



# An analysis of trends in passenger and freight transport energy consumption in India

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## ABSTRACT

This primary objective of this paper is to examine the causes for the change in energy consumption in the transport sector in India. The pattern of energy consumption and their causes for change are benchmarked against select countries. A mathematical model that decomposes changes in energy consumption to various factors has been used. The changes in the energy consumption are attributed to growth in transport volume, structural change or modal shift, and energy intensity. The analysis is conducted for passenger and freight transport separately. Results indicate that the growth in transport volume has been the main cause for increase in energy consumption for both passenger and freight transport in India despite the decline in energy intensity of various transport modes. Though not surprising for a growing economy like India, this poses a challenge for the future. Currently, India is a low carbon economy.

However, the choices that the economy is making, as it is growing, are towards energy intensive options particularly in transportation and building sectors. There is a need for policy framework to steer the economy towards making appropriate choices that are environmentally sustainable and also do not jeopardize economic growth aspirations. In case of passenger transport, the trend is comparable with other countries studied in this paper (US, Canada, China, Japan, UK) except France. For freight transport, the contribution of the increase in transport volume to changes in energy consumption is far higher in India than that amongst the countries compared, though all countries except Japan have shown a positive contribution of increase in volume to the changes in energy consumption. The large contribution of the transport volume to the changes in passenger transport energy consumption is due to increasing shift towards personalized modes of transport (such as cars, two wheelers) in India and decrease in passenger occupancy per vehicle. The growth in freight transport energy consumption is a reflection of the high growth of the economy. The problem, however, is that a large part of freight is transported using road unlike that in some other benchmarked countries. Future policies aimed at containing energy consumption in the transport sector would need to focus on the modal structure which would require more use of rail for transportation of freight and public transportation systems for passenger transport. This would, however, require huge inefficiencies to be overcome before consumer choice shifts towards rail or public transportation system.

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## 1. Introduction

India is the third largest emitter of CO<sub>2</sub> emissions after China and the United States (US), contributing more than 5% to the global emissions in 2009 (International Energy Agency, 2011). Though CO<sub>2</sub> emissions on a per capita basis are well below the world average and per capita emissions in 2035 are projected to be still well below

that in OECD member countries today (International Energy Agency, 2011), emissions are growing in absolute terms because of the rapidly rising energy consumption. In the current policy debate, notwithstanding the recent Prime Minister's National Action Plan on Climate Change, where economic growth objectives take precedence over any climate change agenda, it is imperative that for future sustainability country expands its economy at "diminishing rates of carbon intensity" (Rao, Sant, & Rajan, 2009).

The Indian economy is growing at an average 7% over the last decade. The economic growth has, however, been inequitable benefitting largely the upper and middle income classes. Though it

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is important that economic growth continues, there is a need to strike a balance between the three prong objectives of development namely economic growth, equity and climate change, which current policies seem to ignore. At a macro level, the energy intensity (defined differently here from rest of the paper as energy consumption per unit of gross domestic product) is low and declining. However, trends such as high personalized passenger vehicle growth are tilting the balance towards an economy that is moving towards high energy consumption path.

The transportation sector in India is responsible for about 10% of the total energy consumption (IEA, 2007). While a well developed and modern transport system is the key to sustained economic growth of a country, the development of transportation systems to support economic growth, population growth, rapid urbanization, and industrialization is driving up energy consumption. Energy consumption in the transport sector in India has gone up from about 1300 PJ in 2001 to nearly 1800 PJ in 2007 (INCCA and MoEF GoI, 2010). The quantitative assessment of factors influencing this energy consumption is essential not only for the better understanding of past energy consumption patterns, but also for the formation of future energy and transportation policies in India. This latter is of particular importance because the level of transport infrastructure is not so good either in quantity or in quality, and the country is making huge investments in development of this infrastructure. Further, for the analysis, the transportation sector needs to be divided into freight and passenger transport since they may have different patterns of energy use and the factors responsible for increase in energy consumption may be different, thereby having policy implications.

Within this backdrop, this paper uses a mathematical model that decomposes the passenger and freight transportation energy consumption changes into three factors viz. (i) changes in transportation volume, (ii) changes in transportation energy intensities, and (iii) structural changes to examine the trends and importance of each factor in contributing to the growth of energy consumption by these transportation segments. A caveat may, however, be added here. The analysis in this paper is conducted at a macro level. There are factors that are localized and operate at micro level (such as topography of an area, climate, technical parameters associated with energy intensity of a mode of transport) which have profound impact on transport energy consumption but have not been considered. Though this may seem limiting, the objective of the paper is to understand and discuss macro changes that are taking place in the transportation sector that have an impact on energy consumption, for which the scope and methodology adopted in the paper suffice.

