Climate and Transportation Solutions:

Findings from the 2009 Asilomar Conference on Transportation and Energy Policy

Daniel Sperling
Editor

Institute of Transportation Studies
University of California, Davis

James S. Cannon
Editor

Energy Futures, Inc., Boulder, Colorado

Published by
Institute of Transportation Studies
University of California, Davis
One Shields Avenue, Davis, California 95616

For more information contact its@ucdavis.edu

Chapter 1:

Combating Climate Changes from Transportation

by Daniel Sperling and James S. Cannon

Forty thousand political leaders, climate experts, and concerned citizens converged on Copenhagen in December 2009 for a global climate summit. The summit was widely viewed as a failure, with the media using expressions such as “train wreck.” For those troubled by the risk of chaotic climate disruptions and economic turmoil, this failure of leadership is painful.

Was Copenhagen really a train wreck, and is there really an utter failure of leadership? The disturbing story popularized by the mass media is only part of the answer. Real progress is being made, even in the international negotiations that faltered in Copenhagen. Just a few years ago, the president of the United States (U.S.) was denying the reality of climate change and refusing to take serious action to reduce emissions. At the same time, China, the other principal emitter of carbon, was even more insistent that it need not act. Yet in Copenhagen, a new U.S. president personally lobbied other government leaders and promised to put the United States on a path toward dramatic reductions. He was joined by the premier of China, who just one year before was saying that climate change was a scheme of rich countries to suppress the developing countries of the world. In Copenhagen, he committed China to a modest international partnership to tackle climate change.

While the 2.5-page Copenhagen agreement approved by 188 of 192 nations in attendance was undeniably weak and vague, and didn’t even mention transportation, it, too, was an important step forward. The world has rarely seen a larger group of heads-of-state in one place focused on one issue. Their presence indicated that climate change is a top priority around the world. While they were unable to put in place a new treaty to replace the Kyoto Accord of 1997, much good came of the meeting. Thousands of experts and activists—from governments, industries, and non-governmental organizations—sat together and listened to each other. It is not easy to get such a large and diverse group of nations to agree to major financial and institutional commitments for a problem that is still nearly invisible. In many ways, it is remarkable that so many are so committed.

Whether the Copenhagen meeting was a train wreck or a modest step forward, greenhouse gas (GHG) emissions continue to increase and evidence of climate change becomes ever stronger. Global concentrations of carbon dioxide (CO_2) have reached the highest levels recorded since pre-industrial times.

D. Sperling is Director of the Institute of Transportation Studies at the University of California, Davis and J. Cannon is President of Energy Futures, Inc.

In the United States, CO_2 emissions have grown at an average annual rate of 0.8 percent since 1990, according to data from the U.S. Energy Information Administration (EIA 2009). The total increase since 1990 has been 16.3 percent. The transportation sector is the second largest source of CO_2 emissions after electricity generation, accounting for 33.1 percent of total U.S. emissions. Those emissions are principally from the combustion of motor gasoline, diesel fuel, and jet fuel.

The Emerging Policy Paradigm

These grim statistics give way to some optimism when one turns to policy. As discussed in the pages of this book, transportation-related climate policy is progressing rapidly. In recent years, the European Union (EU), United States, Japan, and China all moved forward with aggressive policies to reduce fuel use and carbon emissions from vehicles. Scattered around the world are strong national and regional policies to decarbonize transport fuels. Only in restraining and reducing vehicle use has there been little progress, but even here, some glimmers of light can be seen.

In fact, policy progress, as modest as it is, far exceeds real-world progress in actually reducing emissions, providing some hope for the future. Many governments are putting in place durable and strong policy frameworks to reduce carbon emissions from the transport sector. California is especially notable. Despite, or perhaps because of, its legacy of pioneering car-centric transportation, California has been creative and aggressive at taming motor vehicles. It leads the way in the United States with aggressive vehicle requirements, a far-reaching low carbon fuel standard that could transform the oil industry, and a law to reduce urban sprawl and vehicle use. Most other countries have a much smaller transport-related carbon footprint than California, but California is leading the way in formulating comprehensive durable policy frameworks, and many states and countries are following its lead.

