Passenger Road Transport in India: Major Challenges in Reducing Energy Consumption and CO2 Emissions and Ways Ahead

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2010

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Abstract

The shift of the Indian economy to a higher trajectory of growth over the last two decades has been primarily associated with urbanisation and rapid motorisation both as a cause and as an effect. Motorised passenger transport is now being considered as a fulcrum for inclusive growth in India. Thus putting a cap on its growth may be difficult. Given the key challenge to decouple the economic and social development from the inherent growth in energy consumption and CO_2 emissions, the paper takes cue from the Bellagio Declaration 2009 and essentially argues for an integrated and multi-pronged *Avoid-Shift-Improve* approach to steer passenger road transport growth in India towards a sustainable low carbon path.

Keywords: Passenger, road transport, challenges, energy consumption, CO2 emission

1. Introduction

Transport plays a crucial role in development and constitutes a significant share of world energy consumption. Transportation primarily relies on petroleum which supplies nearly 95 per cent of the total energy used by the world transport. As of 2005, the total final consumption of petroleum products by the World stood at 3,420 million tons of oil equivalent, of which 2,067 million tons or 60.4 per cent was consumed by the transport sector. Hence, the transport sector has also been largely responsible for the pollution and greenhouse gas (GHG) emissions which pervade all across the globe (Kahn et al., 2007). Figure 1 further delineates that within the transport sector, road transport consumes the largest share of 76.0 per cent (1,571 million tons of oil equivalent) followed respectively by shipping, international aviation, domestic aviation, domestic navigation, rail, pipeline and others.

Insert figure1 here

Figure 2 disaggregates the transport CO2 emissions across the modes for 2005. The figure clearly shows that road transport has the largest contribution to emissions from fuel combustion in the transport sector and the on-road vehicles that are primarily responsible for such emissions are passenger cars and light duty vehicles (LDVs) i.e. four wheeled vehicles (including sports utility vehicles, small passenger vans with up to 8 seats).

Insert figure 2 here

The Intergovernmental Panel on Climate change (IPCC) advises in its fourth assessment report (AR4) that in order to avoid worst impact of climate change global CO2 emissions must be cut by at least 50 per cent. Transport has a very significant role to play in order achieve that goal. Although all modes of transport has to be a part of that emission reduction process, it is quite evident from the modal shares of CO2 emissions (as shown in figure 2) that the onus would fall primarily on passenger road transport and especially on passenger cars and light-duty vehicles.

As far as India is concerned, reducing CO2 emissions from transport as an issue has generally not been driving policy discussions at the national level as well at the state and local level in India until recently. The key drivers of transportation policies had been the externalities like congestion, local air pollution, safety and other environment related concerns the impact of which is immediately visible or perceptible. Although policies aimed at reducing energy consumption and CO_2 emissions has potential synergies with these drivers, they usually continued to remain as an issue of secondary concern.

Considering the trend and pattern of growth in transport sector in India, road transport has emerged as the dominant segment with a share of 4.5 per cent in India's GDP as of 2006-7. From 2000-1 to 2006-7, the annual average growth rate registered by GDP pertaining to the road transport sector was 9.4 per cent and was considerably higher than the overall growth rate of GDP during the same period which was around 6.9 per cent[1]. An important feature in road based mobility in India is the phenomenal growth registered by the motor vehicle population over the years. Between 1951 and 2006 the vehicle population grew at a compound annual growth rate (CAGR) of nearly 11 per cent. Personalized modes (primarily comprised of two wheelers and cars) account for more than four-fifth of the motor vehicles in the country as of 2006 as compared to their share of little over three-fifth in 1951. On the contrary, the share of public transport (buses) in total registered vehicles has declined from 11.1% in 1951 to 1.1 % as in 2006 (Government of India, 2009). This uneven pattern of growth pertaining to land based passenger transport sector in India poses serious challenges in terms of reducing energy consumption and CO_2 emissions.

In the light of this brief backdrop, the analysis in this paper would essentially focus on challenges and opportunities of reducing energy consumption and CO_2 emissions from passenger road transport in India.

2. Challenges in Reducing Energy Consumption and CO2 Emissions from India's Passenger Road Transport Sector

The challenges in reducing CO_2 emissions and hence ensuring low carbon road mobility in passenger transport emanates from the fact that a range of factors influences passenger transport emissions both directly and indirectly. Figure 3 shows the range of factors that determines or influences energy consumption and CO_2 emissions from the passenger transport sector.

Insert figure 3 here

[1] RBI, Handbook of Statistics for the Indian Economy, available at: www.rbi.org.in.

Thus the challenges in curbing absolute and relative emissions in passenger road transport could be clubbed under four broad categories: 1) challenges in controlling vehicle activity (A); 2) structural challenges in influencing modal shift (S); 3) challenges in reducing energy intensity (I) of modes; and 4) challenges in influencing or affecting the choice of fuel (F) used.[2] In India, however, the biggest challenge arises from controlling the travel activity (A) due to increasing urbanisation coupled with favourable factors for rapid motorisation. The other primary challenges pertaining to the broad classification mentioned above are: 1) marginalisation of public transport and declining share of non-motorised modes (influences both S and I); 2) relative decline in rail transport's share in both intra-city and inter-city passenger traffic (S); 3) distortions in prices of domestic auto-fuel (influences both I and F) 4) lack of effective fuel efficiency and emission standards (I) 5) absence of adequate low carbon substitutes of appropriate quality (F); and finally 6) Governance related challenges that reinforces all the aforementioned challenges in some way or the other. Each of these challenges is taken up and discussed in more details below.

Urbanisation and Rapid Motorisation

Economic growth and development in most of the developing nations including India has been largely propelled by their urban areas, which provide the bulk of employment opportunities. A recent study carried out by Asian Development Bank (ADB, 2006) projected that nearly 38 per cent of India's population would live in cities by 2025. In India, the number of cities with population above 1 million increased from 12 in 1981 to 35 in 2001 as per the decennial Census for the respective years. The growing population in urban areas led to de-densification of cities, with rapid growth in suburban areas. This trend of de-densification in turn led to increase in distances that are required to be travelled in order to access jobs and basic services resulting in a rising demand for travel (Kahn et al., 2007). However, this rising travel demand could hardly be served by the existing unsound, unattractive and inadequate public transport systems that are incapable of meeting this demand. This inherently led to an increasing dependence on personalised vehicles and a concomitant decline of walking and cycling as a share of total travel. The trend has been

[2] This broad framework was first suggested in a seminal paper in 1999 by Schipper *et al.* and is referred to as ASIF framework (Schipper et. al , 2000)

reinforced further by lack of integrated land use and transport planning, distortions within transport planning coupled with a liberalised automobile sector.

Although the National Urban Transport Policy (NUTP)[3] in India emphasises on the need for integration of the land use and transport planning, the mega cities with million plus population still continue to address these two problems in isolation. Transport planning in these cities is intended merely to cater to the immediate mobility needs of growing urban sprawls by encouraging the growth of personalised motorised modes rather than preventing the rapid growth of sprawls. Urban planning and land use planning in these cities also address current demands by implementing specific projects but are hardly aimed at shaping the structure of the city or pivot its future growth on a sustainable foundation.

Distortions in transport planning and markets in India like most other developing countries also tend to increase usage of personalised modes. For example, motorists are rarely charged the full costs of congestion, road space, parking, and air pollution. Moreover, the bulk of public expenditure in most of the cities is devoted to expanding infrastructure (like highways, roads, flyovers, parking facilities and so on) to cater to the needs of these personalised modes (Sundar and Dhingra, 2008).

Moreover, due to liberalization of the Indian economy in 1991, a number of new firms entered automobile sector and started producing a large variety of cars in different segments (small, medium and large) and two-wheelers. The availability of plethora of vehicles along with the easy financing of purchase at competitive interest rates has increased the sale of cars and two wheelers substantially during 1990s and afterwards. For example, during the year 2004-5 the number of cars sold in the country already exceeded one million and the number of two wheelers exceeded six million[4]. Figure 4 shows the vehicle fleet projections in India till 2025 (ADB, 2006).

Insert figure 4 here

[3] Available at: http://www.urbanindia.nic.in/policies/TransportPolicy.pdf
[4] Available at: http://www.siamindia.com/scripts/domestic-sales-trend.aspx.

