levied on the gross vehicle weight and engine displacement of automobiles promote the purchase of lighter vehicles with smaller engines. There is also an annual award for the most energy-efficient products and systems.

The standards are expected to result in 23 per cent improvement in petrol passenger car fuel economy from 1995 to 2010 and 16 per cent improvement in diesel car fuel economy from 1995 to 2005. The new standards will further improve fuel economy by 19 per cent in 2015 over 2004 levels.

Monitoring and enforcement

To assess results for the target year a weighted average method per manufacturer and category is followed so that manufacturers can be offered incentives to bring more fuel efficient vehicles and diverse products to market. If manufacturers violate the order they will be liable to pay a fine. The programme also has "name-and-shame" element.

Possible limitations of the approach

There were apprehensions that weight based standards may encourage manufacturers to produce bigger and heavier vehicles that have poorer fuel economy as there are no incentive to produce more small cars. The average vehicle mass has not changed much since the introduction of the standards in Japan.[17] Nonetheless, the additional measures such as tight emissions standards, etc seems to have prevented significant shift in average vehicle mass.

It is also said that to the top runner approach which is based on the available best technology in the market may not create incentives for innovation as the standards are limited to what the market has already achieved. Japan may have been able to circumvent that with special R&D programme and stringent standards, and a dynamic process of revising standards.

It is also said that in this approach the selected top runner may not match their peers in traits that affect fuel economy, e.g. power, luxury features, 2-wheel vs. 4-wheel drive, etc., or in cost. The weight classes could be wide and a "top runner" chosen from the lower end of a weight class may not be representative of vehicles at the heavier end of the class. But it is evident from the expert reviews that the Japanese regulations have in-built safeguards such as not to consider vehicles that are not representative of the class, for example, the costly hybrid-electric vehicles etc.

THE US: WAKING FROM SLUMBER

The Corporate Average Fuel Economy (CAFÉ) standards

The US has lost grounds rapidly despite being the world leader in setting ambitious fuel economy standards in the wake of the 1973-74 oil crisis. This is ironical especially as the road based transport in the US is one of the biggest oil guzzler. About 68 per cent of the fuel in the US is used for transportation. Of this passenger vehicles use 63 percent and medium and heavy trucks use 20 per cent. Moreovre, transportation is the second largest source of CO_2 emissions after coal electricity in the US. EIA projections to 2025 estimate a 50 per cent increase in oil use, 77 per cent increase in oil imports, 9 per cent decline in domestic production, and a 2 mpg increase in new passenger vehicles. Overall fleet fuel economy is static.

The CAFE program was established in the US as mandatory fuel economy standards for passenger cars and light duty trucks. Accordingly, the manufacturers had to ensure that the vehicles in their fleet, on average, meet a specified miles per gallon (mpg) standard or pay a penalty. Originally weighted average fuel economy was set for passenger and light trucks upto 8,000 pounds (or 3632 kg) in a model year. To double the new car fuel economy by model year 1985 a target of 27.5 mpg were set for cars and 20.7 mpg for light-duty trucks. Initially this led to huge amount of oil savings on a cumulative basis in 2000. This was equivalent to reducing 25 per cent demand for gasoline and 13 per cent in demand for oil. In terms of cost it saved about $70 billion/yr. Global Warming Pollution savings in 2000 was about 100 million

metric tons of carbon/yr and 7 percent reduction in overall US emissions.

Policy interest in further strengthening CAFÉ laws waned thereafter and these provisions remained unchanged for decades. Light trucks – pickups and SUVs — are expected to grow faster than any other class of vehicle over the next 20 years.

As late as 2004 the CAFE standards for light-duty trucks were revised again to meet the fleet average standard of 21.0 mpg for 2005, 21.6 mpg for 2006 and 22.2 mpg for 2007. Standards for cars were not changed. But on the whole CAFÉ norms remained very lax.

In April 2006 the national Highway Traffic and Safety Administration adopted a reformed light truck CAFÉ policy that is based on vehicle size (measured as bottom areas between vehicles flour wheels).

The significant feature of the reformed CAFÉ is the introduction of the concept of setting standards according to the size of the vehicles. This is a sharp departure from the traditional practice of setting standards accoding to the weight of the vehicles or at times volume of the engine. In the US vehicle size based standards are emerging. This is called footprint approach. In this size of the vehicles can be maintained while reducing the weight of the vehicle. In a size based approach the wheelbase and length of the vehicle allows enough crush space in case of frontal crashes in accidents. Wheelbase and width provides resistance to rollover and stability. The targets are assigned according to vehicle's "footprint" (the product of the average track width times the wheelbase). Each vehicle footprint value is assigned a target specific to the footprint value.

The vehicle manufacturer can improve weight efficiency by reducing weight but retain the other attributes such as size, carrying capacity etc. The US has proposed to enforce such standards for light trucks in the coming years. As of now there is no regulatory experience with this standard. The objective is to improve fuel economy levels of the vehicles without downsizing the vehicles as the US consumers prefer bigger vehicles for the reasons of safety. Small and light vehicles are publicly percieved as unsafe on the highways.This has strong consumer interest especially in countries like the US where big vehicles dominate and downsizing can raise safety concerns. Size based standards is likely to have a greater appeal in markets dominated by bigger vehicles.

For the first three years 2008 — 2010, manufacturers can choose between size-based targets and truck fleet average of 22.5, 23.1, and 23.5 mpg, respectively. Beginning 2011, manufacturers will be required to meet only size based standards.

Beginning 2011 large sport utility vehicles called medium duty passenger vehicles that weigh between 8,500 and 10,000 GVWR will also be regulated. During 2008-2011 the light trucks have the option to meet the standards established for model years as follow: (Model year) MY 2008 — 22.5 mpg; MY 2009: 23.1 mpg; MY 2010: 23.5 mpg. The other option is to meet the standards as set according to the size of the vehicles.

The USEPA has developed new tests in 2006 to represent real world driving conditions that will be applied to models from 2008 onwards. This will be carried out with additional tests for speed, acceleration, air conditioning use, road surface, wind resistance etc. After 2011, manufacturers will need to perform additional cold temperature, air conditioning, and/or high speed/rapid acceleration driving tests for those vehicles most sensitive to these conditions. The test procedure is the first in the world that covers the effect of the air conditioning.

However, the new norms have drawn flak for being lenient on light trucks and SUVs. A federal appeals court has rejected the new pollution standards for most sport utility vehicles, pickup and vans and ordered regulators to draft a plan that's tougher on auto emissions. The 9th U.S. Circuit Court of Appeals ruled that the National Highway Traffic Safety Administration has failed to address why the so-called light trucks are allowed to pollute more than passenger cars and didn't properly assess greenhouse gas emissions when it set new minimum miles-per-gallon requirements for models in 2008 to 2011. The court also said the administration failed to include in the new rules heavier trucks driven as commuter vehicles, among several other deficiencies found.

Monitoring and Enforcement

A detailed reporting system has been developed for monitoring. Manufacturers are needed to submit details with regard to pre- and post production models for validation. Certification is done either on the basis of self reporting of test data or tests by EPA. If manufacturers are found not in compliance NHTSA reports the matter to the manufacturer. The manufacturers can earn CAFÉ credits to offset deficiencies in their performance. If enough credit is not available then the manufacturer can either pay the fine, or submit a carry back plan to the agency to use future credits it would generate in the three following years. Manufacturer has to pay that amount each time it sells a non compliant vehicle. The fine is charged as $5.50 per month of a mpg under the target value times the total volume of non compliant vehicles in the fleet.[18]

Limitations

The "SUV" Loophole: Due to design flaws in the regulations there has been significant expansion of the SUV population in the US adversely affecting the average fuel economy levels. Originally, the CAFÉ rules had made a distinction between cars and light trucks. But it is said that since then automakers have introduced what is termed as crossover vehicles combining the features of light trucks and cars that blurred the distinction between the two. These light trucks (pickups, SUVs, and minivans) began to be used as passenger transport as well. As a result of increase in their numbers average fuel economy has dropped since 1987 by nearly 7 per cent. In 1980, shortly after the program began, light trucks composed about 20 percent of the new passenger vehicle market in the United States. By 2005, light trucks, accounted for about 50 percent of the new passenger vehicle market in the United States.[19] Estimates ICCT that the average fuel economy of new US vehicles in 2002 was about eight per cent below the peak fuel economies achieved in model years 1987 and 1988. According to the USEPA, this has been lower than it has been at any time since 1980.[20]

The SUV bias of the US market has also increased business risks. This is evident from the huge losses that have been reported following the oil price hike in the recent years. A study stows that General Motors, Ford motor company and Daimler Chrysler that have relied heavily on fuel inefficient SUV suffered heavy losses as oil prices soared. About 75 per cent drop in the sales has lowered profits by US$ 7 billion.[21]

Flex fuel vehicles loophole: Alternative fuel vehicles assigned higher fuel economy values for CAFE compliance purposes, but not required to actually use alternative fuel.[22]

Failure to regularly update standards to reflect new technologies: 30 per cent higher fuel economy possible if technologies since 1981 were not applied to increasing weight and acceleration.

US FINALLY SETS NEW GOALS

An executive order has been issued in 2007 that directs the US Environmental Protection Agency (EPA) and the Departments of Energy (DOE) and Transportation (DOT) to begin developing regulations that would reduce greenhouse gas (GHG) emissions that would reduce projected oil use by 20 percent within a decade. The new policy was triggered by the Supreme Court ruling that the EPA must take action under the Clean Air Act to regulate GHG emissions from motor vehicles. The Court had directed that GHG emissions are air pollutants potentially subject to federal regulation under the Clean Air Act.

