# Getting California on Track

## Seven Strategies to Reduce Global Warming Pollution from Transportation

ENVIRONMENT CALIFORNIA
RESEARCH & POLICY CENTER



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# Executive Summary

California has much to lose from global warming. Declining mountain snowpack that threatens our water supplies, increasing danger from wildfires, sea-level rise that jeopardizes our coastal communities, and changes in plant and animal communities are just a few of the many impacts that global warming will have on California if we don't act swiftly to reduce our emissions of global warming pollution.

California has earned a reputation as a national and global leader in the fight to prevent the worst impacts of global warming. Yet, if California is to succeed in its efforts to reduce global warming pollution, it must significantly reduce emissions of global warming pollution from transportation.

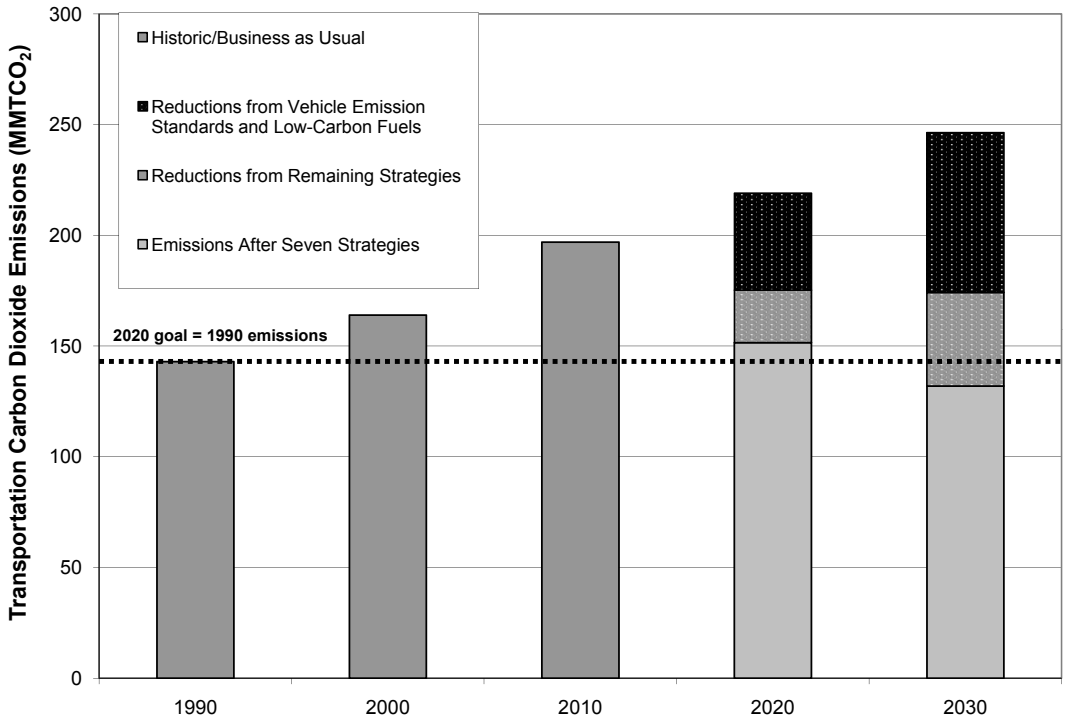
Transportation is the largest source of global warming pollution in California—responsible for 38 percent of our annual emissions. If recent trends continue, carbon dioxide emissions from transportation are expected to grow by 23 percent above 2004 levels by 2020—increases that could derail the state's cutting-edge efforts to address global warming.

There are many tools California can use to reduce global warming pollution from transportation. The state has begun to wield some of these tools, but stronger action is needed.

**By aggressively implementing seven strategies to reduce growth in vehicle travel, improve energy efficiency, and promote the use of lower-carbon fuels, California can reduce emissions of carbon dioxide from transportation by 14 percent below 2004 levels by 2020—a 31 percent reduction below business as usual—and by 25 percent below 2004 levels by 2030—a 46 percent reduction below business as usual.**

Emission reductions of this magnitude will play an important role in helping California achieve its economy-wide targets for reducing global warming pollution. But they are unlikely to be enough—California policy-makers will need to consider additional strategies to reduce the impacts of the state's transportation system on the global climate.

**Figure ES- 1. Emission Reductions from Seven Strategies[1]**




The seven strategies are:

- **Limit global warming pollution from vehicle tailpipes.** California's pioneering limits on global warming pollution from vehicles will reduce emissions from new cars, light trucks and SUVs by approximately 30 percent by 2016, with further reductions in future years. The state should continue to work to ensure that the federal government grants California and other states the ability to enforce the standards as soon as possible and also pursue other options—such as financial incentives—to encourage the purchase and production of vehicles that produce less global warming pollution.

- **Limit global warming pollution from transportation fuels**. California should encourage the development of advanced vehicle fuels and technologies—such as plug-in electric vehicles and biofuels with low life-cycle impacts on global warming—that can reduce emissions from transportation. The state is currently developing a low-carbon fuel standard designed to reduce global warming pollution from transportation fuels by 10 percent by 2020 and California has long promoted innovative sources of vehicle propulsion through the zero-emission vehicle program.

- **Reduce emissions from heavy-duty trucks.** There are currently no fuel economy or global warming pollution standards for heavy-duty trucks like tractor-trailers, which produce large and growing amounts of global warming pollution. California is beginning

to develop regulations to reduce emissions, and the federal government has committed to improving heavy-duty truck fuel economy.

- **Promote alternatives to drive-alone work trips.** Commutes to work account for more than a quarter of all vehicle travel nationally and are a prime reason for congestion on our roadways. States such as Oregon and Washington have shown that creative programs designed to reduce drive-alone trips to work can reduce vehicle travel and ease congestion and California should follow their lead.

- **Build high-speed rail.** Air travel is a large source of global warming pollution in California. Yet, for many long-distance trips within the state, high-speed rail could provide service that is just as quick and convenient as air or car travel, but with far less pollution. The state should build the proposed high-speed rail line linking Sacramento, the Bay Area, Los Angeles and San Diego.

- **Expand the state's transit systems.** Public transportation in California already reduces global warming pollution by 3.6 million metric tons per year. Yet, there are many portions of the state—even in the largest metropolitan areas—where residents do not have easy access to high-quality transit service. California should invest in transit to ensure that most residents of the state's largest metropolitan areas have access to good transit service by 2030.

- **Stop sprawl and expand transit-oriented development.** California's population is projected to grow by 26 percent by 2030. The state should work with local governments to ensure that our growing population is housed not in sprawl-style developments that demand more driving, but rather in compact developments where residents can walk, bike or take transit to get most of the places they need to go.

**California can reduce global warming pollution from transportation, but it must act boldly and it must act quickly.**

Many of the changes California must make to reduce global warming pollution

**Table ES-1. Estimated Annual Emission Reductions from the Strategies, Million Metric Tons of Carbon Dioxide**

| | 2020 | 2030 |
|---|---|---|
| Limit Emissions from Vehicle Tailpipes | 30.8 | 57.1 |
| Limit Emissions from Vehicle Fuels | 13.0 | 15.1 |
| Reduce Emissions from Heavy-Duty Trucks | 11.1 | 23.0 |
| Promote Alternatives to Single-Passenger Work Trips | 2.6 | 5.5 |
| Build High-Speed Rail | 2.5 | 4.9 |
| Expand the State's Transit Systems | 1.4 | 2.8 |
| Stop Sprawl and Expand Transit-Oriented Development | 12.8 | 23.2 |
| **TOTAL*** | **67.4** | **114.5** |

* Total does not equal the sum of the strategies due to overlap among some of the strategies.

from transportation—such as changes in land-use patterns and the construction of new transit infrastructure—will take years or decades to achieve. As a result, California must begin to act now to make the changes needed to achieve global warming emission reductions in 2020, 2030 and beyond.

To achieve the emission reductions described above and to keep California on a path toward reducing its global warming emissions, the state will have to make several important commitments:

- California must continue to move forward with aggressive standards to reduce global warming pollution from transportation vehicles and fuels, including pending or proposed standards for light-duty vehicles, heavy-duty trucks and other transportation vehicles. In addition, California should continue to use regulatory standards to "push" the development of cleaner technologies over time.

- The state must invest in low-carbon transportation infrastructure—including investing in a high-speed rail system and the construction of additional public transit links in California's metropolitan areas.

- California must make global warming a central consideration in transportation and land-use planning and in permitting decisions. All transportation infrastructure decisions should be analyzed for their global warming impacts, with lower emission projects given preference. Cities, counties and regions should incorporate global warming emissions into their planning policies.

- California should develop incentives and disincentives that push companies and individuals to make transportation decisions that are good for the climate. For example, the state should consider reinstating mandatory commute-trip reduction targets for employers, expanding and enforcing the state's parking cash-out law, providing technical assistance to help businesses achieve commute reduction targets, and creating financial incentives to encourage consumers to purchase less polluting vehicles.

# Introduction

California has always been a place where trends begin.

In transportation, California was the place where America's "car culture" first found full flower. It was also the first place to experience the downsides of an automobile-centered transportation system—such as the smog that had already begun to plague Los Angeles by the 1940s and the crushing traffic congestion that continues to paralyze large sections of freeway today.

Not surprisingly, California has also been a pioneer in controlling the worst impacts of our car-dependent lifestyle. We were the first to require emission controls on cars, the first to push automakers to develop advanced-technology cars like hybrids, and the first to reduce emissions of global warming pollution from vehicles.

Now, California faces a bigger challenge than ever before—retooling our state's transportation system to achieve large reductions in global warming pollution. Getting there will require us to rethink the cars we drive, the way we build our communities, and the ways in which we move people and goods around the state.

The choices we make today—from the kinds of new development we allow and encourage to the kinds of transportation infrastructure we invest in—will affect our global warming emissions for decades to come. If California is to meet its global warming pollution reduction goals, therefore, it is important that we take action immediately.

This report lays out seven strategies California can use to reduce global warming pollution from transportation. The state is already making progress in implementing some of these strategies. It has barely begun to implement others. But all seven are important and necessary parts of California's efforts to prevent the worst impacts of global warming.

# Transportation Is Driving Global Warming

California has earned a reputation as a leader in the fight against global warming. Time and again, the state has adopted cutting-edge public policies to reduce global warming pollution—policies that served as models for other states' efforts to address global warming. In 2006, in perhaps the most important step to date, Governor Schwarzenegger signed the Global Warming Solutions Act, which will reduce global warming emissions to 1990 levels by 2020, an estimated 30 percent decrease below business as usual projections, making the state the first to enact an economy-wide emissions cap.[2]

California's work to address global warming won't stop in 2020. Indeed, the most recent science indicates that the United States will need to reduce its emissions by at least 80 percent by 2050 if we hope to prevent the worst impacts of global warming. Many of the choices we make today as a state—the types of transportation infrastructure we build, the types of communities we plan, the types of buildings we build—will have an impact on California's ability to reduce our global warming pollution well beyond 2020.

Perhaps the biggest challenge California faces in reducing global warming pollution is in the transportation sector. Transportation is California's number one source of global warming pollution, responsible for approximately 38 percent of California's emissions in 2004 (see Figure 1).[3]

When emissions from interstate and international aviation and international shipping are excluded (see "Counting Global Warming Pollution from Transportation," page 8) cars and light trucks account for the vast majority of global warming pollution from transportation in California—approximately 73 percent.[5] Heavy duty trucks account for another 20 percent of transportation emissions.[6] (See Figure 2.)