The increasing motorisation and growth of private vehicles especially cars is clearly a matter of serious concern as the energy intensity and CO_2 emission per passenger km for cars is the highest among all modes of transport (as illustrated in Table 1 for India).[5]

Insert table 1 here

Despite the rapid growth in private vehicles in the post-liberalisation era, the current vehicle density in India is nearly 22 vehicles per 1000 persons, compared to say 598 in Germany, 675 in USA and 586 for Japan. Also the number of cars per 1000 people is about 10 per thousand people for India. However, the number of two-wheelers per 1000 population is much higher at around 58 in case of India. The low vehicle density is however marked by its skewed distribution in favour of cities, as indicated above. Although India starts from a low vehicle density but it is quite obvious that as India shifts to a higher growth trajectory the ownership of personal vehicles especially cars would grow at a rapid pace due to increase in per capita incomes and growing trend of urbanisation coupled with growing aspirations of the middle class, which forms a very large segment of metropolitan cities in India. The problem might get all the more compounded with increasing consumer preferences for larger personal vehicles fitted with more energy consuming power steering, air-conditioning etc. leading to higher energy consumption and more emissions.[6]

In addition to the above factors that are increasingly driving motorisation, the Government of India is undertaking an ambitious programme aimed at connecting all villages with all-weather roads by 2012 (Prime Minister Village Road Scheme). Although such a programme will definitely provide easy access to schools, post offices, hospitals and help in faster movement of the rural people and products to bigger markets or mandis, this will simultaneously lead to a concomitant rise in demand for motorized transport in place of existing non-motorised modes (like bullock-carts and camel-carts). While this development is desirable, rather inevitable, if no efforts are really made to either increase the fleet of high capacity public transport in rural areas or use efficient motorised modes then the challenge of

[5] Vehicle kilometer is the unit of vehicle traffic and indicates the total distance travelled by a vehicle. One vehicle kilometer basically means one kilometer traversed by the vehicle. Usually vehicle km is measured and considered on an annual basis. Passenger km is the unit of passenger traffic and is usually measured by multiplying the vehicle km by the occupancy ratio (no. of occupants in the vehicle).

[6] The National Road Transport Policy of India underscores that in the coming years the profile of motorization is expected to witness a number of changes in terms of segment shifts in car ownership, driven by rising incomes, desire for safety and comfort and government regulations. (available at: http://morth.nic.in/writereaddata/sublinkimages/278.pdf).

decoupling economic and social development from energy consumption and CO_2 emission through rapid motorisation would simply get compounded.

Marginalisation of Public Transport and Non-motorised Modes

In the post reform period (1991-2006), while the vehicle population grew at a CAGR of around 10 per cent, the number of buses grew by less than 7 per cent with a meagre growth of less than 1 per cent in the number of public buses owned by the public sector entities (GoI, 2009). The marginalization of public bus transport in India is natural fallout of major sociological and economic changes related to increase in disposable income of households, changes in lifestyles, urbanization which inherently led to demand for speed, service quality, convenience, flexibility and availability. In addition to these behavioural factors, the government regulation and control have exacerbated the poor operational and financial performance of publicly owned transport undertakings, which are the main provider of bus transport services in the country, resulting in increasing reliance on personalized private modes of passenger transport and further marginalization of public transport. One of the major reasons for the poor performance of the public sector undertakings is the high staff cost and loss on account of concessions in fares provided to various special and vulnerable categories of commuters (such as students, freedom fighters etc.) which is not compensated for by state or central governments. Furthermore, operation of the public transport on economically unviable routes and high rate of various taxes are the other major reasons for the financial non-viability of public transport system in India (Kharola and Tiwari, 2008). Figure 5 indicates the contribution of different taxes to the total operating cost of a bus. A good system of public transport is highly desirable in India since it provides higher capacity at less marginal cost; produces less emission per passenger km travelled (see table 1); and reduces congestion on roads by weaning away personal vehicle users. Although buses are popular mode of public transport and are carrying around 40 to 60 per cent of total trips in some large cities of India (GoI, 2009), the fleet is in want of modernisation and strengthening in order to restrain fuel consumption and emissions.

Insert figure 5 here

The non-motorised modes of transport such as walking and cycling are environmentally most benign and have zero emissions. However, with the easy availability of motorized transport coupled with safety concerns in walking and cycling, a marked shift has occurred in India especially in the cities from non-motorised transport to motorised ones. A large number of cities in India even rely on para-transit vehicles (like mini buses and vans) which are usually fuel inefficient and lead to higher emissions.

Relative Decline in Rail Transport Share in Intra-city and Inter-city Passenger Traffic

Table 2 provides a summarised overview of the total road based and rail based passenger and freight traffic from 1951 onwards till 2006. Over the last three and a half decades from 1970-1 to 2005-6, while the total population registered a growth of around 98 per cent, absolute road-based passenger traffic increased from 210 billion passenger km to 4252 billion passenger km in India which represents an overwhelming growth of around 1924 per cent at a CAGR of nearly 9.0 per cent per year. However the rail based passenger traffic remained a laggard and lost its shares to road based passenger traffic.

Insert table 2 here

Railway is popular for inter-city travel and a relatively environmentally benign mode of transport as compared to road transport. In this context, it is worth mentioning about an empirical study carried out by the Asian Institute of Transport Development (AITD, 2002) that made a comparative assessment of rail and road transport in India from perspectives of social and environmental sustainability. The study took into account equivalent volumes of passenger traffic on the two modes across the entire stretches of eight selected inter-city sections of the railway track which are competing with either a state or a national highway. The study revealed that railways consume much less energy per passenger kilometre than road and are environmentally and socially more benign. The energy consumption on different rail sections has been observed to vary between 78.77 to 94.91 per cent of the energy consumed by road transport (see figure 6).[7]

Insert figure 6 here

[7] If one discounts for the higher tare weight of passenger coaches as compared to road vehicles the saving in energy consumption and emission turns out to be phenomenal and much higher than what is specified above.

Unabated Dependence on Imported Crude and Distortions in Domestic Auto-fuel Prices

Among the sectors that use oil in India, transport has the largest share (see table 3). Moreover nearly 96 per cent of the total commercial energy used in the transport sector comes from oil (see table 4). Thus, the transport sector, in general, and road transport sector, in particular, is the most exposed part of the economy to volatility in international crude prices. Increasing volatility creates uncertainties making it non-conducive for fresh investments to pour in and often leads to delay in major investments in new oil production and refining capacity (see Bandyopadhyay, 2008; Bandyopadhyay 2009b). It also acts as a deterrent to investment in fuel efficient car technology aggravating the problem for a major oil consumer like India with the challenge of its growing road transport sector.

Unfortunately the growth in the transport sector in India has been coupled with control on retail selling (pump) prices of petrol (gasoline) and diesel in order to shield these fuels from fluctuation in international oil prices. The regulation has generated perverse incentives and invariably led to an unabated increase in consumption of both the fuel. The high fuel prices acts as a signal to consumers that they need to take action to reduce consumption. Thus, removing that signal also removes the incentive to invest, for example, in more fuel efficient vehicles and make the transport sector, in general, and consumers, in particular, more vulnerable to future price increases. Although India has surplus refining capacities but more than 75 per cent of refinery throughput comes from imported crude. The dependence on imported crude is only going to increase in future as India shifts to a higher trajectory of growth and would inherently lead to higher oil demand. Hence, a process of complete deregulation and determination of retail selling price of automotive fuel by maintaining parity with the movement in global crude prices is necessary in order to encourage conservation and generate higher incentives for investment in fuel efficiency and renewable.

Furthermore, any discussions on pricing of auto-fuel (petrol and diesel) in India remains incomplete without considering the price distorting excise and customs duties that are imposed by the centre and sales taxes imposed by the states on these products. Taking Delhi, the capital city of India, as a benchmark, nearly 49 % of the retail price of petrol and 25% of the retail price of diesel could be observed as comprising of these taxes (see figures 7 and 8).

Insert figure 7 and 8 here

Furthermore, due to India's federal structure, the state governments are authorised to levy certain taxes and surcharges on petroleum products. These mostly include value added tax (VAT) and/or sales tax, entry tax, transit charges and other levies. The charges are either imposed as specific or flat rate or on ad valorem basis and sometimes a combination of both. The number of levies and their magnitude vary widely among states. Figure 9 portrays the comparative picture of the state-wise sales taxes in India on petrol and diesel, which constitute the major component among all these taxes. Although considerable efforts have been made to rationalise central levies (illustrated in the next section), the states have shown little inclination towards rationalising the duties levied on auto-fuel (despite repeated insistence from the centre). The reason that have been frequently cited by most of the states is that in order to meet disparate economic and social challenges at the sub-national level, the revenue generated from the levies on auto-fuel is crucial. However rationalisation of these levies is crucial in facilitating the domestic auto-fuel prices to correctly reflect upon the variations in international oil prices.