The "Twenty in Ten" goal as it is described, is to (1) increase the use renewable and alternative fuels, which will displace 15 percent of projected annual gasoline use; and (2) by further tightening the CAFE standards for cars and light trucks, which will bring about a further 5 percent reduction in projected gasoline use. The U.S. Congress is currently considering several bills that would increase car and truck CAFE standards or establish federal GHG emissions standards for motor vehicles. For the first time in many years, the Senate passed a bill (S.357 "Ten in Ten") that is increasing passenger vehicle fuel economy standards by 10 mpg over a decade to 35 mpg in 2020. The new law raises the gasoline mileage requirements of cars and trucks by 40 percent to an average 35 miles per gallon by 2020, which will eventually reduce US oil demand by 2 million barrels a day.

However, a federal appeals court has rejected the Bush administration's new pollution standards for most sport utility vehicles, pickup and vans and ordered tougher regulations. The 9th U.S. Circuit Court of Appeals ruled that the authorities have failed to assess greenhouse gas emissions when it set new minimum miles-per-gallon requirements for models in 2008 to 2011. Why the light trucks are allowed to pollute more than passenger cars.

A whiff of change

A significant new development in the US is the Supreme Court order of April 2007 that has enabled the US EPA to regulate greenhouse gas emissions from the vehicles. Efforts are on to draft new GHG standards by different states. It is estimated that the current proposals for GHG standards or size based fuel economy standards together may improve the fuel economy of the new US fleet by as much as 30 per cent.[23] (See box: *The US finally sets new goals*)

CALIFORNIA: SETS AMBITIOUS TARGETS

Green house gas emissions regulations: California has twice the number of any other state and cars generate 20 percent of carbon dioxide emissions in the United States, and at least 30 percent of such emissions in California.

California has taken the lead to reduce total GHG emissions from vehicles and also set the most ambitious reduction target for the next decade. California has the power to develop standards that are more stringent than the federal requirements. Other states can also follow California standards. About eleven states have adopted California's motor vehicles requirements for GHG emissions. But GHG regulation development has a very chequered history in California.

The regulatory process to set greenhouse gas regulations had started in 2002, when California had enacted the first state law (AB 1493) requiring GHG emissions limits from vehicles. This aims to set GHG emissions standard (CO_2 equivalent emissions gramme per mile) for vehicles. This requires each manufacturer to meet fleet average GHG targets for two separate categories of light-duty vehicles. This is a broad spectrum regulation that regulates CO_2-equivalent emissions to control wide range of GHG emissions including CO_2, methane (CH_4), nitrous oxide (N_2O) emissions emitted from the operation of the vehicles; CO_2 emissions from car air conditioning; HFC (refrigerant) emissions from air conditioning due to leakage etc; and upstream emissions associated with the production of the fuel used by the vehicles.

In 2004 a statute was issued that limited the fleet average greenhouse gas emissions

values from passenger cars, light duty trucks, and medium duty passenger vehicles. The fleet average caps first apply to model year 2009 vehicles. The caps become more stringent annually, so that by 2016 the fleet average would be 30 per cent below the 2002 level. Notably, emissions regulations for vehicles are expected to contribute about 40 per cent of the target reductions in GHG in California. California is in the process of developing measurement methods for these regulations.

California after meeting the new reduction target of 30 per cent by the model year of 2016, will just about equalise what Europe has achieved today in terms of CO_2, which is about 159 grams CO_2 per kilometer or 35.5 mpg. So what California will achieve by 2020 will be close to what the Europeans have achieved currently . California has begun to consider the next steps for tightening the target beyond 2016.

California's proactive initiative however, has met with scathing opposition from the auto industry. It has also faced obstacles from the Bush administration. Both have challenged California's right to enforce these laws.(See box: *California stopped from taking advanced steps*). California needs consent from the federal Environmental Protection Agency to impose GHG emissions limits on motor vehicles. In a significant turn of events EPA has rejected California's GHG tailpipe emission law. Approval of California's waiver would have meant that other states get approval

CALIFORNIA STOPPED FROM TAKING ADVANCED STEPS

The Bush administration has announced that it will deny California's request to regulate carbon dioxide emissions from automobiles. The administration said an energy bill signed into law by President Bush means no further action is needed to cut carbon dioxide emissions from vehicles, which account for about 30 percent of the US total. In April, the Supreme Court overruled the Bush Administration and concluded that EPA had the authority and responsibility to regulate greenhouse emissions; since then EPA' Office of Transportation and Air Quality has been working around the clock to prepare a proposal which it intended to release by the end of 2007 and to finalize by the end of 2008. Indications were that the proposal called for more stringent reduction than called for in the Energy legislation and on a more rapid time schedule.

The Environmental Protection Agency, charged with making the decision, found that thelandmark law to raise automobile fuel standards by 40 percent by 2020 was a "better approach" than a "patchwork" of state rules. California needed a waiver from the EPA to implement a law to force automakers to make vehicles that cut emissions 25 percent by the 2009 model year. Sixteen other states had either adopted or were considering rules similar to the California standard.

California vowed to appeal the decision and pursue "every legal opportunity" to get the waiver approved. Automakers have fought California's environmental plans in court and lobbied hard in Washington to block the waiver.

Earlier in 2005 trade associations including international automobile manufacturers joined a legal battle to block California from implementing the GHG regulations for vehicles. The petition by the Association of International Automobile Manufacturers and the Alliance of the Automobile Manufacturers and others contended that CARB had overstepped its authority in adopting rules, which require automakers to install technologies in 2009 and later that reduce carbon doxide and other emissions linked with global warming and this is defacto fuel economy standards which only federal government may impose.

Subsequently, in 2006 California's governor, Arnold Schwarzenegger signed into law a ground-breaking global-warming initiative that slaps the US's first ever cap on greenhouse gas (GHG) emissions. Under this law, California will have to reduce GHG emissions to 1990 levels by 2020. By January 2008, the California Air Resources Board (CARB), responsible for its implementation will begin to require the state's major greenhouse-gas producers to report their emissions.

On the basis of the new climate change bill California sued six auto giants on the grounds that GHG emissions from their vehicles have caused billions of dollars worth damage. This is expected to pressure car manufacturers to accept the new rules.

The auto manufacturers' lawsuit challenging the GHG vehicle regulation still continues. But as a safeguard the Climate Change Bill does have a provision that says, in effect, if the light duty vehicle GHG rule is overturned in court, the California legislature commits to establishing a new program that will achieve equal or greater reductions of GHG emissions from light duty vehicles.

automatically as sixteen other states have adopted, or are in the process of adopting California's emissions standards. EPA while rejecting California's proposal argued that it is working out a national solution that is better than a confusing patchwork of state rules - to reduce America's climate footprint from vehicles.

As soon as the California gone ahead with its plans to regulate GHG emissions from cars automakers have fought California's environmental plans in court and lobbied hard in Washington to block the waiver to avoid tougher state standards.

CHINA: PROACTIVE

Fuel economy standards

China has taken the lead among the developing countries to set fuel economy standards anticipating a three to seven fold increase in its vehicle fleet and three to nine times increase only in car numbers. According to the studies carried out by the Beijing based Innovation Center for Energy and Transportation, China has become the second largest vehicle market since 2006, with total new sales surpassing 7 million unites. Car market exploded in the past several years. New carsales has surpassed 3.0 millions in 2006. Annual growth in new car sales averaged about 20 per cent since 1992. China has turned into an oil net-import country, and in 2006 the net-import oil amount has reached nearly half the total oil use. IEA projects imports share to reach 60 per cent by 2010, 70 per cent by 2020.

Essentially to improve its energy security China has made a proactive move to set fuel economy standards for cars, SUVs, and vans in 2004. These standards are the first among the developing countries. [24]

The standards are being implemented in two phases: Phase 1 has taken effect from July 1, 2005 for new vehicle models and from July 1, 2006 for continued vehicle models. Phase 2 will take effect from January 1, 2008 for new models and in January 1, 2009 for continued vehicle models. The standards have been classified and set for 16 weight classes, ranging from vehicles weighing less than 750 kg to vehicles weighing over 2,500 kg. The standards cover passenger cars, SUVS and multi-purpose vans (MPVs), and have separate standards for passenger cars with manual and automatic transmissions. SUVs and MPVs, regardless of their transmission types, share the same standards with passenger cars with automatic transmissions. Commercial vehicles and pickup trucks are not regulated under the standards.

The Chinese standards set up maximum allowable fuel consumption limits by each weight category.[25] Each individual vehicle model sold in China will be required to meet the standard for its weight class. This is different from fleet average target.

The Chinese standards for minivans and SUVs are more stringent for the first phase and much more stringent for the second phase than what such vehicles now achieve in the US. In fact nearly 60 per cent of the current light duty US models in the heavier classes may not be able to meet the Phase 2 standards.

Implementation of the fuel economy regulations have begun. Currently, discussions are going on with regard to the future steps. China is expected to establish fuel consumption limit for light duty commercial vehicles with max vehicle mass below 3.5 tonnes.

It is estimated that at the time of adoption of the fuel economy standards nearly 50 per cent of the current Chinese vehicle models cannot meet the Phase I standards and about 85 per cent cannot meet the Phase 2 standards. This estimate was done

on the basis of the declared fuel consumption levels by the manufacturers in 2003. There is a proposal to develop and implement fuel consumption labelling system.