In the United States, the first major effort to rein in greenhouse gas emissions from transportation was California's 2002 law to dramatically reduce emissions from vehicles by 2016. In a sign of the times, that law was blocked every step of the way. The auto industry filed a series of lawsuits to block implementation in California and other states that adopted the California program. When those industry lawsuits were rejected by the courts, the administration of then-president G.W. Bush refused to allow California and the other states to proceed. California responded by suing the national government.

In 2007, the U.S. Congress, after 30 years of inaction on vehicle fuel use, bumped the corporate average fuel economy (CAFE) standards upward 40 percent to 35 miles per gallon (mpg), to be achieved in 2020. Then, at a press conference in May 2009, newly-elected President Barack Obama and the CEOs of the three major U.S. car companies cheerfully embraced the California law as a national standard, in effect agreeing to move the 2020 deadline up to 2016—essentially agreeing to a requirement they had vociferously opposed for seven years.

Other changes were also taking place. As part of the same 2007 energy law when CAFE standards were first raised, the U.S. Congress also dramatically expanded the biofuels requirement, raising it to 36 billion gallons by 2022. California took it one important step further. In 2009, it adopted a low carbon fuel standard, requiring a 10 percent reduction in the carbon content of transport fuels by 2020, measured as lifecycle greenhouse gas emissions per unit of energy. To achieve this new standard would require about 30 percent of gasoline and diesel fuel to be replaced by low-carbon alternative fuels. The European Union also adopted rules requiring a decarbonization of transport fuels, and many U.S. states and Canadian provinces are following California's lead. As with vehicle standards, industry groups that felt disadvantaged—in this case corn ethanol producers--filed a lawsuit in January 2010 trying to block the fuel standards.

In the United States and most other countries, policies to tame cars and fuels are mostly crafted as performance standards. They call for improvements in the technology and fuel, but they usually don't address how much that vehicle and fuel is used. Thus, a law enacted in California in late 2008 is of special importance. It calls for reductions in urban sprawl and vehicle use, couched as reductions in greenhouse

gas (GHG) emissions associated with passenger travel. While that law, known as Senate Bill (SB) 375, has few carrots and sticks associated with it, it provides a framework for reducing vehicle use that can be built upon in the future. For California and the United States, that is revolutionary. This California law was transferred in similar form to the national climate bill passed by the House of Representatives in 2009. While the bill had still not passed into law as this book goes to press, the inclusion of a provision to reduce vehicle use and urban sprawl is notable.

This cluster of transport-related policies represents a coherent and potentially effective policy framework for reducing oil use and GHG emissions. As experience and analyses accumulate, a better sense of which policy instruments are most effective is developing, including what types of changes are possible and likely. Underpinning this new framework is a set of commonly shared observations among transportation experts, which include the following:

- Climate goals are well aligned with energy and urban livability goals. What is good for climate change is almost always good for energy security and healthy, successful cities.
- Major change and major innovation are needed in the transport sector
- Better technology is key, but these technological changes must be complemented with policies and strategies that alter vehicle purchase and use behavior and reduce sprawl
- Transportation transformations are more a question of vision, leadership, and will than cost
- Fuel and vehicle transformations will require unprecedented coordination internationally, but, in the end, it is local and national will and commitment that will be key.

Change will not be easy or quick. Many barriers remain. The fundamental problem is that surface passenger transport is arguably the least innovative sector of the economy. In fundamental ways, the transport system has barely changed since the 1920s. Functional and design attributes of vehicles and roads have been roughly the same for decades. While vehicles today are safer and more reliable, they have about the same size, carrying capacity, weight, and fuel economy as they did 80 years ago. They still have four wheels, drive the same speed, and operate on petroleum. Roads and transit services are also functionally unchanged. While there are many more expressways, almost all vehicles still travel on almost all roads, and almost all are free. Transit service is also largely unchanged. Mass transit vehicles are more comfortable than in earlier times and are air conditioned, but the frequency and distribution of service remains sparse.

There is a tremendous need for innovation in the transportation sector. The need for new low-carbon fuels and advanced and more efficient propulsion systems is clear, but innovation must go much deeper. This means creating new transportation networks and financing systems supported by governmental institutions to manage the huge financial flows that will be involved. It means effective management of land use by local governments. And it means new and better ways of providing mobility and accessibility to people.