Insert figure 9 here

Dearth of Effective Fuel Efficiency and Emission Standards

Appropriate fuel-efficiency and vehicle emissions standards designed for new and in-use vehicles and well-designed and functional inspection and maintenance (I/M) program are important elements of an overall strategy to reduce vehicle emissions and air pollution. Introduction of mandatory fuel economy standards is a key strategy for fuel saving and GHG emission (especially CO2) from vehicles. The report of the National Integrated Energy Policy brought out by the Planning Commission in 2006 (GoI, 2006c) in India underscored that 50 per cent improvement in fuel economy could facilitate a saving of nearly 86 million tonnes of oil consumption by 2030-31.

The developed countries namely USA, Europe, Japan, Australia and South Korea have regulations for the automobile industry where the regulated metric involves either fuel economy of vehicles, fuel consumption of vehicles, CO2 emission from vehicles or a combination of fuel economy and CO2 emissions over a targeted period of time (see table 3). Among the developing countries, only China introduced regulations to improve fuel efficiency in 2005.

Insert table 3 here

India does not have mandatory fuel economy standards. The Society of Indian Automobile Manufacturers (SIAM) announced a 'Voluntary Labelling Programme' in September 2008 to disclose fuel economy details of vehicles manufactured by its constituents. The leading Indian car manufacturer Maruti Suzuki was the first to act under the programme and has successfully labelled all categories of vehicles that it manufactures. However, there are no legal obligations on the part of Indian automobile manufacturers to notify fuel economy levels of vehicle models they manufacture (Thukral, 2009). Later on the Bureau of Energy Efficiency (BEE) under the Ministry of Power had been entrusted with the responsibility to develop and notify the norms of mandatory fuel economy standards under Energy Conservation (EC) Act.[8] However, the process got unnecessarily stalled due to revival of a long-standing dispute between BEE and Ministry of Road Transport and Highways on the basis for setting fuel efficiency standards. The latter holds the view that the fuel efficiency standards should be designed under Motor Vehicle Act[9] rather than EC Act.

With regard to emissions standards, while India's two wheeler standards are stricter than those in Europe, it lags way behind Europe in respect of four wheelers. Furthermore, the national roadmap for fuel quality and vehicle emission standards is selective and focuses only on the larger cities and neglects the rapidly motorizing medium and small towns (due largely to the non-availability of fuels of the appropriate quality). Emission standards in India were introduced with Bharat Stage I (equivalent to Euro1) in 2000 covering whole of India. Bharat stage II (equivalent to Euro II) standards came into force in the whole of India in 2005. Euro III standards were introduced in 2005 across 11 cities; these will be extended nationwide in 2010. Euro IV standards are in the process of being introduced in 11 major and more polluted cities but no date has yet been set for introducing Euro IV equivalent standards in the rest of India. With regard to inspection and maintenance system (comprising inspection, maintenance, and certification of vehicles) the large population of personalised passenger vehicles in Indian metropolises is not yet covered by any mandatory requirement of periodic

[8] Considering the vast potential of energy savings and benefits of energy efficiency, the Government of India enacted the Energy Conservation Act, 2001 (52 of 2001). The Act provides for the legal framework, institutional arrangement and a regulatory mechanism at the Central and State level to embark upon energy efficiency drive in the country.

[9] For more details of the Motor Vehicle Act see- http://dorth.gov.in/index2.asp?sublinkid=120&langid=2.

fitness certification. What exists in practice is a simple pollution under control (PUC) check which came into existence in 1991 for all on road vehicles.

Absence of Adequate Low Carbon Substitutes to Petrol and Diesel

The substitutes for oil in road transport are currently inadequate or in nascent stage and are not always commercially viable. In 1998, the Supreme Court mandated conversion of all public buses in Delhi to Compressed Natural Gas (CNG), a low carbon alternative, and for subsequent conversion of all Government of India vehicles to CNG. However, no road map has been constructed towards that end due primarily to dearth of adequate natural gas supply. Until recently, the primary source of natural gas in India has been from the offshore Western coast of Bay of Bengal which has also started deteriorating in terms of production. The pumping of natural gas by Reliance Industries Limited (RIL) and Oil and Natural Gas Corporation (ONGC) from the Krishna Godavari (KG) basin of Bay of Bengal has just begun (see Bandyopadhyay, 2009a) and it is only after adequate distribution network and infrastructure are put in place in all the cities for distribution of CNG could one expect the dependence on petroleum to come down considerably.

Furthermore, the government has also been encouraging the use of bio-fuels and has mandated blending of 5 per cent ethanol with gasoline. The government came out with the National Biofuel Policy (NBP) in December 2009 which has set a target level of biofuel blending of 20 per cent to be achieved by 2017 (GoI, 2009a). The blending level will be reviewed periodically depending on the availability of feed stocks. The NBP tried to allay the concerns related to the potential trade-offs between first generation biofuels and food-crop production, land-use changes and bio-diversity by emphasising that such trade-offs are not relevant in the Indian context since bio-ethanol in India is produced primarily from molasses, a by-product of sugar industry and bio-diesel is produced from non-edible oil seeds (like jatropha, karanja, jojoba etc.) grown in waste and degraded forest and non-forest lands. However, the concerns regarding the first generation biofuels' potential for reducing GHG emissions still remain. Furthermore, given the existing infrastructure and the institutional set up, the achievement of target lending of 20 per cent in the next decade seems a remote possibility.

The ethanol industry is facing acute shortage of sugarcane molasses besides countering restrictive government policies, and unsustainable prices. Moreover, the management and operation of the biofuel sector, in general, and ethanol, in particular, has got increasingly complex due to the involvement of multiple government agencies and poses a serious challenge in terms of coordination. For the bio-diesel industry, the foremost problem is availability of land for planting jatropha. The Planning Commission estimated in 2003 that in order to reach a blending target of 20 per cent, the requirement of land would be around 14 million hectares for jatropha cultivation (GoI, 2003). While the land may exist on ground, a considerable part of it may be occupied by landless and marginal farmers who need to be persuaded to grow only jatropha. In the case of wasteland, local farmers may participate only if they are assured of adequate returns. Furthermore, the high yielding varieties of jatropha oilseeds are in the process of being developed and may take a number of years till they become available commercially. Additionally, the present insurance policies that are being offered by the companies for covering the risks involved in planting jatropha are limited in scope. The policies only provide cover for the replanting cost and loss of income and do not include risks involved in loss of yields. This clearly acts as a deterrent. Some other primary concerns relate to fixation of appropriate floor price for the crops; periodic revisions in order to account for increase in cost of production; and setting up appropriate purchasing agencies to buy the crops at the pre-determined prices (Thukral, 2010).

Governance Related Challenges

Transport planning and management especially in urban areas necessitates a holistic and coordinated approach. However in India, there are a plethora of impediments in bringing about such a coordinated approach due mainly to absence of appropriate institutional arrangements and linkages (Sundar and Dhingra, 2008). The authorities and associated responsibilities pertaining to transport planning and management are often fragmented and divided between and within the state and city governments. Furthermore these sub-national authorities also lack the necessary power, resources and capacity to address problems of congestion, air pollution and GHG emissions. The institutional challenges in the context of reducing energy consumption and emissions from transport sector influence most of the components that affects energy use and emissions in some way or other. A particular difficulty in institutional development for sustainable transport in India is posed by the large share of para-transit modes.[10] These modes operate in the (semi-) informal sector and are often undercapitalized. They are not easy to integrate in governmental programs for modernisation and fleet renewal aimed at reforming the transport sector in order to make it less carbon intensive.[11]

3. Addressing the Challenges

Passenger road transport is considered as a major plank for inclusive economic growth in India. Therefore putting a cap on its growth may not be feasible. Hence, as India continues to grow on a higher trajectory in future and as India's population especially its urban population continue to soar, the demand for passenger road transport would continue to increase. Thus, the primary challenge that the transport planners and policymakers in India are facing is to decouple economic and social development from the unabated increase in energy consumption and CO_2 emissions that may arise from rapid growth in passenger transport sector due to reasons explained in the preceding section.

However, a standalone policy of reducing CO2 emissions from passenger road transport sector may not appeal much to the policymakers and other stakeholders because the cost involved is considerably higher. Thus, initiatives to restrain CO2 emissions from passenger road transport in India need to be aligned closely with overall strategies to reform the sector. Hence, besides addressing the bigger question of energy security in India and the transport sector's contribution, in particular, towards that end, reduction of CO2 emissions should essentially be recognised as co-benefits of a more holistic transport reform.