Emissions from the transportation sector in California are growing, having increased by 24 percent since 1990. (See Figure 3, page 9.)[8]

There are several reasons for the growth of transportation global warming emissions in California over the past decade and a half. Vehicle fuel economy—a key determinant of global warming pollution—has been roughly stagnant over the past two

**Figure 1. Global Warming Emissions by Sector – California, 2004**[4]

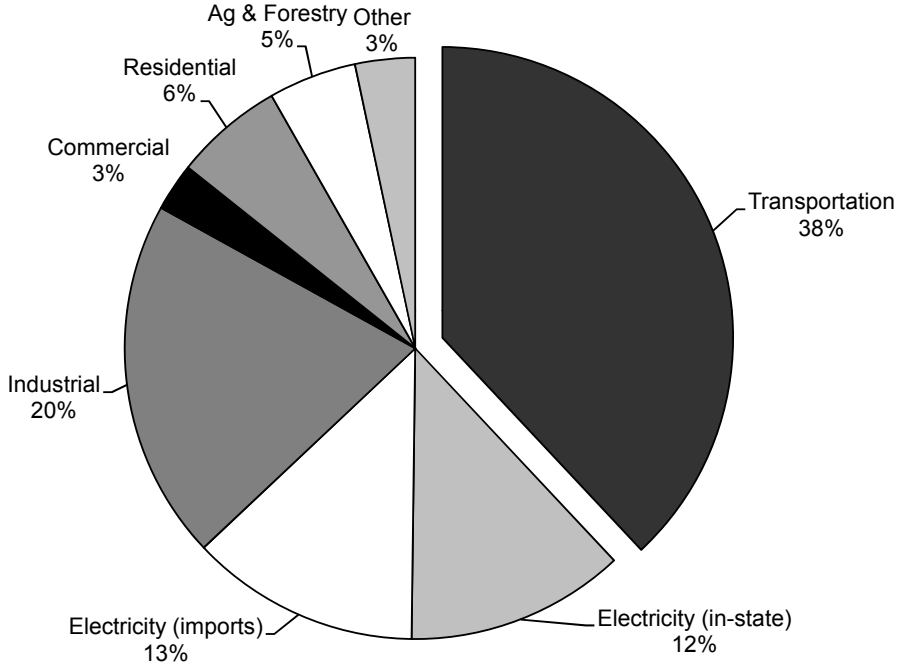
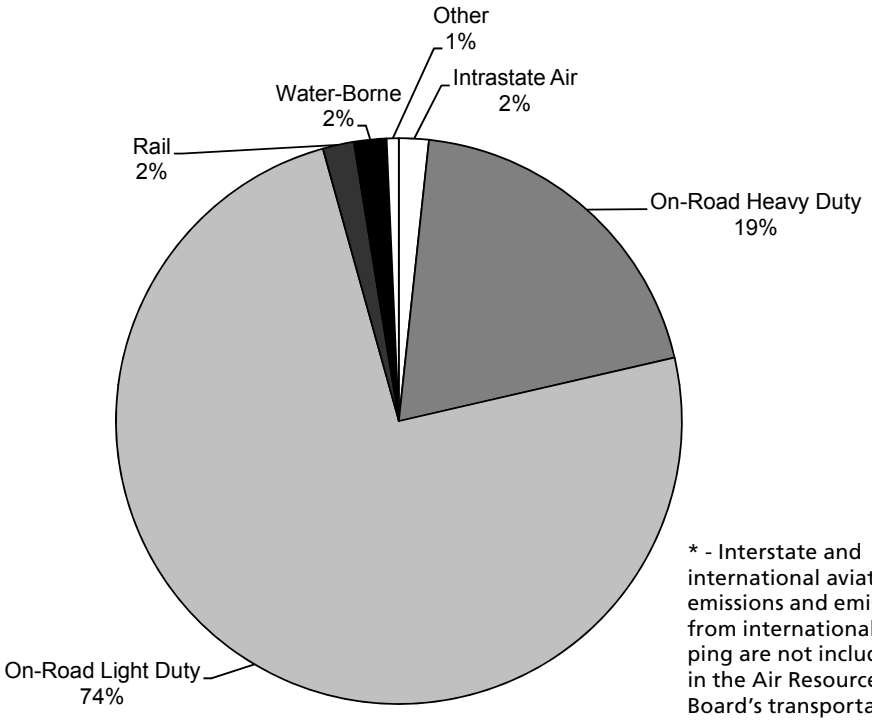



**Figure 2. Transportation Sector Emissions in California, 2004**[7]




* - Interstate and international aviation emissions and emissions from international shipping are not included in the Air Resources Board's transportation sector inventory.

## Counting Global Warming Pollution from Transportation

There are several ways of estimating the amount of global warming pollution produced by transportation in California. Among the major issues that are handled differently in various estimates of global warming impacts from transportation are:

- Which emissions are counted—Some transportation-sector inventories count only emissions of carbon dioxide from transportation energy use, while others count all emissions of greenhouse gases. In this report, we include only emissions of carbon dioxide from transportation sources.

- Which activities are counted as "transportation"—Some activities, such as the transportation of natural gas in pipelines, are considered "transportation" activities in some emission inventories and "industrial" activities in others. Similar issues arise in counting emissions from port activities.

- Which emissions are attributed to California—Much of the emissions resulting from transportation in California are caused by fuel used to transport people or goods outside of the state—or outside of the country. Typically, emissions from fuel used in international transportation are not attributed to any state or country. However, some state-specific inventories (such as the draft inventory prepared by the California Air Resources Board) also exclude emissions from interstate air travel.

California's AB 32 emission reduction target requires the Air Resources Board (ARB) to adopt an official 1990 emission level that the state must reach by 2020. Because the ARB's method of counting global warming pollution will be the official one used to judge compliance with the law, we have attempted to use ARB's definition of the California transportation sector, which excludes most emissions from international shipping and all emissions from interstate and international air travel.

These excluded categories accounted for 43.7 million metric tons of carbon dioxide emissions in 2004, equivalent to about 9 percent of California's total greenhouse gas emissions in that year. While California may not be solely responsible for these emissions, it does have a responsibility to act where it can—and encourage additional actions at the federal and international levels—to reduce them.

decades nationally. Increasing numbers of Californians have shifted from relatively more-efficient cars to less-efficient light trucks and SUVs. And the number of miles traveled on California's highways has grown dramatically, increasing nearly 20 percent between 1995 and 2005.[10]

There are four ways that California can reduce global warming pollution from transportation:

1) Increase the energy efficiency of transportation vehicles.

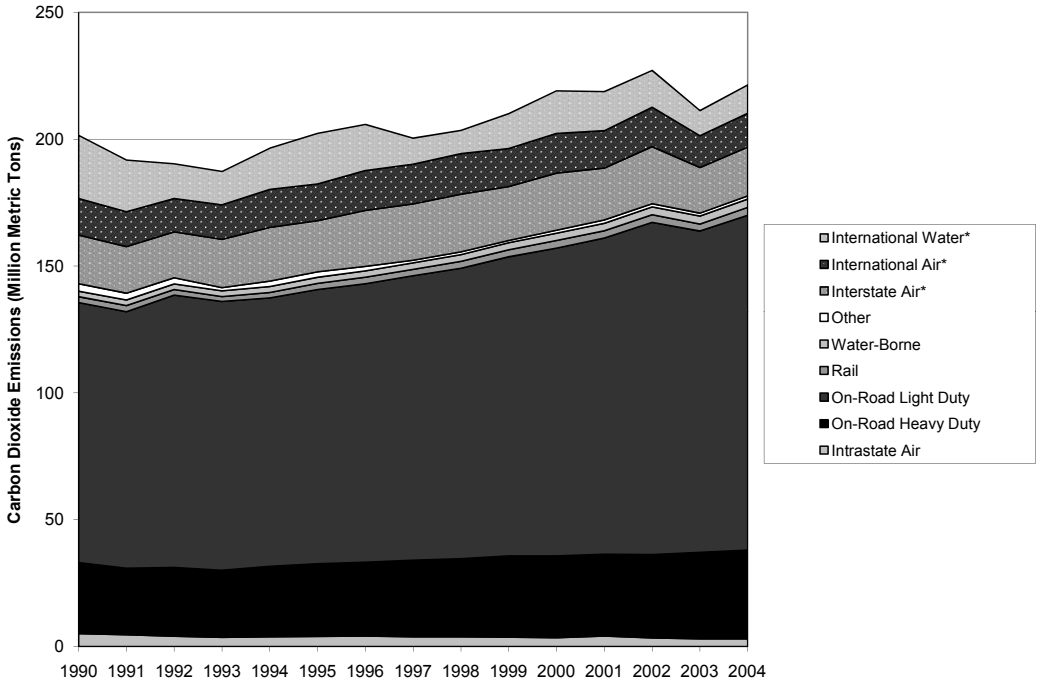
2) Reduce the carbon content of transportation fuels.

3) Reduce the number of miles traveled in vehicles.

4) Shift from higher-emission modes of travel to lower-emission modes.

As will be discussed below, California has already taken strong action in the first two areas. The state has enacted strong emission standards for carbon dioxide pollution from the tailpipes of light-duty vehicles—standards that have since been adopted by 12 other states, but that are currently tied up in a legal battle with the federal Environmental Protection Agency. In addition, Gov. Schwarzenegger has issued an executive order calling for a 10 percent reduction in carbon emissions from transportation fuels by 2020, and the state has begun developing the regulation as one of the first measures to meet the statewide emissions cap.

**Figure 3. Carbon Dioxide Emissions from California's Transportation Sector**[9]



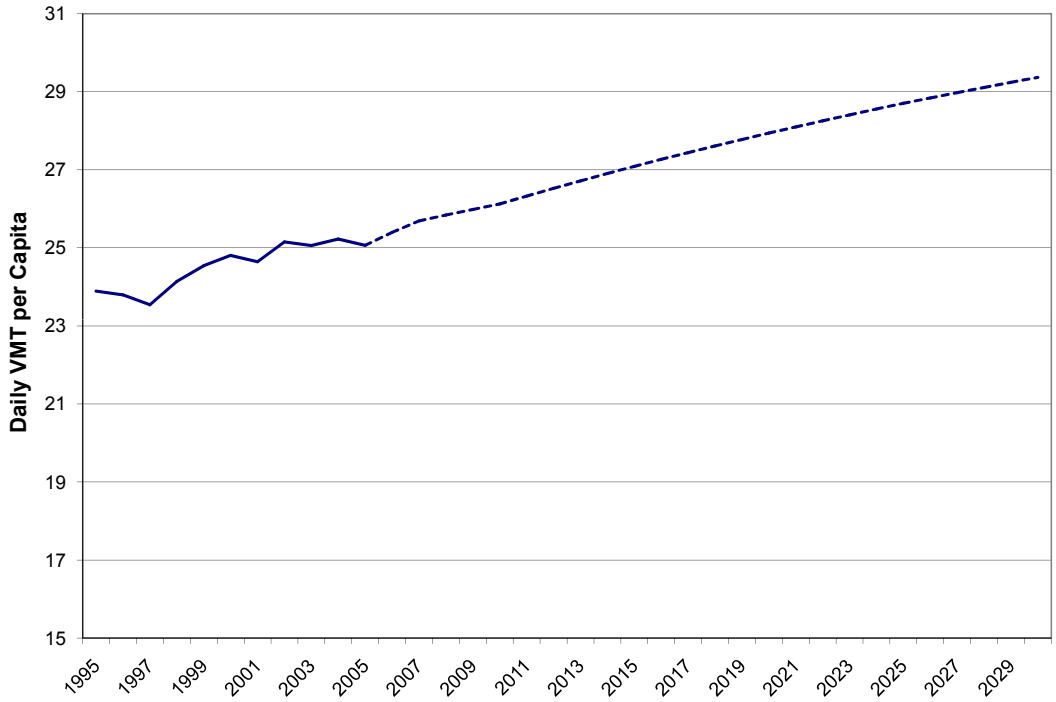

* - Interstate and international aviation emissions and emissions from international shipping are not included in the Air Resources Board's transportation sector inventory and are not included in the estimate of transportation sector emissions in this report.

However, the state has had less success in its efforts to reduce the growth of vehicle travel. Per-capita vehicle travel in California increased by approximately 5 percent between 1995 and 2005.[11] Based on projected levels of vehicle travel and population growth, Californians will drive nearly 30 miles per day in 2030, a 17 percent increase from current levels. (See Figure 4.)[12] At the same time, California's population is projected to grow by 26 percent between 2007 and 2030.[13] The result is that total vehicle travel in the state could increase by as much as 45 percent between now and 2030.[14]

Projected growth in vehicle travel threatens to swamp California's efforts to reduce global warming pollution from vehicles and fuels. Even if the state were to cut emissions from the typical car by 40 percent by 2030—an ambitious but achievable target—total global warming pollution from cars would only decrease by 13 percent compared to today's levels. While a 13 percent reduction in emissions from cars and trucks would be a welcome improvement, it would fall short of the 17 percent reduction California needs just to get back to 1990 emission levels. Failing to address the growth in vehicle travel, therefore, will make it very difficult for California to achieve its overall emission reduction targets.

In recent years, the growth in vehicle travel in California has begun to stabilize—the likely result of higher gasoline prices. The California Department of Transportation reports that vehicle travel on state highways increased by only a small amount (approximately 0.02 percent) in 2007 over the year before, the smallest year to year increase since the aftershocks of the Arab oil embargo in 1974.[16] And the Federal Highway Administration estimates that

**Figure 4. Daily Vehicle Miles Traveled Per Capita, California: 1995 - 2030[15]**



total vehicle-miles traveled in California actually declined in 2007.[17]

But California cannot (and should not) rely on high oil prices to achieve its global warming emission goals. In order to meet the targets set by the Global Warming Solutions Act, California will have to rethink the way it travels and the way we design our communities. Reducing the carbon content of our fuels and the global warming pollution coming from vehicle tailpipes are important first steps. But we also need to invest in clean transportation infrastructure such as modern public transportation, address emissions from vehicles other than cars and light trucks, and house California's growing population in communities where driving is an option, not a requirement.

There are many concrete steps that California can take to develop a modern, efficient transportation system while simultaneously reducing the state's impact on the global climate. The following sections describe those strategies and how they can benefit the state.

# Reducing Global Warming Pollution from Transportation in California

## Strategy 1. Reduce Emissions from Vehicle Tailpipes

**Emission reductions: 30.8 million metric tons per year by 2020[18]; 57.1 million metric tons per year by 2030**

California is a national leader in the effort to reduce global warming pollution from automobiles. In 2002, California passed the first law in the country to cut global warming pollution from vehicle tailpipes. The law (AB 1493), sponsored by then-Assemblywoman Fran Pavley, called for the establishment of standards that would deliver the "maximum feasible and cost-effective reduction of greenhouse gas emissions from motor vehicles."[19] In 2004, the California Air Resources Board (ARB) adopted standards to implement the program, which require a 30 percent cut in global warming emissions from new cars and light trucks (below 2002 baseline levels) by 2016.[20] The ARB has committed to developing standards that will produce additional emission reductions by 2020.