The rest of the paper is structured as follows: Section 2 briefly discusses the transport energy consumption and emissions trends in India. Section 3 presents the decomposition model used to decompose transport energy consumption into its causal factors. Section 4 discusses the international trends in transport energy consumption and the data. Section 5 presents the results for India and benchmarks the same against other countries. Section 6 concludes.

## 2. Transport energy consumption and emissions in India

As shown in Fig. 1, the share of transport in total energy consumption in India is projected to go up from 10% in 2005 to 20% in 2030, though its relative position is not expected to change (International Energy Agency, 2007). In absolute terms, the energy consumption in this sector has increased at about 6% y-o-y during 2001–2007. During the same period the economy grew at about 7% y-o-y. The consumption of energy by the transport sector is low in comparison to the global picture due to high load factor and low per

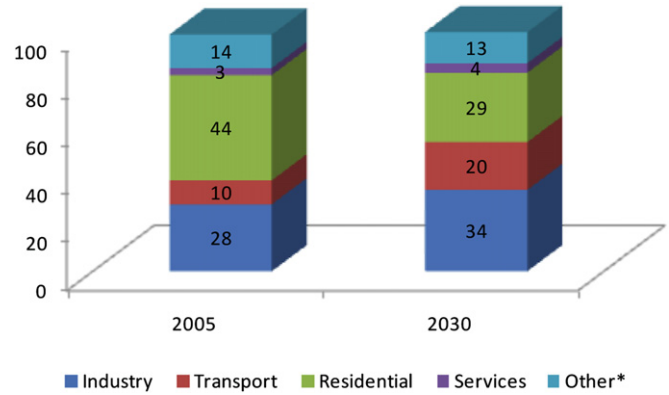


Fig. 1. Share of transport in total energy consumption in India (in per cent). \*Includes agriculture and non-energy use. Source: IEA, 2007

capita count for passenger vehicles; dominance of two wheelers with growing fuel efficiency; high fuel cost, high use of bus, rail, walking for passenger transportation; and relatively low commuting distances in urban areas. Though at present the growth in energy consumption by the transport sector is lower than the GDP growth, the trends indicate that energy consumption in the sector would rise sharply in future.

Within the sector, energy consumption is evenly distributed between passenger and freight transportation (de la Rue du Can, Letschert, McNeil, Zhou, & Sathaye, 2009). However among different modes of transport, road transport accounts for the maximum energy consumption, followed by air (see Fig. 2). This is in line with road transport being the dominant mode of transport in the country (see Fig. 3).

Few patterns emerge from the above discussion:

- The share of transport in overall energy consumption, though low, is likely to increase substantially in future.
- Roads continue to comprise more than 90% of energy consumption (see Fig. 2, sum of two wheelers, cars, trucks and buses) and given that with economic growth in India there is a shift towards personalized modes of transport, rising energy consumption is going to pose enormous challenge in future.
- Though past patterns of development of cities and economy have been less energy consuming, this is not the case any longer. Suburbanization which leads to increase in length of travel and pattern of economic development which is accompanied with increase in use of cars and two wheelers, is contributing to increased energy consumption in the sector.

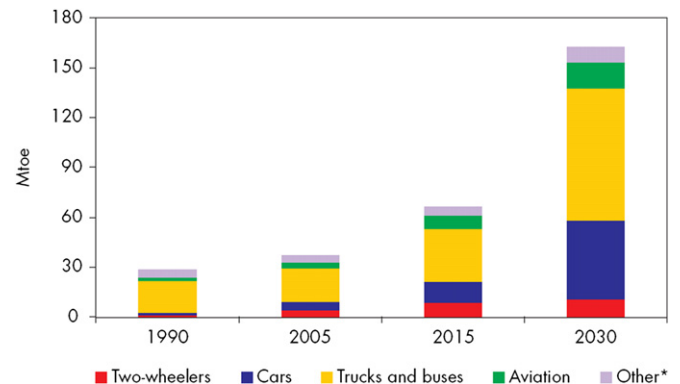


Fig. 2. Transport energy consumption by mode in India. Source: International Energy Agency, 2007

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