Ideas matter, but in this case knowledge matters more. Injecting knowledge into the debate is not easy. Public debates about climate change are frequently framed around ideological and political themes, such as free market versus regulatory approaches, food versus fuel priorities, the needs of haves versus have-nots, and local jobs versus the global marketplace. It is important to engage these big ideas, but ultimately each of them should be firmly grounded in science and data. The challenge for the informed decision maker is to sort through the political slogans to determine those strategies and policies that are most effective and most efficient and equitable. This requires bringing science and data to bear on slogans and concepts. Ignoring these analyses, or leaving them to the imagination of politicians and their staffs, is a recipe for bad policy and bad laws.

The Asilomar Conference Series

The first Biennial Conference on Transportation, Energy and Policy convened in 1988. Oil cost $15 per barrel then, General Motors still dominated the automotive market, no one had heard of reformulated

gasoline, electric vehicles had not yet reappeared, hybrid electric vehicles were more than a decade from commercialization, plug-in hybrids were an academic pipe dream, and fuel cells could take us to the moon but not the corner store.

On the other hand, some of the weapons wielded today to fight climate change were already in the energy policy portfolio. Biofuel policy had launched ethanol fuels, though it was produced almost exclusively from corn, and the CAFE standards were well established, though they remained stuck at 27.5 mpg for cars for another two decades. Much more obviously needed to be done.

Each Biennial Conference on Transportation, Energy and Policy has been held at the Asilomar Center in a secluded coastal California state park in Pacific Grove. During the first two decades and nine conferences, the themes jumped among a wide range of topics from broad sustainable transport themes to the hydrogen economy. The topic switched in 2005 to climate change, where it has remained fixed for three conferences over six years. Climate change is now widely recognized as the most critical environmental problem facing the planet. Transportation is a major cause of the problem, and it has a key role to play in its solution. Transportation policy experts from around the world that travel to Asilomar remain fixated on climate policy because the challenge is so huge and so important.

Thus, this book, like the two previous books that grew out of discussions at Asilomar, *Driving Climate Change* in 2006 and *Reducing Climate Impacts in the Transportation Sector* in 2008, focuses on innovative strategies to reduce GHG emissions from transportation. It addresses the fundamental question: Is it possible to define a path to a future just 40 years away in which transport-related CO_2 emissions have been reduced 60 to 80 percent?

As in the past, the organizer of the 12th Biennial Conference on Transportation, Energy and Policy in July 2009 was the Institute of Transportation Studies at the University of California,Davis (ITS–Davis) on behalf of three committees of the U.S. Transportation Research Board, a research arm of the National Academies in Washington, DC. They are the Energy, Alternative Fuels, and Sustainable Transportation committees.

ITS–Davis once again lured the most sophisticated and knowledgeable experts and leaders on climate policy and transportation to the conference. This invitation-only, three-day event hosted 200 experts and leaders from five continents. This occurred with the global economy in disarray, automakers going bankrupt, and governments handing out IOUs for their steep debts.

Overview of the Book

Strategies for reducing GHG emissions from the transportation sector can be categorized into three clusters, sometimes referred to as the three legs of the transportation stool: improving the efficiency of the vehicles, reducing the carbon content in the fuel, and reducing vehicle use. The thirteen chapters that follow discuss the effects of energy use in transportation on global GHG emissions and suggest new policies to strengthen one or more legs of the transportation policy stool.

Regional Analyses Setting the Stage

The next three chapters examine climate change and transportation issues in specific regions of the world, and offer examples of innovative actions to reduce climate effects in these areas.

The first chapter is by Lew Fulton, Senior Transport Energy Analyst at the International Energy Agency (IEA) in Paris, France. He notes that transport accounts for about 19 percent of global energy use and 23 percent of energy-related CO_2 emissions. Given current trends, transport energy use and CO_2 emissions are projected to increase nearly 50 percent by 2030 and more than 80 percent by 2050. Without new climate policies, the IEA predicts CO_2 equivalent ($CO_{2\text{-eq}}$) emissions nearly doubling in its baseline scenario

forecast, with the mix of transportation fuels remaining fairly constant. The IEA high baseline scenario foresees an even greater 140 percent growth by 2050.