Automakers have a wide variety of options for meeting the standard, including the use of more efficient engines and transmissions, improved electronics, increased use of hybrid technologies, and reductions in leakage of potent global warming pollutants from air conditioning systems. In fact, ARB staff found that, as of 2005, there were "off the shelf" technology packages that would reduce emissions from all types of vehicles—from cars to SUVs—by 15 to 20 percent.[21]

Late in 2007, Congress passed an energy bill that increased fleet-wide fuel economy standards for cars, trucks and SUVs for the first time in over 30 years to 35 miles per gallon by 2020. However, California's program is a far stronger policy—achieving twice the emission reductions as the federal program by 2020.[22]

In the years since California's adoption of the standards, 12 other states—empowered by the federal Clean Air Act to follow California's lead—have also adopted the program. The standards were scheduled to be implemented in California and some of those states in model year 2009, which began in early 2008. However, in late 2007, the U.S. Environmental Protection Agency denied the state of California the Clean Air

Act waiver necessary for California and the other states to implement the program. It was the first time that the EPA has ever denied a waiver request from California and the denial came despite the recommendation of the agency's legal and policy staff that the waiver be approved.[23] The state of California has filed a lawsuit seeking to overturn the EPA's decision and legislation has been filed in the U.S. Congress that would achieve the same result.

*Plug-in hybrids are among the new vehicle technologies that can be used to reduce global warming pollution from cars in California. Credit: Argonne National Laboratory*

Should California prevail in its legal challenge to the EPA's waiver denial, and the greenhouse gas emission standards be implemented, California will enjoy significant reductions in global warming emissions from vehicle tailpipes—the first step toward a less polluting transportation system.

Requiring automakers to sell cars that have less impact on the climate is the most straightforward way to reduce emissions. However, California can augment its efforts to reduce global warming pollution from vehicles by providing financial incentives to encourage the purchase of cleaner cars. One way to do so is through a mechanism known as a "feebate" system, which combines rebates for purchases of low-emitting cars with fees on the purchase of high-emitting vehicles. A feebate system can be revenue-neutral for the state, while driving manufacturers to build—and consumers to buy—less polluting vehicles. A recent study by researchers at the University of Michigan found that implementing a feebate system along with California's vehicle tailpipe emission standards could reduce per-mile emissions by an additional 6 percent.[24] A feebate system could also be an alternative way of achieving the emission reductions called for by California's tailpipe emission standards in the unlikely event that the standards do not survive legal challenge.

## Strategy 2. Reduce Emissions from Vehicle Fuels

**Emission reductions: 13.0 million metric tons annually by 2020; 15.1 million metric tons annually by 2030[25]**

California's transportation system runs on oil. Virtually all of the fuel used to power cars, trucks and airplanes in the state comes from petroleum. In addition to the other problems posed by oil dependence—such as rising costs and reliance on unstable foreign nations for energy—oil is also rich in carbon. California can go a long way toward reducing the impact of its transportation system on the global climate by using transportation fuels with lower carbon content.

In January 2007, Governor Schwarzenegger issued an executive order calling for the development of a "low carbon fuel standard" (LCFS) for California.[26] The standard will be designed to reduce the average life-cycle global warming emissions of California's transportation fuels by 10 percent by 2020. The new standard will be unique in that it doesn't simply measure emissions at the vehicle tailpipe, but also accounts for all the global warming pollution

produced at every step of fuel production, refining and transportation—everything from "well to wheels."

Fuels with lower life-cycle global warming emissions than gasoline and diesel may include ethanol, biodiesel, electricity, and hydrogen—though each of these fuels can be produced in ways that are beneficial or detrimental to the global climate. Recent research, for example, suggests that global changes in land-use patterns resulting from increased production of corn for ethanol could result in more global warming pollution than is saved by using the alternative fuel.[27]

If designed well, a low-carbon fuel standard can act as a "technology push" strategy that drives the development of new vehicle and fuel technologies that reduce global warming pollution. These technologies could include plug-in hybrid and battery-electric vehicles and more environmentally friendly ways of producing biofuels. At the same time, a low-carbon fuel standard will reduce the use of new transportation fuels that are high in carbon, such as coal-to-liquid fuels and gasoline produced from unconventional sources of petroleum such as oil shale and tar sands—both of which have a greater global warming impact than oil produced from traditional sources.

In order to realize these global warming emissions reductions at the lowest cost, the low- carbon fuel standard will utilize market-based mechanisms to allow providers to choose how they reduce emissions while responding to consumer demand. For example, providers may purchase and blend more ethanol produced from low-carbon sources into gasoline products, purchase credits from electric utilities supplying low-carbon power for use in passenger vehicles, or diversify into hydrogen from low-carbon sources.[28]

California's low-carbon fuel standard will substantially reduce global warming emissions. Because the state is still in the early stages of designing a low-carbon fuel standard, it is difficult to estimate the exact level of emission reductions that would result from the policy. Some changes that could result from the low-carbon fuel standard—such as expanded use of flex-fuel, plug-in hybrid or electric vehicles—could be credited both toward compliance with the fuel standard and toward compliance with California's tailpipe emission standards for global warming pollutants. To ensure the conservatism of our emission reduction estimate, we assume that half of the savings that would result from the low-carbon fuel standard for light-duty vehicles would overlap with the vehicle tailpipe standards. We do not assume there will be any overlap for the low-carbon fuel standard for heavy-duty vehicles.

The low-carbon fuel standard will do more than just decrease emissions. Assuming that the average gallon equivalent of alternative fuels would reduce emissions by 50 percent compared with gasoline, a 10 percent low-carbon fuel standard would reduce gasoline consumption by approximately 20 percent, saving California 3.2 billion gallons per year by 2020, equivalent to the output of 2.5 average-sized California refineries.[29]

In designing and implementing the low-carbon fuel standard, California must be sensitive to the impacts of fuel production, distribution and use over the entire product life cycle.

For example, dramatically increasing the production of biofuels such as ethanol and biodiesel can increase the environmental impacts of agriculture and lead to competition between food and fuel for precious resources. In addition, some of these fuels may actually increase global warming pollution, once emissions from land-use changes, crop production, refining and transportation to market are taken into account. By designing the program such that a variety of low-carbon energy sources can contribute to achieving the targets, by

rigorously evaluating the life-cycle global warming emission impacts of various fuels, and by including sustainability standards designed to minimize environmental harm, California can reap the benefits of reducing global warming pollution while weaning our economy off of our dependence on petroleum.

In addition to the low-carbon fuel standard, California has a long-standing program designed to promote the use of cleaner, alternative fueled vehicles: the Zero-Emission Vehicle (ZEV) program. Launched in 1990, the ZEV program was originally designed to require that 10 percent of light-duty vehicles sold by 2003 be battery-electric vehicles. Over time those requirements have been modified and the ZEV program has evolved to support the introduction of a range of advanced technology vehicles—including ultra-clean gasoline vehicles, hybrid-electric cars, plug-in hybrids, hydrogen fuel cell vehicles and battery-electric vehicles. California should strengthen and streamline the ZEV program so that it can continue to serve its historic role in pushing automakers to develop the next generation of advanced-technology vehicles.

## Strategy 3. Reduce Emissions from Heavy-Duty Trucks

**Emission reductions: 11.1 million metric tons by 2020; 23.0 million metric tons by 2030**

Heavy-duty trucks are major consumers of fuel. Large tractor-trailers consumed about 19 percent of the fuel used by all highway vehicles nationally in 2004, and fuel consumption by large trucks has been increasing by more than 4 percent per year since the early 1990s.[30]

As with cars, the amount of global warming pollution produced by heavy-duty trucks is closely related to the amount and type of fuel they consume. Freight trucks and other heavy-duty vehicles are currently exempt from federal fuel economy standards. But significant increases in fuel economy for these trucks are possible at a net lifetime savings to vehicle owners. A 2004 study conducted by the American Council for an Energy-Efficient Economy (ACEEE) found that fuel economy improvements for tractor-trailers of 58 percent are achievable and cost effective.[31]

A variety of technologies are available that can reduce fuel use by heavy-duty trucks. Advanced engines, improved aerodynamics, more energy-efficient tires, the use of auxiliary power sources to provide electricity and heat to the vehicle's cab, and improved electronics, including the use of hybrid-electric technology, all have the potential to significantly improve heavy-duty vehicle fuel economy.

Both the federal and state government have begun to take action to reduce global warming pollution from heavy-duty trucks. The federal Energy Independence and Security Act of 2007 establishes a process for setting fuel economy standards for medium-duty and heavy-duty trucks. But the new standards will take years to develop and will likely not be enforced until 2015 at the earliest.[32]

California, meanwhile, is developing regulations to reduce global warming pollution from heavy-duty trucks. The first phase of the proposed regulatory approach is to require the use of energy-saving equipment—such as aerodynamic add-ons and low-rolling resistance tires—on trucks traveling on California highways. These energy-saving features are available on many new trucks and can also be retrofit onto existing trucks. The second phase of the regulations, expected to be considered in 2011, could impose energy efficiency or hybridization requirements for heavy-duty

truck engines.[33]

In addition to these efforts, California is also pursuing other avenues to reduce global warming pollution from heavy-duty trucks—particularly those emissions caused by idling. The state is tightening enforcement of its existing anti-idling regulations (which prevent truckers from idling their vehicles for more than five minutes under most circumstances) and is considering efforts to promote truck stop electrification, which reduces the need for truckers to run their engines or burn fuel to provide heat and electricity to their cabs.

Strong heavy-duty fuel economy and global warming pollution reduction policies at the federal and state level could result in significant reductions in pollution from heavy-duty vehicles. We assume that the combination of these policies could achieve a 21 percent reduction in emissions from heavy-duty vehicles by 2020 and a 33 percent reduction by 2030. The 33 percent per-mile emission reduction assumes a 50 percent increase in fuel economy for heavy-duty vehicles, implemented beginning in 2015, which would provide enough time for most of the heavy-duty vehicle fleet to be replaced with newer, more fuel efficient vehicles.[34]

### Shifting Freight to Lower-Emission Modes

In addition to improving the fuel efficiency of heavy-duty trucks, California can also reduce global warming pollution from freight movement by shifting more freight from trucks to trains. Trains consume about one-tenth as much energy, on average, to carry a ton of freight one mile as heavy-duty trucks.[35] Yet, as of 1998, about four-fifths of the freight moving into, out of, or within California was carried on trucks.[36] California should work with businesses, shippers and railroads to encourage shifting more freight traffic from trucks to rail.

## Strategy 4. Reduce Single Occupancy Work Trips

**Emission reduction: 2.6 million metric tons by 2020; 5.5 million metric tons by 2030**

Commuting to and from work accounts for 27 percent of vehicle travel nationally and a disproportionate share of travel during periods of peak traffic congestion.[37] The vast majority of that travel—72.9 percent—occurs in single-occupancy vehicles.[38] Because work trips tend to be concentrated during certain periods of the day, and because many of those trips are to centralized sites, they provide a good opportunity to reduce vehicle travel, and thereby reduce global warming pollution from cars and light trucks.

California has a long history with commute-trip reduction efforts. In the late 1980s, for example, southern California air quality officials imposed mandatory commute-trip reduction rules for employers with more than 100 employees. The rules required companies to take a series of steps to encourage alternatives to single-passenger commuting. The program met with significant success—reducing the share of drive-alone commuters by 6.5 percent


*Employers can play an important role in reducing emissions by encouraging their workers to share rides, use transit, walk or bike to work, or work from home.* (*Credit: Adam Nollmeyer, istockphoto.com)*

among affected employers in the South Coast area.[39]

However, objections from the business community—both in California and nationally—led to the elimination of many mandatory commute-trip reduction programs. In 1995, the California Legislature banned mandatory trip reduction programs except where required by federal law. That same year, the federal government made commute-trip reduction programs, which had been required in some areas under the 1990 Clean Air Act, voluntary. As a result, the South Coast program was transformed from a sole focus on commute-trip reduction to a multifaceted credit trading program designed to reduce emissions from cars and light trucks generally. Later legislation increased the threshold for employers required to participate in the program from 100 to 250 employees—thus reducing the number of employers and commuters covered by the program.[40]

Since the 1990s, however, congestion on California highways has continued to mount—as has global warming pollution from work trips. Moreover, evidence from states that have maintained mandatory commute-trip reduction programs—particularly Washington and Oregon—demonstrates that the programs can be effective in driving significant reductions in drive-alone commutes. Finally, improved communication technologies now allow more would-be commuters to work remotely, reducing the need for daily commutes, at least among some workers. These developments suggest that a renewed, statewide commitment to reducing single-passenger work trips—undertaken with the involvement of the business community—can achieve significant results.