If vehicles fail to meet the standards its manufacturing and importation are prohibited. Fiscal penalties are under discussion.

China is now begining to work on the phase III passenger vehicle fuel efficiency standards and enforcement.

Tax measures: As a complimentary measure China has introduced tax incentives for vehicles with smaller engines. The tax rate on small-engine (1.0-1.5 liter) vehicles has been cut from 5 to 3 percent, while that on vehicles with larger-engines (more than 4 liters) is raised from 8 to 20 percent. The preferential 5 percent tax rate on SUVs has been eliminated.

HIGHLIGHTS OF FUEL ECONOMY REGULATIONS IN OTHER COUNTRIES[26]

CANADA: Canada had originally begun with a voluntary Company Average Fuel Consumption (CAFC) program in 1976 to control the fuel consumption of the new light duty vehicles that was quite similar to the U.S. CAFE program.

In 2005, the government of Canada signed a voluntary agreement with automakers seeking significant improvements in GHG emissions -- reduce light duty vehicle GHG emissions of 5.3 million metric tonnes of CO_2 equivalent in 2010 relative to the year 2000 (approximately 25 per cent reduction target). Under the MOU, automakers can receive credits for CO_2 reductions by reducing vehicle fuel consumption, lowering of exhaust N2O and methane (CH4) emissions, hydrofluorocarbon (HFC) emissions reduction from air-conditioning systems among others. Also large number of government programmes is envisaged to increase public awareness to achieve this target.

In 2006, the Canadian government announced a number of other measures to reduce air pollutants and GHG emissions. This included a commitment to formally regulate motor vehicle fuel consumption beginning with the 2011 model year to replace the voluntary CAFC program.

In 2007, the Canadian Government introduced Vehicle Efficiency Incentive (VEI) programme that includes a rebate and tax component linked with vehicle fuel efficiency. The performance-based rebate program offers $1,000 to $2,000 for the purchase or long-term lease (12 months or more) of an eligible vehicle. The new excise tax, called a "Green Levy", is charged on inefficient vehicles.
Other Canadian provinces like Québec, British Columbia and Nova Scotia have announced plans to adopt new vehicle standards similar to California's GHG emission standard.

AUSTRALIA: The automobile industry has signed a voluntary agreement with the government with a commitment to reach an overall fleet average fuel economy improvement of 15 per cent in light duty vehicles (over 2002 baseline) by 2010.

SOUTH KOREA: The fuel economy standards (in kilometre per litre) are based on engine volume classification system. South Korea are following testing methods that are similar to U.S. CAFE procedures. South Korean fuel economy standards established in 2004 will start in 2006. Standards are set at 39.9 miles per gallon for vehicles with engine displacement less than 1500 cc and 26.6 miles per gallon for those above 1500 cc. There are apprehensions that fuel economy levels in South Korea may decline as the size and power of vehicles are increasing.

TAIWAN: Standards are based on seven engine displacement categories and cover all passenger cars, light trucks and commercial vehicles. The fuel economy standards (in kilometre per litre) are based on engine volume classification system.

Taiwan is the only country that is known to have set fuel economy standards for motorcycles. The Fuel Economy Standards and Regulations on Vehicle Inspection and Administration were revised and promulgated by the Ministry of Economic Affairs and the Ministry of Transportation and Communications on January 14, 2004.[27] These regulations are formulated in accordance with Article 15 of the Energy Management Act. Fuel economy testing is conducted in accordance with the Federal Test Procedure (FTP-75) of the United States. The Fuel economy standards have been set for seven engine displacement (cubic centimeters) categories. These include — below 50 cc, 50-100 cc, 100-150 cc, 150 cc – 400 cc, 400 cc – 650 cc, 650 – 1000, over 1000 cc.[28] At this stage there is no discussion on the possibility regulating fuel economy in two-wheelers.

The Chinese standards are designed with an inbuilt disincentive for bigger vehicles (SUVs). The standards for the heavier categories are very stringent than the smaller categories. This coupled with fiscal incentives encouraging more efficient vehicles may prevent market drifts towards heavier vehicles.

China may also face the risk of dieselisation though so far penetration of diesel in the car segments has been very limited in China. The combination of factors including narrow price difference between petrol and diesel fuel prices have effectively checked dieselisation. However, of late aggressive push for diesel has been reported. But Chinese standards have not been designed keeping in view the increased use of diesel cars. This is a cause of concern as clean diesel standards and fuels have not yet been introduced in china.

China's move to regulate fuel economy has sent aftershocks in the global market. It has been reported that 80 per cent of the US cars and half the European models do not meet the new fuel economy standards of china.

Addressing potential limitations

It is said that the Chinese standards are designed to protect the baseline fuel economy of the fleet and may not be dynamic enough to bring about progressive improvements in the market. However, the fact that the standards are being tightened for the phase III may help to counter such limitations.

6. BENEFITS OF FUEL ECONOMY REGULATIONS

The global overview bears out significant fuel savings and CO_2 reduction benefits due to these regulations (See table 4: *A summary overview of the benefits of enforcing fuel economy regulations*).

Table 4: A summary overview of the benefits of enforcing fuel economy regulations

Countries	Benefits of fuel economy regulations
European Union	The voluntary CO_2 emissions reduction agreement if implemented is expected to improve fuel economy by 33 per cent in 2008 and also reduce CO_2 emissions substantially.
Japan	The fuel economy standards is expected to result in 23 per cent improvement in petrol passenger car fuel economy from 1995 to 2010 and 16 per cent improvement in diesel car fuel economy from 1995 to 2005. The new standards will further improve fuel economy by 19 per cent in 2015 over 2004 levels. This amounts to significant fuel and monetary savings.
China	With the fuel economy standards China is expected to save 20.6 million metric tonnes of oil in 2030 with the help of these regulations. If the standards are further tightened to achieve 80 per cent improvement by 2030 China can save 70.8 million metric tonne of oil in 2030.
United States	Overall CAFÉ norms have helped in oil savings of 2.8 mmbd. These have led to 25 per cent reduction in demand for gasoline and 13 per cent reduction in demand for oil (19.5 mmbd total). GHG savings account for 100 million metric tons of carbon per year and 7 percent reduction in overall US emissions.
California	After the enforcement of fleet average greenhouse gas emissions limits from the model year 2009 vehicles onwards, and with the limit values becoming more stringent annually, the fleet average GHG emissions are expected to be 30 per cent below the 2002 level by 2016.
India stands to benefit	The Integrated Energy Policy 2006 has estimated that if the energy efficiency of all motorised vehicles is increased by 50 per cent the oil requirement will go down by some 86 Mt by 2031-32. This amounts to fuel saving of 630 million barrels, and monetary saving of US$ 36 billion at current prices.

7. COMPLEMENTARY POLICY MEASURES

To enhance the effectiveness of the fuel economy stanards other governments have also initiated complimentary and supportive measures to raise consumer awareness, influence consumer choice to enhance compliance with the fuel economy standards. the key approaches include labelling of vehicles according to their energy efficiency performance and tax policies to promote fuel economy. Once standards are set to benchmark improvement in vehicle technology, these additional measures can help to enhance market competition to favour fuel efficient products. Large numbers of countries have begun to implement these programmes. Europe, Japan and the US have elaborate systems in place.

HIGHLIGHTS OF FUEL ECONOMY LABELLING SYSTEM IN OTHER COUNTRIES

JAPAN

Based on a vehicle certification programme introduced in April 2004, vehicles are ranked according to their fuel efficiency performance and certified in four levels - the target level, the level exceeding the target level by 5 per cent, 10 per cent and 20 per cent and stickers are attached to rear windows of the vehicles according to the level. [29]

Under the Energy Conservation Law the vehicle manufacturers are required to label vehicles' fuel efficiency. As per the official requirements manufacturers have to display the following information — vehicle name and vehicle type, engine type, total displacement, maximum power and maximum torque of engine, vehicle curb weight, transmission type and number of gears, major measures for improving fuel efficiency, fuel efficiency in km/L, manufacturer's name, fuel efficiency and CO_2 values. Manufacturer can be penalized for violation.

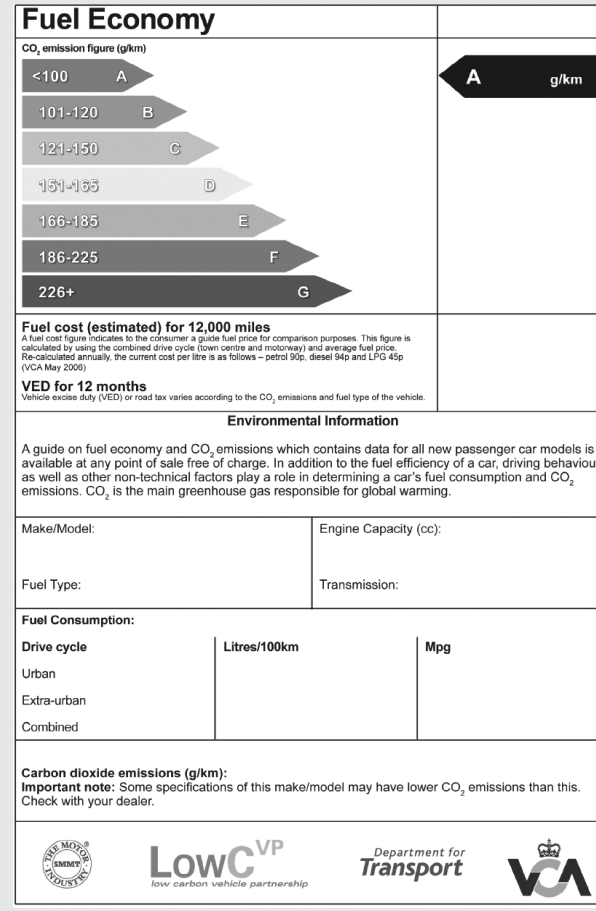
THE EUROPEAN UNION

EU Directive 1999/94/EC (as amended by 2003/73/EC) requires fuel consumption and CO_2 emissions data of new cars to be made freely available to consumers. Car dealers also need to have a label showing the fuel consumption (l/100 km or mpg) and CO_2 emissions of each different model on display. The label will reflect fuel economy according to urban, extra-urban and combined conditions separately. Dealers have the option to produce a new "comparative" label. The new label shows the mandatory Fuel Consumption and CO_2 levels alongside the information about the appropriate VED band for the vehicle.

