



**Transportation in a Climate-Constrained World.** Andreas Schäfer, John B. Heywood, Henry D. Jacoby and Ian A. Waitz. The MIT Press, 55 Hayward Street, Cambridge, MA 02142. 2009. xiii + 340 pp. Price: US\$ 27/£ 17.95.

Greenhouse gases (GHGs) make up only about 1% of the atmosphere, but they act like a blanket around the earth, or like the glass roof of a greenhouse – they trap heat and keep the planet some 30°C warmer than it would be otherwise. Human activities are making the blanket ‘thicker’ – the natural levels of these gases are being supplemented by emissions of carbon dioxide from the burning of coal, oil and natural gas; by additional methane and nitrous oxide produced by farming activities and changes in land use; and by several long-lived industrial gases that do not occur naturally. These changes are happening at an unprecedented speed. If emissions continue to grow at current rates, it is almost certain that atmospheric levels of carbon dioxide will double from pre-industrial levels during the 21st century resulting in rise of average global temperature by 1.8–4.0°C by the year 2100. Over a decade ago, most countries joined an international treaty – the United Nations Framework Convention on Climate Change (UNFCCC) – to begin to consider what can be done to reduce global warming and to cope with whatever temperature increases are inevitable. More recently, a number of nations approved an addition to the treaty: the Kyoto Protocol, which has more powerful (and legally binding) measures especially for high carbon emitting nations in developed world. The very recent Copenhagen Summit was a further step in this direction but failed to

produce the desired results, owing to various reasons.

From various researches, it has been established that worldwide the road transport has got a substantial share of carbon emissions (20–25% on an average). This makes transportation an important sector for reducing carbon emissions and thus for addressing the climate change issue. Therefore, it becomes extremely important to understand the transportation processes and phenomena closely and identify the potential ways based on technology, fuel, methodology, etc., by which substantial reductions in carbon emissions can be achieved from the transport sector. Till date, most of the knowledge in this aspect is only available through few research papers and maybe few book chapters. The present book under review by Schäfer *et al.* is possibly the first such comprehensive attempt in this direction. The book has been written by compiling research done by authors and others at MIT, other universities and various laboratories across the globe. The authors have put in tremendous efforts in studying the various research papers and reports, and in gradually developing this book.

The book is divided into eight chapters, starting from an introduction or overview chapter to chapters on global passenger demand trends and its implication on GHG emissions, and further, the impact of vehicle/aircraft technology and alternative fuels on climate change, and finally chapters on policy measures for GHG mitigations and future prospects and policy choices. Through these chapters the authors gradually move from a do-nothing condition to scenarios with a gradual introduction of different types of technology and policy interventions to address climate change. The first chapter begins with an interesting example of nineteenth century Victorian London, when the horse-driven transport system reached its saturation level and the whole city’s climate was threatened by the unprecedented amount of manure excreted by the horses’ everyday, and how the scenario completely changed with the advent of automobiles in the early twentieth century. The chapter further describes the historical and projected trends of growth in automobile and air transport sector and its relation with trends in oil consumption and GHG emissions. At the end of the chapter, the authors clearly indicate the limita-

tions of the book, particularly being United States centric.

The second chapter deals with both historical and projected trends of global passenger travel demand. The authors highlight, growth of per capita income and population as two important drivers of growth in aggregate passenger travel demand. As observed in this chapter, the average travel cost (of all modes of transportation taken together) has remained approximately constant at about \$ 0.12 per passenger kilometre (pkm), which has increased only recently owing to rise in oil prices. Also interesting is the observation that the average daily travel time per person of 1.2 h has remained largely stable even when time allocation for other activities has changed. The chapter also mentions that the traffic congestion is especially severe in the developing world, where the vehicle fleet often grows by 20–30% per year, a rate that is impossible for infrastructure extension to match. The summary of the chapter highlights that with technology continuing to advance, and both per capita income and population continuing to rise, global passenger mobility will further grow and by mid-century, travel by earth’s inhabitants could nearly triple or quadruple based upon 2005 levels and depending on the assumed growth of Gross World Product (GWP).

The third chapter deals with GHG implications of the present and projected travel demand. The chapter focuses on the effects of travel demand on GHG emissions through analysing passenger travel energy intensity (total amount of energy used for travel divided by total passenger kilometre travelled) from a human behaviour and airline operations perspective. Interestingly, it is observed in the chapter that energy intensities are higher in urban travel than in intercity operation and also the dominant human factors contributing to increase in passenger travel energy intensity are: consumer preferences for larger vehicles with higher engine power, declining occupancy rates, increased urban driving and implications of little consumer reaction to fuel prices. The authors suggests that world average passenger travel energy intensity may increase up to about 20% over current levels by 2050 (in a scenario without any technological advances relative to today’s vehicles). Also, it is concluded that the absence of

technology change, growth in travel demand and the continuation of certain other long-standing consumer and airline behaviours could push the emissions of GHGs by three to five times in 2050 as compared to levels emitted in 2005.