Unlike California, Washington and Oregon enacted commute-trip reduction policies during the 1990s and stuck with them. The two states were the only ones in the United States to experience a decrease in the percentage of drive-alone commuters during the 1990s.[41]

Washington state's program was enacted in 1991 and covers employers with 100 or more full-time employees at a single worksite in the state's nine most populous counties. The program requires employers to develop plans designed to reduce vehicle-miles traveled by employees in line with a set of increasingly stringent targets.[42] Oregon's program applies to employers with 50 employees or more at a single site in the Portland metropolitan area (though the program was recently revised to include only employers with 100 or more employees at a single site). It requires employers to offer incentives for the use of commuting alternatives with the potential of reducing commute trips by 10 percent over three years.[43]

Both programs have achieved results in reducing commuting travel. The Washington program removes 19,000 vehicles from the state's highways each morning, and the rate of single passenger commuting at worksites covered by the program dropped from 70.8 percent in 1993 to 65.7 percent in 2003. The number of commuting vehicle-miles traveled at those facilities would have been 5.9 percent higher were it not for the program. A late 1990s study found that the Washington program created the equivalent of a half-lane of extra highway capacity along one major highway—and did so at far less cost than actually expanding highway capacity.[44] The Washington program also reduces global warming pollution by about 74,000 tons per year.[45]

Oregon claims that 30 percent of employers in its program are meeting the 10 percent reduction target, and another 35 percent have seen trip reductions of between 1 and 9 percent, producing an annual reduction of 35.4 million vehicle-miles traveled.[46]

California has much to gain by reducing the number of drive-alone work trips. In addition to reductions in global warming

pollution, fewer drive-alone commuters means less rush-hour congestion and reduced demand for expensive additions of highway capacity.[47]

There are a number of tools and strategies that California employers and workers can use to reduce the number of single-passenger work trips:

- **Ridesharing:** Carpooling and vanpooling are flexible ways for commuters to share rides to work. Carpools typically use vehicles owned by the participants, while vanpools use vehicles provided by transit agencies or private operators. The San Diego region's RideLink program is an example of the potential benefits of vanpooling. With more than 4,000 participants, the program averted approximately 28,000 tons of carbon dioxide pollution in 2006 alone.[48] A similar program was recently launched by the Los Angeles County Metropolitan Transportation Authority (Metro).[49] Employers and government agencies can expand the number of carpool and vanpool participants by providing financial or other incentives (such as preferred parking) to workers who share rides.

- **Telecommuting and compressed work weeks:** Workers who need to commute to work less frequently could be expected to drive fewer miles. One way to reduce the need to travel to worksites is through telecommuting—the use of communications technology to work from home or other locations away from the office. Studies estimate that for every 10 percent of the workforce that telecommutes, vehicle travel declines by 2-4 percent.[50] (The reason that the reduction in vehicle travel is not also 10 percent is that many telecommuters do local driving during the day.) Similarly, employers could offer compressed work weeks to their employees, giving them the option of working four 10-hour days rather than five 8-hour days per week. By doing so, those workers would take 20 percent fewer trips to and from work. Telecommuting and compressed work weeks aren't appropriate for every job or worker, but they do present opportunities to cut commuting travel.

- **Parking cash-out:** Historically, many California employers have provided free parking to their employees—an expensive perk that is often not matched with similar rewards to employees who walk, bike or take transit to work. Commuters who receive free parking at work are far more likely to drive to work than those who must pay for parking.[51] "Parking cash-out," in which commuters who receive subsidized parking are also offered the cash equivalent if they use alternative travel modes, has proven to be a successful way to reduce single-occupancy commuting among companies that have used it in California.[52] Current state policy requires some companies with more than 50 employees located in designated "nonattainment" air basins to provide parking cash-out.[53] However, the state's current parking cash-out policy applies to only about 3 percent of the 11 million free parking spaces provided by employers statewide.[54] California should expand its parking cash-out program statewide and ensure that all employers provide fair and equitable support to employees who do and do not drive.

- **Other incentives and services:** Businesses can also take steps to make their work sites as inviting to non-automobile commuters as they are to drivers. Employers can provide bicycle parking, showers and other amenities

to workers who bike or walk to work. "Guaranteed ride home" programs, which provide trips home to workers who miss their transit or ridesharing connection, are also an important backstop to efforts to reduce single-passenger commutes.

The experiences of Washington and Oregon suggest that a mandatory commute-trip reduction program will have the most success at reducing single-occupancy work trips. But regardless of whether such a program is mandatory or voluntary, it is important that the state play an active role in investing money in the program, reaching out to the business community, and developing effective strategies that can be employed at the local or regional level. For example, Washington state's program includes businesses and local governments in the governance of the program, resulting in strong partnerships that enhance the program's success.

Investing in commute-trip reduction has the potential to reduce congestion at far lower cost than the addition of new transportation capacity. Even a relatively small investment of public funds can pay large dividends. In Washington State, for example, $2.7 million in annual investment from the state has delivered more than $37 million in reduced fuel expenditures and travel delay alone.[55] A relatively small investment of state funds, if coupled with an aggressive statewide trip-reduction effort, could yield large dividends in reduced global warming emissions, reduced congestion, and reduced dependence on petroleum.

Ideally, California would repeal its prohibition on mandatory commute-trip reduction programs and lower the threshold for participation in the programs to include smaller employers. To relieve the concerns of businesses and improve the program's chances of success, California should include representatives of the business community in the governance of the program, provide technical support to businesses on how to meet the goals, and provide financial incentives and other assistance to maximize the benefits of the program to workers, businesses and the environment.

A reasonable target for the state would be to reduce the number of single-passenger work trips by 10 percent by 2020 and 20 percent by 2030. For the sake of our analysis, we assumed that these reductions would take place only at employers with more than 100 employees, though there is no reason that smaller companies cannot also implement successful commute-trip reduction programs. The 10 percent goal for 2020 is significantly greater than the 5-6 percent reductions in single-passenger commuting achieved by the Washington program and California's earlier efforts. However, those results came at a time of lower gasoline prices and lower levels of congestion, meaning that greater results should be achievable now. By achieving these targets, California could reduce carbon dioxide emissions from vehicles by 2.6 million metric tons by 2020 and by 5.5 million metric tons by 2030.

## Strategy 5. Connect California Cities with High-Speed Rail

**Emission reductions: 2.5 million metric tons by 2020; 4.9 million metric tons by 2030[56]**

California is a large state, spanning the equivalent length of New Jersey to Georgia on the east coast. Travel between California's major cities is common and typically requires either a long automobile trip or a plane flight. Both options release large amounts of global warming pollution.

Building a high-speed rail (HSR) network in California would displace many of these car and plane trips, and dramatically reduce emissions in the Golden State.

Currently, 98 percent of intercity trips in California are made in automobiles or airplanes, modes of transportation that release a great deal of carbon dioxide.[57] Short-haul flights—those of 500 miles or less—are particularly energy inefficient and damaging to the climate. A large share of the fuel consumed in any flight is used on take-off and landing. As a result, short-haul flights tend to consume more fuel per mile than longer flights.[58] And the number of Californians taking these flights is increasing—the number of passenger-miles traveled on in-state, short-haul flights increased 9 percent from 2000 to 2007.[59]

Intercity travel within the state is projected to increase even further in the years to come. The number of passengers traveling between cities in California is forecast to increase up to 63 percent over the next 20 years, from 155 million passengers to as many as 253 million passengers.[60] The number of passengers that depart from or arrive in California via plane is expected to more than double between 1999 and 2020.[61]

California's reliance on cars and planes for intercity travel doesn't just cause excess pollution, but it also clogs up the state's transportation infrastructure. On-time performance at California airports has deteriorated in recent years as the number of flights and passengers has increased. At Los Angeles International Airport, the number of passengers has increased by 16 percent since 2002, with the percentage of on-time departures falling from 86 percent to 80 percent, and the percentage of on-time arrivals declining from 84 percent to 77 percent.[62] Similar declines in on-time performance have been registered at airports in San Francisco, San Diego and Oakland.[63] Los Angeles International Airport projects a demand of 19.2 million more annual passengers than its 78.7 million total passenger capacity by 2015, and San Diego International-Lindbergh Field expects to be at capacity prior to 2020.[64]

The highway infrastructure between cities in the Golden State is also unable to accommodate the increasing transportation needs of California's growing population. A report by the California High Speed Rail Authority found that, assuming highway construction progresses at its current rate, over half of 68 intercity highway segments studied would operate at unacceptable levels of service with increased congestion, travel delays and accidents by 2020.[65]

Construction of a high-speed rail network connecting San Diego and Los Angeles to Sacramento and the Bay Area is a potentially groundbreaking solution to the state's intercity transportation challenges. The high-speed rail line, which has been in the planning process for over a decade, would be the first of its kind in the United States, but similar to rail networks reliably connecting cities in Japan and Europe for years.

The proposed high speed rail system will serve 30 stations and will be capable of speeds of up to 220 miles per hour.[66] By the year 2020, the proposed service would include approximately 86 weekday trains in each direction, with 64 trains running between northern and southern California and the remaining 22 serving shorter distance markets.[67] The full system is projected to attract 42 to 68 million passengers per year in 2020, and has the potential to accommodate over 100 million passengers per year in 2030.[68]

High-speed rail will provide faster service to and from cities within California than can be provided via air or highway. A trip from downtown Los Angeles to downtown San Diego, for example, would take 18 minutes less by high speed rail than by car and nearly 40 minutes less than by air (including the time spent boarding the plane and in security lines).[70]

The proposed high-speed trains will utilize wheel-on-steel rail technology and draw electric power from overhead wires connected to the commercial power grid and, in braking, will regenerate electricity, thereby conserving power and reducing costs.[72]

High-speed rail reduces global warming pollution in two ways. First, high-speed rail will use electricity, rather than oil, as its source of power, reducing California's dependence on petroleum. Should California continue to make progress in reducing global warming emissions from power generation, electricity will become a cleaner source of energy in the years to come. Second, high-speed rail in California is likely to be very energy efficient, consuming approximately 42 percent of the energy per passenger-mile of intercity

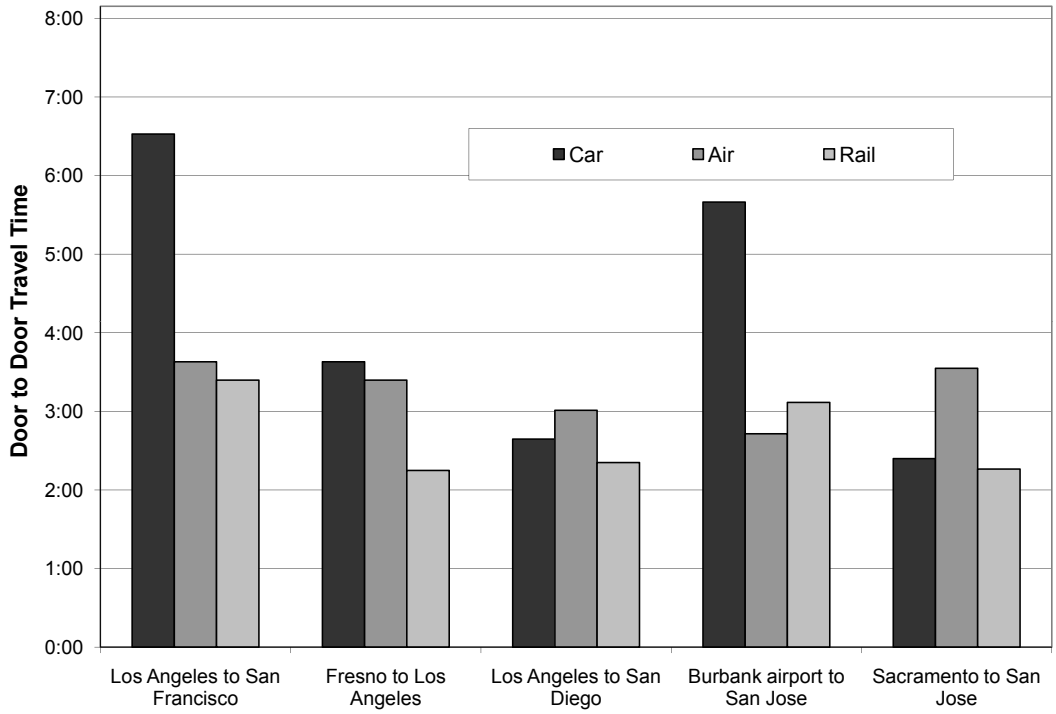
**Figure 5. Route of Proposed California High-Speed Rail System[69]**

car travel and 30 percent of the energy per passenger-mile of plane travel.[73] Finally, the California High-Speed Rail Authority is studying the potential to use zero-emission electricity to power the system; a move that could reduce global warming pollution even further.[74]

The combination of energy efficiency and the use of low-carbon electricity leads to significant reductions in global warming pollution. The California High Speed Rail Authority projects those reductions to amount to 8 million metric tons of carbon dioxide annually by 2030.[75] However, the authority's savings estimate does not take into account the reductions in global warming emissions that will result from the state's low-carbon fuels standard and its vehicle tailpipe emission standards for global warming pollutants. Since most of the emission reductions that will result from high-speed rail will come from averted automobile trips, construction of the system could be expected to reduce emissions by approximately 4.9 million metric tons in 2030.[76]

Estimating emission reductions for 2020 is more difficult, as it is unclear how much of the system will be complete at that time. Planning documents from the California High-Speed Rail Authority suggest that it will take eight to 11 years to develop an initial segment of the high-speed rail network, meaning that it is possible, though by no means certain, that a portion of the network could be completed by 2020.[77] For the purposes of this report, we assume that at least part of the network is on-line by 2020 and that the overall emission savings are half those that will ultimately be achieved by 2030. California will need to act quickly to provide funding to, and begin

**Figure 6. Estimated Total Travel Times for Auto, Air, and High Speed Rail 2030, After Construction of High Speed Rail (Door-to-Door Times for Downtown-to-Downtown Trips, Unless Otherwise Indicated)[71]**



development of, high-speed rail if the technology is to play a meaningful role in achieving the emission reduction targets in AB 32.