In this context, a meeting that was held in Bellagio in May 2009 assumes great significance (for details see Box 1). The meeting came out with a declaration and formulated a common policy framework on sustainable low carbon transport for developing countries aimed primarily at the road transport. The common policy framework recognised an integrated multi-pronged approach based on co-benefits. The framework also recognised that technological improvement by themselves might not be enough for the transport sector in

[10] In South Asia this includes the motorized three wheeled rickshaws, in the Philippines locally assembled jeepneys and buses built around imported second hand truck engines, in the Indonesia the Bemo.

[11] Because they operate in the informal sector they often do not keep formal books, have formal franchises, or pay taxes on a regular basis which can be a guarantee to benefit from financial assistance programs.

order to make a significant dent on CO2 emissions. Thus it underscored on sector wide re-orientation of transport sector combining policies and measures aimed at - a) avoiding or reducing travel or need to travel b) shifting to more environment friendly or energy efficient modes and c) improving efficiency of motorised modes. The approach is more popularly known as *Avoid-Shift-Improve* framework. This framework would be instrumental in saving a chunk of energy consumption by –

- Reducing the distances driven or the number of trips taken (*Avoid)*
- Reducing emissions per passenger unit (*Shift)*
- Reducing emissions per kilometre driven per vehicle (*Improve)*

Insert Box 1 here

Some of the important measures pertaining to this framework are as follows:

- **Reducing the distances driven or the number of trips taken** (*Avoid*)**:** This includes, among others, changing people's behaviour, substituting or reducing the need to travel through various virtual mobility alternatives using information and communication technology; better traffic management and route designs; integrated land use and transport planning.
- **Reducing emissions per passenger unit (*Shift*):** This includes generating incentives of modal switch from private vehicles to public transport by restraining vehicle ownerships (using measures like vehicle taxes, congestion charges, parking charges, toll taxes and road pricing for private vehicles); encouraging car-pooling and non-motorised transport like cycling and walking for shorter distances; increasing share of public transport and introducing high capacity comfortable and attractive buses along with bus rapid transit; expansion of mass rapid transit system (like metro rail) across all the cities in India.
- **Reducing emissions per kilometre driven (*Improve)***. This could be achieved in a number of ways which includes, among others, fuel switch to cleaner fuels with low carbon density (like CNG, biofuels etc.); introducing or expanding battery operated hybrid vehicles; introducing low carbon and combustion efficient vehicle technologies, introducing best practices (e.g. improved maintenance, introducing fuel efficiency standards and stringent fuel quality and emission standards for personalised

modes), changing behaviour (by creating incentives for purchase of more energy efficient vehicles) and continued infrastructure improvements to reduce congestion.

Significant emission reductions could be achieved by introducing more efficient modes of transport, changing people's travel habits and up gradation of technology. The most promising among all these measures especially in urban areas are mass urban transit projects like metro railway and bus rapid transit (BRT), which not only increases the efficiency of transporting passengers but also has significant sustainable development co-benefits, such as reducing air pollution and congestion.

It also deserves to be underscored that an essential prerequisite for ensuring a sustainable transport system is to provide for a rational modal distribution amongst the alternative modes of transport. This can be achieved primarily by government policies on transport which could legislate for internalization of social costs into the pricing of different modes. Better land use and transport planning, substituting need for travel by use of information technology (IT), better traffic management, increased share of public transport and improving vehicle and fuel technologies, as already mentioned above, are some ways to improve efficiency in road transport especially in urban areas. But for inter-city long-distance travel an optimum modal choice could be achieved through an intermodal shift from road to rail.

Furthermore, appropriate and non-distortionary automobile fuel pricing is considered as a very effective economic instrument for energy conservation that facilitates in reinforcing measures pertaining to the multipronged approach illustrated above. Continuance of price control on automobile fuels inherently tends to benefit the relatively well-off section of passengers primarily in the densely populated cities in India as the propensity for travel using personalised modes like cars tends to be considerably higher among the latter. This, in turn leads to higher energy consumption and CO2 emissions. In this context, an earlier study carried out in 2009 (Bandyopadhyay, 2009) made an attempt to assess the potential implication of fuel price deregulation on fuel consumption and CO2 emissions across various modes of passenger road transport in India. Table 5 and 6 summarises the results of the study.

Insert table 5 here

Insert table 6 here

Instead of universally insulating the domestic pump prices of automobile fuel from international oil price variations, a better targeted social policy catering to relatively poor travellers (in both rural and urban areas), say in the form of subsidised public transport, would be able to cater to the objectives of sustainable mobility much more efficiently and effectively. Furthermore, in order to allow public transport to provide affordable mobility to the rural and urban poor, incentives could be provided in the form of subsidised fuel exclusively for public transport.

4. Recent Policy Initiatives Undertaken by the Indian Government: A Snapshot

Indian government has undertaken a number of recent policy initiatives at the national level in order to address some of these challenges. Box 2 gives a snapshot of the recent national policies that addresses some components of the multi-pronged *Avoid Shift Improve* approach as illustrated above.

Insert Box 2 here

In terms of financing initiatives to bring about changes at the local level with support of strategic plans and programs at national level the Jawaharlal Nehru National Urban Renewal Mission (JnNURM) in India provides a great example (see Box 3 for details). JnNURM provides financial assistance as soft loans, grant-cum-loans or grants to Urban Local Bodies and parastatal bodies via state-level nodal agencies in return for formulating City Development Plans (CDPs) and detailed project reports for urban infrastructure development. Furthermore, grants for urban buses have recently been made available, subject to the set-up of Dedicated Urban Transport Funds at state and city levels.

Insert Box 3 here

Considering some notable city level public transport initiatives, the first BRT corridor in India opened in Delhi. Surveys among the users of the BRT indicated general satisfaction with the service provided despite the shortcomings in the original design and its implementation of the corridor. In Ahmedabad, the city residents have embraced their new Janmarg BRT system; 18,000 daily passengers use Janmarg to commute to work, to school and elsewhere. In just a few months of operation, Janmarg has transformed the delivery of transit in South Asia. [12] Janmarg uses innovative central median stations pulled away from the junctions. Bus stations feature passive solar design, an inexpensive way to keep stations naturally cool. The city is making continued efforts to be a leader in sustainable transport, including incorporating high-quality pedestrian facilities in some corridors, as well as bicycle lanes.

Considering the recent initiatives with respect to providing encouragement to non-motorised transport, a landmark judgment dated 10 February 2010 in Delhi High Court deserves special mention. In response to petitions filed against the cap of 99,000 three wheeler cycle rickshaw licenses imposed by the Municipal Corporation of Delhi in 1997, the Chief Justice bench of the Delhi High Court removed the restriction on the number of licenses that can be issued to the rickshaw pullers. The bench also stated that confiscation and scrapping of cycle rickshaws are against the law.[13] The High Court thus pro-actively saved an important non-motorised mode from near extinction. The High Court bench also mandated the formation of special task force to explore all questions pertaining to road traffic in the city aimed at minimising congestion, reducing pollution levels from vehicles and ensuring equitable access to all classes of vehicles that ply on roads (including non-motorised transport such as bicycles and cycle rickshaws).[14] Additionally, the final ruling also endorsed congestion charges for car owners passing through congested areas of the city. In this context, the Delhi High Court bench drew examples from the existing congestion charging system in other developing countries and directed for regulation on movement of personal vehicles in the city and suggested considering all options including congestion fee on private cars in certain congested areas of the city and limit their use.[15]

With respect to rationalisation of duties on petrol and diesel, a number of government committees have also deliberated since 2005 (GoI, 2005; GoI, 2006a; GoI, 2006b; GoI, 2008; GoI, 2010). In line with these recommendations, first from March 2005 onwards, excise duties had been reduced from 30 % and 14% respectively to 8 % plus Rs. 13/litre and to 8 % and Rs. 3.25/litre while custom duties were reduced from 20 % to 10 % for branded petrol and diesel. Then, from March 2007 onwards the ad valorem component of excise duties on

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[12] The city of Ahmedabad has recently bagged the award of most sustainable transport system for 2010 among the developing countries.The information on sustainable transport award is available at: www.st-award.org.

[13] Delhi High Court ruling in the two cases - Manushi Sangathan, Delhi vs. Government of India and others, WP(C) No. 4572/2007; Initiative for Transportation and Development Programmes vs. Municipal Corporation of Delhi and others, WP(C) No. 8580/2009.