Either of these IEA baseline scenarios would be catastrophic for the global climate. To avoid the worst impacts from climate change, the United Nations Intergovernmental Panel on Climate Change (IPCC) advises that global CO_2 emissions be cut at least in half by 2050. To achieve this, transport will have to play a significant role. The IEA projects that a 70 percent reduction in transport $CO_{2\text{-eq}}$ emissions in 2050 is possible compared to the IEA baseline projection, though it would be highly challenging.

Fulton asserts that it will require both widespread adoption of today's best available technology and longer term development and deployment of a range of new technologies. All transport modes will need to reduce their emissions significantly compared to the baseline trends, in every region of the world.

John Conti, Director of the Office of Integrated Analysis and Forecasting at the U.S. Energy Information Administration (EIA), and his colleagues Nicholas Chase and John Maples note in their chapter that transportation emits more GHGs in the U.S. than the commercial, residential, and industrial end-use sectors. Transport-related GHG emissions more than tripled in the U.S. between 1950 and 2009, but they forecast a leveling off in the future.

The EIA projects U.S. GHG emissions from transportation will remain relatively flat between 2010 and 2030, though this leveling off is a far cry from the 80 percent reductions that may be needed in industrialized countries to counter climate changes. Total liquid fuel consumption in transportation is projected to grow from 164 billion gallons in 2000 to 196 billion gallons by 2030, but nearly all of the increase is forecast to come from biofuels, including ethanol and biodiesel, which generally have fewer net CO_2 emissions than gasoline or diesel refined from petroleum.

The authors report on their EIA analysis of a cap-and-trade program to reduce emissions. They conclude that such a program will produce relatively little reduction in GHG emissions from the transportation sector. This implies that, while transportation is a key to CO_2 emission reductions, a price on CO_2 will have little effect on transportation demand. They suggest four proposals that would be more effective: increasing vehicle fuel economy standards, using low carbon fuel alternatives, reducing passenger vehicle use, and switching from heavy truck freight to rail and marine freight.

Lee Schipper at the Center for Global Metropolitan Studies at the University of California, Berkeley and his colleagues Elizabeth Deakin and Carolyn McAndrews mov the geographical focus to Latin America. Their chapter presents some disquieting statistics on rapid increases in CO_2 emissions from transportation in the developing world. In Mexico, for example, the number of passenger vehicles more than doubled in one decade, from 8.3 million in 1996 to 21.5 million in 2006. This was an astounding 9.6 percent annual growth rate, with dire implications for climate change.

In comparison with the world as a whole, the CO_2 emissions in Latin America are more heavily concentrated in transportation, with 35 percent of its total emissions from transportation. These transport emissions are concentrated in road transport, accounting for over 90 percent of the region's transport emissions.

Latin American cities have pioneered one of the most important transportation innovations, Bus Rapid Transit (BRT), first in Curitiba, Brazil, but now in other large cities. Mexico City made a significant investment in dedicated bus lanes and BRT. BRT was devised and championed to reduce traffic congestion, but it has the additional benefit of reducing local air pollution, oil use, and GHG emissions.

New Transportation Policies

The next set of five chapters address new policy approaches to reduce GHG emissions. The first chapter, by Sonia Yeh and Daniel Sperling at University of California Davis, is an in-depth examination of the California low carbon fuel standard (LCFS) adopted by the California Air Resources Board in April 2009

and implemented statewide in January 2010. The LCFS is a performance standard, measured by total GHGs per unit of fuel energy, that aims to reduce the GHG intensities of transportation fuels. The goal is to account for all GHGs emitted in the lifecycle of transportation fuels, from extraction, cultivation, land use conversion, processing, distribution, and fuel use.

California's LCFS applies only to on-road transport fuels, excluding air and maritime transportation, where California has limited authority. The standard is imposed on all transport fuel providers, including refiners, blenders, producers, and importers. Each fuel supplier in California must meet a GHG-intensity standard that becomes increasingly stringent over time, ramping up to the 10 percent reduction in 2020. The LCFS allows for trading and banking of emission credits. An oil refiner could, for instance, buy credits from biofuel producers. Alternatively, it could buy credits from an electric utility that sells power for use in electric vehicles. Those companies that are most innovative and best able to produce low-cost, low-carbon alternative fuels would do best.