The construction of high-speed rail in California will require major investment. The project is ultimately expected to cost approximately $40 billion.[78] But highway and airport expansion projects are also extremely expensive. For example, the cost of widening Highway 99 to six lanes is estimated at $6 billion, and expanding the highway to meet Interstate standards has been estimated to cost as much as $25 billion.[79] The cost of completing all the projects in the LAX master plan has been estimated at $11 billion.[80] By building the high-speed rail system now, the state can avoid future expenses for highway and airport capacity expansion, while easing congestion, reducing the state's dependence on petroleum, sparking economic development, and, most importantly, reducing global warming pollution.

## Strategy 6. Expand and Improve Transit Service

**Emission reductions: 1.4 million metric tons by 2020; 2.8 million metric tons by 2030. (Greater reductions if accompanied by more compact development patterns and expansion of transit in smaller California cities.)**

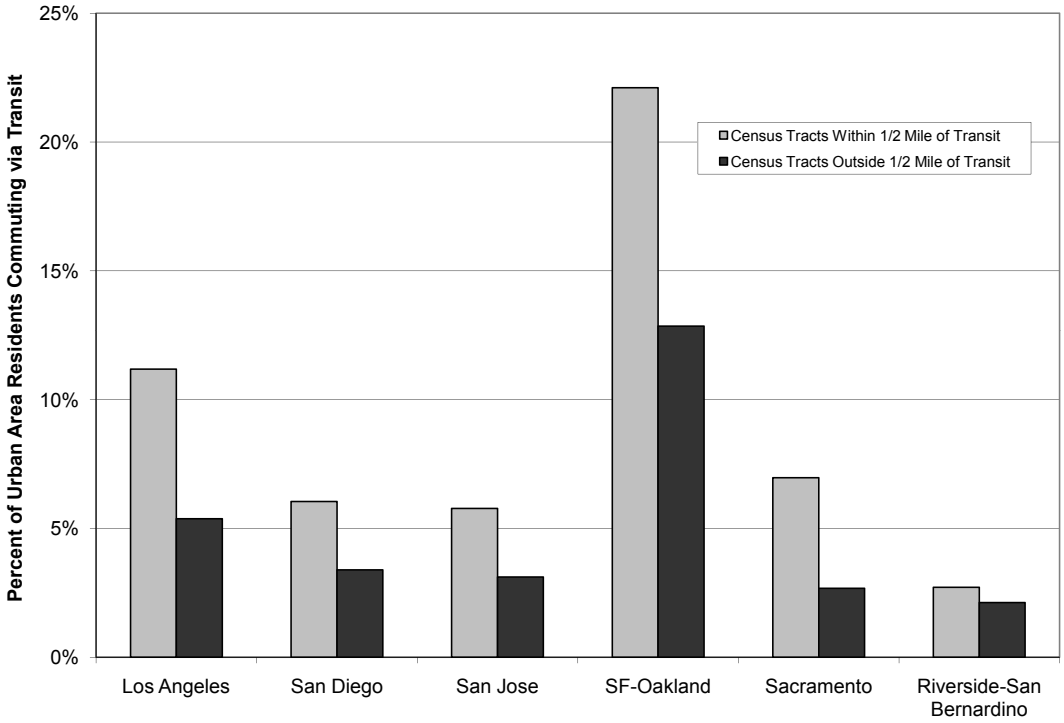
Trains, buses and other forms of public transit in California already play a major role in reducing global warming pollution in the Golden State. In 2006, California's transit systems reduced global warming pollution by approximately 3.6 million metric tons of carbon dioxide—the equivalent of taking nearly 680,000 cars off the road.[81]

Transit reduces global warming pollution in a number of ways. People who use transit can often travel more efficiently, and with fewer emissions, than if they had

**Table 1. Carbon Dioxide Emission Savings from California Transit Agencies, 2006[82]**

| Transit agency | Carbon dioxide emission reductions (thousand metric tons) |
|---|---|
| San Francisco Bay Area Rapid Transit District (BART) | 1,711 |
| Los Angeles County Metropolitan Transportation Authority (Metro) | 863 |
| San Diego Trolley, Inc. | 281 |
| San Francisco Municipal Railway (Muni) | 198 |
| Southern California Regional Rail Authority (Metrolink) | 178 |
| Peninsula Corridor Joint Powers Board (Caltrain) | 106 |
| Sacramento Regional Transit District (RT) | 99 |
| Santa Clara Valley Transportation Authority (VTA) | 53 |
| Orange County Transportation Authority (OCTA) | 36 |
| San Diego Association of Governments (RideLink vanpool) | 28 |

**Figure 7. Commuting Behavior of Urban Residents by Proximity of Homes to Transit Stop**




driven instead. In addition, the presence of high-quality transit service in a community is correlated with reduced vehicle travel—the result of the more compact development patterns that often exist near transit stops and reduced vehicle ownership. (We address the potential for global warming emission reductions from land-use changes in Strategy 7, page 28.)

But for many Californians—even those living in the state's largest and most densely populated urban areas—access to high-quality transit service is inconsistent or non-existent. The result is that many Californians have few choices for how they get to work, school or shopping—leaving them dependent on cars and resulting in greater than necessary emissions of global warming pollution.

An analysis of journey-to-work data from the 2000 U.S. Census shows that when Californians have access to transit,


*Light rail transit lines, like this one in Sacramento, reduce global warming pollution from transportation in California.*
*(Credit: istockphoto.com)*

they use it. Californians living in Census tracts within one-half mile of a "fixed guideway" transit stop (subway, light rail or commuter rail) in the state's six largest urbanized areas are far more likely to take transit, walk or bike to work than those living farther away.[83] For example, about 22 percent of residents of the San Francisco-Oakland urbanized area who live in Census tracts within a half-mile of a transit stop take transit to work, compared with just 13 percent of those living in tracts more than a half-mile away. (See Figure 7.)

Even in areas where transit usage is far lower, there is still a large relative difference in commuting patterns between residents who live near transit and those who live farther away. Consistently, residents living near transit stops are about twice as likely to take transit as those living farther away, and are significantly less likely to drive to work alone. Evidence from the Bay Area suggests the difference in the percentage of residents driving alone extends to non-work trips as well.[84]

The impact of transit is magnified when transit stops are located near both homes and jobs. An analysis of Bay Area commuting patterns found that 42 percent of residents who both lived and worked within a half-mile of transit took transit to work. By contrast, only 4 percent of those who lived and worked more than a half-mile away from a transit stop used transit.[85]

California's urbanized areas vary greatly in the availability of transit service. While more than half of all residents of the San Francisco-Oakland urbanized area live in census tracts within a half-mile of a transit stop, less than one-fifth of residents in the Los Angeles area have similar access to fixed guideway transit.[86] (See Table 2.)

The data in this section do not include bus service, which often plays an important role in local transit networks. The data above suggest that Californians living near rail transit are more likely to use transit than those who live near bus routes only.

**Table 2. Percentage of Urbanized Area Residents Living in Census Tracts within a Half-Mile of Fixed Guideway Transit Stops**

| | |
|---|---|
| San Francisco-Oakland | 57% |
| San Jose | 26% |
| San Diego | 21% |
| Los Angeles | 16% |
| Sacramento | 11% |
| Riverside-San Bernardino | 16% |

However, residents living near rail stops also frequently have access to good bus service. Indeed, among residents living within a half-mile of rail transit stops in the San Francisco-Oakland urbanized area, more than half of those using transit to get to work use the bus. Moreover, some forms of high-quality bus services, such as express buses and "bus rapid transit" lines that use their own separate rights-of-way, can play a role similar to that of rail transit in some areas.

To expand Californians' access to transit, the state can bring transit to more people (by expanding the transit network) and bring more people and jobs to transit through transit-oriented development—compact, mixed-use developments located near transit stops. We will discuss transit-oriented development in "Strategy 7. Stop Exurban Sprawl and Promote Transit-Oriented Development," page 28.

Simply expanding Californians' access to high-quality transit will allow for a significant reduction in vehicle travel. If, for example, Los Angeles' transit network were expanded such that half of the area's residents lived within a half-mile of high-quality, fixed-route transit by 2020, the number of single passenger commutes could be expected to decline by about 3 percent—even if all other trends remain the same. If the same target were also to be achieved in the state's other major

metropolitan areas, and if the reduction in single-passenger trips extended to non-work trips as well, the state could reduce carbon dioxide emissions of 1.4 million metric tons by 2020. Achieving the more ambitious goal of bringing 75 percent of the population of the state's largest urbanized areas within the reach of transit by 2030 would reduce carbon dioxide emissions by approximately 2.8 million metric tons. This would result in California nearly doubling the amount of global warming pollution it averts through transit use statewide versus today's levels.

These figures are merely rough estimates of the amount of benefits California would receive from expanding transit services—the actual level of savings would depend on the type of service provided and the locations served. However, they are also only the tip of the iceberg of what is possible. Expanding high-quality transit from one or a few lines into a full-fledged network of the kind present in the Bay Area gives more residents better access to more destinations, thereby providing a boost to ridership. Moreover, by pairing transit expansion with transit oriented development, California can achieve even greater emission reductions.

California transit agencies and regional transportation planners have already proposed a series of transit projects that would lead to a dramatic increase in transit access for Californians. In the metropolitan areas of southern California, bus rapid transit (BRT) and "rapid bus" projects (express bus lines that enjoy priority at traffic lights and operate on a frequent schedule) are on the docket. Los Angeles currently has plans to expand its current BRT and rapid bus network from nine to 28 lines by 2014, extending to Pasadena, Riverside-San Bernardino, and Irvine.[87] San Diego is planning several new BRT and rapid projects as well, to be implemented within 10 years.[88] Light rail construction and expansion is also gaining traction in the Los Angeles area, with five major projects either being planned or already under construction.[89]

The heavy rail network serving the Bay Area, known as BART (Bay Area Rapid Transit), has plans to expand over the next two decades as well, with expansions planned in Santa Clara, Contra Costa, and Alameda counties.[90] San Jose has two light rail expansion projects planned, and San Francisco has three.[91] The Bay Area could also see as many as seven new bus rapid transit lines.[92]

In short, there are already plans on the drawing board to dramatically expand the reach of public transit service in California's major metropolitan areas. Because transit investments take a long time to go from drawing board to completion, California will need to prioritize transit expansion projects, starting now. By investing the resources needed to build robust public transportation networks, the state can take a large step toward achieving its climate protection goals.

## Transit in Smaller Metropolitan Areas

The benefits of transit aren't just limited to the state's major metropolitan areas. Transit agencies in some of California's smaller metropolitan areas play an important role in reducing global warming pollution and the state must ensure that improvements in transit take place in smaller communities as well.

According to a recent analysis, transit agencies in several small California urban areas (with a population of less than 500,000) make significant contributions to reducing global warming pollution. (See Table 3.) Transit service in small cities does not always contribute to emission reductions—in many cases, transit service in small cities is underfunded, meaning that transit mainly serves as a transportation backstop. But, in many smaller cities, transit provides a valuable low-carbon

transportation alternative. In addition to expanding transportation options in the state's major metropolitan areas, California should also invest in providing improved transit choices in smaller urban areas as well.

**Table 3. Carbon Dioxide Emission Reductions from Transit, Urbanized Areas Under 500,000 People[93]**

| Urban Area | Carbon dioxide emission reductions (metric tons) |
|---|---|
| Stockton, CA | 10,695 |
| Santa Clarita, CA | 4,327 |
| Lancaster-Palmdale, CA | 3,644 |
| Santa Barbara, CA | 3,109 |
| San Luis Obispo, CA | 1,810 |
| Santa Cruz, CA | 1,252 |
| Indio-Cathedral City-Palm Springs, CA | 1,136 |

## Reducing Emissions from Transit Vehicles

While transit plays an integral role in reducing global warming pollution from transportation, transit vehicles still produce pollution. As California expands its transit networks, it must simultaneously move to make transit vehicles cleaner.

There are many opportunities to reduce global warming pollution from transit vehicles. The simplest is to improve the energy efficiency of transit operations—either by purchasing more energy efficient buses or by purchasing smaller transit vehicles for use in areas with lower ridership.

