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Low carbon scenarios for transport in India: Co-benefits analysis

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HIGHLIGHTS

- India's BAU transitions pose challenges for energy security and climate change.
- Sustainable transport policies deliver benefits for air quality and energy security.
- Sustainable transport policies fall short of mitigation needed for 2 °C stabilisation.
- Transport sector becomes increasingly dependent on electricity.
- Low carbon policies are essential to clean transport and electricity generation.

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ABSTRACT

Dependence on oil for transport is a concern for India's policymakers on three counts – energy security, local environment and climate change. Rapid urbanisation and accompanying motorisation has created some of the most polluting cities in India and rising demand for oil is leading to higher imports, besides causing more CO_2 emissions. The government of India wants to achieve the climate goals through a sustainability approach that simultaneously addresses other environment and developmental challenges. This paper analyses a sustainable low carbon transport (SLCT) scenario based on sustainable strategies for passenger and freight mobility, vehicle technologies and fuel using global CO_2 prices that correspond to 2 °C global stabilisation target. The scenarios span from years 2010 to 2050 and are analysed using the energy system model-ANSWER MARKAL. The SLCT scenario has improved energy security (cumulative oil demand lower by 3100 Mtoe), improved air quality (PM 2.5 emissions never exceed the existing levels) and the cumulative CO_2 emissions are lower by 13 billion t CO_2 thereby showing that achieving development objectives with CO_2 co-benefits is feasible.

1. Introduction

Transport sector globally is highly dependent on oil and India is no exception to this trend (IEA, 2013). High dependence on oil is a concern for India on account of three factors – energy security, local environment and climate change. Energy security concerns arise due to a very high dependence on imports which create uncertainties for prices and supplies. In 2012 India imported 74.6% of oil and 37.5% of natural gas (BP, 2013). Rapid urbanisation and accompanying motorisation has created some of the most polluting cities in India. The top four cities globally, according to PM 2.5, were Delhi, Patna, Gwalior and Raipur from India and the top 100 cities had 33 from India (WHO, 2014). High levels of $PM_{2.5}$ and $PM_{10,}$ much beyond national standard, is increasing morbidity (Guttikunda and Jawahar, 2012). Fossil fuel combustion leads to CO_2 emissions and around 14% of energy related CO_2 emissions are attributable to transport sector (MoEF, 2010).

Transport sector energy use and emissions are also highly related to development patterns and investments in infrastructures. For example the per capita energy use for transportation between cities in US and those in developing Asia varies from more than 100 GJ to less 10 GJ and the main reason is their urban form and infrastructure priorities (Newman and Kenworthy, 2011). Transport infrastructures account for a major part of infrastructure investments (Garg et al., 2013) and therefore to achieve a low carbon transition it is important to direct the same in a direction which allows in achieving the climate and development goals through a sustainable approach (GoI, 2008).

Low carbon scenarios of transport sector for India have either been analysed for passenger transport (Singh, 2006; Reddy and

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Balachandra, 2012) or provided in an aggregate fashion with no break up between passenger and freight transport (IEA, 2012, 2013). The low carbon scenarios also tend to focus only on improvements in efficiency of vehicles (Singh, 2006; IEA, 2012) and do not analyse the role of demand side measures for passenger and freight transport. This paper focuses on both passenger and freight transport and analyses both the demand side as well as supply side measures to draw policy recommendations.

2. Characteristics of Indian transport system

2.1. Passenger transport

The per capita mobility in India for transport (excluding walking and cycling) has shown high correlation with per capita income (Fig. 1) and is consistent with evidence from outside India (Small and Dender, 2007; Schafer and Victor, 2000). Increasing per capita mobility and an increasing population have combined to result in an increase in demand for passenger transport (Table 1) that has been faster than economic growth. The elasticity of passenger transport demand to GDP has been higher than 1, however come down from 1.64 for the period from 1950 to 1970 to 1.42 for the period 1990 to 2010 (NTDPC, 2014). The policies for passenger transport have mainly focused on motorised modes of transport and infrastructures for non-motorised modes such as walking and cycling have been ignored leading to a high share of accidents involving pedestrians and cyclists (Sundar and Ghate, 2013). Walking and cycling is a dominant mode of transport within Indian cities (Tiwari, 2013) especially within weaker socio-economic groups. There is no time series available for non-motorised transport officially however the same has been estimated at 220 billion pkm for 2010 using an average trip length of 1.6 km for walking and 3.9 km for cycling. Non-motorised transport catered to 25% pkms in 2010 out of a total demand of 892 billion pkms for urban transport.

