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A Golden Opportunity

California's Solutions for Global Warming

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Executive Summary

With the landmark California Global Warming Solutions Act of 2006, California seeks to mitigate the risks of global warming and to become the home of the fast-growing clean technology industry. Assembly Bill 32 (also known as AB 32) is the most ambitious global warming solutions law in the nation, making California the first state to firmly limit statewide emissions. The law commits California to reduce its global warming pollution emissions back to 1990 levels by 2020, or nearly 30 percent below forecasted levels.

PROTECTING THE STATE FROM GLOBAL WARMING

Although curbing global warming will ultimately require a global solution, California can make a difference. Compared to other countries, the state is the 11th largest emitter of greenhouse gases in the world, so the state's pollution cuts will be substantial. More important, California's efforts aim to catalyze similar action across the country and abroad, building on the state's strong history of developing groundbreaking environmental solutions that also provide economic benefits, such as air quality and energy-efficiency standards.

THE HIGH COST OF DOING NOTHING

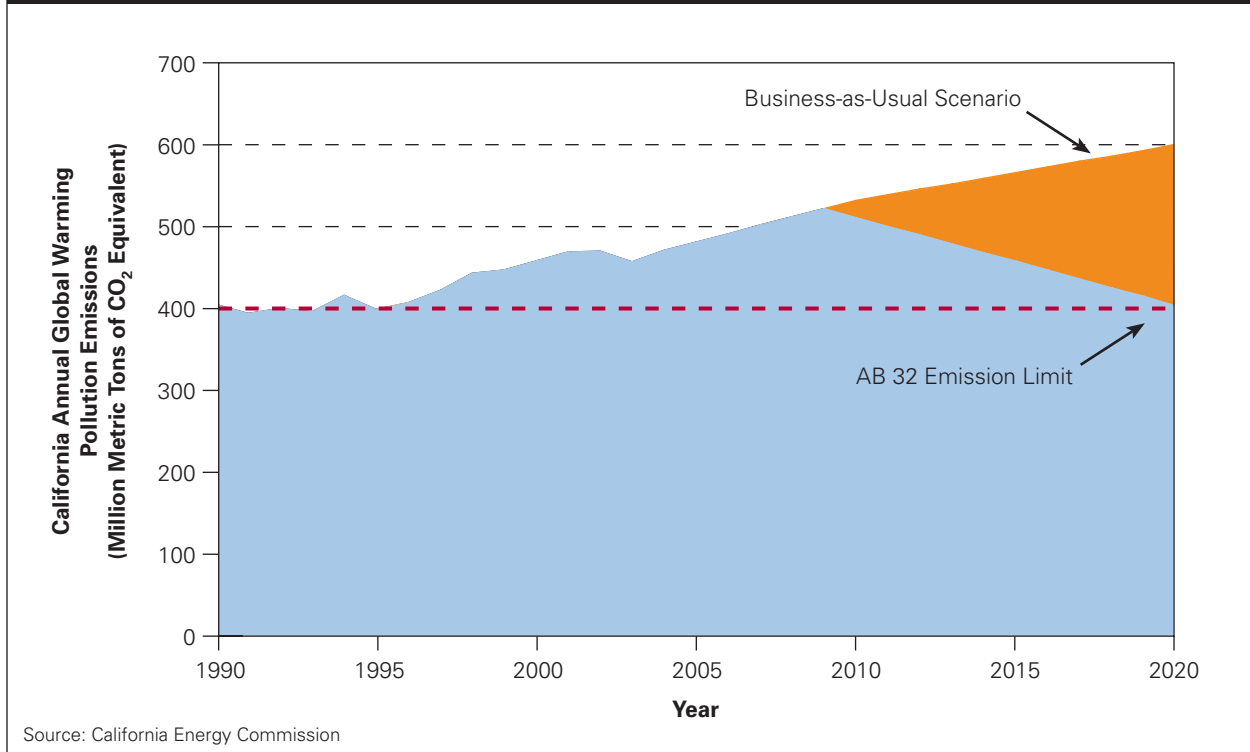
By spurring a broader effort to curb global warming, California aims to protect the state from the considerable economic and environmental risks of climate change. Inaction could have severe consequences for California:

- **Degraded air quality that threatens the health of Californians**, with more than 95 percent of the state's residents already living in areas with unhealthy air.
- **More frequent and severe heat waves**, similar to the one in July 2006 during which more than 100 people died across the state.
- **Loss of snowpack in the Sierra Nevada mountains**, which will threaten the state's water supply and valuable summer hydroelectric peak power generation.
- **Rising sea levels**, which will put additional strain on the state's levee system and further threaten water supplies as saltwater intrudes into aquifers.

A MODEL FOR GLOBAL WARMING SOLUTIONS

California is using bipartisan leadership to create a model for progress. The passage of the Global Warming Solutions Act reverberated around the world, but it is just the beginning. Over the next five years, state agencies will put in place a package of policies, which may include

Figure 1: AB 32's Impact on California's Greenhouse Gas Emissions



both traditional regulatory and market-based approaches, to advance pollution-cutting strategies to meet the state's emission limit, including:

- **Cleaner cars and trucks**, which cut pollution and save drivers billions of dollars;
- **Low-carbon fuels** that provide consumers with more choices at the pump and buffer against increasingly frequent gasoline price spikes;
- **Smart growth strategies** to design communities so that Californians can walk, bike, or take public transit to reach most places they want to go;
- **Energy efficiency**—getting more work out of less energy—which saves consumers billions of dollars and enhances competitiveness;
- **Renewable energy**, such as solar and wind resources, which help protect consumers from volatile fossil fuels prices; and
- **Cleaner power plants** that are more efficient and take advantage of advanced technologies such as carbon capture and storage.

Numerous additional strategies, including water efficiency and sustainable forestry practices, will also contribute to meeting the state's emission limit.

