

Critical Crossroad:

Advancing Global Opportunities to Transform Transportation

By Deborah Gordon and Daniel Sperling



Emerging countries, like China and India, face a critical crossroad. These countries can follow developed, auto-dependent nations down an unsustainable path or transform transportation to encourage environmentally and economically sound choices. Innovative industries and conscious consumers—guided by prudent government policies—hold the key to future global mobility.

The world is rapidly motorizing. At the start of the twenty-first century, some one billion vehicles occupied the roads. But this number will likely double in the next decade. By mid-century the Earth could be home to billions more cars, trucks, and motorized two-wheelers, which will collectively have profound effects on global oil demands, energy security, climate stability, and urban mobility. (See Figure 1)

We are at a critical crossroad. The global proliferation of vehicles presents many risks and opportunities. One *seemingly* easy way forward is to adopt last-century approaches that seek to

accommodate the high demand for vehicles through cheap oil, free roads, sprawled development, and subsidized home ownership. A preferred alternative course beckons, however, one that promises new, low-carbon, location-efficient, economically productive mobility. Government, industry, and consumers—especially in emerging economies—can reinvent transportation models and employ innovative solutions to avoid a foreboding car monoculture.

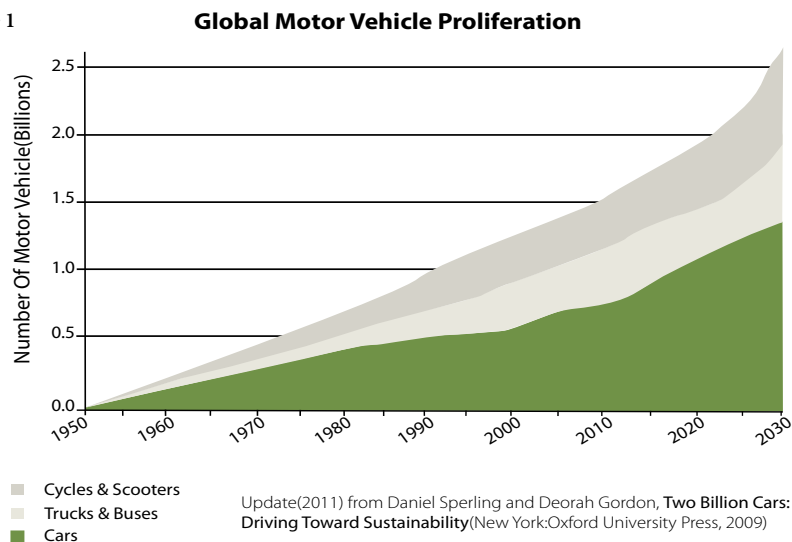
The allure of the car monoculture

The desire for personal vehicles is powerful and pervasive. Cars bestow untold

benefits on those fortunate enough to own them, despite their many social costs. No matter how much they guzzle, pollute, maim, or congest, cars aren't going to go away. As global wealth grows, especially among the 2.5 billion citizens of China and India, so too will personal motorization.

Income is a very powerful force for auto ownership. Nowhere is this more evident than in the United States. With more than one vehicle for every licensed driver—about 1.15 at last count—virtually every American adult who wants a vehicle has one. Most lives are built around 24/7 access to cars. American consumer desires have shaped today's car culture. During the past hundred years, U.S. automakers, the oil industry, and lawmakers all have worked to keep consumers happy and motoring. They've been successful, perhaps too successful.

Figure 1



Emerging nations are following down the same path. Over the past decade, China, India, and Indonesia have each experienced double-digit annual growth in motor vehicles. Even Eastern Europe, South America, and Africa are motorizing at 5-7% a year.

Just ten years ago, virtually no one anticipated phenomenal growth rates in global motorization. In China, for example, the number of cars grew by a factor of 20 between 2000 and 2010. Last year, China zoomed to first place in world car sales, positioning itself to surpass the 250 million vehicles on America's roads. While government officials are presently contemplating whether Chinese automakers should shift their focus from sheer volume to advanced technology for export, it will be hard to contain red-hot growth absent systematic policies and strategic investments. As its economy rebounds and if China's desire to curb vehicle sales waivers, by 2030, upwards of 600 million vehicles could fill China's roads.