The directive also requires manufacturers to include fuel consumption and CO_2 emissions data in all brochures and printed advertisements, provided that the literature relates to a specific model of car. These requirements were implemented in the UK through the Passenger Car (Fuel Consumption and CO_2 emissions Information) Regulations 2001. For non compliance dealers are liable to pay a fine of up to £5,000.

The Directive 1999/94/EC has been implemented by all Member States though some countries have further developed the method. Some countries also include data on noise or fuel cost. Energy efficiency rating systems have been introduced by 7 countries.

Example of comparative label (UK)



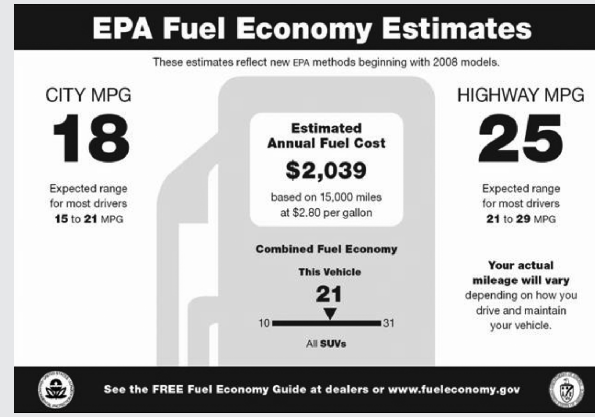
From July 2005 onwards, manufacturers have switched to a new style of "comparative" fuel economy label that shows the applicable band for the car, the CO_2 figure and estimated annual running costs for the vehicle.

THE UNITED STATES

Fuel economy estimates have been provided to consumers since the 1970s. The "Energy Policy and Conservation Act" of 1975 established the fuel economy labeling system that include posting on window stickers of all new motor vehicles, and the publication of an annual booklet of fuel economy information to be given by the car dealers.

To more clearly convey fuel economy information to consumers, EPA has recently revised the fuel economy window sticker that appears on new vehicles beginning with 2008 models manufactured after September 1, 2007.[30]

For the first time the EPA will require fuel economy labels on certain heavier vehicles up to 10,000 pounds (lb) gross vehicle weight, such as larger SUVs and vans. Manufacturers will be required to post fuel economy labels on these vehicles beginning with the 2011 model year. The new label design to be enforced after September 1, 2007 will make it easier for consumers to compare fuel economy



while buying new vehicles. The fuel economy label provides information on estimated annual fuel costs based on a given number of miles and fuel price, expected city and highway range, comparison with the highest and lowest fuel economy of all other vehicles in its class, reminder that there are many reasons why actual fuel economy may vary from the estimates, a web address where more information can be found. The EPA and US Department of Energy (DOE) produce annually the Fuel Economy Guide to help car buyers choose the most fuel-efficient vehicle that meets their needs.

HIGHLIGHTS OF TAX POLICIES TO PROMOTE FUEL EFFICIENCY

In order to influence consumer's behaviour towards more environmentally-friendly and fuel efficient vehicles, several countries have begun to implement fiscal measures. Car taxation is a powerful instrument to stimulate demands for fuel efficient vehicles especially as labeling is not strong enough inducement for market shifts.

THE EUROPEAN UNION

In order to implement the EU's strategy to reduce CO_2 emissions from passenger cars, the registration taxes and annual circulation tax will be restructured to be totally or partially CO_2 based. This proposal from the European Commission in September 2005, got the support from the European Parliament. Through these fiscal measures, the EU and Member States aim to provide an incentive to influence consumers' behaviour towards purchasing more fuel-efficient passenger cars.

THE UNITED KINGDOM

In the UK, a number of steps have been taken to promote the purchase and use of more fuel efficient vehicles[31]:

- In the March 2001 Budget the Chancellor announced the extension of the lower rate of Vehicle Excise Duty (VED) to cover cars in the private and light goods taxation class with an engine size of 1549cc or less.
- Since March 2001, a system of Graduated VED has been in operation for new cars based primarily on their level of CO_2 emissions.
- Since April 2002, Company Car Tax has been based on the CO_2 emissions of the vehicle provided to an employee for their private use.
- During the March 2006 Budget, the Chancellor introduced a new zero rate for cars with the lowest carbon emissions and a new top band for the most polluting cars.

FRANCE

From 1 July 2006, cars registration certificates will be more expensive for vehicles with CO_2 emissions above 200 g/km. Based on 2004 car sales, 8 per cent of new cars would be affected by this additional tax according to the French environmental protection agency, the ADEME.

THE NETHERLANDS

The Netherlands has introduced a tax break in the form of a discount on the Private Motor Vehicle and Motorcycle Tax

(the BPM) in July 2006. This tax break is based on the energy bands, which are already used in the country's energy labels. A-labelled vehicles will have a US $1,000 discount (US $6,000 if hybrid) whereas G-labelled vehicles will have a US $540 additional charge. Accordingly, the taxes on fuel-inefficient cars will be increased.

GERMANY

An exemption in the tax circulation is granted to cars that meet advanced emission standards or that have very low fuel consumption.

DENMARK

Denmark has introduced tax reductions in the registration tax for the most efficient new cars with effect from 2000. The reduction rates are different for the periods 2000-2005 and 2006-2010 and higher during the first period.

AUSTRIA

The most energy efficient cars do not pay the tax.

SWEDEN

Electric vehicles are exempted from taxes in some Member States including Sweden.

The member states are being encouraged to adapt their car taxation policies so as to promote the purchase of fuel efficient cars throughout the EU.

JAPAN

Tax incentive for fuel efficient vehicles was introduced in 2001. It was revised in 2003, 2004 and 2006 and currently applies to all vehicles. This has helped to accelerate improvement and in 2005, average passenger car fuel efficiency in all categories met the 2010 fuel efficiency standards.

THE US

The US Congress has established Gas Guzzler Tax provisions in the Energy Tax Act of 1978 to discourage the production and purchase of fuel-inefficient vehicles. The Gas Guzzler Tax is assessed on new passenger cars. Trucks, minivans, and SUVs are not covered because these vehicle types were not widely available in 1978 and were rarely used for non-commercial purposes. The amount of tax is posted on the window stickers of new cars — the lower the fuel economy, the higher the tax. This tax has kept the SUVs out of the ambit of taxation despite the fact that this segment is fuel inefficient compared to cars.Other tax incentives are also available to encourage the purchase of alternative fuel and hybrid vehicles.

CHINA

China is linking vehicle purchase tax to fuel economy of vehicles. This tax has two components: exercise tax levied to automakers, and sales tax levied to consumers. The sales tax levied to consumers is 10 per cent and there is no reform proposal yet. But China has proposed to reform the excise taxes levied on automakers. As per the proposal the excise tax on small engine (1.0-1.5 L) is reduced from 5 per cent to 3 per cent and on larger engines with capacity more than four liters it is proposed to be increased from 8 per cent to 20 per cent. Further SUV that enjoyed special rate of 5 per cent is eliminated. Fiscal penalty for non compliance has not been implemented yet. Further tax reforms are under consideration.

Highlights of fuel economy labelling system in other countries:

Japan

Based on a vehicle certification programme introduced in April 2004, vehicles are ranked according to their fuel efficiency performance and certified in four levels - the target level, the level exceeding the target level by 5 per cent, 10 per cent and 20 per cent. Accordingly stickers are attached to rear windows of the vehicles.

Under the Energy Conservation Law the vehicle manufacturers are required to label vehicles' fuel efficiency. As per the official requirements manufacturers have to display the following information – vehicle name and vehicle type, engine type, total displacement, maximum power and maximum torque of engine, vehicle curb weight, transmission type and number of gears, major measures for improving fuel efficiency, fuel efficiency in km/L, manufacturer's name, fuel efficiency and CO_2 values.

Manufacturer can be penalized for violation.

The Eurpean Union

EU Directive 1999/94/EC (as amended by 2003/73/EC) requires new car fuel consumption and CO_2 emissions data to be made freely available to consumers. Car dealers are required to have a label showing the fuel consumption and CO_2 emissions of each different model on display. Fuel consumption figures will be expressed both in litres per 100 kilometres (l/100 km) and in miles per gallon (mpg). The label will list the figures achieved in urban, extra-urban and combined conditions separately. Dealers have the option to produce a new "comparative" label. The new label shows the mandatory Fuel Consumption and CO_2 figures mentioned previously, alongside information about the appropriate VED band for the vehicle.

The directive also requires manufacturers to include fuel consumption and CO_2 emissions data in all brochures and printed advertisements, provided that the literature relates to a specific model of car. These requirements were implemented into UK law by The Passenger Car (Fuel Consumption and CO_2 emissions Information) Regulations 2001, which came into force on the 21st of November 2001.

