Book Reviews

Cars and Climate Change

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Transportation and Global Climate Change

DAVID L. GREENE and
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Over the past half decade, the idea that continued high rates of fossil fuel combustion may alter the atmosphere by a sufficient amount to cause significant and permanent increases in global temperatures has rapidly gained scientific and political credibility. As a result, there has been a flurry of research examining the potential damages that such climate change may inflict and the options that exist for mitigating those damage by decreasing the projected rate of greenhouse gas emissions. An uncomfortable fact that has emerged from this research is that transportation may be the area of human activity where the growth in fossil fuel use is the most rapid, and at the same time the most difficult to reverse. In an era of increasing trade, decreasing spatial concentration of activities, and increased emphasis on the rapid movement of goods and people, growth in the demand for transportation services necessarily outstrips growth in the broader economy. Perhaps the greatest fear is that as people in the emerging market economies seek to achieve levels of personal mobility that we in the OECD countries take for granted, global fossil fuel use could grow at rates even greater than any observed over the past fifty years. If this occurs, it is hard to imagine how the level of greenhouse gas emissions could possibly be reduced, or even held constant.

Two recent books address the critical role of the transportation sector in the emission of greenhouse gasses. The first is *Cars and Climate Change*, published by the International Energy Agency (IEA). Founded at the height of the 1970's petroleum crisis, the IEA is an agency of the Organization for Economic Cooperation and Development (OECD) with a mandate to promote and coordinate energy policy among its affluent member countries. While the IEA originally focused on the economic and security problems arising from a heavy reliance on energy resources located, for the most part, outside the OECD area, its interest has now shifted somewhat in the direction of examining the potential environmental impacts of current energy use trends.

Cars and Climate Change is welcome evidence of that shift.

The book is organized into three parts. The first is a review of the current and potential impacts of transportation on the environment, with a useful chapter comparing emission by mode. Given the difficulty of finding comparable data, empirical evidence is for the most part limited to OECD Europe and North America. Also, as the book's title suggests, there is a strong emphasis on greenhouse gases, although a concise appendix reviews transportation emissions with immediate health impacts, as well as those that contribute to ground level ozone and acid precipitation. Contrary to what the book's title suggests, the analysis is not limited to personal light duty vehicles. There is some useful discussion of emissions from trains, airplanes, and a quite substantial analysis of heavy duty road vehicles.

The second and most substantial part addresses the potential for greenhouse gas emissions abatement through technical change to road vehicles. After a brief chapter assessing the potential for improved energy efficiency in conventional vehicles, the book moves on to a comprehensive analysis of the potential for greenhouse gas reduction through the introduction of alternative fuel technologies. This analysis adopts a full-cycle approach, whereby estimates of energy use and associated emissions from vehicle construction and disposal and from fuel production are combined with direct fuel consumption and tailpipe emissions to provide a more complete picture of the costs and benefits of alternative technologies. Without going into too much detail, I would conclude that the most important message that one takes away from this book is to beware of analyses that rely exclusively on comparisons of tailpipe emissions. For example, the production of ethanol from maize is estimated to require so much energy in fuel production that its full-cycle greenhouse gas emission is roughly comparable to that of gasoline, despite much lower tailpipe emissions. These assessments are based on technical assumptions that are open to question. In particular, the estimation of upstream emissions depends critically upon what type of energy is used in fuel production. To their credit, however, the IEA authors make their technical assumptions quite explicit. A separate analysis is conducted for electric vehicles to take full account of the effect that different methods of electricity generation have on their full-cycle emissions. They conclude that electric vehicles would produce more emissions in North America than in OECD Europe because of the greater dependence upon thermal generation in the former region. A somewhat disappointing note is that hydrogen based fuel cell vehicles were left out of the analysis because they were not deemed economically feasible in the medium run and their technology is not yet mature enough for accurate assessment.

The third part of *Cars and Climate Change,* which is called "Markets and Policies", addresses the potential for market penetration of various vehicle technologies and policies that might be used to accelerate their adoption. A careful comparative analysis of the costs of alternative technologies is conducted. The results give rise to some pessimism, as the only technology that appears to be cost competitive in the short run is one fueled by compressed natural gas. The same technology is shown in Part II to have full-cycle greenhouse gas emissions that are only marginally lower than conventional gasoline based technologies, and it has the drawbacks of a shorter range and increased fuel storage space requirement. Given that the potential for technological shifts based on normal market mechanisms is shown to be quite limited, the key question is what types of market interventions are needed. It is on this topic, however, that *Cars and Climate Change* is weakest. There is some discussion of policies being used in the US and Europe and a rather mechanical listing of possible instruments, but there is very little on the efficacy of policy options and no final recommendations. This may simply reflect the currently poor state of our knowledge in the policy analysis field. Perhaps it also reflects that IEA sees it mission as limited to providing information to policy makers in the OECD member coun-

tries without making any recommendations. Either way, an otherwise good book ends on a rather flat note.

