CLIMATE CHANGE:
CURBING TRANSPORTATION'S CONTRIBUTIONS

INTRODUCTION

Transportation and Climate Change

Developing Technologies, Policies, and Strategies

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The rapid increases in the speed, efficiency, and accessibility of the transportation system over the past century have enabled unprecedented levels of social interaction and economic productivity throughout the world. Transportation for personal mobility and for the movement of freight is integral to the high standard of living in developed nations and to fostering growth in developing nations.

Transportation activity, however, is a major user of the world's carbon-rich fossil fuels and a major source of carbon dioxide (CO_2) and other greenhouse gas (GHG) emissions associated with climate change. In the past 40 years, the developed world has mitigated many of the adverse environmental and public health impacts from transportation emissions—particularly in reducing the tailpipe pollutants from the burning of gasoline and diesel fuels.

Challenging Endeavor

Yet the recent oil release in the Gulf of Mexico starkly and dramatically emphasizes that the environmental impacts of oil use remain a vexing problem. Addressing the transportation sources of climate change, in particular, is a challenging and complicated endeavor—climate change is possibly the greatest environmental and social challenge worldwide. Nonetheless, previous success in mitigating environmental problems instills a confidence that the transportation sector can reduce its significant contributions to climate change.

GHG emissions accumulate in the atmosphere; reducing emissions therefore offers the best strategy for preventing the buildup of GHGs to levels that pose a major risk to human and natural systems. Significantly reducing GHG emissions from transportation will require actions that go beyond increasing vehicle fuel efficiency and that encompass initiatives in all of the major passenger and freight modes.

PHOTO: WIKIMEDIA COMMONS

Traffic near Siam Square in Bangkok, Thailand. Expanding personal transportation networks play a major role in the growth of developing nations.

Transportation GHG emissions consist largely of CO_2 from petroleum combustion (93 percent of emissions) but also include non-CO_2 emissions of methane and nitrous oxide from fuel combustion, as well as hydrofluorocarbons from vehicle air conditioning units—see Table 1, next page (*1*). Globally, the transportation sector is responsible for 23 percent of energy-related GHG emissions, with approximately three-quarters from road vehicles (*2*). In the United States, the transportation sector produces 34 percent, reflecting the higher per capita consumption of carbon-based fuels compared with the rest of the world (see Figure 1, next page). Transportation also exerts an indirect effect on climate change by inducing land use changes in agriculture, settlement patterns, housing, and business locations.

TABLE 1 Total U.S. Greenhouse Gas Emissions by the Transportation Sector, 2007

	Million metric tons in CO_2-equivalent warming potential
Carbon dioxide	1,902.5
Methane	5.1
Nitrous oxide	56.2
Hydrofluorocarbons	72.7
Total	2,036.5

(Source: *Transportation Energy Data Book*, Edition 28, Table 11.4. www-cta.ornl.gov/data/tedb28/Edition28_Full_Doc.pdf.)

Body of Evidence

This issue of *TR News* brings together leading experts to provide an overview of transportation's role in GHG buildup and in energy use. Several articles highlight recent reports published by the Transportation Research Board and by other units of the National Research Council (NRC). NRC is releasing reports in two series, America's Energy Future and America's Climate Choices, that present the perspective of all the major energy-consuming sectors.[1]

As explained in the NRC reports summarized in this issue (page 6), a strong and credible body of evidence documents that the earth is warming and that this warming is caused largely by human activities, especially through the release of GHGs from the burning of petroleum and other fossil fuels. Many models of emissions trends and climate risks indicate that GHG emissions may need to be reduced worldwide by 50 to 80 percent—perhaps by even more—by the middle of this century. To achieve these deep reductions will require actions that cut across all energy-using sectors to effect a marked departure from the current trajectory of increasing emissions, as one of the new NRC reports makes clear.

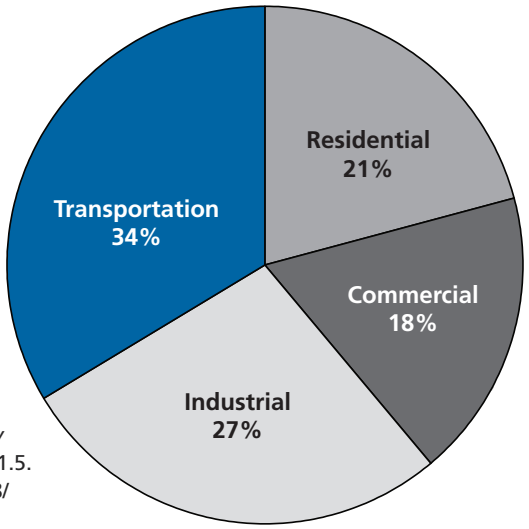

FIGURE 1 U.S. carbon dioxide emissions from fossil fuel consumption by the energy-use sector, 2007. (Source: *Transportation Energy Data Book*, Edition 28, Table 11.5. www-cta.ornl.gov/data/tedb28/Edition28_Full_Doc.pdf.)

