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Decoupling urban transport from GHG emissions in Indian cities—A critical review and perspectives

Jun Li

CIRED, 45 bis, avenue de la Belle Gabrielle, 94736 Nogent-sur-Marne Cedex, France

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ABSTRACT

How to sustain rapid economic and urban growth with minimised detriment to environment is a key challenge for sustainable development and climate change mitigation in developing countries, which face constraints of technical and financial resources scarcity as well as dearth of infrastructure governance capacity. This paper attempts to address this question by investigating the driving forces of transport demand and relevant policy measures that facilitate mitigating GHG emissions in the urban transport sector in Indian cities based on a critical review of the literature. Our overview of existing literature and international experiences suggests that it is critical to improve urban governance in transport infrastructure quality and develop efficient public transport, coupled with integrated land use/transport planning as well as economic instruments. This will allow Indian cities to embark on a sustainable growth pathway by decoupling transport services demand of GHG emissions in the longer term. Appropriate policy instruments need to be selected to reconcile the imperatives of economic and urban growth, aspiration to higher quality of life, improvements in social welfare, urban transport-related energy consumption and GHG emissions mitigation target in Indian cities.

1. Introduction

Transport plays an important role in addressing the challenges of climate change mitigation as it consumes nearly half of global oil and contributes one-quarter of total fossil fuel combustion related CO_2 emissions of the world (IEA, 2010b). In 2004, the transport sector is responsible for 14% of anthropogenic greenhouse gas emissions and 17% of global CO_2 emission (WRI, 2008; IPCC, 2007),[1] of which on-road transport represents more than 90% globally. Transport demand and related emissions in the world would increase significantly over the next decades in the business as usual (BAU) scenarios according to the estimates in a number of studies (Fig. 1), in which both bottom-up and top-down modelling methodologies were used. In a recent paper published in PNAS, Unger et al. (2010) argue that motor vehicles have emerged as the greatest contributor to atmospheric warming now and in the near term. More specifically, the authors stress the fact that transport growth-related economic and environmental impacts might inhibit services to enable economic growth in the next decades if unchecked. Clearly, these prospects for transport pose a great challenge to achieve the 2-degree climate target, which was confirmed again at the recent Cancun UNFCCC conference. On the other hand, mitigating emissions from road transport sector is particularly attractive because this action yields both rapid and long-term climate benefits, as well as co-benefits for human health.[2]

With its leapfrogging economy, India has become a major energy consumer and GHG emitter in Asia. Whilst India undergoes fast economic growth and profound societal transformation, energy consumption and GHG emissions in the transport sector could increase exponentially given the scale of urban expansion and continued quest of higher living standards if no drastic policies were undertaken appropriately and timely. Motorised traffic volume in India would reach 130 000 billion passenger km (92% on-road transport), resulting in a 5-fold increase in energy demand and carbon emissions in transport by 2020 relative to 2000 under the current trend (Singh, 2006).

Specifically, the scope for fuel substitution is relatively small even though the renewable transport fuels will have to account for a share in the fuel supply, but only to a limited degree in the foreseeable future. Globally, transport energy is over 95% dependent on oil. As in most countries, transport in India mainly consumes non-renewable fuels and contributes to CO_2 emissions. In 2005–2006, the transport sector in India consumes about 17% (36.5 Mtoe) of the country's total energy (217 Mtoe); energy

E-mail address: jun.li@centre-cired.fr

[1] In some areas of the world the percentage is much higher. For example, in California, transport accounts for more than 40% of the state's annual greenhouse gas emissions (California State Government, 2007).

[2] As mentioned in Colvile et al. (2001), road traffic exhaust emissions have been the cause of much concern about the effects of urban air quality on human health and tropospheric ozone production.

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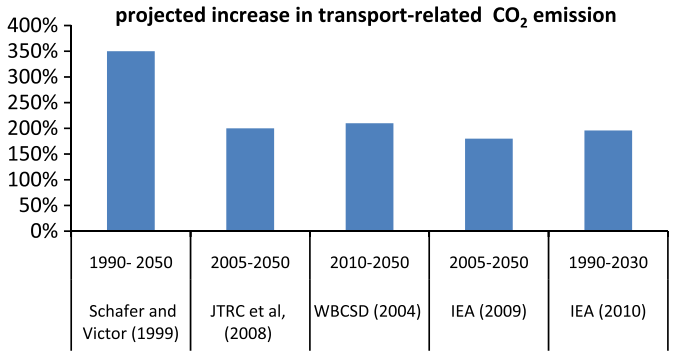

Fig. 1. Estimates of global CO_2 emissions from transport sector in different studies.

