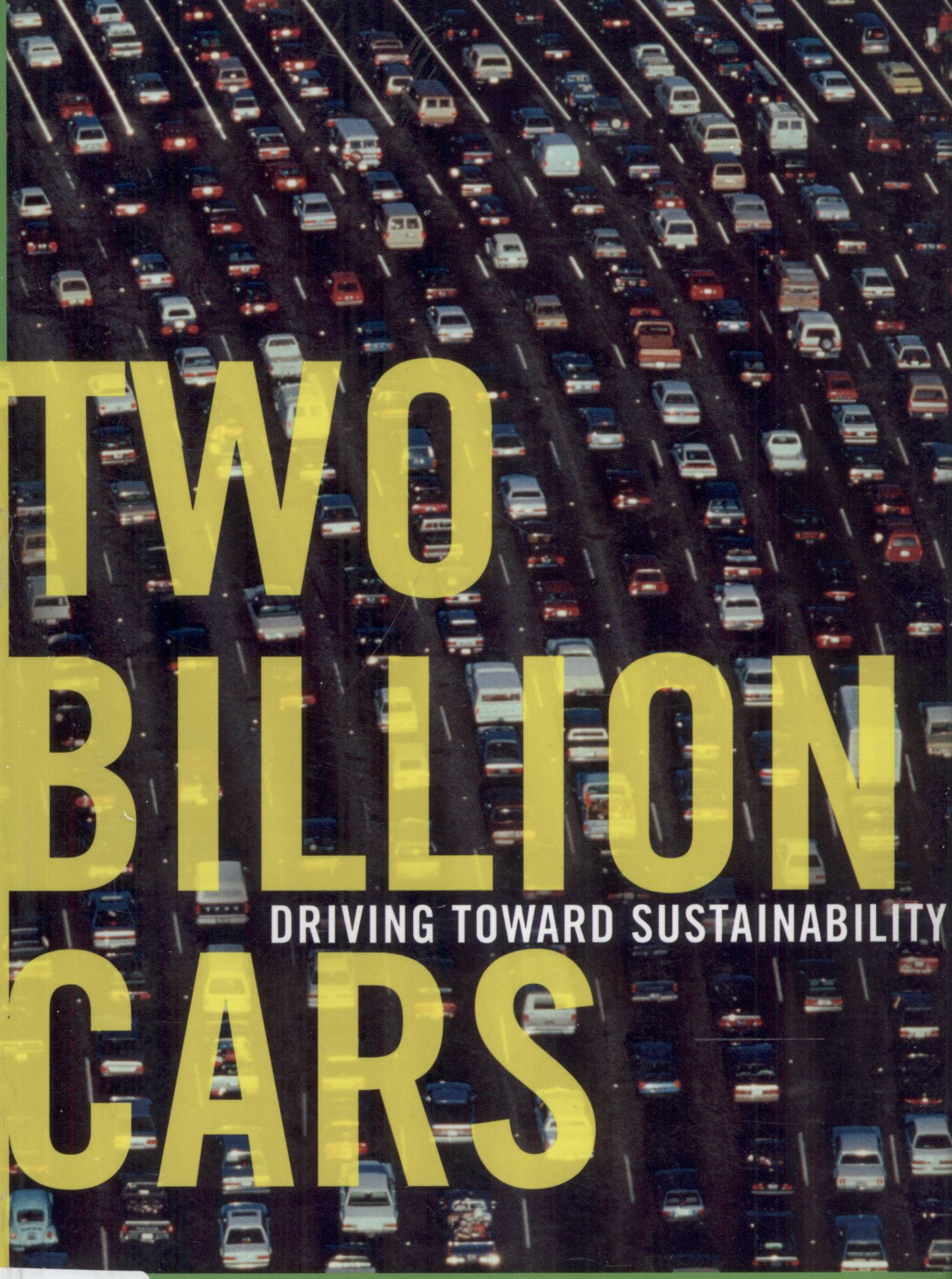

TWO BILLION CARS

DRIVING TOWARD SUSTAINABILITY

IEL SPERLING & DEBORAH GORDON

FOREWORD BY GOVERNOR ARNOLD SCHWARZENEGGER

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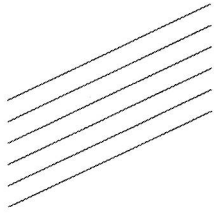