Hybrid-electric buses have the potential to deliver better fuel economy, thereby reducing transit's contribution to global warming. New York City, Seattle and San Francisco have all made major investments in hybrid buses.[94] A recent study by the National Renewable Energy Laboratory of the implementation of hybrid buses in Seattle found that hybrids are 27 percent more fuel efficient than the diesel buses they displaced, and reduce fuel costs by 22 percent per mile.[95] In a cross-city analysis of metropolitan transit agencies using hybrids, hybrid buses were found to decrease carbon dioxide emissions by 23.4 to 43.9 percent compared to the diesel buses they replace.[96]

Other alternative fuels also have the potential to reduce global warming pollution. Los Angeles, for example, has invested heavily in buses that operate on compressed natural gas (CNG). With more than 2,300 CNG buses, more than 90 percent of its fleet, Los Angeles operates the largest alternative fuel transit bus system in the United States.[97] CNG buses emit approximately 20 percent less global warming pollution than conventional diesel buses.[98] By providing an environmentally superior alternative for passengers, the Los Angeles fleet is responsible for reducing air pollution by nearly 25,000 metric tons per year.[99]

In addition to choosing the most energy efficient buses and using clean alternative fuels, California transit agencies should also make smart choices about the transit systems they plan to build. Transit systems that operate on electricity—including electrified commuter rail, subways, light rail lines, streetcars and trolleybuses—tend to be more energy-efficient per passenger mile than bus systems. Light rail and subway systems consume approximately a third less energy per passenger mile than bus systems.[100] As California continues to expand its development of renewable electricity sources, the benefits of electric transit will likely increase. Rail transit isn't always the best solution to a community's transit needs, but in places where population and job densities are sufficient to support rail transit, California should prioritize building it.

## Strategy 7. Stop Exurban Sprawl and Promote Transit-Oriented Development

**Emission reductions: 12.8 million metric tons per year by 2020; 23.2 million metric tons per year by 2030**

California is growing rapidly. By 2030, the state's population is projected to increase by an additional 26 percent, adding more than 9 million Californians. Where those Californians will live, and the kinds of communities we build to house them, will help determine the state's contribution to global warming for decades to come.

California faces a choice: we can either continue to build sprawling new communities ever farther from metropolitan centers in which the automobile is the only realistic transportation option, or we can build dynamic, compact communities near transit lines in which residents have a wealth of transportation choices.

For decades, exurban sprawl—characterized by dispersed development in which different uses of land are separated from one another and reachable only by automobile—has dominated development patterns in much of California. A 2002 report ranked the fast-growing Riverside-San Bernardino metropolitan area as the most sprawling metropolitan area in the United States, with the Oxnard-Ventura and Vallejo-Fairfield-Napa areas also ranking in the top 20.[101] By contrast, the San Francisco area was ranked as the nation's fourth least-sprawling area, after New York City, Jersey City, NJ, and Providence, RI.[102]

Residents in areas with sprawling development patterns drive more miles per day than their counterparts in compact, mixed-use communities. On average, the typical resident of a sprawling metropolitan area drives 6 more miles per day, or 28 percent more, than the typical resident of a compact metropolitan area.[103]

Furthermore, residents of sprawling places are far less likely to take the bus or train to work. Inhabitants of non-sprawling areas are twice as likely to take public transit to work as their counterparts living in sprawling communities.[104]

Sprawling development patterns are not inevitable, however. With a community-wide commitment to smart growth—backed up by strong planning and zoning policies—communities and metropolitan areas can choose a different course.

Consider the case of Portland, Oregon. In 1980, Portland implemented an urban growth boundary, which was designed to accommodate and encourage further growth near the city center and discourage it in rural areas. At roughly the same time, Portland's transit agency, TriMet, began building an extensive light rail network, which now consists of four lines.[105] The result: since peaking in 1996, per-capita vehicle travel in the Portland-Vancouver, WA region has declined by 7.5 percent. The percentage of Portland residents driving to work alone is the same as it was a decade ago, bucking the national trend.[106] Transit ridership has increased by 41 percent since 1998.[107] And Portland continues to add population at a rapid rate, while serving as an economic engine for its region.

Regional planners in California have explored the potential for the Golden State's metropolitan areas to grow in a similar fashion—with more development taking place in compact, mixed use neighborhoods close to transit stops and less taking place in sprawling outlying areas. A series of regional growth blueprints developed by planners with extensive public input have shown that such a path would deliver large benefits for California. For example:

- The Sacramento area could consume 50 percent less land to accommodate

new growth by 2050, conserve 60 square miles of agricultural land, and reduce vehicle travel by more than one-quarter by following a more compact vision for future growth instead of continuing current sprawling developing patterns.[108]

- The Bay Area could consume about one-third the new land and significantly reduce per-capita vehicle ownership by choosing a smart growth path for the region's future compared with continuing to develop according to current trends.[109]

- Southern California could reduce per capita vehicle travel by more than 4 percent by following a growth vision for the region that channels most new development into areas with existing infrastructure.[110]

The results of these studies are not unusual: in a survey of 23 metropolitan growth scenarios nationwide, compact growth scenarios averaged 8 percent fewer total miles driven than business-as-usual ones, with a maximum reduction of 31.7 percent.[111] The better-performing scenarios were those with higher degrees of land-use mixing and population density, as well as a larger amount of expected growth.[112]

A particularly powerful tool in reducing vehicle travel is transit-oriented development—that is, mixed-use developments near transit stops that allow individuals to conduct more of their daily tasks via transit, on bike or on foot. The combination of good transit service with a mix of residential and commercial uses can have a powerful impact on the amount that people drive.

Transit oriented development is associated with decreased auto ownership, decreased daily vehicle miles traveled, and increased use of public transit—all of which result in reductions in global warming pollution.[113]

California has already begun to promote transit-oriented development near transit stops. In the Bay Area, for example, the Metropolitan Transportation Commission adopted a first-of-its-kind transit-oriented development policy that requires minimum levels of housing development along new transit lines and promotes well-planned development around transit stations.[114] Similar efforts to build mixed-use development near transit stations have occurred in the Los Angeles and San Diego areas as well.

Demand for housing and commercial space near transit is likely to boom in the years to come. A 2005 study, for example, projected that one-third of Bay Area households were likely to look for housing near transit and that 42 percent of jobs could be located in proximity to transit.[115] The demand for transit-oriented development—both residential and commercial—could be even greater in areas of the state that currently have little transit infrastructure.

Stopping exurban sprawl and promoting transit-oriented development will require action from all levels of government. Specifically, the state should:

- Incorporate global warming emission impacts into all land-use planning and infrastructure decisions, and require local governments to do so as well. Local, regional and state planners should be required to develop long-range plans that address projected local needs while reducing global warming pollution.

- Use state funding for transportation and infrastructure to leverage better land-use practices. California taxpayers should not subsidize infrastructure investments that will lead to further sprawl.

- Increase support for transit-oriented development by providing funding and technical assistance to help developers, local governments and transit agencies plan for transit-oriented development. In addition, state and local governments should implement incentives designed to encourage the development of housing near transit stations.

In assessing the potential global warming pollution reductions that could result from smart growth and transit-oriented development in California, we made the following assumptions:

- Per-capita vehicle-miles traveled would remain constant at 2010 levels for the current population of California. The experience of cities like Portland, and the results of various land-use planning analyses in California, suggests that this target can be reached.

- Population increases between 2010 and 2030 would be accommodated in transit-oriented developments, with those residents driving an average of 20 percent fewer vehicle miles, compared with average 2010 per-capita VMT.[116]

- These reductions do not include those that would be achieved by expanding the reach of current transit systems, reducing long-distance trips with high-speed rail, or reducing commuting through ride-sharing, telecommuting and other means.

These assumptions do not presume that every new Californian will live in a transit-oriented development or that there will be no new exurban sprawl. Rather, they assume that, with a combination of strong land-use policies and a focus on transit-oriented development, California can gradually reduce per-capita vehicle travel over time. Indeed, per-capita vehicle-miles traveled has been roughly stable at about 25 miles per person per day since 2002.[117]

By directing California's future growth away from sprawl in exurban areas and toward the development of compact, mixed-use neighborhoods near transit stops, the state could curb the growth of vehicle travel on our roads, while cutting global warming pollution.

# Results of the Strategies

California has great potential to reduce global warming pollution from transportation. The seven strategies described above, if pursued aggressively and simultaneously, could significantly reduce global warming emissions from transportation in the state.

Achieving the targets laid out above—each of which is achievable given a vigorous and sustained public policy effort—would reduce carbon dioxide emissions from transportation in California by approximately 31 percent by 2020 and 46 percent by 2030 compared with business-as-usual levels.

These seven strategies would bring transportation emissions down to 6 percent above 1990 levels by 2020 (compared with 24 percent above 1990 levels in 2004), enabling the transportation sector to play an important role in achieving the statewide target established by AB 32, the landmark cap on global warming emissions adopted by California in 2006. By 2030, California could reduce transportation sector emissions to approximately 8 percent below 1990 levels.

In addition to the seven strategies above, California can also take other steps to reduce global warming pollution from transportation, including strategies designed to:

- Reduce energy consumption and emissions from freight railroads, ships, and port operations.

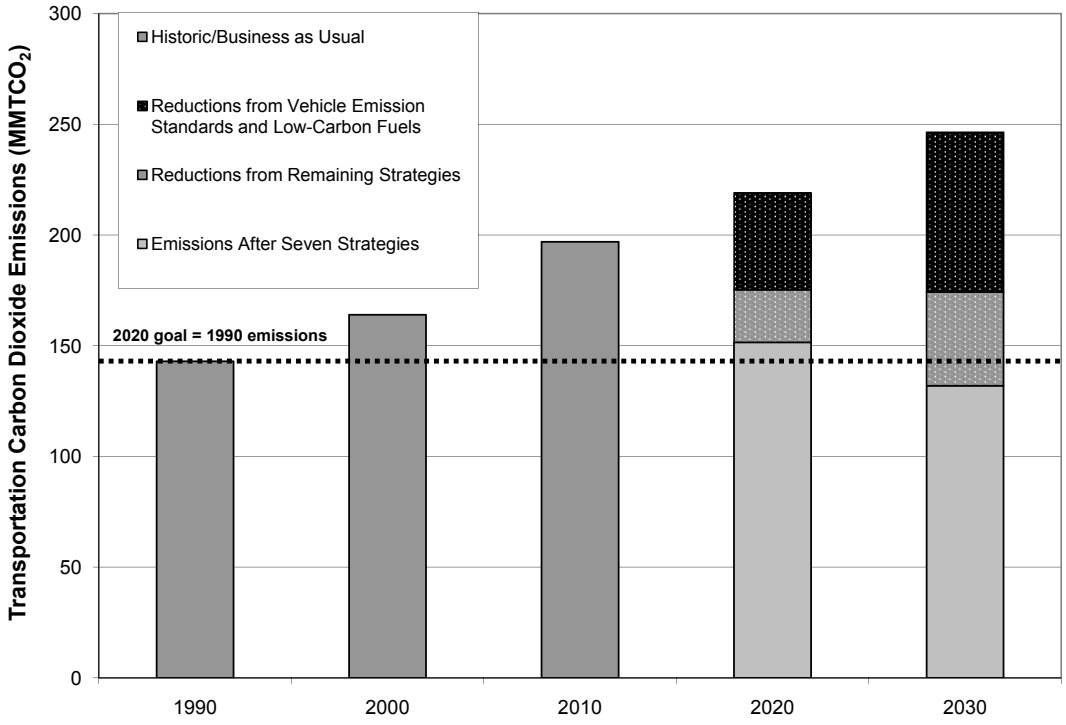
- Reduce non-carbon dioxide global warming pollution emissions from transportation vehicles.

- Create market incentives to encourage reductions in vehicle travel or improvements in energy efficiency—for example, by shifting vehicle insurance and other flat-rate charges to per-mile fees.

To achieve the emission reductions described above, however, California must act boldly and must act fast. The state must make the following core commitments:

- California must continue to move forward with aggressive standards to reduce global warming pollution from transportation vehicles and fuels, including pending or proposed

**Figure 8. California Transportation Carbon Dioxide Emissions With and Without the Seven Strategies**




standards for light-duty vehicles, heavy-duty trucks and other transportation vehicles. In addition, California should continue to use regulatory standards to "push" the development of cleaner technologies over time.

- The state must invest in low-carbon transportation infrastructure—including investing in a high-speed rail system and the construction of additional rapid transit links in California's metropolitan areas.

- California must make global warming a central consideration in transportation and land-use planning and in permitting decisions. All transportation infrastructure decisions should be analyzed for their global warming impacts, with lower emission projects given preference. Cities, counties and regions should incorporate global warming emission considerations into their land-use plans and develop plans that lead to net decreases in global warming pollution.

- California should develop incentives and disincentives that push companies and individuals to make transportation decisions that are good for the climate. For example, the state should consider reinstating mandatory commute-trip reduction targets for employers, providing technical assistance to help businesses achieve those targets, and creating financial incentives to encourage consumers to purchase lower polluting vehicles.

# Methodology

## Historic and Business-As-Usual Emissions

Historic emissions of carbon dioxide from transportation sources were obtained from California Air Resources Board (ARB), *Draft California Greenhouse Gas Inventory*, 19 November 2007. Projections of future emissions for 2010 and 2020 are based on assumptions of the percentage increase in emissions for light-duty and heavy-duty vehicles and jet fuel consumption from Appendix F-2 of California Energy Commission (CEC), *Update to the Greenhouse Gas Inventory*, (Excel workbook), 24 January 2008. Emissions from rail, water-borne travel and other sources of transportation emissions were projected to remain constant at 2004 levels, consistent with the CEC's assumptions. Increases in fuel consumption for aviation were assumed to take place in the same proportions for in-state, domestic and international flights. A cell lookup error in the worksheet was corrected to provide accurate transportation sector projections for 2020. Projected emissions for 2030 are based on a linear extrapolation of emission trends from 2010 to 2020.