Growth in global auto ownership is expected to continue as the developing world gains affluence. Once a nation's annual per capita gross domestic product exceeds about U.S. \$2,000, motorcycle ownership becomes common; over U.S. \$4,000, burgeoning car ownership follows. Rapid motorization encourages land use sprawl in a spiral that feeds on itself. Virtually every city in the world

is becoming less dense. Lower density tends to lock in auto dependence and stymie investments in rail and other mobility alternatives. These motorization trends are overwhelming cities in emerging nations.

As global vehicle markets spread from developed to emerging nations, innovation and leadership—both in technology and policy—will also need to shift. The world needs to move away from a brittle, unreliable, wasteful transportation system to a more sustainable, diverse approach that mimics natural ecosystems in its redundancy, reliability, robustness, resilience, and resistance to external shocks.

The pressing questions moving forward are: Which prudent policies and investments can best balance sustainability and mounting mobility demands? How can industry best shrink vehicles' environmental footprints? What are successful initiatives and models to transform transportation, and who is leading them?

The costs of motorization

Dependence on conventional motorization presents daunting challenges that cause a host of energy, environmental, economic, and social problems.

One great concern for China, India, the EU, United States, and other countries with limited conventional oil supplies, is how to feed the voracious de-

mand of their expanding vehicle fleets. With oil supplies increasingly strained and prices highly volatile, the risks of oil dependence are troublesome.

The specter of dwindling conventional oil supplies is leading to new quandaries. Renewed interest in ultra-deep and heavy oils, oil sands, shale oil, and shale gas brings new environmental problems to the fore. These *unconventional* fossil fuels require more energy to extract and process (resulting in higher carbon emissions), require huge amounts of water, and can devastate local habitats and obliterate landscapes. Major oil companies, no matter how much they say they want to find more environmentally sustainable, renewable sources of energy, continue to invest mostly in the search for dirtier fossil fuels.

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Air pollution is another serious problem. Improvements are slowly being made but auto tailpipe emissions still present numerous risks, especially in emerging countries. While new cars produce much less local air pollution almost everywhere in the world, old diesel trucks, unregulated motorized two-wheelers, and poor fuel quality all contribute to smoggy skies, morbidity and mortality, reduced crop yields and building decay. Air pollutants from cars and trucks also cause short-term climate forcing, due to carbon monoxide, black carbon, and ozone precursors—along with carbon dioxide—building up in the atmosphere and contributing to climate change.

The proliferation of cars collides with cities. With some 30 megacities expected by 2025—each with populations over 10 million—and 70% of humanity

living in megacities by 2050, rapid urban motorization will result if left unchecked. More vehicles drive the construction of more roads, and more roads bring more vehicles. This spiraling motorization process results not only in unhealthy, inefficient, unsustainable cities, but also crushing financial burdens to build more roads. Intervention is called for. Vast sums can either be spent to further increase dependence on motor vehicles or to spur alternative mobility options.

The challenges of motorization will play out differently in different places. But once designed into citizens' lives and livelihoods, mobility patterns will be locked in and easily reversed. The next generation of automobiles, trucks, and two-wheelers—along with planes, trains, and buses—must leave a much smaller societal impact. Policymakers, businesses, and citizens around the globe must aspire to find new ways of providing more sustainable mobility, guiding the way forward.

A new systematic approach

As the world zooms down the road to two billion cars, innovative strategies will be needed to transform vehicles, fuels, and mobility. Fortunately, good ideas underpinning transformational change exist. Once incentives are better-aligned and innovative mobility choices surface, a new vision should be more attractive than investments in an inefficient car monoculture. Exiting this road requires the direct involvement of business, government, and consumers.

Governments must adopt regulatory and fiscal policies at the local and national level that redirect investments and behavior toward sustainability. Transportation funding must be realigned to favor low-carbon mobility services and low-impact infrastructure. The array of rules and standards need to continue to evolve, along with the tax code, to reward energy efficiency, decarbonization, and less sprawl. Fuel efficiency and fuel quality standards are needed to continually push vehicle innovations toward increasingly stringent low-carbon goals. Carbon pricing, home mortgage deductions, sales taxes, and vehicle fees and rebates (*feebates*) should be tied to environmental impacts.

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Consumer choice plays an important role in transforming transportation. The price of fuels, vehicles, parking, and roads affects purchasing and driving decisions. Environmentally-indexed price signals make consumers aware of their societal footprints and can influence more socially-benign behaviors. Manufacturers, in turn, must respond or risk market loss. Moreover, as travelers, voters, and shareholders, consumers can influence government policy and industry investments.