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Acclaim for *Two Billion Cars*

"This look at the global automobile industry explains how such a staggering number of autos came to be, and how we can sustain them all and the planet at the same time."
—*Publishers Weekly*

"This is an American story with international ramifications, and mandatory reading in the current economic crisis."
—Colleen Mondor, *Booklist*

"In this insightful and persuasive book, Sperling and Gordon highlight one of the biggest environmental challenges of this century: two billion cars. They rightly contend that we cannot avert the worst of global warming without making our cars cleaner and petroleum-free. Luckily the authors also offer a roadmap for navigating this problem that is both visionary and achievable."
—Frances Beinecke, President, Natural Resources Defense Council

"The future of mobility should concern every citizen and government official. We have to tackle this together, but we've not been good at it, except in crisis. Now is the time to move forward. *Two Billion Cars* provides inspiration and a compelling pathway."
—John D. Hofmeister, Former President, Shell Oil Company, and Founder and CEO, Citizens for Affordable Energy

"The authors make a compelling and urgent fact-based case that we must quickly expand the universe of affordable, low-impact transportation options if we are to survive the doubling of the world's cars. They show how a combination of leadership, smart policy, the unleashing of a can-do technological revolution, and carefully understanding consumer motivations will save the day. It's a must-read for anyone eager to be part of the solution."
—Kevin Knobloch, President, Union of Concerned Scientists

"Provocative and pleasurable, far-seeing and refreshing, fact-based and yet a page-turner, global in scope but rooted in real places. The authors make a convincing case that smart consumers driving smart electric-drive cars can find the critical path to a safer planet."
—Robert Socolow, Princeton University

"This book provides with considerable objectivity and foresight an analysis of the unsustainable pattern of transportation that human society has become accustomed—indeed addicted—to. In very simple terms the authors deal with the profound issues arising from the growing human desire for locomotion and mobility."
—R. K. Pachauri, Chairman, Intergovernmental Panel on Climate Change

Foreword

The world is speeding toward two billion vehicles, and there can be no denying that cars and trucks are integral to our lifestyle and our economy. Cars provide mobility and personal freedom while trucks carry the goods that keep our economy humming. But all these vehicles and our near-total dependence on gasoline to fuel them contribute to global warming, deplete our natural resources, and undermine our national security.

America must commit itself to ending its dependence on costly, polluting oil and other fuels with high greenhouse gas emissions. Government must work with businesses and consumers to transform the transportation sector. Our collective future depends on it.

In *Two Billion Cars,* Daniel Sperling and Deborah Gordon explain why more isn't being done to achieve the crucial goal of ending our dependence on oil. They show how shortsighted politicians in Washington, unimaginative automobile executives in Detroit, and dysfunctional oil markets have all but paralyzed innovation and bold policy steps.

They paint a sobering picture of the challenge that confronts us, but there is also good news and cause for hope in these pages. In fact, *Two Billion Cars* is a refreshingly optimistic book that spells out what is possible when we all work together—local, state, national, and international governments; business and industry; consumers and citizens; and experts like the two authors of this book.

As governor of California, I'm proud of the role our state has played and will continue to play in leading America to the kind of smart and healthy

future we all want. The landmark global warming bill I signed in 2006 and our follow-up low-carbon fuel standard are now models for other states and nations, and I have no doubt that Washington is about to get on board in a very big way. This accessible and highly readable book explains how enlightened leadership, smart technology, and savvy consumer choices can provide a viable escape route for a planet that will surely be doomed unless we heed this call to action.