Motorised passenger demand has been mainly met by road transport (two wheelers, buses and cars) within the cities and road, rail and air for intercity travel. Inside the cities, two wheelers have emerged as the largest mode of transport (estimated demand of around 256 billion pkm in 2010) due to sharp increase in ownership of two wheelers from 24.7% of households in 2001 to 35.2% of households in 2011 (Census-India, 2012). Poor public transport within the cities and increasing size of cities has contributed to a growth of two wheelers. Rail transport has been steadily losing share of intercity passenger transport and had an 11% share of overall passenger demand in 2010 (Table 1). In the last decade air traffic has grown fastest amongst rail, road and air however the overall share of air is still less than 1% (Table 1).

2.2. Freight transport

The per capita freight demand has been increasing at a fast pace (Fig. 2) and is strongly linked to growing demand for commodities within economy e.g., growing demand for energy (Fig. 2). The growth in demand for freight in the past has been faster than the GDP growth, elasticity of freight demand (only rail and road) to GDP since 1950 is estimated at 1.3. Elasticity to GDP has however reduced from 1.77 (for period 1950–1970) to 0.87 (for 1990–2004 period) (NTDPC, 2014).

Freight has been mainly transported by road and rail (Table 2) with road based freight taking the larger share of this demand. Since 2000 rail traffic growth has kept pace with road traffic to maintain share of rail in freight at around 40% (see Table 2). Coastal shipping and pipelines are the two other major modes of freight transport however no time series for tonne kilometres is available for them. A RITES study estimated freight transported through coastal shipping at 85.1 billion tkm and through pipelines at 105.5 billion tkm for 2007 (RITES, 2009). The growth in gross tonnage of coastal shipping (which can be taken as an indicator for coastal freight demand) has however been slower than both rail and road (Table 3, NTDPC, 2014). The government is however keen to increase the share of rail, a relatively energy efficient mode to road (Sims et al., 2014) by increasing the investment for rail which are currently much lower than road (NTDPC, 2014).

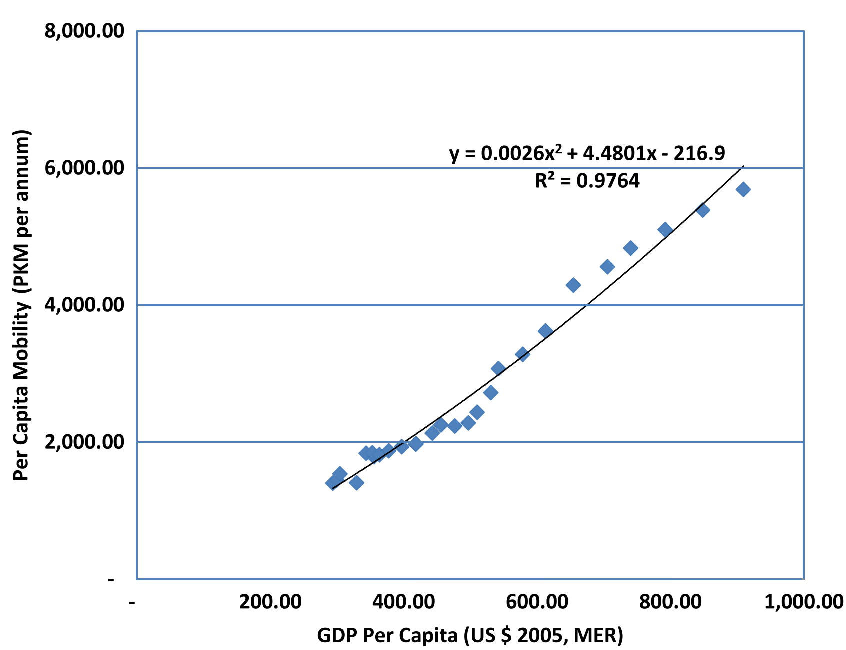

Fig. 1. Correlation of motorised per capita mobility with per capita GDP (MER in 2005 US $) using data from 1980 to 2010. Data: population (UNPD, 2013), GDP (WB, 2014) and mobility (data source provided in Table 1).