Non compliance renders dealers liable on conviction to a fine of up to £5,000.

The Directive 1999/94/EC has been implemented by all Member States though some countries have further developed the method. In addition to the data on CO_2 emissions and fuel consumption, some countries also include data on noise or fuel cost. Energy efficiency rating systems have been introduced by 7 countries. These are coloured scales that rank cars according to their CO_2 emission. The UK, Denmark, France, Spain and The Netherlands. Austria and Belgium use horizontal coloured scales.

In the UK for instance Vehicle certification agency is responsible for making and managing the new car fuel consumption and carbon dioxide emission database. This is meant to be used by individuals and organizations informs (a) buyers of new cars how they can reduce the impact of their vehicle on the environment; (b) identify the vehicle excise duty and/or the relevant Company Car tax percentage bracket, based on CO_2 levels; (c) search for cars that offer lower fuel consumption or use alternative fuel types.

From July 2005 onwards, manufacturers have switched to a new style of "comparative" fuel economy label that shows the applicable band for the car, the CO_2 figure and estimated annual running costs for the vehicle.

The United States

Fuel economy estimates have been provided to consumers since the 1970s. The "Energy Policy and Conservation Act" of 1975 established the fuel economy labeling system that include posting on window stickers of all new motor vehicles, and the publication of an annual booklet of fuel economy information to be given by the car dealers.

To more clearly convey fuel economy information to consumers, EPA has recently revised the fuel economy window sticker that appears on new vehicles beginning with 2008 models manufactured after September 1, 2007.

For the first time the EPA will require fuel economy labels on certain heavier vehicles up to 10,000 pounds (lb) gross vehicle weight, such as larger SUVs and vans. Manufacturers will be required to post fuel economy labels on these vehicles beginning with the 2011 model year. The EPA is changing the design and content of

the window sticker. The new label design will make it easier for consumers to compare fuel economy while buying new vehicles. This will be enforced after September 1, 2007. The fuel economy label provides information on estimated annual fuel costs based on a given number of miles and fuel price, expected city and highway range, comparison to the highest and lowest fuel economy of all other vehicles in its class, reminder that there are many reasons why actual fuel economy may vary from the estimates, a web address where more information can be found. The EPA and US Department of Energy (DOE) produce annually the Fuel Economy Guide to help car buyers choose the most fuel-efficient vehicle that meets their needs.

The fuel economy for each vehicle model, however, will continue to be presented to consumers on the label as city and highway MPG estimates.

Tax policies to improve fuel economy

In order to influence consumer's behaviour towards more environmentally-friendly and fuel efficient vehicles, several countries have begun to implement fiscal measures. Car taxation is a powerful instrument to stimulate demands for fuel efficient vehicles especially if labeling is not strong enough inducement for market shifts.

The European Union

In order to implement the EU's strategy to reduce CO_2 emissions from passenger cars, the registration taxes and annual circulation tax will be restructured to be totally or partially CO_2 based. This proposal from the European Commission in September 2005, got the support from the European Parliament. Through these fiscal measures, the EU and Member States aim to provide an incentive to influence consumers' behaviour towards purchasing more fuel-efficient passenger cars.

The United kingdom

In the UK, a number of steps have been taken to promote the purchase and use of more fuel efficient vehicles :

- In the March 2001 Budget the Chancellor announced the extension of the lower rate of Vehicle Excise Duty (VED) to cover cars in the private and light goods (PLG) taxation class with an engine size of 1549cc or less.
- Since March 2001, a system of Graduated VED has been in operation for new cars based primarily on their level of CO_2 emissions.
- Since April 2002, Company Car Tax has been based on the CO_2 emissions of the vehicle provided to an employee for their private use.
- During the March 2006 Budget, the Chancellor introduced a new zero rate for cars with the lowest carbon emissions and a new top band for the most polluting cars.

France

France has launced an incentive scheme to reduce carbon dioxide scheme to redue emissions from new cars.From July 2006, cars registration certificates became more expensive for vehicles with CO_2 emissions above 200 g/km. Based on 2004 car sales, 8 per cent of new cars are affected by this additional tax accroding to french environment protection agency. Now buyers of cars emitting more than 160 g/km will have to pay a premium of upto Euro 2600. These cars represent 25 per cent of all sales. Conversely, individuals purchasing cars emitting less than 130 g/km of CO_2 emissions will recieve fiscal incentives. Cars with emissions betweeen the two limits are not affected.

The Netherlands

The Netherlands has introduced a tax break in the form of a discount on the Private Motor Vehicle and Motorcycle Tax (the BPM) in July 2006. This tax break is based on the energy bands, which are already used in the country's energy labels. A-labelled vehicles will have a 1000 discount (6000 if hybrid) whereas G-labelled vehicles will have a 540 additional charge. Accordingly, the taxes on fuel-inefficient cars will be increased.

Ireland

New-car buyers in Ireland will pay a CO_2 tax and face higher rates for cars with big engines starting next year. Ireland's vehicle registration tax (VRT) will be linked to a car's CO_2 emissions rather than engine size. VRT is a one-time tax levied on new cars. Currently it is calculated using the car's selling price plus sales tax.

The rates range from 22.5 percent to 30 percent depending on engine size. A seven-tier rate system will be applied based on a car's CO_2 emissions from the summer of 2008. The low end of the tax scale will be 100 Euros on a new car that emits 120 grams per kilometer or less. In addition, the annual tax rates for cars have increased. The tax on a vehicle with an engine under 2.5 liters increases by 9.5 percent and goes up 11 percent for vehicles above that capacity.

Germany

An exemption in the tax circulation is granted to cars that meet advanced emission standards or that have very low fuel consumption. The car-buyers are to be rewarded with a tax exemption in the future for selecting environmentally friendly vehicles. New vehicles that emit 100 grams of carbon dioxide per kilometer or less will no longer be subject to an annual tax, according to a plan released by the German government.

The car tax proposal is intended to replace the existing law, which charges car owners based on the size of their vehicle. If approved by Germany's state governments in early December, the tax exemption would apply to vehicles admitted as of January 1, 2009. Starting in 2009, a sliding tax scale would apply to new vehicles with higher CO_2 emissions. Old vehicles would continue to be charged according to their size, but at higher rates.

Denmark

Denmark has introduced tax reductions in the registration tax for the most efficient new cars with effect from 2000. The reduction rates are different for the periods 2000-2005 and 2006-2010 and higher during the first period.

Austria: The most energy efficient cars do not pay the tax.

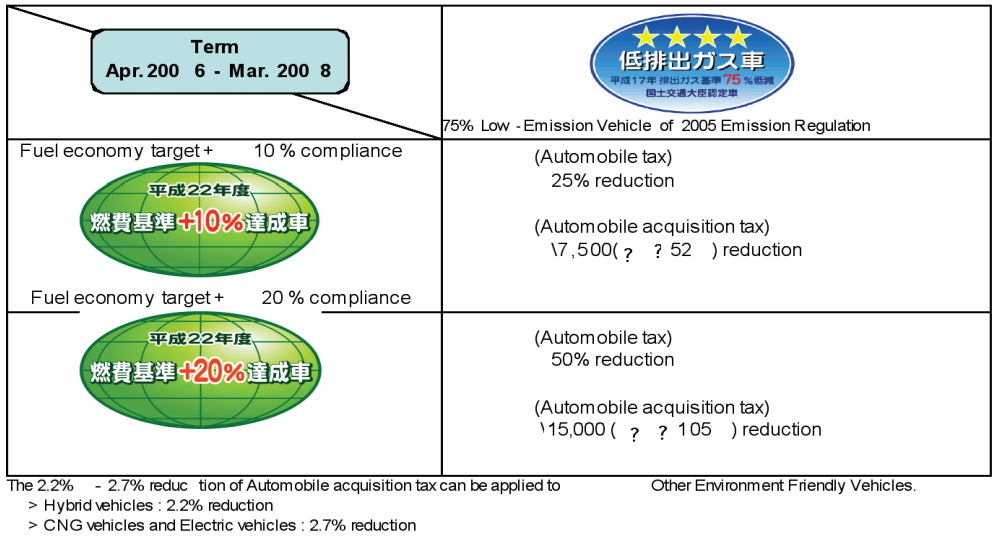
Sweden: Electric vehicles are exempted from taxes in some Member States including Sweden.

The member states are being encouraged to adopt car taxation policies to promote the purchase of fuel efficient cars throughout the EU.

Japan

Tax reduction incentive for fuel efficient vehicles was introduced in 2001. It was revised in 2003, 2004 and 2006 and currently following tax reduction incentives are applied to vehicles. This has helped to accelerate improvement. In 2005, average passenger car fuel efficiency in all categories met the 2010 fuel efficiency standards. Only standards alone could not have made this possible.

Figure 18: Tax reduction incentive for fuel efficient light-duty vehicle in Japan



Source: Japan MLIT

The US

The US Congress has established Gas Guzzler Tax provisions in the Energy Tax Act of 1978 to discourage the production and purchase of fuel-inefficient vehicles. The Gas Guzzler Tax is assessed on new passenger cars. Trucks, minivans, and SUVs are not covered because these vehicle types were not widely available in 1978 and were rarely used for non-commercial purposes. The amount of tax is posted on the window stickers of new cars — the lower the fuel economy, the higher the tax. This tax has kept the SUVs out of the ambit of taxation despite the fact that this segment is fuel inefficient compared to cars.