Ever since I took office in 2003, I have stressed repeatedly that we no longer have to get bogged down in the false old choice of what's more important to protect: our environment or our economy. California's leadership on using a combination of traditional approaches along with market-based mechanisms to attack global warming and limit our dependence on high-carbon fuels is proving to the rest of the nation and the world that we can in fact protect both.

Capitalism, long the alleged enemy of the environment, is today giving new life to the environmental movement. In fact, as Sperling and Gordon demonstrate, the environmental cause would be unwinnable without competition and the technological progress it spurs. Our clean-tech policies in California are attracting billions of dollars in venture capital and new investment, a phenomenon the *Wall Street Journal* has called California's New Gold Rush. Sound environmental policy doesn't have to hamper the economy; it can help it to soar.

Two Billion Cars is an urgent wake-up call, and like the policies we have advanced in California, it's not just a wake-up call for the United States. The authors have laid out a blueprint the entire world can use to dedicate itself to attacking global warming by implementing sustainable energy and transportation policies before it's too late. With this book and other groundbreaking work, the authors are providing the science and the road map that elected officials, industry, and the public need to make it happen.

When I signed an executive order in January 2007 to establish the world's first low-carbon fuel standard, mentioned above, I immediately called on Daniel Sperling to help us draft the scientific protocols needed to bring this historic policy to fruition.

So I know firsthand that in a state rich with innovators and visionaries, Professor Sperling stands out as one of the world's most farsighted and admired thinkers on transportation policy, energy, and the dire implications of being overly dependent on oil to move people and goods. Deborah Gordon has also been an innovator and leader, dating back to her days at Chevron reducing air emissions at their oil facilities, to developing novel vehicle incentive programs as a graduate student at the University of

California at Berkeley, and finally bringing the Union of Concerned Scientists to California to work on groundbreaking zero-emission vehicle and other innovative transportation strategies.

Every bit of evidence we can present to the public that shows how economic growth, technological innovation, and environmental protection reinforce one another moves us closer to the kind of sustainable future we all want and deserve. I for one greatly appreciate the work Daniel Sperling and Deborah Gordon have done to help us get there.

Arnold Schwarzenegger,
Governor of California

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And, finally, we must thank those of you who are reading our book. For you—as citizens, voters, consumers, commuters, shareholders, policymakers, educators, entrepreneurs, investors, and innovators—will help us survive two billion cars.

Contents

Chapter 1

Surviving Two Billion Cars

More than one billion vehicles populate the earth today. The globe is accelerating toward a second billion, with South and East Asia leading the way and Russia, Eastern Europe, and South America following along. More vehicles mean more vehicle use. And unless vehicle technology and fuels change, more vehicle use means more oil burned and more pollution.

Can the planet sustain two billion cars? Not as we now know them.[1] Today's one billion vehicles are already pumping extraordinary quantities of greenhouse gases into the atmosphere, draining the world's conventional petroleum supplies, inciting political skirmishes over oil, and overwhelming the roads of today's cities. Billions of hours are wasted stuck in traffic, and billions of people are sickened by pollution from cars. From Paris to Fresno, and Delhi to Shanghai, conventional motorization, conventional vehicles, and conventional fuels are choking cities, literally and figuratively. Cars are arguably one of the greatest man-made threats to human society.

Yet cars aren't going to go away. The desire for personal vehicles is powerful and pervasive. Cars offer unprecedented freedom, flexibility, convenience, and comfort, unmatched by bicycles or today's mass transit. Cars bestow untold benefits on those fortunate enough to own them. They have transformed modern life and are one of the great industrial success stories of the twentieth century.

What, then, should be done about the soaring vehicle population? Radical changes are called for. Vehicles need to change, as do the energy and

transportation systems in which they're embedded. Even according to the most conservative scenarios, dramatic reductions in oil use and carbon emissions will be needed within a few decades to avoid serious economic and climatic damage.