Mix of Transportation Strategies

The article by Fulton (page 15) notes that no single transportation technology or policy action offers a promising means of achieving such deep reductions; instead, a mix of different technologies, policies, and strategies is necessary. The mix likely will involve sustained increases in the fuel economy of all kinds of vehicles, switching to fuels with lower GHG emissions per mile, and reducing the demand for energy- and emissions-intensive transport services, with a range of actions from shifting modes to changing urban form.

The spectrum of actions includes the deployment of intelligent transportation systems that improve operational efficiency (see article by Barth and Boriboonsomsin, page 26) and public policies that promote less energy-intensive patterns of land use (see article by Gómez-Ibáñez and Humphrey, page 24). As Frankel and Menzies point out (page 10), these outcomes require many well-informed and complementary policy choices.

Because CO_2 emissions from transportation are roughly proportionate to the amount of petroleum consumed, the price of gasoline, diesel, and alternative fuels can affect emissions through fuel demand and supply. Despite recent spikes in the price of petroleum, however, U.S. transportation fuel costs have been relatively low. The low price, along with rising incomes, has favored heavier and larger personal vehicles that tend to use more fuel and produce greater quantities of GHG emissions.

Regulatory Approaches

To counter this, the U.S. government has taken several actions. For example, federal tax incentives and other policy initiatives are spurring the introduction of vehicles with battery-powered electric drives. As explained by Turrentine (page 32), this poses many challenges, including integration with the electricity infrastructure. In addition, the U.S. Environmental Protection Agency and the National Highway Traffic Safety Administration have promulgated new performance regulations to increase the fuel economy of cars and light trucks and to reduce vehicle emissions of GHGs, including substances besides CO_2 (see article by Noland, page 12).

At the state level, California is pioneering an approach to control GHG emissions by regulating fuels, seeking to spur the development and use of low-carbon fuels such as advanced biofuels. In his article (page 29), Sperling explains California's low-carbon fuel standard, which accounts for the total emissions from fuels, from production to consump-

[1] http://sites.nationalacademies.org/energy/; http://www.americasclimatechoices.org/index.shtml.

Photo: Ohio Department of Transportation

The changes in land use in the areas surrounding roadways and other transportation networks indirectly contribute to climate change.

tion, to achieve net GHG reductions—a critical challenge for all mitigation policies.

Modal Initiatives

Freight activity and its modal distribution also may need to change substantially, depending on progress in boosting energy efficiency and diversifying the energy supply, especially in the trucking sector (see article by Mintz, page 34). The international maritime sector, instrumental in providing cheap transportation for global trade, emits as much CO_2 as some of the world's most prosperous countries—and therefore is becoming a target of policy interventions, as discussed by Corbett, Winebrake, and Wang (page 40).

The aviation sector is becoming a major contributor to transportation emissions globally, and international efforts to control emissions are under way. Aviation depends on liquid fuels with a high energy content, prompting research to develop biofuels for this vital and safety-conscious sector (see article by Anger and Putnam, page 45).

Opportunities for Innovation

The research challenge is beginning, with many issues needing more informed and careful analysis, as Meyer and Godwin point out (page 21). Meeting the challenge of climate change will provide opportunities for innovation—extensive and intensive innovation in technologies, practices, and policies. Although this issue of *TR News* can cover only a sample of the needs for research and innovation, the articles reflect the importance of a large, varied, and vibrant transportation research community going forward.

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References

1. *Emissions of Greenhouse Gases Report*. DOE/EIA-0573, U.S. Energy Information Administration, December 2009.
2. Kahn Ribeiro, S., S. Kobayashi, M. Beuthe, J. Gasca, D. Greene, D. S. Lee, Y. Muromachi, P. J. Newton, S. Plotkin, D. Sperling, R. Wit, and P. J. Zhou. Transport and Its Infrastructure. In *Climate Change 2007: Mitigation—Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [B. Metz, O. R. Davidson, P. R. Bosch, R. Dave, and L. A. Meyer (eds.)], Cambridge University Press, Cambridge, United Kingdom, and New York, 2007.