Market mechanisms may also play a role in California's package of policies to meet the 2020 limit, complementing regulatory programs that advance specific strategies. While the state may pursue a variety of options, including incentives and rebates, a program that creates an enforceable cap on emissions from certain sectors and allows covered entities to use certain types of market mechanisms to demonstrate compliance is among the most promising candidates. (This type of program is commonly known as a "cap and trade" program, although trading may be minimal if allowances are auctioned.) Such a system is an important component of fighting global warming pollution because, although AB 32 establishes a statewide emission limit that the state itself commits to achieve, a cap and trade program creates an enforceable limit on emitters. If properly designed, this approach can reduce costs, push emissions lower than regulatory programs alone, and stimulate innovation by providing companies with an incentive to exceed minimum requirements.

The state will need to use a package of policy tools to meet AB 32's aggressive statewide emission limit. Fortunately, California has a head start in reducing its emissions thanks to decades of clean energy policies. The state's investments in energy efficiency and renewable energy over the last 30 years have already reduced annual greenhouse gas (GHG) emissions by approximately 27 million metric tons of carbon dioxide—equivalent to the annual emissions of 5 million cars—while saving the state billions of dollars. New efforts will build on this record of success.

GROWING THE CLEAN TECHNOLOGY INDUSTRY

The Global Warming Solutions Act sends a clear signal to the market that California is “open for business” to clean technology companies and developers of innovative new products that cut emissions. Economists have found that meeting AB 32's pollution limit will provide tens of thousands of new jobs for residents of the Golden State, while saving families and businesses billions of dollars, largely from improved efficiency. And California can capture even larger benefits by cultivating the state's clean technology industry. Energy is a \$750 billion a year market in the United States alone, and the world spends trillions of dollars on energy every year. As countries around the globe invest in new clean energy infrastructure to curb global

warming, an enormous market opportunity for clean technologies is being created. California aims to lead this fast-growing clean technology market, just as it has led the high-tech and biotech industries.

CALIFORNIA'S CUTTING-EDGE COMPANIES SHOW HOW

AB 32's emissions limit activates entrepreneurs to pursue pollution-cutting technologies, and challenges California's innovators. The state has numerous institutions that will drive this innovation, including research, development, and demonstration centers, universities, and venture capital firms, which will all help commercialize, deploy, and export technologies and services that cut pollution.

Many California businesses are already leading the way to the state's clean energy and technology future. The case studies on page 19 highlight companies that are standouts in reducing emissions at their facilities, delivering pollution-cutting products and services to the marketplace, and demonstrating corporate leadership on global warming.

With continued leadership from California's policy-makers, businesses, and residents, California can tackle the biggest environmental challenge of our time while bringing jobs and economic opportunity to the state.

1. California Takes on Global Warming

Global warming is one of the largest problems facing the world today, posing serious risks to our economy and environment (see Appendix A). Scientists agree that global warming is happening as a result of human activity, primarily from burning fossil fuels to propel our cars, generate our electricity, and heat our homes.¹ Fortunately, we have the will to act and the solutions at hand: clean energy technologies and innovative practices that can reduce global warming pollution, stabilize energy costs by reducing our dependence on fossil fuels, and create new businesses and jobs for the 21st century.² California's new firm long-term limits on global warming pollution, coupled with its history of environmental policy innovation, will help protect the state and spur the fast-growing clean technology market.

PROTECTING THE GOLDEN STATE

Action in the next 10 to 20 years will have a profound effect on the global climate in the second half of this century and beyond.³ Scientists say that unless steps are taken now to reduce global warming pollution, average temperatures could rise another 4 to 11 degrees Fahrenheit by the end of the century.⁴ In California, global warming will have a significant impact, including:⁵

- Loss of snowpack in the Sierra Nevada mountains, which will disrupt the state's water supply and valuable summer peak power generation;
- More frequent and severe heat waves, similar to the one in July 2006 during which more than 100 people died across the state;
- Degraded air quality threatening the health of Californians, with more than 95 percent of the state's residents already living in areas with unhealthy air; and
- Rising sea levels, which will put additional strain on the state's levee system and further threaten water supplies as saltwater intrudes into aquifers.

See Appendix B for more detail about the effects of global warming on the state of California.