Automakers, backed by policymakers, must develop and sell far more energy-efficient vehicles. Oil companies must become energy companies, wean themselves off petroleum, and resist the temptation of pursuing high-carbon fossil fuel alternatives. Consumers must purchase fuel-efficient vehicles and embrace low-carbon fuels as they enter the market. And governments and entrepreneurs, together with travelers, must nick away at the transportation monoculture by creating new mobility options supported by sustainable development.

Is this possible or likely? Not if the world remains in denial about the dire impacts cars have on humans, society, the earth's climate, and world geopolitics. George W. Bush can talk about oil addiction, and Al Gore and the Intergovernmental Panel on Climate Change can win the Nobel Peace Prize for bringing attention to climate change. But the reality is that the world continues to barrel forward on an unsustainable transportation path.

Global oil markets are dysfunctional and global carbon markets are still largely absent. Even with record profits and high oil prices, oil companies aren't making it a priority to invest in low-carbon alternative fuels and are instead pouring billions into stock buybacks and new forms of high-carbon fossil fuels. Meanwhile, most consumers continue to drive their gas-guzzling vehicles even in the face of high fuel prices. And car companies cling to internal combustion engines and reject policies to significantly improve fuel economy and reduce carbon emissions. The net effect has been decades of paralysis over energy and climate policy. Over and over, the public interest has been overwhelmed by regional and special interests and the private desires of consumers. In the United States, a transportation monoculture has taken root that's resistant to innovation. The rest of the world follows close behind.

When two billion cars inhabit the earth, where will the fuel come from? Will tensions over oil erupt into still more wars? Will the dumping of ever more carbon dioxide emissions into the atmosphere accelerate climate change, causing hardship around the globe? And will there be enough roads to handle all those vehicles? The risk of disaster is unacceptably high. What can and should be done?

This book is a call to action. Entrepreneurs, engineers, policymakers, and the public must work together to reinvent vehicles, fuels, and mobility. The

first step is to move beyond the simple explanations and simple solutions that pundits and politicians glory in. The more sophisticated among them have a good sense of the problems, but few have more than a vague idea of what will really work. The chapters that follow dissect global transportation and energy ills and suggest sound and sensible strategies for addressing them.

Transportation Trends: Headed in the Wrong Direction

We need to admit that current global transportation trends aren't sustainable and that today's transportation system, particularly in America, is highly inefficient and expensive. Despite much rhetoric about energy independence and climate stabilization, the fact is that vehicle sales, oil consumption, and carbon dioxide emissions are continuing to soar globally. One-fourth of all the oil consumed by humans in our entire history will be consumed from 2000 to 2010. And if the world continues on its current path, it will consume as much oil in the next several decades as it has throughout its entire history to date (see figure 1.1). The increasing consumption of oil, and the carbon dioxide emissions resulting from it, are the direct result of dramatic growth in oil-burning motor vehicles worldwide. Barring dramatic events such as wars, economic depressions, or newfound political leadership, these trends will continue.

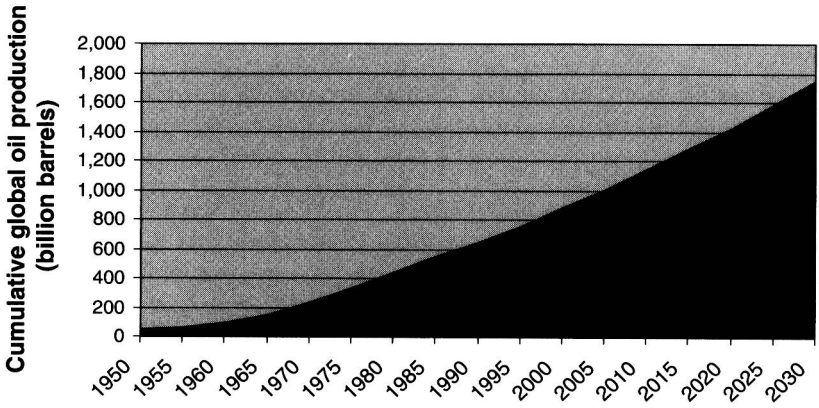

FIGURE 1.1 Cumulative global oil production, 1950–2030. *Sources*: U.S. Department of Energy, Energy Information Administration, *International Energy Outlook 2006*, DOE/EIA-0484 (Washington, DC: U.S. Department of Energy, 2006) and *International Energy Outlook 2007*, DOE/EIA-0484 (Washington, DC: U.S. Department of Energy, 2007), www.eia.doe.gov/oiaf/ieo/index.html.