A second book on a similar theme is *Transportation and Global Climate Change*, edited by David Greene and Danilo Santini. This book comprises eleven chapters, all by different authors. While the style, quality, and level of technical detail is quite variable, the chapters are organized in a quite logical way, starting with a number of chapters on emissions trends, then moving on to a number of chapters on specific technological options, and ending with a very broad and comprehensive assessment of likely transportation emissions of greenhouse gasses in the year 2030 under alternative scenarios. While a good deal of international information is presented throughout the book, it is fair to say that the focus is clearly on the US. Also, because the chapters are contributed by people who are concerned with a broad range of environmental issues, the book is not so much exclusively concerned with greenhouse gas emissions as is *Cars and Climate Change*. I doubt whether this constitutes a serious drawback for most readers.

The early chapters provide sufficient evidence to convince the reader of the importance of the transportation sector in the climate change picture. An especially interesting point is provided by Schipper, Steiner and Meyers in Chapter 2. They decompose growth trends in energy use into parts due to changes in the level of transportation activity, shifts among transportation modes, and changes in modal energy efficiencies. The conclusion they draw is that, in the long run, trends in activity levels and modal shifts are likely to overwhelm efficiency improvements. In other words, improved technologies cannot by themselves meet emissions targets — behavioural changes will also be necessary. With the exception of a single chapter on Asian cities however, this important point seems to get lost in the remainder of the book, and is almost absent from *Cars and Climate Change*. A further chapter on assessing the economic impacts of incentives based policies to reduce greenhouse gas emissions comes to the rather encouraging conclusion that significant improvements can be achieved at quite modest cost.

The chapters in the middle of the book all address technological options. There are chapters on the potential for efficiency improvement in internal combustion engines, various electric vehicle options, solar hydrogen fuels, aviation fuels, heavy vehicle energy use, and a review of propulsion research at the US Department of Energy. These chapters should give most readers a broad, if somewhat imbalanced, picture of the types of technological options that are currently available or under study. I found MacCready's chapter on electric vehicle options especially useful as it went beyond purely technical issues to consider such things as the role of consumer attitudes and the factors that drive development of more efficient technologies. Ogden and DeLuchi's chapter on solar hydrogen fuels is worthy of special note, as it provides a model of how to present technical information to a mixed audience of readers in a clear and interesting way.

The final chapter presents what is actually a subset of a large and ambitious research project examining alternative energy futures for the entire United States economy. (The complete project is described in Alliance to Conserve Energy *et al.*, 1991). It details estimates of energy use and CO_2 emissions by the US transportation sector out to the year 2030 under alternative scenarios. Most of the chapter is concerned with defining and explaining the difference between projections under two scenarios: a reference scenario that assumes continuation of current trends and policies, and an environmental scenario that assumes a socially optimal allocation of resources based on the definition of externalities costs associated with energy use. Under the latter scenario, not only are energy efficient technologies and alternative fuels assumed to be adopted at an accelerated rate, but policies inhibiting the growth of energy intensive activities, such as long distance commuting, are assumed to be in place. The bottom line result is that energy use goes up significantly from 1990 levels under the ref-

erence scenario and goes down significantly under the environmental scenario. In 2030, the estimated end-use under the reference scenario is more than twice what it is under the environmental scenario. While exercises of this type are subject to criticism on the basis of the assumptions they employ, they at least provide the basis for meaningful debate over what is desirable and what is achievable. They also can generate some interesting propositions. For example, of the difference in 2030 energy use between the reference and environmental scenarios, two-thirds are attributed to technological improvement, and one-third to changes in activity levels due to urban planning initiatives and transportation demand side management.

These two books taken together provide a useful entree into the problem of transportation and the environment — especially with regard to greenhouse gas emissions. Both books do a good job defining the magnitude of the problem, and identifying important technological trends. Both are weaker, however, in addressing the effects that economic changes and individual transportation choices have on the levels of activities that underlie energy end-use. *Transportation and Global Climate Change* includes two chapters that provide evidence of the numerical importance of activities levels, and *Cars and Climate Change* includes an interesting appendix on traffic management in the Netherlands. Neither, however, contains any major element of behavioural research. Especially in light of the current (and welcome) shift away from command and control regulation, it is important to recognize that it is the decision making of firms and individuals that must drive both the penetration of new technologies and the curtailment of energy intensive activities. This is especially true in transportation, where virtually everyone is involved in the decision making. This suggests a need for more social science on the energy research agenda.

References

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