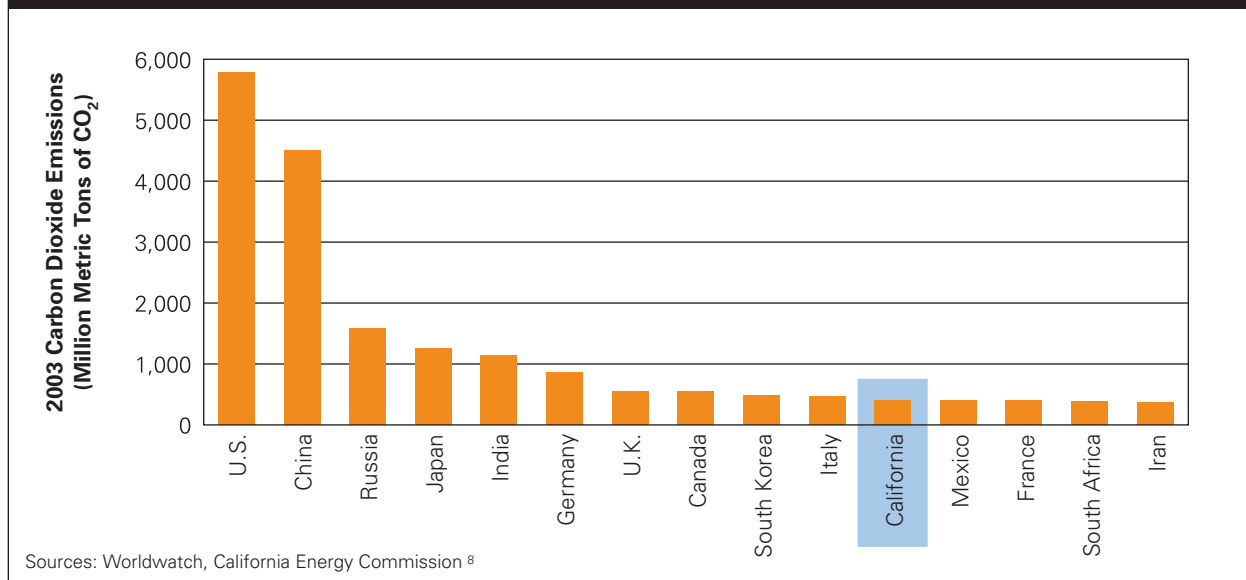
CHANGES IN CALIFORNIA HAVE FAR-REACHING EFFECTS

California's actions can help mitigate global warming's risks to the state. In 2004, California emitted 492 million metric tons of carbon dioxide (CO₂) equivalent, roughly equal to the annual emissions from 93 million cars, or more than half the cars on the road in the United States.^{6,7} Compared to entire countries, California is now the 11th largest emitter in the world (see figure 2). When the state cuts its pollution, it can make a big difference.

More important, time and again, California's policies have spurred other states, the entire nation, and countries around the world to take similar action, amplifying the state's successes. For example:

- In 1969, California adopted the world's first air quality standards. The federal government followed in 1971,

Figure 2: 2003 California CO₂ Emissions Compared with Other Countries



creating national air quality standards.⁹ This led to the use of catalytic converters in cars to limit pollution emissions.

■ California was the first state to adopt energy-efficiency standards for appliances and new buildings in the late 1970s. Other states, such as Florida, Massachusetts, Connecticut, and New York, did the same, leading to the enactment of national standards in 1987.¹⁰ Similarly, other countries, such as Russia and China, have modeled their building efficiency codes on California's.¹¹

■ In 2002, California was the first state to limit global warming pollution from passenger vehicles. Today, 11 other states and Canada have adopted similar regulations.¹² As a result, California's standards now apply to more than one-third of the North American car market.

In all of these cases, California set an example by adopting policies that provide environmental and economic benefits—energy savings and avoided health care costs due to air pollution, for example—and sparked similar efforts far beyond the state's borders.

THE CLEAN ENERGY FRONTIER

AB 32's firm limit on greenhouse gases (GHGs) sends a clear signal to residents and to the market to reduce global warming pollution, focusing California's entrepreneurs to pursue clean technologies.

Reducing the state's reliance on fossil fuels is one way for California to cut its global warming pollution while boosting the economy. Today, California imports approxi-

mately \$30 billion of fossil fuels annually, whose use is the primary cause of the state's global warming pollution—this is an average of \$2,500 from every California household.¹³ By reducing the state's reliance on these fuels, California can reduce its global warming pollution and invest in clean technologies, creating jobs, buffering against energy price volatility, and catalyzing other economic benefits.

Several studies have shown that California can meet AB 32's emissions limit using currently available technologies while boosting the state's bottom line. Economists at the California Air Resources Board (CARB) found that meeting the 2020 limit can increase Californians' income by \$4 billion and provide 83,000 additional jobs by 2020.¹⁴ A study by a team of economists at the University of California, Berkeley, found that meeting the state's emission limit can increase the Gross State Product by approximately \$60 billion by 2020.¹⁵ These estimates model only some of the potential benefits for California.

By jumping to the forefront of the worldwide effort to curb global warming, California can build on its strong position in the fast-growing clean technology market. Energy is a \$750 billion a year market in the United States alone, and the world spends trillions of dollars on energy every year.¹⁶ As countries around the globe invest in a new clean energy infrastructure in order to curb global warming, an enormous market opportunity for clean technologies is being created. Just as California launched the high-tech and biotech industries, the state is now poised to develop a vibrant clean technology industry.

2. California's Framework for Cutting Pollution

The Global Warming Solutions Act commits the state to reduce global warming pollution back to 1990 levels by 2020 through a concerted effort to deploy clean energy technologies and other emission reduction strategies. Some of these strategies are already underway, and they are projected to provide about half of the emission reductions needed to meet the 2020 emissions limit.¹⁷ AB 32 will provide the overarching framework for California's programs to reduce global warming pollution (see figure 3).

The law is a product of bipartisan leadership from Assembly Speaker Fabian Núñez, Assemblymember Fran Pavley, Senate President pro Tem Don Perata, and Governor Arnold Schwarzenegger. It codifies and makes enforceable the 2020 greenhouse gas emission reduction target established by the governor in a 2005 Executive Order, which the multi-agency Climate Action Team had shown can be achieved using currently available technologies while providing economic benefits to the state. The Legislature passed AB 32 as part of a package of bills to curb global warming and promote clean energy, including the landmark Senate Bill 1368, which establishes the first minimum emissions standard in the world for any new long-term utility investments in baseload power plants.

AB 32 received widespread support from clean energy companies, high-tech businesses, venture capitalists, environmental organizations, and health professionals. In 2006, polls showed that eight in 10 California residents believed that global warming is a very serious or serious concern, 70 percent of likely voters favored the state adopting its own policies on global warming, and a majority supported reducing GHG emissions to 1990 levels by 2020.¹⁸