America pioneered the motorization of human society and leads the world in auto ownership today, with more than one auto for every licensed driver. Other nations are following its lead. Auto ownership (and use) is on the rise everywhere. The desire for cars is profound; while it can be slowed, it probably can't be stopped. The estimated 85 percent of the world's population still without cars is crying out for the same mobile lifestyle that Americans have. An A. C. Nielsen poll conducted in 2004 found that more than 60 percent of residents in each of the seven fastest-growing nations, including China and India, aspire to own a car.[2]

As global wealth grows, especially among the 2.4 billion citizens of China and India, so too will personal motorization. Automakers are increasingly focusing their efforts on emerging markets, with their phenomenal growth. Our projection, with input from a cadre of other experts, is that the number of motorized vehicles around the globe—cars, trucks, buses, scooters, motorcycles, and electric bikes—will increase on the order of 3 percent annually. By 2020, more than two billion vehicles will populate earth, at least half of them cars (see figure 1.2). The slowest car growth is expected in the United States (less than 1 percent a year) and Western Europe (1 to 2 percent), while China's and India's fleets are expected to grow more rapidly, at around 7 or 8 percent per year.[3] Growth in vehicle use continues despite the fact that China, India, and many other countries don't possess oil supplies to fuel their expanding vehicle fleets. Can countries peacefully coexist as they compete for increasingly scarce petroleum resources?

The implications for climate change are just as disconcerting. Greenhouse gas emissions continue to increase, even as scientific and political consensus has emerged that these emissions must be cut by 50 to 80 percent by 2050 if the climate is to be stabilized. Until 2007, the United States was the largest emitter of greenhouse gases. Now China is number one. Transportation is a big part of the problem. Globally, transportation produces about a fourth of all emissions of carbon dioxide (CO_2), the primary greenhouse gas.[4] Transport-related CO_2 emissions have more than doubled since 1970, increasing faster than in any other sector. In the United States, transportation's share is a third of CO_2 emissions. Clearly, greenhouse gas emissions targets aren't going to be met without a dramatic reduction in transportation CO_2 emissions.

Beyond their huge oil appetites and carbon footprints, cars cause other problems, only some of which have been effectively addressed thus far. Local