[14] Staff Reporter, 'Task Force to find solution to Delhi's traffic woes', the Hindu, February 11, 2010.

[15] Abhinav Garg, 'Delhi High Court moots congestion fee on cars', the Times of India, February 11, 2010.

both petrol and diesel has been reduced from 8% to 6% and the custom duties on both products were reduced from 10% to 7.5 %. From July 7, 2009 onwards the basic excise duty on branded petrol and diesel has been revised from 6 % plus Rs 5 per litre and 6 % plus Rs 1.25 per litre to Rs 6.5 per litre and Rs 2.75 per litre respectively. In other words, the basic excise duty has been altered from a combination of specific and ad valorem to specific duties.[13] However, the state sales taxes on petrol and diesel could not be reduced concomitantly despite repeated requests from the central government to state governments for doing so.

Conclusion

Many of the potential policies and measures under *Avoid-Shift-Improve* framework are already well known and have been tested in specific countries and cities in the developing or developed world and can be relatively easily replicated or scaled up. The Indian policymaking with respect to passenger transport has also internalised some components of this approach. However the financial, technological, and institutional resources are yet to be fully reoriented towards this integrated framework in order to address the multi-faceted challenges involved in restraining or reducing energy consumption and GHG emission (especially CO2) from passenger transport in India.

An important issue that deserves attention is that contrary to the perception created by the heightened concern and growing public attention for climate change, climate change does not seem to be the key driver of transport policies and projects in India and other developing countries. This is because the potential financial earnings from GHG reduction tends to be significantly lower than other earnings or cost savings associated with a good transport policy or project that addresses local benefits, such as reduced traffic congestion and air pollution. Thus the observable and perceptible negative spillovers like traffic congestion and air pollution still play a much bigger role in development of transport polices and investments rather than climate change, where the consequence is not immediately visible.

In this context, it needs to be recognised that the transport policies and programs can have: (a) *Benefits* –the primary intentional goal of policies and project (say, reduced traffic congestion), (b) *Primary co-benefits* - other benefits that directly result from transport policies or projects (e.g. GHG and air pollution reduction), or (c) *Secondary co-benefits* -

benefits that indirectly result from transport policies or project (e.g. reduced health impact and costs from air pollution). The success of passenger transport in addressing the challenges of energy consumption and CO2 emission could be achieved in an efficient manner by a holistic implementation of integrated *Avoid–Shift-Improve* approach which synergises these benefits and co-benefits most effectively. However the speed of implementation and costs involved therewith is largely contingent upon the nature of policies and institutions (whether fragmented with lack of clarity or well-coordinated); availability of tools; and institutional capacity to apply such tools; and finally the availability of resources.

Thus, a critical mass of well equipped institutions is needed in order to enable structural changes in policies to implement this approach. Institutional development in support of low carbon passenger transport includes- (a) clarification of institutional mandates at all geographical levels (local, sub-national, national, regional and global) (ii) strengthening of institutional capacities within all sectors (government, civil society, academia and private sector), and (c) improved coordination and cooperation between different sectors at, and between, different geographical levels. The requirement of improved coordination applies especially to integration of land-use and transport planning and should essentially be directed towards development of comprehensive passenger transport systems, rather than individual, ad-hoc, projects.

Furthermore, private sector participation in the provision of low-carbon passenger transport needs to be encouraged as the private sector is better at mobilizing investments. However, in order to facilitate increased private sector participation appropriate regulatory frameworks need to be developed and put in the first place. The same applies to civil society which can help in mobilizing support for policy development and implementation and which can also take on an important role in flagging problems before they become unmanageable and in following-up of policy commitments made by governments.

Developing countries like India should be playing a key role in applying this co-benefit approach and making their transport system sustainable and low carbon based through the combination of policy instruments, institutional capacity development, appropriate pricing mechanisms and mobilisation of financial resources. However in order to implement co-benefits approach it should also be integrated in a more structured and quantified manner in policy analysis and the feasibility studies of programmes and projects.

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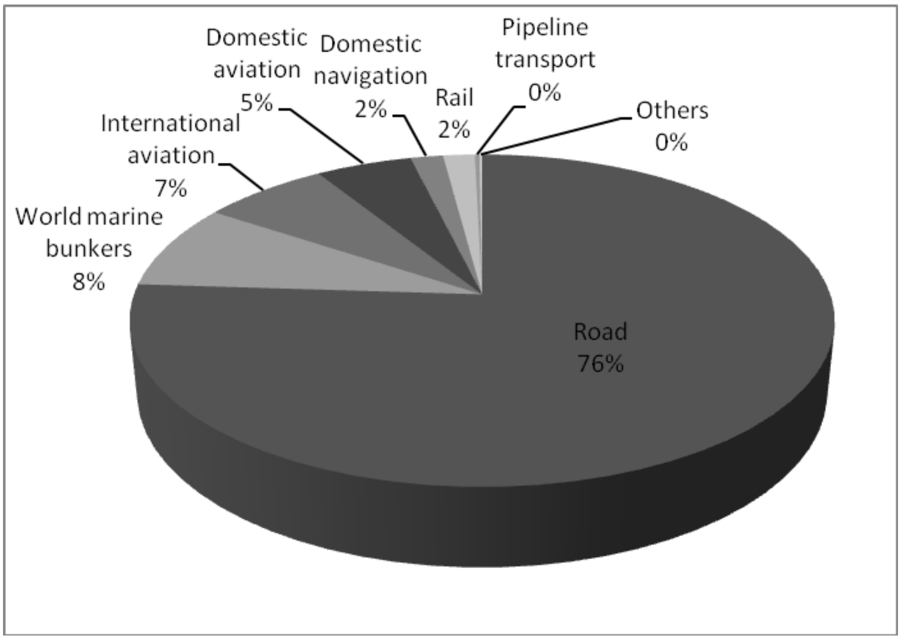
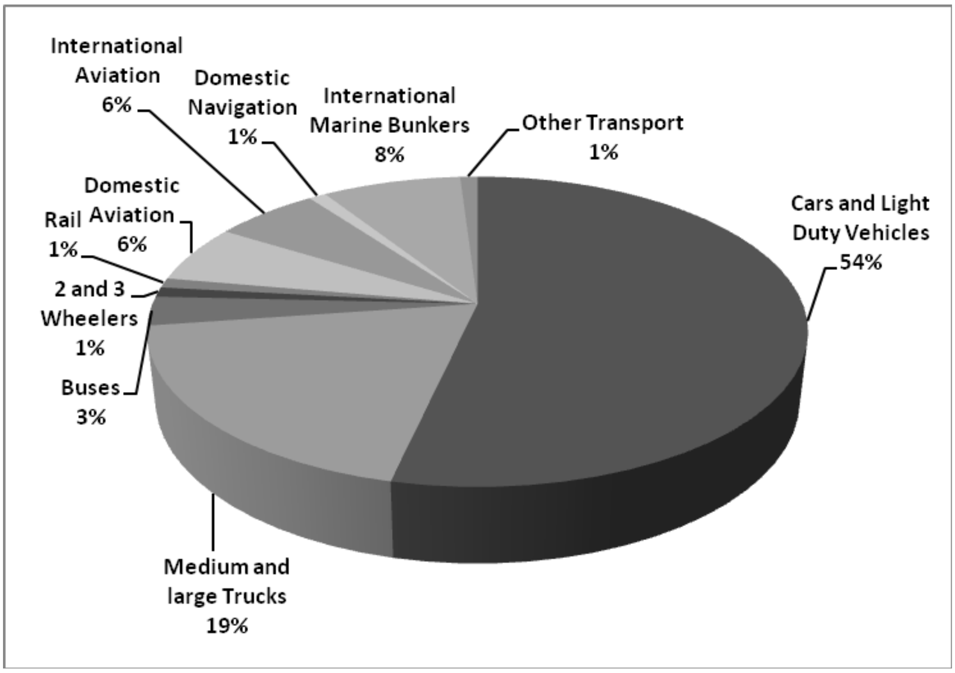
Figure 1. World Petroleum Products Consumption by the Transport Sector, 2005