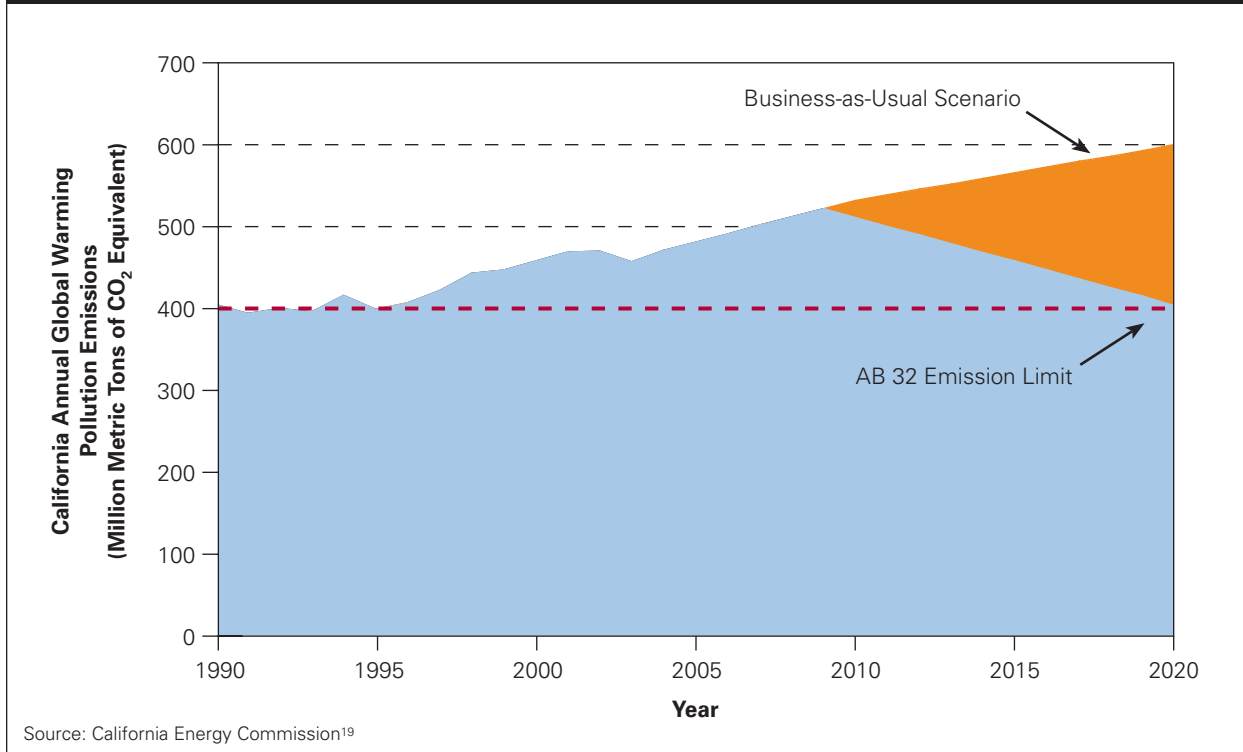


Signing of the California Global Warming Solutions Act of 2006.

PUTTING AB 32 INTO ACTION

AB 32 provides guidelines and a timeline for state agencies to implement programs to meet the GHG limit. The law creates a central role for the California Air Resources Board (CARB), while at the same time recognizing that many other state agencies—coordinated by the Secretary of the California Environmental Protection Agency

Figure 3: AB 32’s Impact on California Greenhouse Gas Emissions



through the Climate Action Team—will also have a crucial role in reducing emissions. CARB and all of the agencies in the Climate Action Team will need to adopt and implement a whole package of policies to enable the state to meet AB 32’s pollution limit.

The law authorizes CARB to establish both regulatory and market-based programs to reduce emissions. CARB must design these programs through an open public pro-

cess to meet a variety of guidelines, including minimizing costs and maximizing benefits to California, encouraging early action to reduce emissions, ensuring that low-income communities are treated equitably, complementing efforts to improve air quality and reduce toxic emissions, and more. Further, CARB must ensure that any market mechanisms produce real and verifiable emission reductions.

TIMELINE FOR IMPLEMENTING AB 32

AB 32 sets an aggressive timeline for implementation (see sidebar). Beginning in 2008, CARB will adopt a reporting program for significant emitters to enable the agency to enforce compliance with emission reduction programs and to monitor progress toward the 2020 limit. CARB will establish reporting protocols based on those developed by the California Climate Action Registry. Next, CARB will identify early regulatory measures that can be adopted and enforced by 2010. Finally, by 2009, CARB will adopt a comprehensive plan for achieving the 2020 limit, adopt regulations to implement that plan by 2011, and begin enforcement of those programs beginning in 2012.

To meet the state's 2020 emissions limit, CARB and the other state agencies will be considering a package of complementary policies, including programs to encourage individual emission reduction strategies (such as energy-efficiency standards), as well as policies to limit overall emission from certain sectors (such as a cap and trade program). These policies are discussed in the following section.