Automakers and fuel providers need to evolve. Automakers, backed by policymakers, must continue to develop and sell low-carbon, fuel-efficient vehicles, and broaden their focus to become mobility companies. Oil companies must become energy companies, wean themselves off petroleum, and resist the temptation to invest immense sums in unconventional oil that locks us into a higher carbon future.

It will take a new approach to avoid a global car and oil monoculture. Three changes are needed—transform vehicles, transform fuels, and transform mobility. Consumers, government, and industry will share the responsibility moving forward.

Vehicle choices

Vehicles must become more civilized. From an energy and climate perspective this entails greatly improving the fuel efficiency (and reducing the carbon emissions) of conventional vehicles through use of lightweight materials and more efficient engines and transmissions. These innovations are beginning to take root, directed by strong vehicle efficiency and carbon standards in the EU, Japan, United States, and China. Even the United States, which has been a laggard on vehicle efficiency, is now greatly strengthening its standards. In July 2011 President Obama, the auto industry, and California reached an agreement to enact regulatory reductions of nearly 5% per year through 2025.

The next vehicle transformation is to replace combustion engines with electric motors, batteries, and fuel cells to further improve efficiency using low-carbon energy. This shift to electric-drive vehicles is underway, starting with gasoline-electric hybrid vehicles and evolving through plug-in hybrids, battery electric vehicles, and fuel cell electric vehicles.

Here, China is at the forefront. China's battery-powered bicycles, scooters, and motorcycles are the first and most successful mass-marketed battery powered electric vehicles in the world. Annual sales of electric two wheelers in China grew from 40,000 in 1998 to over 20 million in 2011. E-bike ownership reached about 140 million by 2010. This move to electrified transport is unique to China, with the government supporting broader electrification across cars and buses. Still, it remains to be seen whether China will retain its strong mandates for electric vehicles and prove to be an international leader in developing and commercializing electric vehicle technology.

At the same time, greater use of communication and control technologies are needed to make the use of all types of new vehicles more efficient. Developed in partnership with Shanghai Automotive Industry Corporation (SAIC), General Motor's new urban concept car, the EN-V (or "electric networked vehicle"), provides such a glimpse of the vehicle's future. Today's cars are already akin to computers on wheels. So it should not be a surprise that an all-electric, GPS-guided autonomous vehicle was unveiled at the 2011 Consumer Electronics Show. Smart-grid compatible, this strong, lightweight,

carbon fiber, 1.5 meter by 1.5 meter, dual-passenger vehicle is designed to relieve congestion in cities and decarbonize the environment. These concept vehicles show promise for megacities around the world.

Fuel choices

Beyond vehicle transformations, the commercialization of *low-carbon* alternative fuels encompasses a second set of strategies. It is important to distinguish between those alternative fuels that are low-carbon and those that are not. Biofuels, hydrogen, and electricity can have widely varying carbon footprints, depending upon how they are produced. For instance, biofuels could be produced in less sustainable ways by razing rainforests or growing crops with high-energy inputs. Conversely, biofuels can be produced from agricultural, forestry and urban wastes, with dramatically fewer emissions, a much smaller environmental footprint, and no impact on food markets.

The challenge is to create a durable policy context, using low carbon fuel standards and other incentives, that encourages businesses to invest in low-impact fuels. At present, electricity is the *fuel du jour*, but the fuel future remains uncertain. That is why flexible performance and market-based policies are needed to guide direct investments toward reduced greenhouse emissions and environmental impacts. A more secure future clearly lies with electric-drive vehicles fueled with low-carbon electricity and/or hydrogen, complemented with low-carbon biofuels. The challenge of overcoming startup barriers and costs are daunting, resulting in slow progress.

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Mobility choices

Strategies aimed at moderating vehicle use have proven to be the most challenging and least successful. For rich developed nations, where vehicles are already ubiquitous, it is important to reduce vehicle use by replacing single-occupant vehicles with a wide array of appealing lower-carbon mobility options. For emerging nations, reimagining car use is even more critical as they enter a period of rapid motorization. The challenge is to enhance access and increase productivity in a less resource-intensive manner. Given low current vehicle penetration, emerging nations have the option to craft entirely different transportation and land use models. But time is running out.

Today's public policy and infrastructure investments will determine mobility options in the years ahead. Transportation infrastructure investments should be prioritized based on

long-term societal benefits through green banks, low-carbon public-private partnerships, and carbon pricing mechanisms. Public transparency, sound planning, accounting for externalities, and careful implementation are important guideposts.