The LCFS policy is gaining momentum, with other states and Canadian provinces embracing the California LCFS model as of early 2010. The European Union is also implementing a carbon intensity standard for fuels that is similar to the California LCFS.

Automakers in the United States are committed to a low-carbon future, say Dave McCurdy and Kathryn Clay from the Automotive Manufacturers Association (AMA), the principal trade association for the U.S. auto industry. In their chapter, they note that transportation energy policy in the United States has been dominated by the CAFE standards for over 30 years. They describe the May 2009 landmark agreement between the automakers and President Obama that established a new fuel economy standard of 35.5 mpg for the U.S. motor vehicle fleet by 2016.

Policies directed at transportation sector emissions, such as the new national fuel economy program, are important, the AMA believes. At the same time, sector-based approaches cannot substitute for a more economically efficient, economy-wide program. The overall program should encompass the national economy as completely as possible, they argue, whether the approach is based on a cap-and-trade program or on other measures, such as a carbon tax. The approach should include market measures to the greatest extent possible. Using market mechanisms can provide the pull needed to incentivize the rapid deployment of advanced technologies. This national climate change strategy should clearly delineate appropriate roles for federal, state, and local governments. They note that current legislative efforts in the U.S. Congress reflect many, but not all, of these principles.

They further argue that sustainable mobility should be pursued along four pathways. The first involves development of new vehicle technologies. Second, new low-carbon fuels are needed to power these vehicles. Third, improvements to the national transportation infrastructure, including advanced roadway designs, are needed. Finally, consumers, who are ultimately responsible for the purchase and use of cars and fuels, need appropriate price signals and better information about vehicle and fuel choices.

The following chapter addresses the role of innovation in transforming the transportation and energy systems. Jack Johnston, recently retired from ExxonMobil Research & Engineering, and his co-authors at the U.S. Department of Energy, Chevron Energy Technology Company, and the United Kingdom Carbon Trust argue for a close coupling of science, technology, and policy. "One size fits all" approaches are not consistent with the diversity of demand and supply patterns already existing in developed economies and emerging in developing economies, they say in their chapter. It will be necessary to focus resources on the technologies and policies that achieve the largest emission reductions and to integrate these policies with economy-wide policies to reduce GHG emissions. In particular, it is essential that there be a close linkage between policies to electrify the transportation sector and policies to reduce GHG emissions from the power sector.

They explore examples of how government can encourage innovation, modify transportation demand, and change the character of mobility. Changes in existing policies and measures can also be crucial. Almost any

innovation that requires a significant change in fuel infrastructure, vehicle systems, or consumer behavior will need government support in the early stages because of the magnitude of the existing transportation systems and the relatively slow turnover of technology and evolution of practices.

John DeCicco at the University of Michigan School of Natural Resources and Environment believes vehicle performance standards related to GHG emissions are important because they directly target decision making in the auto market, which is an important determinant of total emissions. U.S. policymakers have decided that vehicle performance standards—based on either fuel economy or GHGs—are an essential tool in the climate policy mix. Neither form of vehicle standard, however, now includes a mechanism for formal coordination with economy-wide climate policy, says DeCicco. Reviewing the history of fuel economy standards and emissions standards for conventional air pollutants suggests that a legal linkage to well-defined environmental goals is important for ongoing progress toward those goals. Such an economy-wide policy could be a cap-and-trade system or other national program that provides well-defined targets and timetables for limiting GHG emissions.

DeCicco proposes to link the administration of vehicle standards to overarching GHG emissions goals by requiring agencies overseeing all elements of the transportation sector, including motor vehicles, to periodically assess the sector's progress in limiting GHG emissions. Agencies would then be obligated to update their policies as needed to ensure that the sector is effectively helping reduce GHG emissions in a manner consistent with the targets and timetable of the national cap. Such an approach places vehicle standards within the framework of an overall climate policy.