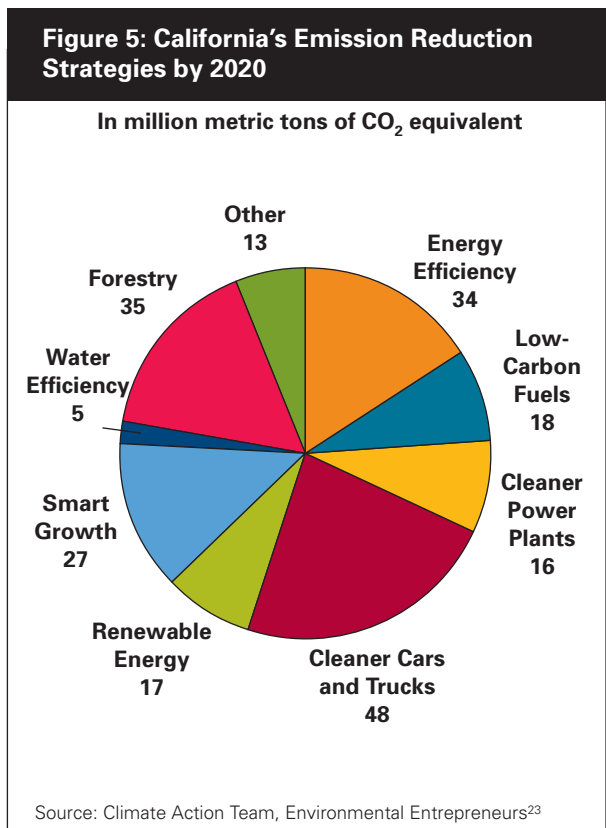
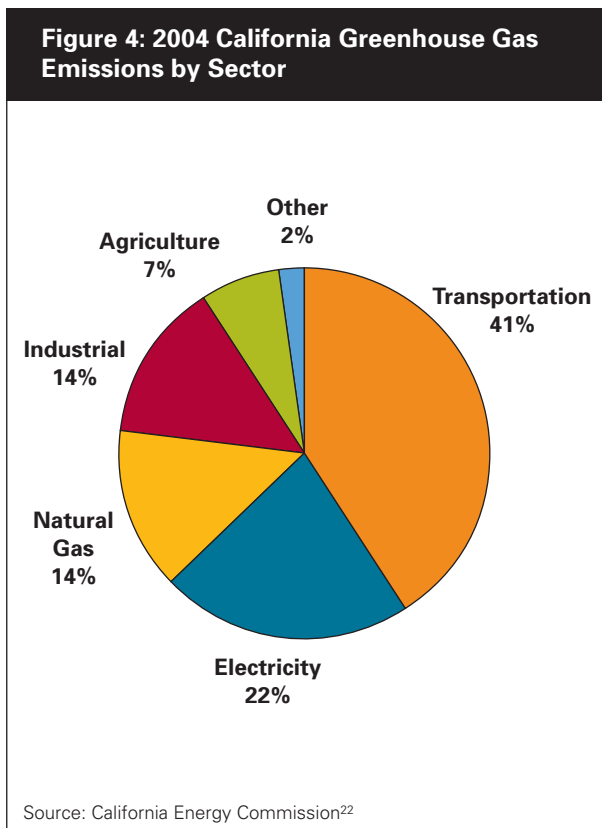
California Global Warming Solutions Act Implementation Timeline

- January 1, 2007:** AB 32 becomes law
- June 30, 2007:** CARB publishes list of early action emission reduction measures
- January 1, 2008:** CARB adopts 2020 emissions limit at 1990 levels, and a mandatory reporting program for significant sources
- January 1, 2009:** CARB adopts scoping plan to achieve maximum reductions by 2020
- January 1, 2010:** CARB adopts regulations and begins enforcing early action measures
- January 1, 2011:** CARB adopts regulations to implement the 2009 scoping plan
- January 1, 2012:** CARB begins enforcement of emissions limits
- January 1, 2020:** California reduces emissions to 1990 levels

Source: Assembly Bill 32²⁰

3. Strategies to Reduce Emissions

The largest source of global warming pollution in California is the carbon dioxide emitted from burning fossil fuels—the oil used in cars and trucks, the coal and natural gas burned to generate electricity, and the natural gas used in homes and businesses (see figure 4). Together, these represent 81 percent of the state’s greenhouse gas emissions.²¹ Reducing global warming pollution goes hand-in-hand with reducing dependence on fossil fuels.



California's Climate Action Team has identified numerous strategies to reduce emissions.²⁴ There are eight broad categories that provide the most savings: energy efficiency, renewable energy, and cleaner power plants to reduce emissions from the electricity and natural gas sectors; cleaner cars and trucks, low-carbon fuels, and smart growth to reduce emissions from the transportation sector; water efficiency; and sustainable forestry management. Figure 5 summarizes the potential contributions from each of these strategies.

ENERGY EFFICIENCY

Energy efficiency—getting more work and better services out of less energy—presents significant opportunities to reduce the state's emissions and save money. California has a long history of success with energy efficiency, but substantial opportunities remain. Today, the energy savings from the state's investments in energy efficiency are already reducing the state's annual GHG emissions by approximately 15 million metric tons of CO₂ equivalent—the annual emissions of 2.8 million cars.²⁵

Over the last 30 years, California's investments in energy efficiency have:

- Generated energy savings of about 40,000 GWh each year, equivalent to 15 percent of the state's annual electricity consumption (see figure 6).²⁶
- Held per capita electricity use in the state essentially constant, while the rest of the nation's per capita electricity use increased by nearly 50 percent (see figure 7).²⁷ While a baseline difference is partly due to a mild climate and there is a demand-dampening effect of higher electricity prices, no less than half of the difference in per-capita use is due to policies and programs aimed at more efficient use of electricity.²⁸
- Saved the state more than 12,000 megawatts (MW) in peak demand, equivalent to avoiding the construction of 24 large power plants.²⁹

These efficiency investments have saved billions of dollars. The cost of efficiency programs has averaged 2.5 to 3.5 cents per kWh over their lifetime, less than half the cost of building and fueling the power plants that would have otherwise been needed.³⁰ Over the last decade, California's utility energy efficiency programs alone have provided more than \$5.3 billion in savings to the state's economy.³¹ These savings flow directly to customers and increase their competitiveness in the global economy.

In January 2006, California's investor-owned utilities kicked off the most aggressive program in the country,