The fourth chapter examines the opportunities that improvements in current technology can provide for light-duty vehicles (LDVs) and, to a more limited extent, for other surface modes of transportation. The authors make use of relationship between vehicle energy used per unit of distance travelled and acceleration resistance, aerodynamic drag and tire rolling resistance to understand the implications of various road technology interventions on GHG emissions. Interestingly, the authors point out that out of the total fuel energy entering the engine, only an average of 16% actually drives the wheels; the remaining 84% is dissipated in the engine, transmission, drivetrain, vehicle accessories, as well as when the engine idles; and therefore engine efficiency improvements are a very important strategy for reducing vehicle fuel consumption and correspondingly the GHG emissions. The authors conclude that over the next two to three decades, technologies can be developed to reduce fuel consumption and CO<sub>2</sub> emissions of the average new midsize automobile in the United States of the early 2000s by up to 60% without significantly compromising performance, size and safety.

The fifth chapter continues the analysis of previous chapter with respect to commercial passenger aircraft. The chapter summary highlights that the airlines strive for minimum direct operating costs, of which fuel costs account for a significant share and because of this historically there has been a sharp decline in CO<sub>2</sub> emissions per passenger kilometre travelled (PKT). However, due to requirement of more sophisticated technology and higher costs for further reduction of CO<sub>2</sub> emissions in future, the expected decline in future will be half the historical rates.

Chapter six examines the possibility of using alternative transportation fuels for reducing GHG emissions. The authors basically compare oil products (diesel, jet fuel, gasoline) with GHG emission reduction potential of alcohol fuels (ethanol, methanol), methane (CNG, LNG), hydrogen (CH<sub>4</sub>, LH<sub>2</sub>) and electricity. It is highlighted that due to rise in oil prices

and increased dependence on oil imports, the share of synthetic oil products from unconventional oil and natural gas is already growing, however, it may result in increased level of lifecycle GHG emissions, unless CO<sub>2</sub> emissions at the synthetic fuel refinery are sequestered. The chapter also concludes that among the gaseous fuels, only hydrogen has potential for large-scale application. However, in addition to the fuel use and on-board vehicle storage challenges, and the inconvenience of gaseous fuels, a hydrogen transportation system would require a completely new production, distribution and storage infrastructure.

Chapter seven explores various policy measures for GHG mitigation. The authors consider measures such as market-based measures (price premium on fuel or CO<sub>2</sub>, modified vehicle price, accelerated retirement), subsidies on low-carbon fuels, regulatory measures (CAFE or CO<sub>2</sub> cap, technology and fuel composition mandates), and research and development. It is concluded in the chapter that nearly all measures cause consumers or airlines to rebalance their preferences among attributes of new automobiles or aircraft, and they could also induce the vehicle industry to develop and offer less GHG-intensive vehicles and fuels at a faster rate and larger scale than they would do otherwise. A carefully combined set of actions, covering all stages of a vehicle and fuel cycle, could lead to a large-scale reduction in the growth of GHG emissions from passenger travel. Chapter eight finally integrates insights from the previous chapters into a picture of the impact that technology and fuels currently under development, combined with adjustments in travel patterns, might have on GHG emissions. The book concludes with a very right statement: 'We all want to continue to enjoy unfettered personal mobility while protecting the planet. Unfortunately, there are too many of us, and we are becoming too wealthy, for that to be feasible without changes in traveler behaviour and improvements in technology, somehow spurred by government policy'.

The book has many positive points. It is the first such book to comprehensively address climate change through interventions in transport sector. Also, it is a well researched book which is evident from the number of references given below each table of the book. The book gives a clear picture of past, present and future

trends of GHG emissions and the effect of various interventions on mitigating GHG emissions, and therefore it will be an important reference and guiding document for industries, practitioners, bureaucrats, policy makers, politicians, etc., to address the challenge of climate change by suitably introducing policies and reforms in transport sector.

On the negative side, the book is primarily United States (US) focused and does not cover the scenario in developing nations well, which is quite obvious considering the affiliation of authors and also the major challenge and legal bindings the US is facing under the Kyoto Protocol to address the climate change. Accordingly, the focus and analysis of various interventions are primarily with respect to trends observed in US. However, besides climate change, developing countries like India are also currently facing severe challenges with respect to mobility and safety and hence, as compared to vehicle technology and alternative fuel interventions for personal vehicles; their focus has to be more on promoting sustainable transport and better land use-transport planning as a means for addressing mobility/safety and also climate change. Unfortunately, these aspects have not been touched at all in this book. Another negative aspect of the book is that it is heavily number-centric and statistics-based, in other words the description of methodological approaches and modelling behind various trends and figures is minimal or often missing in the book. This makes it unattractive for students and inappropriate to be used as a text book.

Overall, the authors' effort in touching this new subject through their book is commendable and laudable, and it will provide right direction for many such books to be written in future.

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