Mike McKeever of the Sacramento Area Council of Governments (SACOG) notes that new land use planning efforts are another critical component of future transportation policies to reduce climate impacts. He describes in his chapter how SACOG, representing the governing bodies of 22 cities and six counties in central California, has developed a regional land use plan that has become the model for a statewide smart growth law, SB 375. Known as the Blueprint, the Sacramento plan aims to reduce VMT from new growth by 10 to 30 percent per capita and GHG by 15 to 40 percent per capita.

The Blueprint calls for higher land use densities and more infill development. The reduced development area means less driving and fewer GHG emissions from transportation. In the base case scenario, in 2050 vehicle miles traveled per household increase by 12 percent, while in the Blueprint scenario, they decrease by 17 percent.

New Fuels and Advanced Vehicles

The last five chapters of this book examine the potential role for new fuels and vehicle technologies in combating climate change. Johannes-Joerg Rueger, Senior Vice President for Engineering at Robert Bosch LLC, one of the largest automotive suppliers in the world, addresses opportunities to reduce GHG emissions by improving today's gasoline and diesel engines. He notes that regulatory and industry attention has recently focused on zero emission vehicles, but all are in demonstration or pre-commercialization phases, and none are yet cost competitive with traditional gasoline and diesel vehicles. He focuses on the many enhancements to internal combustion engines that are possible, such as start/stop technologies, gasoline direct injection, and turbocharging. These technologies promise GHG reductions at relatively low costs. Additional hybridization offers even more significant CO_2 reduction potential.

The chapter by K.G. Duleep, Managing Director at ICF International, summarizes recent analyses of new developments in technologies to improve the fuel economy of LDVs, including cars and light trucks. Like Rueger of Bosch, he notes that while the popular press focuses much of its attention on advanced electric vehicles, manufacturer product plans show that improvements to the existing engine and drivetrain will continue to be the major focus of efforts over the next decade. Improvements to conventional technology can reduce GHG emissions by 33 percent in 2016 and by up to 50 percent in 2025.

Hybrid technology will provide even greater reductions, and plug-in electric vehicle technology even more, but it may be premature to judge these technologies. Over the next five to 10 years, understandings of

battery costs and durability will improve, allowing better vehicle design decisions. This could help create cost-effective plug-in hybrid and battery electric models as the next wave of technology improvements takes effect in the post-2025 period.

The focus shifts from LDVs to heavy duty vehicles in the chapter by Anthony Greszler, Vice President of Government and Industry Relations at Volvo Powertrain North America. He focuses on heavy trucks and buses, which account for 21 percent of U.S. transport petroleum consumption. Globally, these vehicles could well surpass light duty passenger vehicles to become the largest users of petroleum and emitters of CO_2 within the transport sector.

The energy efficiency of diesel engines improved approximately 10 percent from 1980 until 1999, but increasingly stringent nitrogen oxide emission requirements have slowed progress in efficiency. Nonetheless, the desire for GHG emission reductions through efficiency improvements is leading toward advancements in fuel injection, air induction, and combustion chamber design for diesel engines. More advanced combustion designs promise even greater reductions.

The chapter by James Winebrake of the Rochester Institute of Technology and his colleague James Corbett of the University of Delaware addresses the use of trucks and other modes to move goods. Winebrake and Corbett explore the potential for mode shifting, but find relatively small opportunities. They suggest that expected benefits from freight mode shifting are often overstated. They argue for a more holistic approach to efficiency improvements in the freight sector, noting that the freight industries are closely tied to economic activity, much more so than passenger transport.

Finally, Andrew Lutz and Jay Keller from Sandia National Laboratories in California argue in their chapter that the best transportation solutions may come from combinations of alternative fuels and advanced vehicle technologies. They focus on vehicle electrification and conduct an extensive analysis of the potential reductions from vehicle and electricity generation improvements. They conclude that incremental improvements to existing vehicle and generation technologies can barely offset continued growth in transport demand, and that the magnitude of the GHG emissions problem requires that research and development be directed toward technologies that both greatly improve end use efficiency and greatly reduce or eliminate carbon from fuels. Energy policy needs to be established today, they argue, to motivate the transition to net-zero carbon technologies.

References

U.S. Energy Information Administration (EIA). 2009. Emissions of Greenhouse Gases in the United States 2008. www.eia.doe.gov. Accessed January 25, 2010