Figure 6: Energy-Efficiency Savings in California

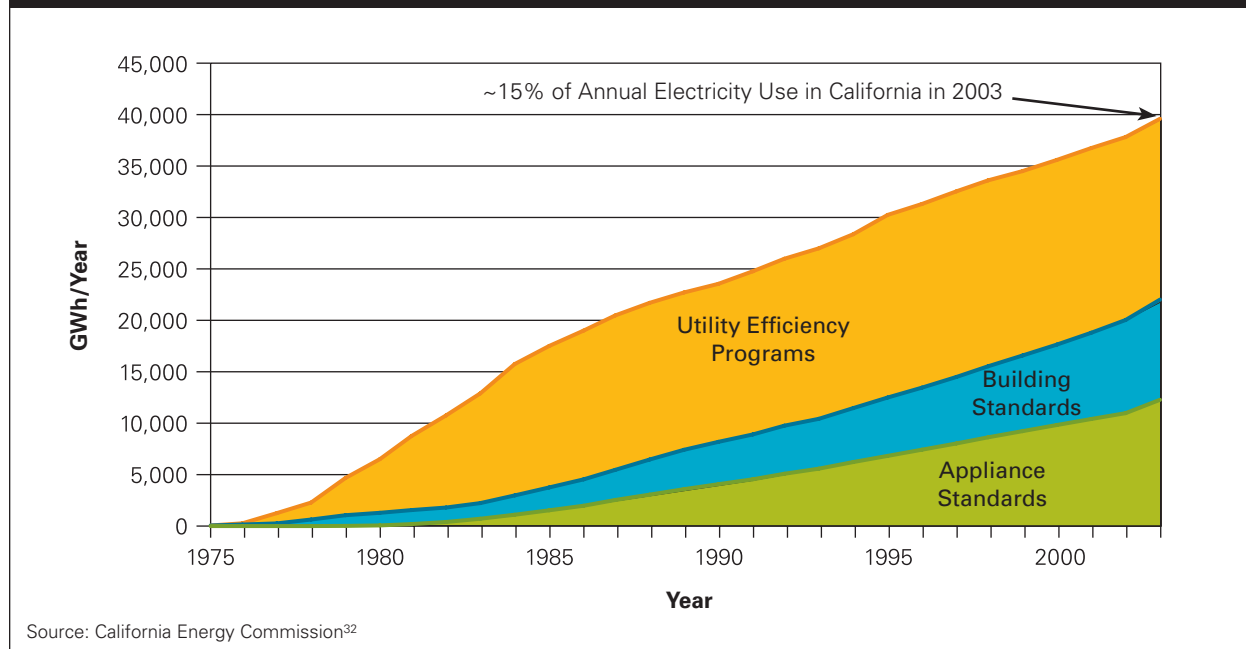
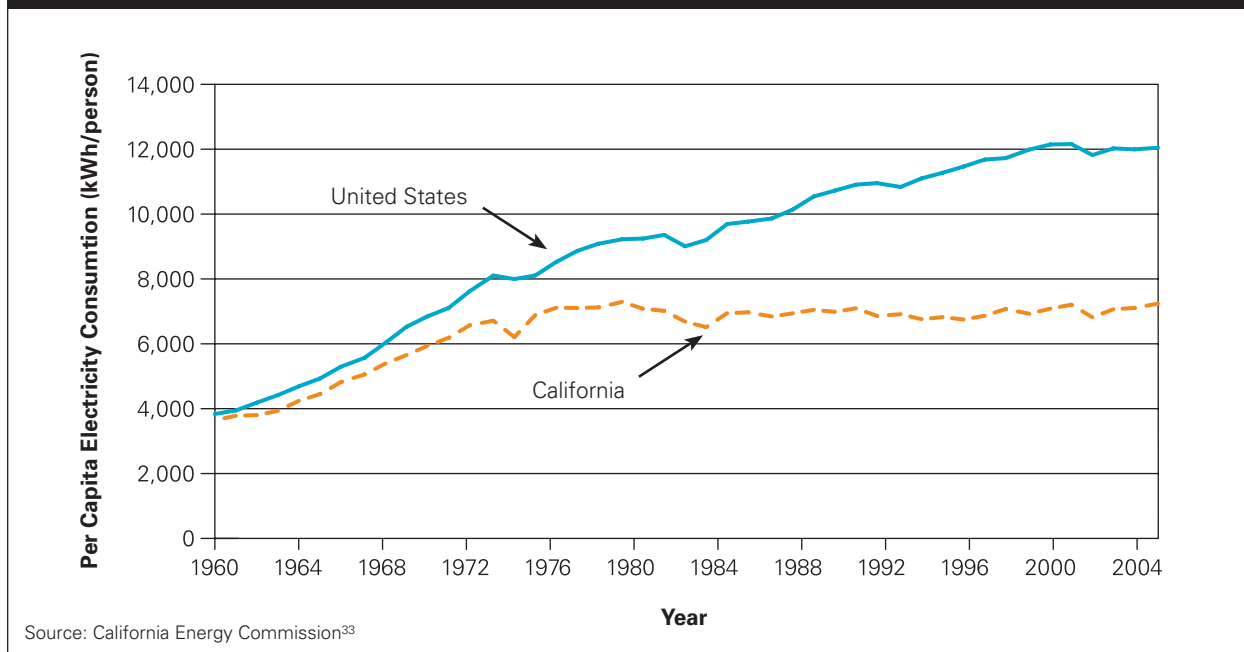


Figure 7: Comparison of Per Capita Electricity Consumption in the United States and California



providing information, rebates, and technologies to customers to use energy more efficiently. This \$2 billion investment over three years will return nearly \$3 billion in net benefits to California's economy (a yield of about \$2 in benefits for every \$1 invested), averting the need to build a large 500 MW power plant every year and avoiding more than 3.4 million metric tons of CO₂ emissions, equivalent to the annual pollution from 650,000 cars.³⁴ Publicly owned utilities, which provide about one-quarter of the state's power, are now also required to set efficiency targets to procure all cost-effective savings.³⁵

Several policies in California continue to drive these impressive savings:

Making Cost-Effective Energy Efficiency the Top Priority

Cost-effective energy efficiency is the state's top priority resource for meeting customers' energy service needs. Electric and natural gas utilities across the state are required by law to invest in energy efficiency whenever it is cheaper than supplying power or gas.³⁶ For example, if providing incentives to encourage customers to install technologies like compact fluorescent bulbs is cheaper than supplying the energy for inefficient incandescent bulbs, the utilities are obligated to help their customers

be more efficient first. The state's utilities have 10-year energy saving targets, designed to ensure that they capture all cost-effective savings, and the savings are subject to rigorous independent verification.³⁷