Transportation-sector emissions, as defined in this report, are those defined in the ARB inventory. These emissions do not include emissions from international bunker fuels and interstate air travel.

## Emission Reductions

### Reducing Emissions from Vehicle Tailpipes

California's vehicle tailpipe emission standards for global warming pollution were estimated to reduce emissions from on-road gasoline-powered vehicles by 20 percent by 2020, based on California Air Resources Board (ARB), *Comparison of Greenhouse Gas Reductions for the United States and Canada Under U.S. CAFE Standards and California Air Resources Board Greenhouse Gas Regulations*, 25 February 2008.

To estimate the impact of the standards

for 2030, we used the ARB's estimates of emission reduction levels from new vehicles under the future "Pavley 2" standards for model years 2017 through 2020. We then estimated how the current and future standards would impact emissions for the light-duty vehicle fleet in 2030, using estimates of vehicle miles traveled by vehicle type and model year from the ARB's EMFAC emission inventory model to estimate the percentage of emission reductions versus the baseline. The data used were from the ARB's analysis of the relative benefits of California's vehicle tailpipe emission standards for greenhouse gases and the federal Corporate Average Fuel Economy program, provided by Jon Taylor of the ARB to Elizabeth Ridlington of Frontier Group on 18 March 2008.

## Reducing Emissions from Vehicle Fuels

We assumed that half the emission reductions produced by the low-carbon fuel standard for light-duty vehicles could also be counted toward California's vehicle tailpipe emission standards for global warming pollutants. This assumption is highly speculative, since the state of California has not yet adopted a low-carbon fuel standard. Depending on how the standard is structured, the level of overlap between the low-carbon fuel standard and the tailpipe emission standards could be greater or less than is assumed here.

We assumed that California would receive the full benefit of the low-carbon fuel standard for heavy-duty vehicles, a 10 percent emission reduction, by 2020 and that the low-carbon fuel standard would remain in force through 2030. For both light-duty and heavy-duty vehicles, we also gave California credit for all the life-cycle emission reductions delivered by the program—even if some of the emissions and emission savings occur in other states.

## Reducing Emissions from Heavy-Duty Trucks

Emission reductions are based on estimated improvements in heavy-duty truck fuel economy of 21 percent by 2020 and 33 percent by 2030. The 21 percent reduction in 2020 assumes that new heavy-duty trucks sold after 2015 will experience a 33 percent reduction in per-mile, and that remaining, older trucks will experience a 9 percent reduction in carbon dioxide emissions per-mile, based on adoption of a policy for truck retrofits by the California Air Resources Board. The 9 percent energy savings figure for retrofits is based on California Air Resources Board, *Proposed Greenhouse Gas Measures*, downloaded from www.arb.ca.gov/msprog/onrdiesel/documents/080125_ghg_measures.pdf, 13 February 2008. Half of all truck vehicle-miles in 2020 were assumed to be in post-2015 trucks and half in pre-2015 trucks, based on national VMT accumulation rates by model year for heavy-duty trucks from U.S. Census Bureau, United States: 2002 Economic Census: *Vehicle Inventory and Use Survey*, December 2004. The 33 percent reduction in per-mile emissions from new trucks after 2015 is consistent with the level of feasible, cost-effective fuel economy improvements in Therese Langer, American Council for an Energy-Efficient Economy, *Energy Savings Through Increased Fuel Economy for Heavy-Duty Trucks*, prepared for the National Commission on Energy Policy, 11 February 2004.

## Reducing Single-Passenger Work Trips

Commute-trip reduction efforts were estimated to reduce drive-alone commuting by 10 percent by 2020 and 20 percent by 2030 at California employers with more than 100 employees. The 10 percent figure is slightly higher than the percentage of drive-alone trips displaced

by existing and previous commute-trip reduction programs, but is consistent with the potential results of a comprehensive program based on Todd Litman, Victoria Transit Policy Institute, *Transit Demand Management Encyclopedia: Commute Trip Reduction*, 27 August 2007. Companies with more than 100 employees employ approximately 63 percent of California workers, based on U.S. Census Bureau, *Statistics of U.S. Businesses: 2005: All Industries: California*, downloaded from www.census.gov/epcd/susb/2005/ca/CA--.HTM, 14 February 2008. Commute trips were estimated to make up 27 percent of vehicle-miles traveled, per Pat S. Hu and Timothy R. Reuscher, U.S. Department of Transportation, *Summary of Travel Trends: 2001 National Household Travel Survey*, December 2004.

## Connecting California's Cities with High-Speed Rail

Carbon dioxide emission reductions from high-speed rail were based on 2030 estimates from U.S. Department of Transportation, Federal Railroad Administration and California High Speed Rail Authority, *Draft Bay Area to Central Valley High-Speed Train (HST) Program Environmental Impact Report/ Environmental Impact Statement (EIR/EIS)*, Volume 1: Report, July 2007. This document does not factor in emission reductions from California's vehicle tailpipe emission standards or the low-carbon fuel standard. We assume that these standards would reduce the emission benefits of the high-speed rail network by the same proportion that they would reduce overall light-duty vehicle emissions. For 2020 emission reductions, we assumed that the system would deliver half the amount of emission reductions delivered in 2030. This estimate assumes that a substantial portion of the high-speed network will be completed by 2020.

## Expanding California's Transit Networks

To estimate potential emission reductions from transit system expansion, we identified census tracts in six California urbanized areas (San Francisco-Oakland, San Jose, Sacramento, Los Angeles, Riverside-San Bernardino, and San Diego) within one half-mile of a fixed-guideway transit stop (typically commuter rail, heavy rail and light rail), using U.S. Census geospatial information embedded in ArcMap v. 9.2 and data on transit stop locations from U.S. Department of Transportation, Bureau of Transportation Statistics, *National Transportation Atlas Database*, 2007. Data on commuting patterns in 2000 by Census tract were obtained from Census Transportation Planning Package, Part 1, Table 2, downloaded from www.transtats.bts.gov, 11 January 2008.

The number of workers traveling to work by various modes was calculated for those residents living in tracts within one half-mile of a transit stop and those living in the remainder of the urbanized area, for each of the six urbanized areas. These data were used to calculate the percentage of residents living near transit who drive to work alone versus the percentage of drive-alone commuters in the rest of the urbanized area. Geospatial data were also used to calculate the percentage of urbanized area residents who lived in census tracts within one half-mile of a transit stop. We assumed that expanding the percentage of residents with access to transit would result in the non-drive-alone share of commuting approaching the rate for those currently living within a half-mile of transit stops in that area. For example, we assumed that an expansion of transit service that put an additional 1 percent of Los Angeles residents within a half-mile of a transit stop would reduce drive-alone commuting by 0.09 percent. We also assumed that the same level of VMT reductions would occur for non-

work travel as well. We then multiplied the reduction in drive-alone commuting per percentage increase in transit access by the percentage of additional residents that would have to be reached by transit to achieve a 50 percent transit access goal by 2020 and a 75 percent goal by 2030.

To account for increased emissions from transit vehicles, we divided the amount of carbon dioxide pollution averted through transit operations by the amount of carbon dioxide produced by transit vehicles in California in 2006, using data from CALPIRG Education Fund, *A Better Way to Go: Meeting America's 21st Century Transportation Challenges With Modern Public Transit*, March 2008. This resulted in a 27 percent reduction in the emission reductions delivered by transit as calculated above.

There are two known problems with the estimation approach used here. First, the National Transportation Atlas Database includes the LA Metro Gold Line, which was not completed until 2003, while other data used in this analysis dates from the 2000 Census. As a result, the data in this report likely underestimate the benefits of transit expansion in the Los Angeles area. Second, the National Transportation Atlas does not include data for bus rapid transit stations.

## Stopping Sprawl and Expanding Transit-Oriented Development

We assumed that land-use policies that prevent exurban sprawl would maintain statewide per-capita vehicle-miles traveled (VMT) at approximately 2010 levels for the current population of California, based on VMT data obtained from the California Energy Commission.[118] We also assumed that future population growth would be accommodated by increasing the supply of housing in transit-oriented developments (or developments with the vehicle travel characteristics of transit-oriented development). Residents of transit-oriented developments were assumed to drive an estimated 20 percent fewer miles, based on the lower bound of estimates presented in Reid Ewing, Keith Bartholomew, Steve Winkelman, Jerry Walters and Don Chen, Smart Growth America, *Growing Cooler: The Evidence on Urban Development and Climate Change*, 18 September 2007. The result of these two assumptions is that policies to stop sprawl and promote transit-oriented development would reduce the statewide growth in VMT by roughly half between 2008 and 2030.

# Notes

1. Emissions do not include interstate or international aviation or international shipping outside California waters.

2. Assembly Bill 32, downloaded from www.arb.ca.gov/cc/docs/ab32text.pdf on 18 January 2008; Decrease below business as usual based on an Excel worksheet provided by the California Energy Commission corresponding to Table F-2 in California Energy Commission, *Inventory of California Greenhouse Gas Emissions and Sinks, 1990 to 2004*, Final Staff Report, December 2006, with correction as described in "Methodology," page 33.

3. California Air Resources Board, *Draft California Greenhouse Gas Inventory*, 19 November 2007. Figures do not include international shipping or interstate or international aviation.

4. California Air Resources Board, *Draft California Greenhouse Gas Inventory*, 19 November 2007.

5. Ibid.

6. Ibid.

7. Ibid.

8. Ibid.

9. Ibid.

10. Panama Bartholomy, California Energy Commission, personal communication, 9 January 2008.

11. Based on vehicle miles traveled estimates and projections obtained from Panama Bartholomy, California Energy Commission, personal communication, 9 January 2008, and population estimates from U.S. Census Bureau, *Intercensal Estimates*, downloaded from www.census.gov/popest/archives/2000s/vintage_2001/CO-EST2001-12/CO-EST2001-12-06.html, 24 March 2008, and U.S. Census Bureau, *Table 1: Annual Estimates of the Population for the United States, Regions, States, and Puerto Rico: April 1, 2000 to July 1, 2007*, 27 December 2007.

12. Based on vehicle miles traveled estimates and projections obtained from Panama Bartholomy, California Energy Commission, personal communication, 9 January 2008, and population projections from United States Census Bureau, *Interim Projections of the Total Population of the United States and States*, downloaded from www.census.gov/population/projections/SummaryTabA1.pdf on 18 February 2008.

13. United States Census Bureau, *Interim Projections of the Total Population of the United States and States*, downloaded from www.census.gov/population/projections/SummaryTabA1.pdf on 18 February 2008.

14. See note 10.

15. VMT projection: Panama Bartholomy, California Energy Commission, *2007 Integrated Energy Policy Report*, 15 October 2007; Population projection: United States Census Bureau, *Interim Projections of the Total Population of the United States and States*, downloaded from www.census.gov/population/projections/SummaryTabA1.pdf on 18 February 2008.

16. California Department of Transportation, *Historical Monthly Vehicle Miles of Travel*, downloaded from traffic-counts.dot.ca.gov/monthly/VMTHIST1.pdf, 25 March 2008.

17. U.S. Department of Transportation, Federal Highway Administration, *Traffic Volume Trends* series of reports, downloaded from www.fhwa.dot.gov/ohim/tvtw/tvtpage.htm, 24 March 2008.

18. This compares to a projected annual reduction in 2020 of 31.7 million metric tons of carbon dioxide equivalent from California Air Resources Board, *Comparison of Greenhouse Gas Reductions for the United States and Canada Under U.S. CAFE Standards and California Air Resources Board Greenhouse Gas Regulations*, 25 February 2008.

19. CA Health & Safety Code § 43018.5.

20. California Air Resources Board, *Comparison of Greenhouse Gas Reductions Under CAFE Standards and ARB Regulations Adopted Pursuant to AB 1493*, 2 January 2008.

21. California Air Resources Board, *Staff Report: Initial Statement of Reasons for Proposed Rulemaking, Public Hearing to Consider Adoption of Regulations to Control Greenhouse Gas Emissions from Motor Vehicles*, 6 August 2004.

22. See note 20.

23. Juliet Eilperin, "EPA Chief Denies Calif. Limit on Auto Emissions," *Washington Post*, 20 December 2007.

24. Walter S. McManus, University of Michigan Transportation Research Institute, *Economic Analysis of Feebates to Reduce Greenhouse Gas Emissions from Light Vehicles for California*, May 2007.

25. Emission reductions assume 50 percent overlap between the standard for light-duty vehicle fuels and the use of alternative fuel vehicles to receive credit under the state's vehicle tailpipe emission standards.

26. California Energy Commission, *Low Carbon Fuel Standard*, 2 August 2007.

27. Timothy Searchinger, Ralph Heimlich, et al., "Use of U.S. Croplands for Biofuels Increases Greenhouse Gases Through Emissions from Land Use Change," *Science*, 28 January 2008.

28. David Crane and Brian Prusnek, Office of the Governor, *The Role of a Low Carbon Fuel Standard in Reducing Greenhouse Gas Emissions and Protecting Our Economy*, 9 January 2007.