Other tax incentives are also available to encourage the purchase of alternative fuel and hybrid vehicles.

Table 5: Gas guzzler tax in the US

Gas guzzler tax	Tax
Unadjusted MPG (combined)*	
at least 22.5	No tax
at least 21.5, but less than 22.5	$1000
at least 20.5, but less than 21.5	$1300
at least 19.5, but less than 20.5	$1700
at least 18.5, but less than 19.5	$2100
at least 17.5, but less than 18.5	$2600
at least 16.5, but less than 17.5	$3000
at least 15.5, but less than 16.5	$3700
at least 14.5, but less than 15.5	$4500
at least 13.5, but less than 14.5	$5400
at least 12.5, but less than 13.5	$6400
less than 12.5	$7700

Source: Takao Onoda, 2007, A working paper, Review of international policies for vehicle fuel efficiency, International Energy Agency, Paris, Draft discussion paper for internal meetings, (unpublished) *Mimeo*

China

China is linking vehicle purchase tax to fuel economy of vehicles. This tax has two components: exercise tax levied to automakers, and sales tax levied to consumers. The sales tax levied to consumers is 10 per cent and there is no reform proposal yet. But China has proposed to reform the excise taxes levied on automakers. As per the proposal the excise tax on small engine (1.0-1.5 L) is reduced from 5 per cent to 3 per cent and on larger engines with capacity more than four liters it is proposed to be increased from 8 per cent to 20 per cent. Further SUV that enjoyed special rate of 5 per cent is eliminated. Fiscal penalty for non compliance has not been implemented yet. Further tax reforms are under consideration.

8. TECHNOLOGY ROADMAP TO IMPROVE FUEL ECONOMY OF VEHICLES

One of the primary reasons for the technology lag in India is the absence of fuel economy standards. This has influenced the Indian technology trajectory differently. India has not seen similar technology shifts as in the European market during the last decade while moving from one stage of emissions standards to the next.

The difference is showing up already. Europe has witnessed early and widespread introduction of improved technical features in cars because of the fuel economy improvement targets combined with the emissions standards. For eg, Europe graduated early from mechanical injection to electronically controlled injection systems; saw early application of direct injection system in diesel cars across the board replacing indirect injection in the diesel segment, and more consistent development of advanced direct fuel injection systems (CRDi) etc. But this transition has been delayed considerably in India. Most of these changes have occurred especially in the small and compact cars at the Euro III stage. Bolder technology choices could have been made earlier in India if fuel economy regulations were in place.

While technology solutions have already configured to improve both emissions and efficiency of vehicles globally, policy mandates do not exist in India to enable these technologies. Driven by regulations the global automobile industry is working with a combination of technologies that aim at weight reduction, drag reduction, rolling resistance reduction and improved engine technologies for drive train efficiencies.

Regulatory agencies around the world are constantly mapping out the available and the emerging technology options to improve fuel economy for both petrol and diesel vehicles. The roadmaps emerging in different regions have many points of convergence but also divergence to address unique factors of the respective regions.

In Europe for instance, the European Commission had commissioned a study to prepare a new strategy to reduce CO_2-emissions from light-duty vehicles to a level of 120 g/km in 2012.[32] This was jointly conducted by the TNO, Institute for European Environmental Policy, Laboratory of Applied Thermodynamics of Aristotle University of Technology in 2006 on behalf of the European Commission to review and analyse the reduction potential and costs of technological and other measures to reduce CO_2-emissions from passenger cars in Europe. This study has identified technical options which could be used to improve the fuel economy and reduce CO_2-emissions of passenger cars during the time frame of 2002 to 2012.[33] (See table 6: *Technical options to improve fuel economy and reduce CO_2-emissions of passenger cars in Europe, 2002 and 2012*). This indicates that in Europe the focus will be all inclusive and cover the engine improvement along with downsizing, and aerodynamics improvement.

California has also charted a technology route to improve efficiency and reduce GHG emissions (See table 7: *Technical options to improve fuel economy and reduce GHG emissions from passenger cars in California*). The technology roadmap emerging from California shows that it will continue to rely largely on the technology and drive train improvement instead of downsizing or weight reduction strategies. In fact, emerging laws in California to reduce GHG emissions from passenger vehicles do not mandate required reduction in vehicle weight, any limitation on speed, or any limitation on vehicles miles travelled. The entire focus is forcing technology to improve.

California also does not consider special strategies hinged on diesel or alternative

Table 6: Technical options to improve fuel economy and reduce CO_2-emissions of passenger cars in Europe, 2002 and 2012

	Petrol	Diesel
Engine	Reduced engine friction losses	Reduced engine friction losses
	DI / homogeneous charge (stoichiometric)	4 valves per cylinder
	DI / Stratified charge (stoichiometric)	Piezo injectors
	DI / Stratified charge (lean burn / complex strategies)	
	Mild downsizing with turbocharging	Mild downsizing
	Medium downsizing with turbocharging	Medium downsizing
	Strong downsizing with turbocharging	Strong downsizing
	Variable Valve Timing	
	Variable Valve Control	
	Cylinder deactivation	Cylinder deactivation
	Variable Compression Ratio	
	Optimised cooling circuit	Optimised cooling circuit
	Advanced cooling circuit + electric water pump	Advanced cooling circuit + electric water pump
		Exhaust heat recovery
Transmission	Optimized gearbox ratios	6-speed manual/automatic gearbox
	Piloted gearbox	Piloted gearbox
	Continuous variable transmission	Continuous Variable Transmission
	Dual clutch	Dual clutch
Hybrid	Start-stop function	Start-stop function
	Regenerative braking	Regenerative braking
	Mild hybrid (motor assist)	Mild hybrid (motor assist)
	Full hybrid (electric drive)	Full hybrid (electric drive capability)
Body	Improved aerodynamic efficiency	Improved aerodynamic efficiency
	Mild weight reduction	Mild weight reduction
	Medium weight reduction	Medium weight reduction
	Strong weight reduction	Strong weight reduction
Other	Low rolling resistance tyres	Low rolling resistance tyres
	Electrically assisted steering (EPS, EPHS)	Electrically assisted steering (EPS, EPHS)
	Advanced aftertreatment	DeNOx catalyst
		Particulate trap / filter

Note: The exhaust gas aftertreatment technologies at the end of the list obviously are not intended to improve fuel economy. These options may need to be applied to certain (packages of) engine improvement options in order to meet Euro 5/6 emission limits. They are listed here as they have an impact on the overall CO_2-benefit of these options which needs to be taken into account in the calculations.

Source: Anon 2006, Review and analysis of the reduction potential and costs of technological and other measures to reduce CO_2-emissions from passenger cars, Final Report, October 31, TNO, IEEP and LAT

fuel vehicles as a means to meet targets. California has already enforced fuel neutral emissions standards in which diesel will not find any preferential treatment to meet GHG emissions target. This opens up vistas for more advanced and emerging technologies and if diesel also fulfils the stringent requirements they become part of the strategy.

The key message from the global experience is that stringency of regulations influences technology trajectory and the performance and competitiveness of the manufacturers. Performance and the actual fuel economy levels attained by the individual automobile companies vary according to the regulatory demand in different markets. The available information shows that the same automobile company can have poorer CO_2 emissions levels in the US market with weaker

Table 7: Technical options to improve fuel economy and reduce GHG emissions from passenger cars in California

	California Climate Change (CO_2 eqv targets)
Available technologies assumed to be widely used by 2012	•GDI-S
	•Dual cam phasing
	•Turbo-charging or cylinder deactivation
	•6 speed automated manual transmission
	•Electric power steering
	•Improved alternator
	•More efficient, low-leak A/C
Emerging technologies assumed to be widely used by 2016	•Camless-valve actuation
	•Integrated starter generator with some assist
	•Electric accessories
Technologies available to reduce CO_2 not assumed needed to meet proposed standards	•Weight reduction
	•Alternative fuel engines
	•Mild or strong gasoline HEVs
	•Diesel

Source: Tom Cackette 2004, Diesel engines: what role can they play in an emissions constrained world? Paper presented at the 'Diesel Engine Emissions Reduction conference 2004', Coronado, California, USA, August 29-September 2

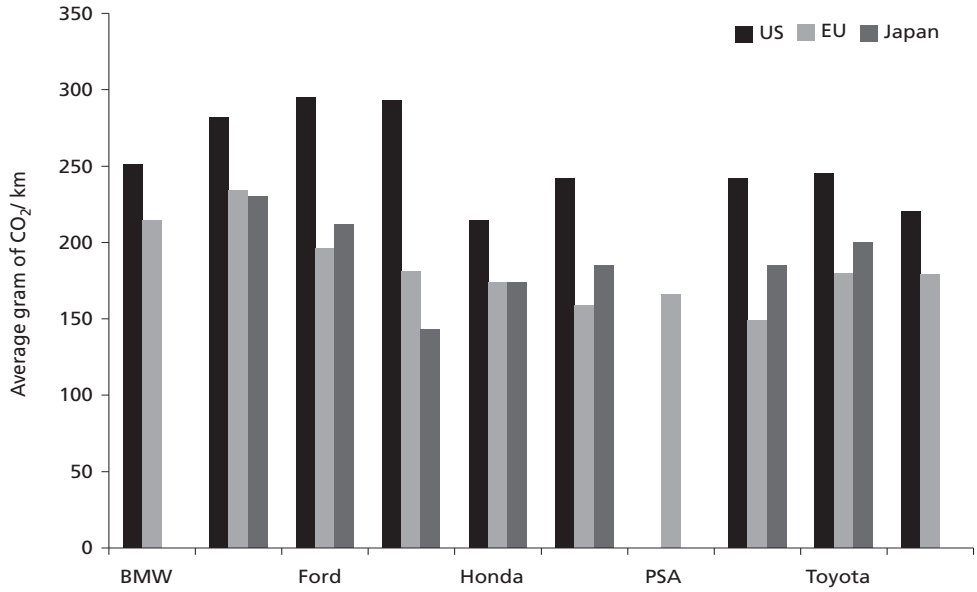
regulations but have more improved emissions in the European and Japanese markets that have more stringent regulations. This bears out the importance of regulations.