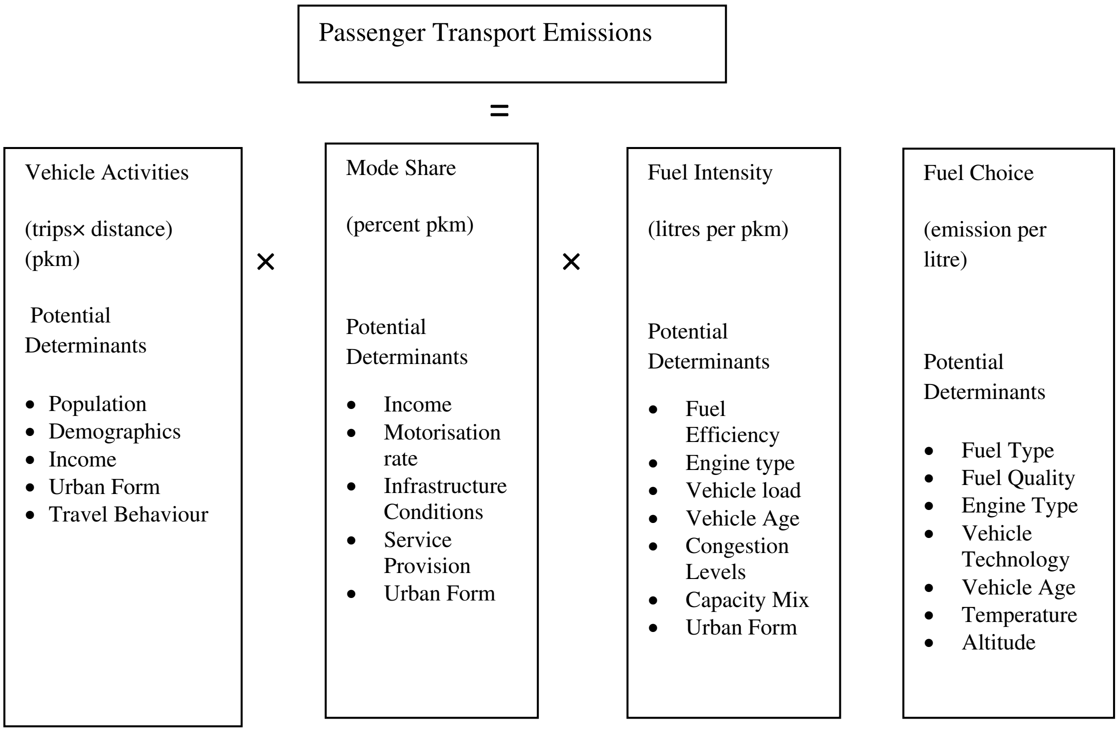
Source: IEA (2007a)

Figure 2. Modal Shares of Transport CO2 Emissions (2005)



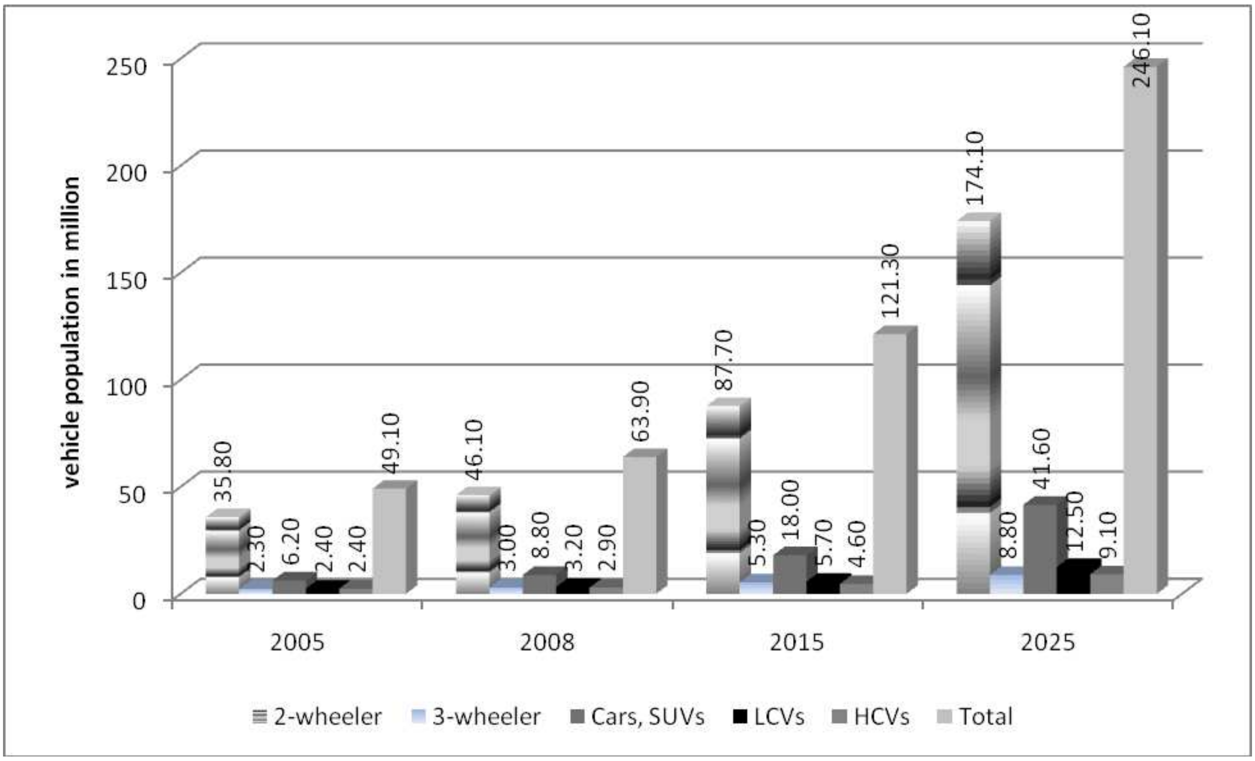
Source: IEA, 2007b

Figure 3. Potential Determinants of Emissions from Passenger Transport



Source: Browne et al. (2005)

Figure 4. Projections of Vehicle Fleet



Source: ADB (2006)

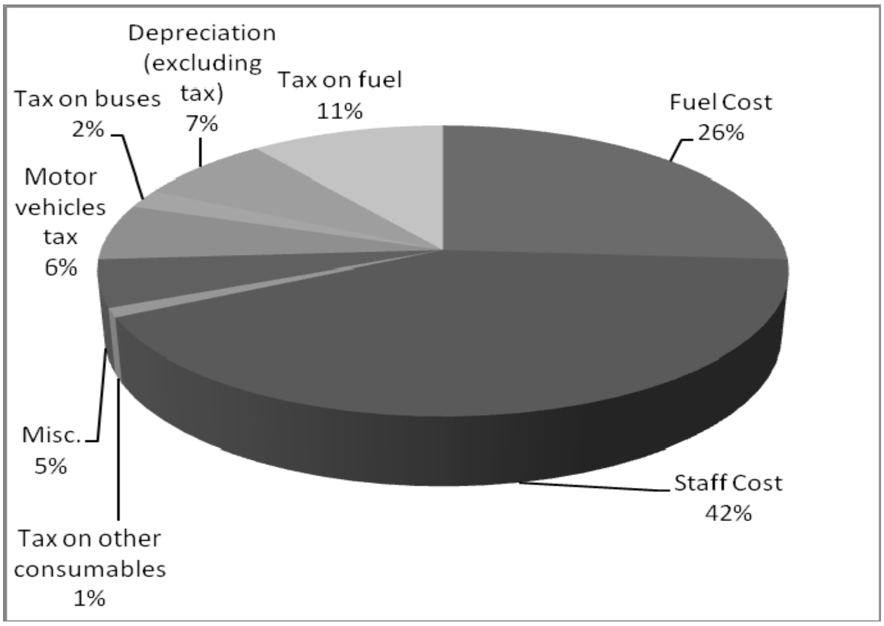
Table 1. Energy Intensity and CO_2 Emission for an On-road Passenger Vehicle across All Modes of Road Transport in India (as of 2004-05)

Modes	**Energy Intensity (in MJ/passenger km)**	**CO2 emissions (in Kg)**
Cars	0.864	0.058- 0.064
2-wheelers	0.476	0.032- 0.036
3-wheelers	0.580	0.039- 0.043
Buses	0.137	0.009- 0.0102

Note: MJ-Mega Joule; CO2 emissions have been computed for the uncertainty range of CEF factors provided in IPCC Guidelines, 2006

Source: Calculated by the author using data on passenger traffic for 2004-05.