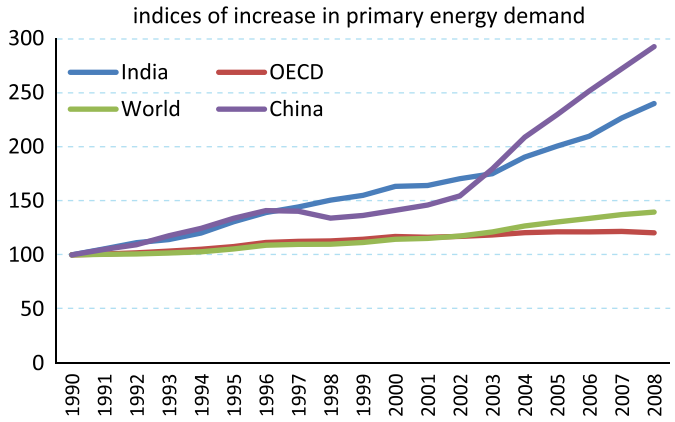

Fig. 2. Indices of increase in fossil fuels consumption (1990=100). (*Source*: BP, 2009; IEA, 2010a).

sources used in this sector are coal, diesel, petroleum (gasoline) and electricity (Ramachandra and Shwetmala, 2009).

Currently, most transport-related emissions are concentrated in urban areas, which account for the bulk of on-road transport energy consumption. It is foreseeable that most increase in carbon emissions in rapidly developing countries like India will come from cities as a result of unprecedented urbanisation and motorisation, which in turn is determined by the urban transport policy and governance structure. In the meantime, India is urbanising rapidly, and more than 250 million people will come to live in Indian cities by 2030 (UNFPA, 2007; Mckinsey, 2010). Over the period 1991–2005, energy consumption from urban transport in 23 major urban areas (million plus cities) in India became more than double, growing from 103 to 209 PJ, whilst carbon emissions increased from 7.9 to 15.3 Mt. Consequently, transport infrastructure provisions in cities will play an increasingly important role in GHG mitigation in India in the next decades given the spectacular pace of urban development, growing aspiration to private car ownership and required resources to meet the constantly growing demand.

Private car ownership in many large Indian cities increased significantly and dominates the car use in rural areas. According to Reddy and Balachandra (2010), per capita travel by cars in 23 urban areas was 331 pkm in 2005, in particular, in the city of Delhi, which recorded a markedly high level of 894 pkm in 2005, whereas the national average of car use per capita was only 58.6 pkm in the same year. Therefore, the way the Indian cities develop their urban infrastructure today will shape the pathway of energy demand and carbon emissions for several decades, and wrong decisions must be avoided to minimise the risk of carbon lock-in.

Nonetheless, exploiting technological progress potentials such as improvements in fuel economy and alternative fuels alone may not provide the 'one size fits all' answer to GHG mitigation in the transport sector, policies and economic instruments influencing consumer preferences and lifestyles are also needed (Michaelis and Davidson, 1996). Besides technical aspect, energy consumption and related GHG emission in urban transport are also heavily influenced by urban development policies in relation to land use and public transport organisation (Kenworthy, 2003).

Due to the strong inertia and long lifetime, failure in implementation of energy efficient and low-carbon transport will risk locking in irreversible carbon-intensive mire and would entail huge social costs in fast developing cities during the entire operating stage. This means that environmental quality of the transport infrastructure built now will determine the level of energy consumption and GHG emissions of the cities for decades. Thus a key question arises: how to meet the growing demand while minimising environmental impacts during the urban growth process? The purpose of this paper is to address this question and outline relevant strategies from the perspective of large-scale urban infrastructure governance in Indian cities, based on a critical review of key findings and advancement in recent literature on urban transport policies.

2. Energy policies in India

2.1. Raison d'être of reconciling urban growth and environment in India

India is facing various challenges in its socioeconomic development priorities: poverty reduction, urban growth, infrastructure provision, environmental quality, security of energy supply and climate change mitigation and adaptation. Stimulated by fast economic development, the next few decades will see an unprecedented scale of urban growth in India's metropolitan area. India's current urbanisation rate is still low, only 30% in 2008 (World Bank, 2010), but is increasing rapidly. It is projected that India will take over China to become the most populous country by 2030 and urban population will double then in India with more than 320 million rural residents migrating to the cities during the 2000–2030 period (UNFPA, 2007), implying a huge potential for increase in demand for urban infrastructure, and transport in particular in the next decades.

Over the past two decades, resources consumption in India has risen steadily to fuel the industrialisation and to meet the growing living standards of people, as a result of fast economic development and urbanisation. Fig. 2 delineates the past trend of increase in fossil fuels consumption (carbon emissions follow similar trends implicitly) in India and other regions in the world. Together with China, fossil fuels consumption in India increased significantly since its economic reforms in the early 1990s.

In 2007, India consumed 595 Mtoe energy, and energy-related CO_2 emissions reached 1324 Mt, ranking India the 5th major GHG emitter in the world (MOEF, 2010). Meanwhile, per capita emission increased more than three times whilst total population increased only 60% over the same period (IEA, 2009b; US Census Bureau, 2009).

In a recent study, Azomahou et al. (2006) employ a nonparametric approach to show that the per capita CO_2 emission in India is following upward trend with respect to economic development.[3] Likewise, the high CO_2 emission–urbanisation elasticity in

[3] Statistically significant at 5% level, countries like India and China are pursuing the upwind trend of per capita CO_2 emission as per capita GDP increases (Azomahou et al., 2006).