29. Ibid.

30. 19 percent from U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics 2005*, 18 December 2006; increasing by more than 4 percent per year from Stacy C. Davis, Susan W. Diegel, Oak Ridge National Laboratory, *Transportation Energy Data Book: Edition 25*, 2006.

31. Therese Langer, American Council for an Energy-Efficient Economy, *Energy Savings Through Increased Fuel Economy for Heavy-Duty Trucks*, prepared for the National Commission on Energy Policy, 11 February 2004.

32. The 2007 federal energy bill requires a study by the National Academy of Sciences (NAS), gives the federal government a year after the NAS study to develop test procedures for heavy-duty vehicle fuel economy, gives the government two years to develop a fuel-economy standard, and promises at least four model years of regulatory lead time before a standard can be enforced.

33. California Air Resources Board, *Proposed Greenhouse Gas Measures*, downloaded from www.arb.ca.gov/msprog/onrdiesel/documents/080125_ghg_measures.pdf, 13 February 2008.

34. Trucks 10 years of age and younger account for approximately 83 percent of the miles traveled by trucks (other than light-duty trucks) on U.S. highways. Source: U.S. Census Bureau, *2002 Economic Census: Vehicle Inventory and Use Survey*, December 2004.

35. U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, *Indicators of Energy Intensity in the U.S.*, downloaded from intensityindicators.pnl.gov/trend_data.stm, 25 March 2008.

36. U.S. Department of Transportation, Federal Highway Administration, "Freight Transportation Profile—California Freight Analysis Framework," *Freight News*, November 2002.

37. 28 percent from Pat S. Hu and Timothy R. Reuscher, U.S. Department of Transportation, *Summary of Travel Trends: 2001 National Household Travel Survey*, December 2004.

38. U.S. Bureau of the Census, *American Fact Finder*, downloaded from factfinder.census.gov, 8 January 2008.

39. UrbanTrans Consultants, *Mandatory Trip Reduction Programs*, Power Point presentation to RAQC Ozone Stakeholder Meeting, Transportation Programs, 11 December 2007.

40. Tricia Price, Southern California Council of Governments, *Employer Transportation Programs in L.A., Myth vs. Reality*, presentation to European Conference on Mobility Management, 15-17 May 2002.

41. Washington State Department of Transportation, *Commute Trip Reduction Results—It Works!*, downloaded from www.wsdot.wa.gov/TDM/CTR/CTRworks.htm, 14 February 2008.

42. Revised Code of Washington 70.94.527.

43. Oregon Department of Environmental Quality, *Employee Commute Options (ECO) Program Frequently Asked Questions*, downloaded from www.deq.state.or.us/nwr/ECO/FAQ.htm, 17 September 2007.

44. Z. Andrew Farkas, "Employer Trip Reduction Programs: How Effective and at What Cost?", *Business Forum*, Winter-Spring 2001.

45. Commute Trip Reduction Task Force, *CTR Task Force 2005 Report to the Washington State Legislature*, February 2006.

46. Oregon Department of Environmental Quality, *Oregon State Implementation Plan*, *Section 4.50*, *Portland-Vancouver AQMA (Oregon portion) and Salem-Keizer 8-Hour Ozone Maintenance Plan* (discussion draft), 18 April 2006.

47. Reduced congestion has both positive and negative impacts on global warming pollution. On the positive side, less congestion means less fuel wasted by vehicles idling in traffic jams. On the negative side, however, reduced congestion makes driving an easier and more appealing choice for commuters, thus encouraging more driving.

48. San Diego Association of Governments, *Vanpools Offer Solution to Rising Gas Prices*, downloaded from www.sandag.org/index.asp?newsid=390&fuseaction=news.detail, 14 February 2008.

49. Los Angeles County Metropolitan Transportation Authority, *Los Angeles Metro Launches New Metro Vanpool Program to Save Commuters Money*, *Improve Regional Mobility*, (press release), 7 August 2007.

50. Todd Litman, Victoria Transit Policy Institute, *Telework: Using Telecommunications To Substitute for Physical Travel*, 27 August 2007.

51. Elizabeth G. Hill, California Legislative Analyst's Office, *A Commuter's Dilemma: Extra Cash or Free Parking?*, 19 March 2002.

52. Donald Shoup, *Parking Cash Out*, Report 532, Planning Advisory Service, American Planning Association, 2005.

53. California Air Resources Board, *California's Parking Cash Out Program*, March 2002.

54. See note 51.

55. See note 45.

56. Emission reduction for 2020 is based on the assumption that ridership will be half the projected 2030 level.

57. California High Speed Rail Authority and United States Department of Transportation, *Final Program Environmental Impact Report/Environmental Impact Statement for the* Proposed *California High-Speed Train System*, August 2005.

58. Royal Commission on Environmental Pollution (UK), *The Environmental Effects of Civil Aircraft in Flight*, 29 November 2002. Short-haul aircraft do not, however, consume as much fuel per passenger-mile as very long-haul aircraft (such as those traveling between continents), whose fuel economy is eroded by the vast amount of fuel that must be stored on board the aircraft.

59. United States Department of Transportation, Research and Innovative Technology Administration, Bureau of Transportation Statistics, *Air Carrier Statistics (Form 41 Traffic)—U.S. Carriers*, downloaded from www.transtats.bts.gov/DL_SelectFields.asp? Table_ID=259&DB_Short_Name=Air%20Carriers on 23 January 2008.

60. See note 57.

61. Ibid.

62. U.S. Department of Transportation, Bureau of Transportation Statistics, *Airport Snapshots*, downloaded from www.transtats.bts.gov/airports.asp?pn=1 on 3 March 2008.

63. Ibid.

64. Ryan N. Hall, San Diego County Regional Airport Authority, *The San Diego Region's Air Transportation Future*, 22 June 2006

65. See note 57.

66. Ibid.

67. Ibid.

68. California High Speed Rail Authority, *What's New?*, downloaded from www.cahighspeedrail.ca.gov/ whats_new/ on 24 January 2008.

69. Dan Leavitt, California High Speed Rail Authority, personal communication, 20 March 2008.

70. U.S. Department of Transportation, Federal Railroad Administration and California High Speed Rail Authority, *Draft Bay Area to Central Valley High-Speed Train (HST) Program Environmental Impact Report/ Environmental Impact Statement (EIR/EIS)*, Volume 1: Report, July 2007. The travel times for car and air travel here and in Figure 6 reflect the construction of high-speed rail, which will also reduce congestion (and, by extension, travel times) on highways and by air. Car and plane trips would take longer

than indicated here were California not to build high-speed rail.

71. U.S. Department of Transportation, Federal Railroad Administration and California High Speed Rail Authority, *Draft Bay Area to Central Valley High-Speed Train (HST) Program Environmental Impact Report/ Environmental Impact Statement (EIR/EIS)*, Volume 1: Report, July 2007.

72. California High Speed Rail Authority, *Implementation Plan*, downloaded from www.cahighspeedrail.ca.gov/implementation/ImplementationPlan.pdf on 24 January 2008.

73. See note 71.

74. California High-Speed Rail Authority, *California High-Speed Rail Authority to Study Zero Greenhouse Gas Emission*, (press release), 7 February 2008.

75. See note 71.

76. There have been few third-party estimates of the amount of emissions that could be averted through high-speed rail. A previous national study, released by the Center for Clean Air Policy and the Center for Neighborhood Technology in 2006, estimated that a California high-speed rail system using conventional rail technology would save approximately 1.7 million metric tons of carbon dioxide per year at ridership levels projected for 2020. The CCAP/CNT study, however, used older estimates of ridership that had originally been prepared for the California High-Speed Rail Authority. See Center for Clean Air Policy and Center for Neighborhood Technology, *High-Speed Rail and Greenhouse Gas Emissions in the U.S.*, January 2006.

77. See note 72.

78. Michael Cabanatuan, "Pacheco Pass Chosen Over Altamont for Proposed High-Speed Rail Line," *San Francisco Chronicle*, 20 December 2007.

79. Transportation California, *New State Funding will Help Upgrade Highway 99*, downloaded from www.transportationca.com/displaycommon.cfm?an=1&subarticlenbr=214, 1 April 2008.

80. Master Plan LAX, *About the Program: Frequently Asked Questions*, downloaded from www.laxmasterplan.org/, 1 April 2008.

81. Based on 19.6 pounds of carbon dioxide per gallon of gasoline.

82. CALPIRG Education Fund, *A Better Way to Go: Meeting America's 21st Century Transportation Challenges with Modern Public Transit*, March 2008.

83. Figures for Los Angeles include residents who live near stations on Metro's Gold Line, which was completed in 2003. The Census data referred to here are from the 2000 Census. The inclusion of data on the travel habits of residents living near the not-yet-completed Gold Line means that the data for Los Angeles likely understate the propensity of people living near transit stops to commute to work via transit.

84. Steve Heminger, Metropolitan Transportation Commission, *Regional Policies for TOD: The San Francisco Bay Area Experience*, Power Point presentation to RailVolution, 1 November 2007.

85. Association of Bay Area Governments, et al., *New Places, New Choices: Transit-Oriented Development in the San Francisco Bay Area*, November 2006.

86. "Rapid transit" includes fixed-guideway transit stops identified in U.S. Department of Transportation, Bureau of Transportation Statistics, *National Transportation Atlas Database*, 2007. These include stops for commuter rail, heavy rail and light rail services. They do not include stops for bus rapid transit lines.

87. Southern California Association of Governments, *2008 Regional Transportation Plan: Transit Report*, December 2007.

88. San Diego Association of Governments, *2030 San Diego Regional Transportation Plan*, November 2007.

89. See note 87.

90. Metropolitan Planning Commission, *Transportation 2030: Mobility for the Next Generation*, February 2005.

91. Ibid.

92. Ibid.

93. See note 82.

94. Union of Concerned Scientists, *Hybrid Watchdog: Hybrid Transit Buses: Are They Really Green?* downloaded from www.hybridcenter.org/hybrid-transit-buses.html.

95. K. Chandler and K. Walkowicz, National Renewable Energy Laboratory, *King County Metro Hybrid Articulated Buses: Final Evaluation Results*, December 2006.

96. Ibid.

97. Los Angeles Metro, *Federal CNG Tax Credit Keeps a "Green" Metro Bus Fleet On the Move*, June 2007.

98. Ibid.

99. Ibid.

100. Stacey C. Davis and Susan W. Deigel, U.S. Department of Energy: Energy Efficiency and Renewable Energy, *Transportation Energy Data Book Edition 26*, 2007.

101. Reid Ewing, Rolf Pendall and Don Chen, *Measuring Sprawl and Its Impact*, 2002.

102. Ibid.

103. Ibid.

104. Ibid.

105. TriMet, *Facts About TriMet*, October 2006.

106. Office of the City Auditor, Portland, Oregon, *City of Portland Service Efforts and Accomplishments: 2006-2007, Seventeenth Annual Report on City Government Performance*, December 2007.

107. TriMet, *TriMet Fixed Route Service and Ridership Information*, downloaded from trimet.org/pdfs/ridership/busmaxstat.pdf, 3 January 2008, based on "boarding rides."

108. Sacramento Area Council of Governments, *Sacramento Region Blueprint: Special Report: Preferred Blueprint Alternative*, January 2005.

109. Smart Growth Strategy/Regional Livability Footprint Project, *Shaping the Future of the Nine-County Bay Area: Final Report*, October 2002.

110. Southern California Association of Governments, *Southern California Compass: Growth Vision Report*, June 2004.

111. Reid Ewing, Keith Bartholomew, Steve Winkelman, Jerry Walters and Don Chen, Smart Growth America, *Growing Cooler: The Evidence on Urban Development and Climate Change*, 18 September 2007.

112. Ibid.

113. Gloria Ohland and Shelley Poticha, Reconnecting America, *Street Smart: Streetcars and Cities in the Twenty-First Century*, 2006.

114. Nelson/Nygaard Consulting Associates, *MTC's Resolution 3434 Transit-Oriented Development Policy: Interim Evaluation*, prepared for the Metropolitan Transportation Commission, July 2006.

115. Center for Transit-Oriented Development, et al., *San Francisco Bay Area Transit-Oriented Development Study, Tasks 4A, 4B & 4C: Types and Distribution of TOD Opportunities in the Bay Area*, April 2005.

116. 20 percent based on the lower bound of estimates presented in Reid Ewing, Keith Bartholomew, Steve Winkelman, Jerry Walters and Don Chen, Smart Growth America, *Growing Cooler: The Evidence on Urban Development and Climate Change* 18 September 2007.

117. Roughly stable based on vehicle miles traveled estimates obtained from Panama Bartholomy, California Energy Commission, personal communication, 9 January 2008; population estimates from U.S. Census Bureau, *Intercensal Estimates*, downloaded from www.census.gov/popest/archives/2000s/vintage_2001/CO-EST2001-12/CO-EST2001-12-06.html, 24 March 2008 and U.S. Census Bureau, *Table 1: Annual Estimates of the Population for the United States, Regions, States, and Puerto Rico: April 1, 2000 to July 1, 2007*, 27 December 2007; and preliminary VMT estimates from U.S. Department of Transportation, Federal Highway Administration, *Traffic Volume Trends* series of reports, downloaded from www.fhwa.dot.gov/ohim/tvtw/tvtpage.htm, 24 March 2008.

118. See note 10.