Figure 5. Contribution of Different Taxes to the Total Operating Cost of a Bus



Source: Kharola and Tiwari (2008)

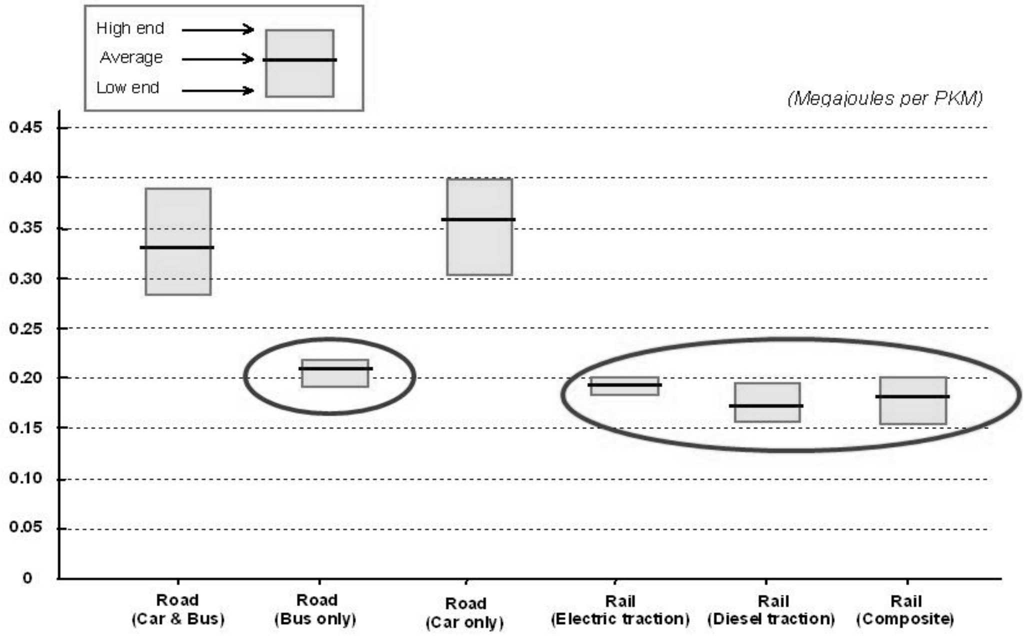
Table 2. Road Based and Rail Based Passenger and Freight Traffic

Year	Road Based Passenger Traffic	Rail Based Passenger Traffic
	(billion passenger km)	
1950-51	23.00 (15.40)	66.50 (84.60)
1960-61	80.90 (51.0)	80.90 (49.0)
1970-71	210.00 (64.0)	118.10 (36.0)
1980-81	541.80 (72.2)	208.60 (27.8)
1990-91	767.70 (72.2)	295.60 (27.8)
1999-00	1831.60 (81.0)	430.70 (19.0)
2000-01	2075.50 (82.0)	457.70 (18.0)
2001-02	2413.10 (83.1)	1490.90 (16.9)
2002-03	2814.70 (84.5)	515.00 (15.5)
2003-04	3070.20 (85.0)	541.20 (15.0)
2004-05	3469.30 (85.8)	575.70 (14.2)
2005-06	4251.70 (87.4)	615.60 (12.6)

*Figures in the parenthesis indicate percentage share

Source: Government of India (2009)

Figure 6. Energy Consumption: Intercity Passenger Road and Rail



Source: AITD (2002)

Table 3. Sectoral Distribution of Oil Use in India.
(as percentage share of total oil use across sectors)

Year	Industry	Transport	Agriculture	Commercial & Public Services	Residential Households
1971	24.5	37.4	4.3	0.8	21.6
1990	22.9	45.1	0.4	3.1	23.8
2005	17.9	33.3	5.6	0.4	19.7

Note: The shortfall of the row sum from 100 is to be imputed to non-energy use of energy resources or use by other sectors.

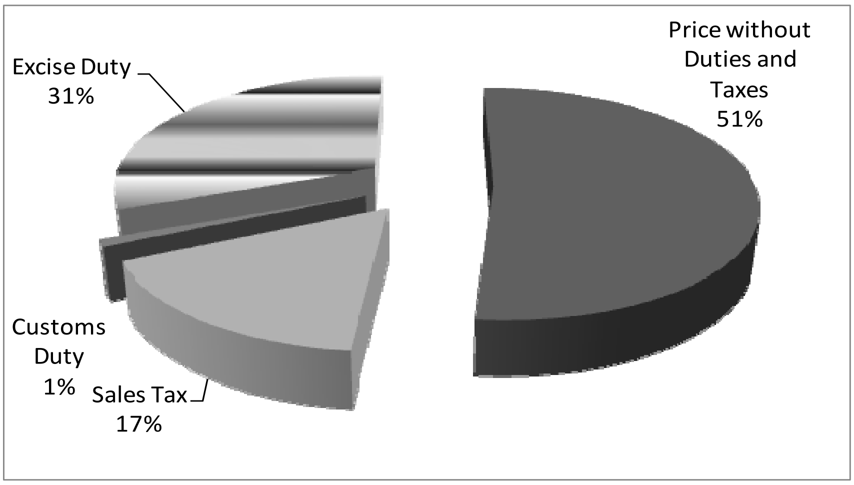
Source: Sengupta (2007); originally computed using different volumes of Energy Balances of Non-OECD Countries published by IEA.

Table 4. Sector-wise Oil Application in India
(as percentage of total final commercial energy use in a sector)

Year	Industry	Transport	Agriculture	Commercial & Public Services	Residential Households
1971	19.3	45.8	63.6	27.8	64.8
1990	17.0	88.9	4.7	47.2	79.6
2005	26.6	95.8	41.5	-	63.0

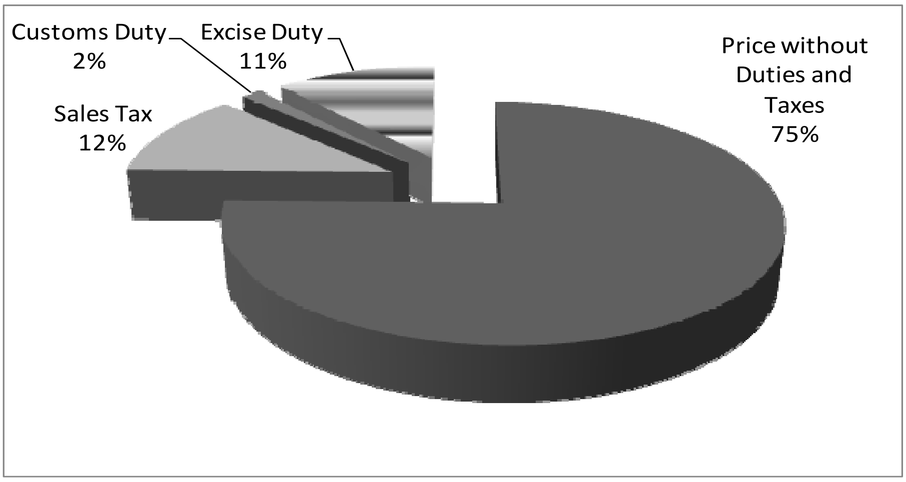
Source: Sengupta (2007); originally computed using different volumes of Energy Balances of Non-OECD Countries published by IEA.

Figure 7. Percentage Share of Duties and Taxes in Petrol Price at Delhi



Data Source: Petroleum Planning and Analysis Cell (PPAC), website:ppac.org.in

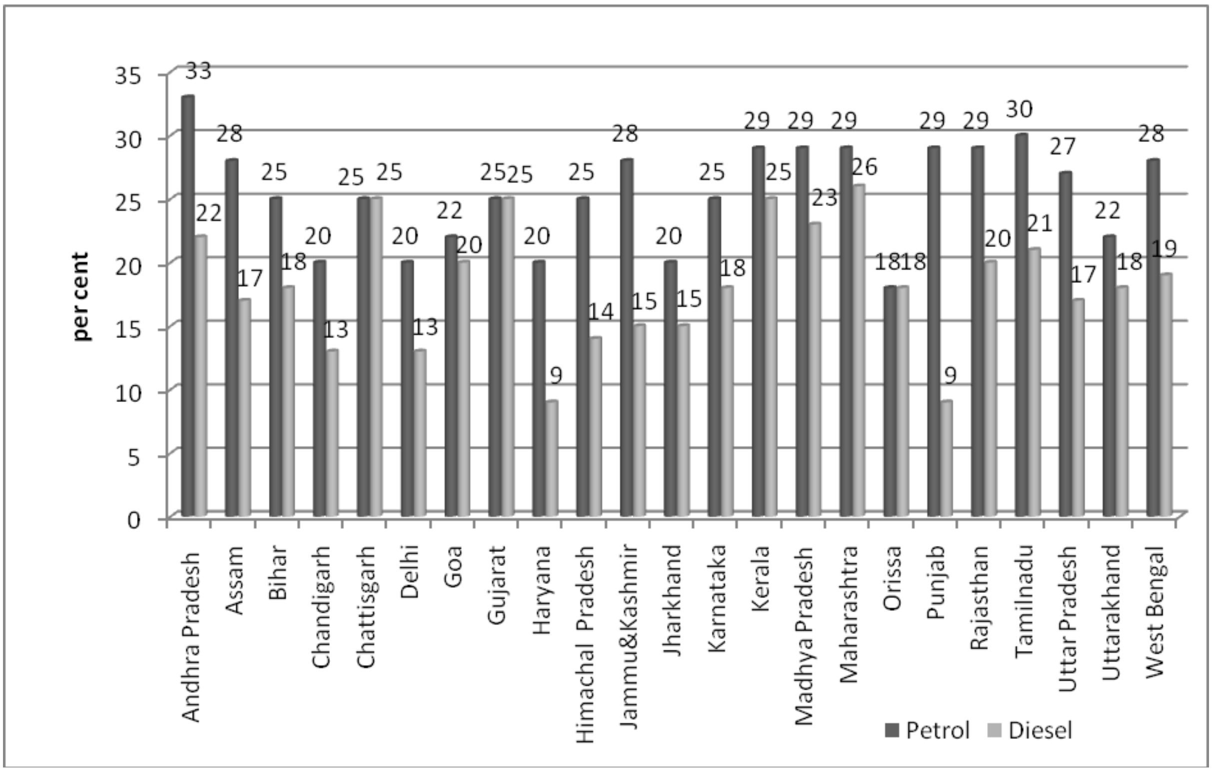
Figure 8. Percentage Share of Duties and Taxes in Diesel Price at Delhi