The US based World Resources Institute (WRI) has analysed the carbon intensity of sales of different original equipment manufacturers (OEMs) for 2002 in three markets of the US, Europe and Japan. The analysis shows markedly different average CO_2 emissions rates of the companies across these markets. For instance, average CO_2 emissions rate per vehicles of the US company General Motors in Japan is two times better than in the US market. Similarly, average CO_2 emissions rate per vehicles of the European company Renault in the US market is markedly higher than its home market. (See Figure 19: *Average CO_2 emission rates per vehicle for each OEM by region, 2002*)

India does not have fuel economy regulations yet. Therefore, there is no official assessment of the possible technology options in the country. Only the recently completed Report of the Working Group on Petroleum & Natural Gas Sector for the 11th Plan (2007-2012) has emphasised on the need of fuel economy standards and the working group has taken into account the proven technologies that are available globally and commercially to improve the average fuel economy of new vehicles by 40–65 percent within a decade. (See table 8: *Technology options for passenger vehicle fuel economy improvement*)

The report further states that in addition to the incremental improvements, vehicle manufacturers around the world are developing and starting to manufacture hybrid electric vehicles that so far have exhibited 50–85 percent greater fuel efficiency compared to typical new cars in their size class. It states that improving fuel economy does add to the first cost of a vehicle, but the value of the fuel savings usually more than offsets this first cost premium. It has therefore recommended a combination of policies including: tougher regulations; financial incentives; continued R&D; and consumer education and marketing should be adopted to ensure that vehicles sold during the next few decades are "gas sippers" rather than "gas guzzlers."

Figure 19: Average CO_2 emission rates per vehicle for each OEM by region, 2002



Notes: 1. GM's sales in Japan represent less than 8,000 sales of Suzuki and Isuzu vehicles, which reflect GM's ownership stakes in these companies.
2. Renault's figures for the United States and Japan represent sales of vehicles by Nissan, in which Renault has a 44 percent ownership stake.

Source: Duncan Austin et al, Changing Drivers: The Impact of Climate Change on Competitiveness and Value Creation in the Automotive Industry, World Resources Institute, US

Table 8: Technologies options for Passenger Vehicle Fuel Economy Improvement

Technology Fuel Economy	Improvement (Percentage)*
Weight reduction	10–30
Aerodynamics	4–10
Variable valve control	12–16
Direct injection spark ignition	5–23
Other engine refinements	5–10
Improved transmissions	6–14
Hybrid powertrain—near and mid-term	40–80
Hybrid powertrain—longer term	100–200

*Improvements relative to US average mid-1990s passenger vehicle at 25 MPG.
Note: Adapted from strategies for reducing oil imports: expanding oil production vs. increasing vehicle efficiency, Howard Geller, April 2001, American Council for an Energy-Efficient Economy

Source: Anon 2006, Report of the Working Group on Petroleum & Natural Gas Sector for the XI Plan, (2007-2012), Planning Commission of India, November 2006

9. THE WAY AHEAD: DEVELOPING FUEL ECONOMY REGULATIONS IN INDIA

To address the energy crisis and the looming threat of rising greenhouse gas emissions immediate fuel eficiency measures for vehicles are needed to minimise the impact of the rapid increase in motor vehicles.

There is huge potential for rapid diffusion of improved technologies that are already available commercially in the global market and ensure significant fuel savings if

regulatory standards are in place in India. This will also help the Indian industry which is aiming to globalize and the societal benefits would be immense for the country.

Motorisation in India is at a take off stage. This is the time to apply legal safeguards against oil guzzling otherwise India's energy future will be at risk. Without regulations there can be steady increase in size, weight, and power of vehicles as has been noticed in other countries. For example, in the US between 1988 and 2001 the average horsepower of vehicles has increased by 53 per cent, weight by 19 per cent, while fuel economy has declined by 8 per cent.[34] India is also witnessing the same trend. Only standards can help to protect the current baseline for the fuel economy levels of the fleet that is dominated by small vehicles and set targets for the future improvement.

Fuel economy standards in India can also have the ancillary benefit of reducing heat trapping carbon dioxide emissions as well. This is consistent with the global trend.

The global review shows that the major regions of the world have not only adopted medley of measures to improve fuel economy but they are also on their way to introducing the next degree of stringency to achieve tighter targets. As these regulations are taking effect the global automobile industry is under pressure to comply with the regulatory requirement in different markets and also maintain their competitiveness. Technologies are therefore shaping up quite quickly in markets with more stringent requirements. Given the international character of the auto industry in terms of small number of manufactures operating in different markets or through joint ventures, and also the fact that only a handful dominate even the domestic market, there is huge potential for rapid diffusion of technologies if regulatory benchmark is in place.

The automobile industry from time to time has expressed apprehensions that no certification test can capture the wide variety of factors that influence fuel economy of vehicles including driver behaviour, traffic and roads, climate, etc., and that might lead to complaints and legal petitions against manufacturers and testing agencies. Customers may therefore challenge the fuel economy data based on vehicles certification. But it is important to note from the regulatory experience elsewhere that the purpose of the fuel economy standards is not to provide absolute values of the fuel economy but indicate the fuel economy performance that can help the consumers to make a choice and also help industry to set benchmark to improve technology effectively. But this can ensure significant fuel savings.

Moreover, there are also apprehensions that lack of proper data on vehicle registration and fuel economy data in the country, inadequate information on how vehicles have and are being used, possible discrepancies between test cycle and on-road driving conditions and so forth may require more time and preparedness to craft fuel economy regulations. These problems are not insurmountable. The beginning can be made with what is available. China has also faced similar and severe constraints when it was crafting its fuel economy standards. But this has not deterred China from setting standards, and, also implementing those standards within a tight time frame.

Regulations in India should be crafted based on the experience and lessons from other countries and the uniqueness of the Indian situation. Comprehensive approach is needed to improve fuel efficiency and emissions from vehicles. A lot can go wrong if the regulations are not properly designed and it can lead to unintended consequences.

SETTING THE PRINCIPLES RIGHT

Set fuel economy standards: Given the imperative of energy security in India regulating fuel economy levels of the vehicles will help to achieve substantial fuel savings. This tangible benefit can help to enlist public support for the regulations. High import dependence and high crude oil prices are already a serious threat to the country's economy and growth. This is aggravating India's fiscal deficit, price caps are creating enormous strains, and the resultant losses borne by the oil companies and the government have become colossal. Fuel economy regulations will also give ancillary benefit of reducing heat trapping carbon dioxide emissions for climate benefits.

Voluntarism does not work. Need mandatory fuel economy standards. Global experience bears out that voluntary effort by the industry has not worked effectively. Voluntary efforts make compliance more uncertain especially when industry begins to increase the power and performance of the vehicle that affects overall fuel efficiency of the fleet. Voluntary system has not worked anywhere in the world. Standards should be legally enforceable. Europe has tried voluntary standards and it has failed with the result that there will certainly be several years delay in meeting their target. Therefore, regulatory and mandatory target with supportive enforcement measures and penalty for non-compliance are needed in India to ensure effective implementation.

The World Energy Outlook 2006 explains that without the regulations there can be serious market failures. For instance, with rising incomes people tend to put higher priorities on safe, comfortable and superior performance than fuel efficiency. Therefore, car manufacturers would use technological advances to increase the power and performance of the vehicle rather than improve fuel efficiency if there is no government intervention.

Standards should target key vehicle segments: Separate set of fuel economy standards can be developed for passenger vehicles and heavy-duty vehicles as distinct programmes in phases. Passenger vehicles market are very sensitive to fuel economy changes and thus has a strong potential for fuel savings. Set standards for heavy-duty vehicles given the fact that road based freight transport and also public transport is expected to grow dramatically in the future and these guzzle substantial share of transport fuel. Given the very large number of two-wheelers and growing interest in bigger engines in India standards for these vehciles can be introduced to protect the baseline. Till that time these vehicles should be brought under labeling and fuel economy related tax measures.

Design standards carefully: There are so many different ways that fuel economy and GHG regulations have been designed across regions. But clear lessons from all of them is that standards should be designed carefully to prevent leakages. If standards do not prevent drift towards heavier vehicles, fuel saving potential of the regulations can be eroded. If efficiency gains are not balanced adequately with emissions conrol strategies countries can get locked in serious efficiency vs emissions trade off. For instance, diesel cars may afford some fuel savings but they can increase toxic emissions manifold if clean diesel emissions standards are not in place. Fuel economy regulations should be designed to maximise fuel savings and GHG emissions reduction benefits without compromising on the safety and emissions requirements. India already has the advantage in its predominantly small car fleet that are relatively more fuel efficient than big cars and SUVs. Standards can help to protect the baseline and then make improvements.