The situation in China highlights these priorities. China has increased highway capacity tenfold over the past decade and is expected to surpass the United States with the world's most extensive high-speed intercity highway system by 2012. Such immense investment in auto infrastructure casts a shadow on the prospects of transforming mobility.

Beyond infrastructure, policy matters: Consider Shanghai and Beijing. Beijing has rapidly expanded its road network, building a series of ring roads that encourage decentralization beyond the city center and increasing suburban growth. Shanghai more tightly controls land use, has adopted a mixed-use development model, and limits car ownership through an auction for vehicle registrations. Despite their roughly equivalent population, income, and culture, Shanghai now has only one-third as many vehicles per capita as Beijing. Chinese officials are considering extending similar restrictions on vehicle ownership to other cities.

Building a sustainable transportation future

Transportation must be redesigned as a system and not bound to a single mode. Embracing a broad array of options will put us on a new path toward sustainability. Cutting-edge cities are leading the way on a number of fronts, using strategic policy tools to advance low-carbon mobility.

Bus rapid transit (BRT) is bringing appeal back to one of the most affordable mobility options. These grade-separated mass transit vehicles offer high levels of service at a lower cost than rail. Guangzhou, Ahmedabad, Johannesburg, and Bogota are testament to viable BRT services in China, India, Africa, and Latin America. The availability of high-quality BRT service (and rail transit where it exists) encourages middle class travelers to defer car purchases and slow the trend toward sprawled land use.

Beyond transit, there is much to be done. Parking policy has long been targeted as an important urban mobility strategy. Car-oriented parking policies define much of the United States, but alternatives abound elsewhere. Zurich caps city center parking supplies and charges higher hourly rates for each hour to reduce daily parking demands and land use devoted to parking. Antwerp has removed neighborhood parking and replaced it with trees and furniture to create more livable environments. The London Borough of Richmond-Upon-Thames charges for parking based on vehicle carbon dioxide emission levels, assessed at the time of vehicle registration. Copenhagen has reclaimed public space from traffic and parking and now boasts one of the longest pedestrian corridors in the world.

Even in the U.S., a rethinking of car dependence has begun. New York City is in the throes of rekindling its car-free days. Times Square has been closed to traffic, bike lanes are increasing in number and use, and rapid bus transit—with off board



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fare collection and bus-only lanes—is being implemented. Pricing travel into Manhattan is again under consideration; this policy would provide funds for transit and other mobility options while reducing the city’s payroll tax.

Bicycles are yet another promising mobility alternative. China has the largest bike share systems in the world. Hangzhou leads the way with some 50,000 bikes in a city of almost 7 million people (about 1.5 million people fewer than New York City). With over 2,000 bikeshare stations spaced less than ¼ mile apart, cyclists make 240,000 trips on an average day. Hangzhou is adding electric bicycles to its program.

What all of these cities have in common is a plethora of mobility options with far less dependence on cars. While challenging to enact, these examples highlight the reach of strong policies and strategic low-carbon investments.

Beyond low-carbon infrastructure investments, information technology and social networking will also play an increasingly important part in expanding mobility choices. Facebook, smartphones, and direct-demand TV didn’t exist in the last century and yet are now central to the lives of many around the globe. Social networking and globalization are connecting people like never before and creating new forms of virtual mobility. Perhaps this is the next generation of transportation—*being there without getting there*.

Still, there will always be a need for travel. Information technology can be used to create high-quality, low-impact work environments and services, such as demand-responsive vans that operate flexibly, picking up travelers en-route. Other information-based services could facilitate carpooling by using cellphone apps to link neighbors, coworkers, and even strangers traveling to the same locations. The goal is to pro-

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vide high-value, clean mobility and elevate its use over that of expensive, resource-consumptive travel.

For all nations and cities, navigating the critical crossroad is a matter of vision, policy, and execution. Wealthier, developed nations with extensive road infrastructure already in place, must focus on improving vehicle technology and fuels while taking advantage of opportunities to reduce personal motor vehicle use through economic incentives and improved connectivity. In China, India, and other emerging nations, opportunities abound for providing greater mobility at less cost and less waste. These countries are at an opportune moment in their development to transform transportation with a novel mix of technology, policy, and behavior choices.

Global motorization is inevitable. But its advance must be slowed, its path reconfigured, and its societal footprint shrunk.

*This article is based on Sperling and Gordon, *Two Billion Cars: Driving Toward Sustainability* (Oxford University Press: 2010)*

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