Rewarding Utility Investments in Efficiency That Save Customers Money

California is aligning utility incentives with customer interests to encourage investments in all cost-effective energy efficiency. The state has removed the disincentive for investor-owned utility investments in energy efficiency by breaking the link between their revenue and the sale of energy.³⁸ No longer do these utilities gain by selling more electricity and gas, or suffer financially when sales decline. And the Public Utilities Commission (PUC) is developing a risk-reward mechanism that will soon offer these utilities an opportunity to boost earnings if they achieve excellent performance in maximizing cost-effective energy savings.³⁹

Setting Aggressive Building and Appliance Efficiency Standards

The California Energy Commission sets aggressive efficiency requirements for new buildings and appliances, such as requiring better insulation in homes, that comple-

ment the programs offered by the utilities. California's most recently adopted standards are expected to save 3,200 MW and avoid the need for six large power plants over the next 10 years.⁴⁰ These standards are upgraded regularly, ensuring that California's new buildings and appliances will continue to be the most energy efficient in the nation.

Reducing Peak Demand

The state has also set a goal to reduce peak energy demand by 5 percent using programs and technologies (such as advanced meters, which have been proposed as a statewide upgrade) that encourage customers to reduce energy use when the power grid is most strained. More energy is used during the hottest parts of summer days when air-conditioners are running full speed. By using programs such as demand response to reduce energy use during these times, utilities avoid the need for expensive power—which sometimes comes from inefficient, dirty power plants—and help stabilize the grid.

RENEWABLE ENERGY

California has made significant investments in renewable energy, taking advantage of the state's ample sun, wind, geothermal, and other renewable resources. Currently, renewable resources provide approximately 11 percent of the state's electricity, compared to 2 percent nationally.⁴¹ This has reduced the need for fossil fuel-based generation technologies, helping protect Californians from the volatile prices of conventional fuel supplies and reducing carbon dioxide emissions by approximately 12 million metric tons every year.⁴²

California has two primary policies that encourage investment in renewable energy: the Renewable Portfolio Standard and the California Solar Initiative.

The Renewable Portfolio Standard

The Renewable Portfolio Standard (RPS) requires the state's utilities to provide 20 percent of their power from renewable resources by 2010.⁴³ Governor Schwarzenegger and the California Energy Commission have recommended increasing this target to 33 percent by 2020.⁴⁴

Some renewable resources, like geothermal and biomass, can operate around the clock, while others, like

The Shiloh Wind Power Plant

The Shiloh Wind Power Plant in Solano County provides 150 MW of power to Pacific Gas and Electric, the Modesto Irrigation District, and the City of Palo Alto Utilities. California's Renewable Portfolio Standard has helped to grow the market for and interest in large-scale wind farms.

Wind power generates clean energy while supporting local communities. Through the Shiloh project, 26 local landowners will receive hundreds of thousands of dollars each year through lease payments and the project is expected to generate more than \$1 million in tax dollars each year.⁴⁵

Photo credit: Craig Noble.



wind and solar, are not always available. By integrating these resources into a grid that includes more flexible resources like hydroelectric and natural gas-fired peaking plants, California maintains a reliable grid and takes advantage of the best aspects of each type of resource. While integrating intermittent resources like wind into the grid adds a small amount to its cost (between 0.2 and 0.5 cents per kWh), energy procured through the state's RPS remains cost competitive with conventional power generation.^{46, 47} Further studies of cost impacts and intermittency effects on the grid are underway and will help inform expansion of the RPS.⁴⁸

The California Solar Initiative and Other Incentives

The California Solar Initiative (CSI) provides rebates for rooftop solar photovoltaic systems, with the aim of encouraging investment in 3,000 MW by 2017 and reducing the cost of the technology. The CSI provides more than \$2.8 billion in funding in the form of performance-based (and, in some cases, estimated performance-based)

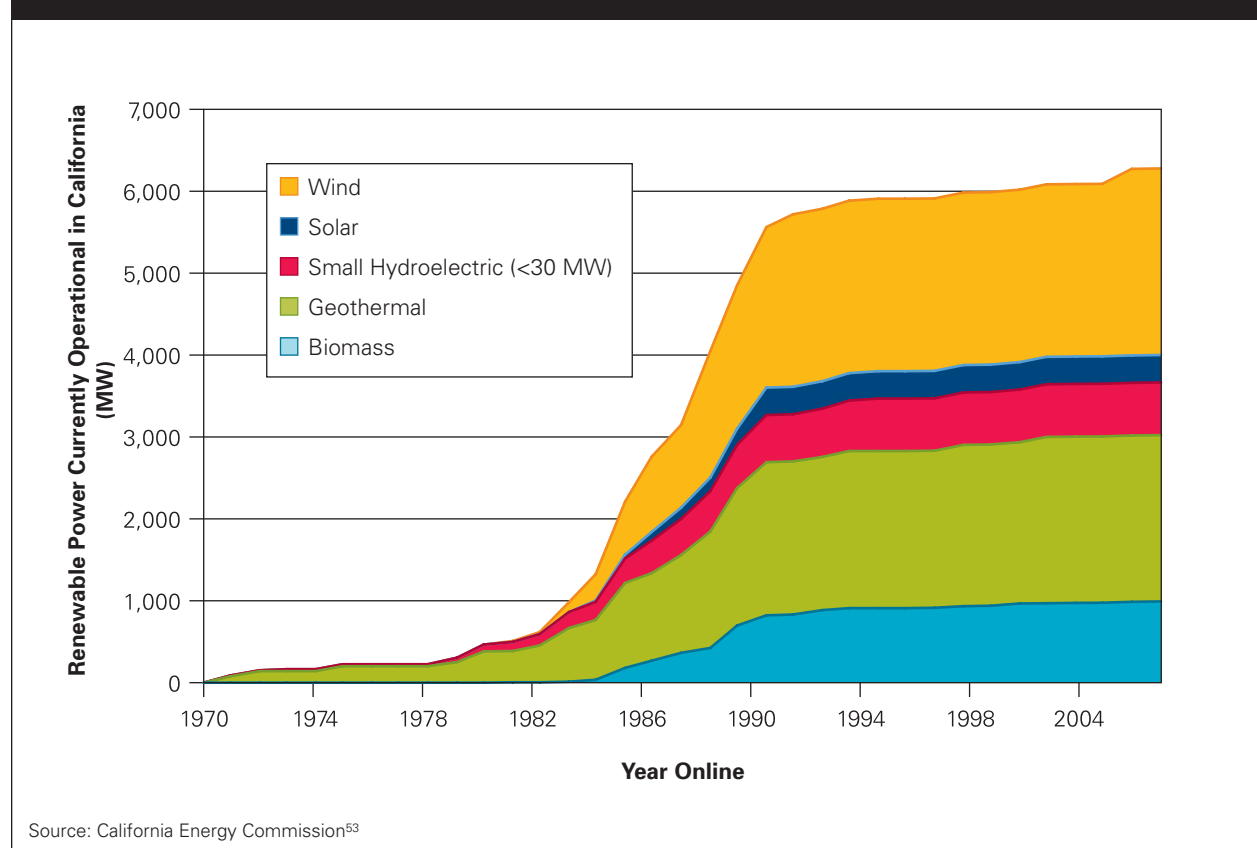
rebates, which tie all payouts to actual and estimated power generation (as opposed to the size of the systems).⁴⁹ Net-metering, which allows customers to sell excess power back to the grid when they produce more than they need and buy power back when they need it, also encourages home-scale renewable installations. Numerous other rebate programs offer incentives for renewable energy installations in the state.⁵⁰