Data Source: PPAC, website:ppac.org.in

Figure 9. Sales Tax Rates on Petrol and Diesel in Various States across India

(As of November 2009)



Note: Rates are inclusive of cess, additional tax and VAT concession and sales tax at last point but precludes entry tax and other irrecoverable taxes.

Data Source: PPAC, website: ppac.org.in

Table 4. Worldwide Automobile Efficiency or GHG Standards

Country/Region	Regulated metric	Expected reduction in CO_2 per-distance emissions*
European Union	CO_2 emissions (CO_2/km)	40% reduction, MY@ 2008-20
United States	Fuel economy (miles/gallon) GHG emissions (CO_2e/miles)	20% reduction, MY 2011-16
Japan	Fuel economy (km/L)	19% reduction, MY 2010-15
China	Fuel consumption (L/100km)	12 % reduction, MY2008-15
California	GHG emissions (CO_2e/miles)	25% reduction, MY 2008-16
Australia	Fuel consumption (L/100km)	10% reduction, MY 2004-10
South Korea	Fuel economy (km/L) CO2 emissions (CO_2/km)	13% reduction, MY 2012-15

* Expected reduction in CO2 reduction pertains to different test driving cycles for different countries.
@ MY stands for measurable year.

Source: Bandivadekar (2009)

Box1: Bellagio Declaration

Twenty one representatives from eighteen different organizations working on transport and climate change in developing countries met 12 -16 May, 2009 in Bellagio, in a meeting to build a consensus on the required policy response to the growing CO2 emissions from transport in the developing world. The meeting resulted in the Bellagio Declaration on Transportation and Climate Change. This Declaration calls on organizations and individuals to support urgent action to change the change the trajectory of future GHG emissions from transport and to make transport in developing countries more sustainable. It appeals to all participants in the climate negotiations to provide strong support for the following 3 key-principles

- Principle 1: Effective Climate Action Is Incomplete Without Addressing the Overall System Performance of the Transport Sector.
- Principle 2: Climate action in the transport sector should recognize co-benefits
- Principle 3: Carbon finance mechanisms and associated procedures should catalyze sustainable transport policies, programs and projects

The meeting also formulated a Common Policy Framework on Sustainable, Low Carbon Transport, which elaborates the vision underpinning the Bellagio Declaration on Transportation and Climate Change.

Source: www.sutp.org/bellagio-declaration

Table 5. Estimated Energy Demand for an On-road Passenger Vehicle per Year across Various Modes of Road Transport (in Tera Joule)

Year	Scenario	Car	Two Wheeler	Three Wheeler	Buses
2004		0.038	0.005	0.035	0.561
2010	**BAU**	0.049	0.006	0.042	0.822
	HP	0.045	0.005	0.033	0.644
	HPHE	0.041	0.004	0.030	0.585
2020	**BAU**	0.738	0.009	0.058	1.391
	HP	0.044	0.004	0.024	0.573
	HPHE	0.328	0.003	0.018	0.431
2030	**BAU**	0.112	0.013	0.079	2.412
	HP	0.039	0.002	0.014	0.417
	HPHE	0.024	0.001	0.009	0.259

Note:

BAU (Business as Usual) Scenario- In this scenario it is assumed that no policy initiatives are taken to reduce energy consumption or CO2 emissions

HP (High Price) Scenario- In this scenario it is assumed that variation in domestic real fuel prices will be aligned to changes in international real crude prices

HPHE (High Price High Efficiency)- In this scenario in addition to the assumption under High Price scenario an increase in fuel efficiency per vehicle at the rate of 10 % every five years is assumed

Source: Bandyopadhyay (2009)

Table 6. Estimated CO_2 emissions for an on-road Passenger Vehicle per year across Various Modes of Road Transport (in kg)

Year	Scenario	Car	Two Wheeler	Three Wheeler	Buses
2004		2691.74	335.43	2455.34	39898.48
2010	**BAU**	3485.80	427.45	2995.64	58502.38
	HP	3201.71	334.72	2345.79	45811.23
	HPHE	2910.64	304.29	2132.53	41646.57
2020	**BAU**	5248.58	635.58	4119.23	98999.13
	HP	3102.02	261.96	1697.81	40804.09
	HPHE	2330.59	196.82	1275.59	30656.72
2030	**BAU**	7947.36	940.42	5647.26	171648.9
	HP	2740.03	162.49	975.74	29657.78
	HPHE	1701.34	100.89	605.86	18415.15

Note: Same as table 5

Source: Same as table 5

Box 2 : Indian Government Initiatives that Addresses Some Components of *Avoid-Shift-Improve* Framework

National Urban Transport Policy (NUTP), 2006

- Integrate land use and transport planning
- Invest in and promote public transport and encourage in non-motorized modes
- Develop transport projects focused on equitable allocation of road space
- Promote clean vehicles
- Raise resources through innovative financing mechanism
- Build capacities

Source: http://www.urbanindia.nic.in/policies/TransportPolicy.pdf

National Action Plan on Climate Change (NAPCC), 2008

- Suggests early introduction of fuel economy standards.
- Promotes investments in high capacity public transport systems
- Suggests introducing transport pricing measures to influence purchase of vehicles on the basis of their energy efficiency
- Abandoning old vehicles to be made illegal; fixing the responsibility of the last owner of the vehicle to handover the vehicle at the end of its life to the collection centres to be nominated by the government.
- Encourages setting up of demonstration centers to take up recycling of vehicles especially two wheelers
- Encourages energy R&D in Indian railways
- Promotes use of coastal shipping , inland waterways, encourage rail based movement instead of long distance road based movement

Source: http://pmindia.nic.in/climate_change.htm

Box 3: Transport Funds in India

Examples of local transport funds in action can be seen in India, where recently two urban areas have adopted such an approach. In Surat, vehicle taxes, parking charges and advertisement fees are fed into a dedicated urban transport fund, which is used to support its urban mobility plan, including the expansion of bus services and modification of three-wheelers to power on CNG. In Pimpri-Chinchwad, a 130km BRT network is being developed through an urban transport fund, funded by fares, monthly passes, advertisement and land related taxes (e.g. development rights around the BRT corridor, and property tax). India also possesses the Jawaharlal Nehru National Urban Renewal Mission (JnNURM) which at national level provides assistance to megacities in their efforts to improve urban infrastructure. Sustainable transport is one focus of this ambitious scheme. The philosophy behind the JNNURM is one of cost-sharing between national and local level, in design, construction and operation of infrastructure. Recently, as part of the Indian government's economic stimulus package, a one-time assistance grant of $58 billion has been provided to the states under the framework of the JnNURM for the purchase of urban buses. This provision is subject to various conditions, including the setting up of a dedicated Urban Transport Fund at both the state and the city level. Revenue sources suggested for the Fund at state level include sales tax on petrol, vehicle registration fees, renewal fees for driving licenses, congestion taxes and green taxes. The Fund at the city level includes betterment levies on land, parking fees, property development taxes, advertisement revenue.

Source: Leather (2009)