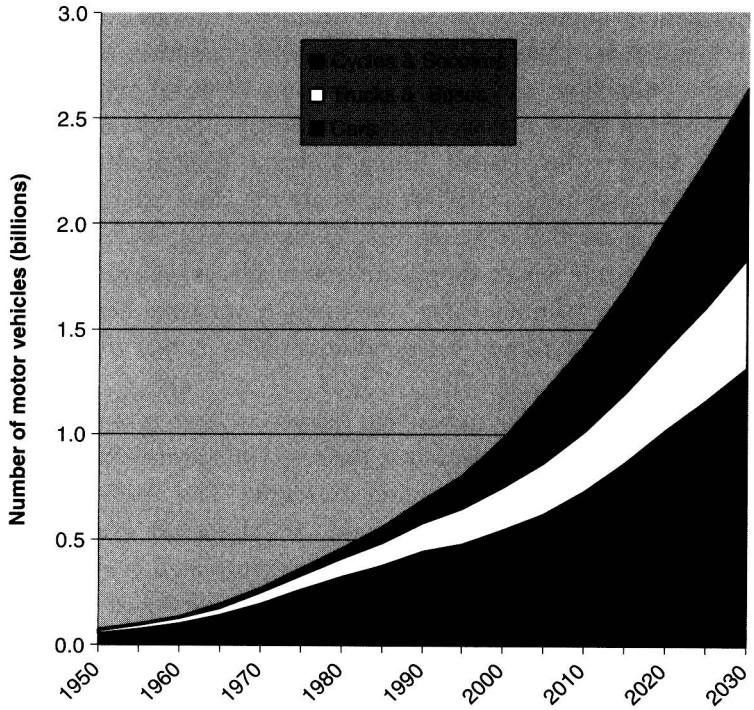

FIGURE 1.2 Historical and projected increases in global motor vehicle population, 1950–2030. *Sources*: U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, *Transportation Energy Data Book: Edition 26* (2007); U.S. Department of Energy, Energy Information Administration, *International Energy Outlook 2007*, DOE/EIA-0484 (Washington, DC: U.S. Department of Energy, 2007; Japan Automobile Manufacturers Association, *The Motor Industry of Japan*, (Tokyo, Japan: JAMA, 2007); Michael P. Walsh, "Ancillary Benefits for Climate Change Mitigation and Air Pollution Control in the World's Motor Vehicle Fleets," *Annual Review of Public Health* 29 (2008): 1–9; authors' estimates. For additional background calculations on the car and truck portion of future vehicle projections, see Joyce Dargay, Dermot Gately, and Martin Sommer, "Vehicle Ownership and Income Growth, Worldwide: 1960–2030," *Energy Journal* 28 (2007): 163–190.

air pollution, commonly known as smog, is one issue that policymakers and engineers have focused on with considerable success in certain nations. Policymakers have ratcheted down tailpipe standards over time, and engineers have responded with continuing improvements in emissions control technology. New cars emit nearly zero conventional (local) pollutants.

But this shining success is neither complete nor uniform. While the United States and Japan have led the fight against local air pollution, others

have lagged, including Europe. In part because of Europe's embrace of diesel engines and more lenient regulation of diesel emissions, the Parthenon in Athens is crumbling from chemical reactants of diesel exhaust and Milan suffers some of the worst air pollution in Europe. But even far worse smog envelops Mexico City, Cairo, Beijing, Kolkata (Calcutta), and many other cities in the developing world. Vehicles are the chief culprits almost everywhere. Even in the United States, despite tremendous resolve and many successes, air pollution hasn't disappeared. Some places such as California's Los Angeles and San Joaquin Valley areas may never have healthy air, due to temperature inversions and surrounding mountains that trap the pollution for days at a time.

The success story isn't complete for yet another reason. Older, more-polluting vehicles can remain in use for a very long time, and emission control systems on vehicles deteriorate over time. The problem is far worse in developing countries, where emission standards are even more lenient, enforcement is lax, and vehicles are often not regulated at all.

While local air pollution is on its way to being solved in most affluent cities and soon in developing countries, there's another car problem that's not being solved. Proliferating cars inevitably cause traffic congestion. Some congestion is desirable—if congestion were absent, it would indicate a depressed economy, a somnolent society, or overinvestment in infrastructure. But by any measure, congestion levels are so severe in most large cities of the world that they seriously harm economic and social activity. The culprit is the auto-centric transport system pioneered by the United States. It's inefficient and costly—and becoming more so.

Despite the existence of innovative alternatives here and there—such as carsharing pioneered in Switzerland, telecommuting and carpooling in the United States, and bus rapid transit in Curitiba, Brazil—the spreading hegemony of cars and the withering away of alternatives has resulted in a transportation monoculture. In a spiraling feedback loop, most growth in the United States and increasingly elsewhere is now in low-density suburbs served almost exclusively by cars. As suburbs grow, they become too dense for cars and not dense enough for conventional mass transit. Cities like Los Angeles, Houston, and Phoenix that developed together with autos are essentially masses of suburbs with a sprinkling of small commercial districts; they aren't easily served by conventional bus and rail transit services with their fixed routes and schedules and will have a hard time shifting their citizens out of cars.