Standards should be enforceable. Define the enforcement structures upfront: Design standards that are easier to enforce and do not have to rely on complicated administrative and enforcement structures. Fuel economy regulations will require appropriate adminstrative structure and data recording system for monitoring, compliance and effective implementation of the standards. Fuel economy or GHG regulations that rely more on giving greater flexibility to the manufacturers to meet standards as in the US CAFE system or in the European CO2 regulations, require sophisticated and complex supervisory structures. In the US, to assess the compliance with fleet wide average target the manufacturers are required to keep sales figures for every engine family and report that data to NHTSA and EPA at the end of the model year. There are large penalties if they are caught cheating. The fuel economy and emissions data are collected as part of the EPA Certification process. The Committee in India on the Auto Fuel Policy had concluded that "a system, like CAFÉ which is very cumbersome and laborious is not practicable for Indian conditions."

In Japan for instance, all registration data including fuel efficiency data are stored in one government server called MOTAS along with data on the tax incentive for each vehicle that are submitted. For judging compliance with the standards, each company submits necessary data to the government annually, and the government checks the data by using the central server. On the other hand, a minimum standard that each model of vehicle needs to comply with as in China is more practical especially when enforcement systems are premature. The degree of sophistication

PROS AND CONS OF WEIGHT VS SIZE/AREA APPROACH

Challanges of weight based standards: The key concern related to weight based standards is that there may not be much incentive to produce small cars as standards can be met for any weight class. It may impede downsizing which is seen as one of the strategies to improve fuel economy.

Moreover, in the case of sales weighted average standards manufacturers can increase the weight of a vehicle model especially if the weight of the vehicle model is close to the next weight class to move to more lenient standards and thus beat the standards. Japan however has been able to avoid such pitfalls because simultaneously it has been able to set stringent emissions standards that prevent such class jumping.

The key challenge therefore is how weight based standards can be enforced that will increase weight efficiency but not the average weight of the fleet. Clearly, if India adopts weight based approach it would need to build in safeguards as already there is strong consumer pressure for bigger and powerful cars. Concurrent policies would be needed to retain the interest of the car manufacturers and consumers in the smaller segments.

The challanges of footprint or size/area approach: Regulators in the US and Europe are examining other vehicle characteristics for setting fuel economy standards and to find the most efficient way to improve weight efficiency (that is reducing weight while leaving size unchanged). One such approach is to consider the vehicle size attribute or the footprint approach. Though there is no clear relationship between size of a vehicle and fuel economy, this approach may have greater consumer acceptance. This has found strong support in the US where downsizing and weight reduction have raised safety concerns. In a size based approach the wheelbase and length of the vehicle allows enough crush space in case of frontal crashes in accidents. Wheelbase and width provides resistance to rollover and stability.

The merit of such a proposal lies in the fact that people can relate to the size of a vehicle and therefore, consumer may be more responsive to such standards. This also means that if the vehicle manufacturer can improve weight efficiency by reducing weight but retaining the other attributes such as size, carrying capacity etc they can be rewarded for that. Only the US has proposed to enforce such standards for light trucks in the coming years. As of now there is no regulatory experience with it.

of the enforcement systems can be improved over time as more experience is gathered.

Disincentivise heavier cars: Tax policies must continue to prevent shift towards heavier vehicles, while also reducing car usage. Yet again China provides a good model in which efficiency standards for the heavier vehicles are made more stringet for that class of vehicles to offset the impact of SUVs. The argument that India predominantly produces fuel efficient small cars and therefore fuel economy regulations are not needed is not correct. The Japanese standards are more stringent for small cars. When large volumes are produced two small cars combined generally consume more fuel than a large car. Small cars should also achieve durable clean emissions and efficiency performance.

Develop the system of compliance, enforcement and monitoring along with penalty system: This is critically important for compliance. Japan and the US have developed compliance and penalty systems.

Remove perverse incentive for diesel cars: Fuel efficiency standards should not be traded off for higher harmful emissions. Diesel cars score moderately high on efficiency and lower carbon dioxide emissions per unit of distance, but are high emitters of harmful emissions. Much of its efficiency gains and climate benefits can be lost if more diesel is burnt due to its cheap costs. More carbon dioxide is emitted per litre of diesel than petrol as it has higher carbon content. Therefore, additional tax measures are needed to offset the lower cost of diesel fuel and check dieselisation. At the same time clean diesel standards (diesel fuel with less than 15-10 ppm sulphur used with advanced particulate trap) should be implemented to check toxic emissions. Despite having retail prices of diesel at about two third of petrol Japan has been able to prevent dieselization with stringent emissions and fuel efficiency standards.

It is important to remove incentive for conventional diesel cars while crafting the fuel economy regulations. For instance, the Union Budget of 2006 in India has allowed reduction in the excise duty to 16 per cent from 24 per cent for small cars. But this segment has been defined as a car of length not exceeding 4,000 mm and with an engine capacity not exceeding 1,200 cc for petrol cars and 1,500 cc for diesel cars. The more relaxed limit for diesel cars has brought within net a large number of mid segment diesel cars to qualify for the tax cut and created greater incentive for small diesel cars when India has not yet implemented clean diesel standards (diesel fuel with less than 15 ppm sulphur used with advanced particulate trap).

Other governments such as Japan and California have taken multi-pronged approach — they have set tight fuel economy and green house gas emissions regulations along with stringent fuel neutral emissions standards. Despite having retail prices of diesel at about two third of petrol Japan has been able to prevent dieselization with stringent emissions and fuel efficiency standards.

The Indian diesel vehicles industry has already begun to express concerns regarding the challenge of meeting the future NOx standards along with fuel economy improvement targets as meeting the two targets together presents an expensive technology challenge in diesel cars. In their submission of the Auto Fuel Policy Committee SIAM had claimed, “In the case of diesel engines, there is an inherent trade off between fuel consumption and NOx emissions. Special efforts are needed to address the issue of fuel consumption as one tries to achieve stringent emission norms.”[36] But as global review has shown that such contingency can be best avoided if fuel economy regulations are combined with stringent emissions

standards. Then advanced and clean vehicle technologies can compete fairly and equitably to accelerate fundamental paradigm shift in technology such as hybrids and electric vehicles and other vastly improved technologies. India need not remain locked up in dieselisation and suffer its adverse consequences.

Design standards carefully to plug loopholes: There are so many different ways that fuel economy and GHG regulations can be designed as seen across regions. But clear lessons from all of them are that standards should be designed carefully to prevent leakages. For instance, if standards do not prevent drift towards heavier vehicles, fuel saving potential of the regulations can be eroded. If efficiency gains are not balanced adequately with emissions control strategies countries can get locked in serious efficiency vs emissions trade off. For instance, diesel cars may afford some fuel savings but they can increase toxic emissions manifold if clean diesel emissions standards are not in place. Fuel economy regulations should be designed to maximise fuel savings and GHG emissions reduction benefits without compromising on the safety and emissions requirements.

Create disincentive for big cars: The fuel economy regulations must retain India's strength in small cars. Policies must continue to create incentives for small cars while also reducing car usage. Focused tax policies are needed to prevent shifts in average fleet-wide weight towards heavier ends. Yet again China provides a good model in which efficiency standards for the heavier vehicles are made more stringent for that class of vehicles to offset the impact of SUVs. But standards for smaller size range are also critical to push the laggards as in the Japanese standards and when small cars are produced in large volumes. Two small cars combined usually consume more fuel than one large car.

As seen earlier, there is considerable scope for a large number of models within the same vehicle class to improve and match the best in the same class. This means even the best can be targeted to meet better standards to keep the process dynamic. Currently, India follows a fiscal policy of providing tax incentive for small cars. This has played an important role in maintaining the popularity of small cars. It is however, important to push technology innovation in this segment to achieve durable clean emissions and efficiency performance.

Tax measures and fuel economy labelling can activate market: Tax policy and labelling linked to fuel efficiency of vehicles must be enforced along with fuel economy standards for the most effective impact. This has been found to be very effective around the world in influencing consumer demand for fuel efficient vehicles and also check drift towards bigger vehicles.

Technology solutions exist. Standards can enable them: A combination of technical approaches is possible for fuel savings -- weight reduction, drag reduction, rolling resistance reduction and improving engine technologies. The fuel economy regulations should be designed to accelerate innovations and also enable early introduction of advanced technology options such as electric hybrids etc. Fiscal measures are needed to enable rapid commercialisation of these technologies. Fuel economy regulations can push innovations and accelerate change if combined with policies for focused research and development (R&D). Fiscal measures and targeted market development with environmentally enhanced standards are needed to enable rapid commercialisation of these technologies.

Transparency in fuel economy data reporting: Urgent policy intervention is needed to make automobile companies report certified data on fuel economy and carbondioxide emissions on a regular basis. Only open public access to officially

backed data can win consumer confidence and help to stimulate market. This is also needed for good regulations. It is unacceptable that this crucial dataset that is generated on a routine basis by the certification agencies is kept under wraps. But the same Indian car companies that export cars release data in other countries. This duality should end in public interest. Fleet Database on design and performance characteristics of all models and make along with details of engine design and related parameters are critical to make good regulations.

SIGNPOST

A spillover risk of motorisation that so far has remained unnoticed in India is the complete neglect of regulations to improve energy efficiency of vehicles. India cannot afford unrestricted oil guzzling that increases the economic burden of oil imports, leads to staggering pressure of rising oil prices, and escalates greenhouse gas emissions.

This scenario is now expected to change with the recent policy decision of the government to set fuel economy standards for vehicles. If designed well and implemented on time this measure can ensure enormous fuel savings and energy secure future.

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