CLEANER POWER PLANTS

California can also achieve significant global warming pollution reductions by ensuring that its fossil fuel-fired power plants are as clean and efficient as possible. Nearly half of the state's power plants are more than 30 years old.⁵¹ Repowering aging plants with state-of-the-art technology can make them at least 15 percent more efficient and provide significant emission savings.⁵²

Further GHG emissions reductions can be achieved by increasing the use of distributed, on-site power plants that use fuel for two purposes simultaneously—providing heat

Figure 8: California's Renewable Energy Installations



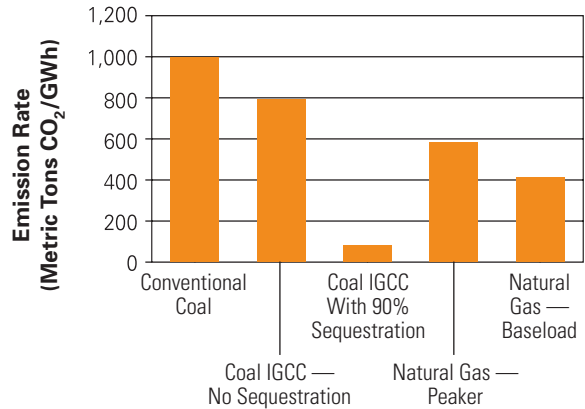
California's GHG Emissions Performance Standard for Power Plants Inspires Market Change

California's utilities will be making billions of dollars of long-term investments on behalf of electricity consumers over the next few years. These investments could generate electricity and greenhouse gas emissions for the next 30 to 60 years. The state faces serious financial risks in committing to long-term investments in carbon-intensive generation when the emergence of enforceable federal limits on emissions is likely. The emissions performance standard established by SB 1368 mitigates these significant financial risks by steering California's investments away from the very highest emitting sources.

While the standard applies to all resources, conventional coal-fired power plants present the most serious financial risk in the face of potential carbon dioxide regulation, because of their higher emissions. A new conventional coal plant will emit more than twice as much CO₂ per kilowatt-hour as a new combined cycle natural gas plant (see figure 9). Just a single 500 MW coal plant's emissions would result in approximately \$50 million per year in cost exposure for a utility and its customers, assuming that carbon dioxide emissions cost only \$12 per ton. And it would nearly negate the emission savings from the state's entire efficiency investments that year.

All fuels can meet the state's greenhouse gas emissions performance standard, depending on the generation technology used. The standard does not pick the winners and losers, but rather leaves it up to the marketplace to develop the most cost-effective way to meet the standard. While plenty of existing technologies already meet the performance standard, it will also help advance state-of-the-art technology

Figure 9: Emission Rate Comparison of Electricity Generation Resources



Source: Northwest Power and Conservation Council⁵⁴

by sending a clear market signal that California will only invest in low-carbon technologies. For example, efficiency, renewables, natural gas-fired plants, and advanced coal technologies that capture and store carbon dioxide emissions could meet the standard, whereas a conventional coal-fired plant that emits all of its carbon dioxide emissions would not. The policy is already stimulating the development of advanced technologies. For example, BP and Edison Mission Group recently announced plans to build the first power plant in California that will capture and store its global warming emissions.⁵⁵ And in a memorandum of understanding with California, Wyoming established a working group to further develop advanced coal and renewable technologies.⁵⁶

and/or cooling and generating electricity in commercial and industrial facilities. California already has 9,000 MW of such "combined heat and power" facilities, and has the potential to increase the use of combined heat and power by about 80 percent in existing and new facilities by 2020, according to the California Energy Commission.⁵⁷ California policymakers are considering extending existing rebates for efficient and/or renewable distributed generation (such as solar thermal heating) technologies further into the future.⁵⁸

California has two primary policies to encourage investment in cleaner power plants: Requiring that long-term investments meet an emissions standard, and incor-

porating the cost of GHG emissions in evaluating these long-term investments.

Long-term Investments Must Meet an Emissions Standard

In 2006, California enacted Senate Bill 1368, authored by Senate President pro Tem Perata, as a companion bill to AB 32. This groundbreaking law requires that new long-term investments in baseload power plants have greenhouse gas emissions that are as low, or lower, than emissions from a combined-cycle natural gas power plant.⁵⁹ See the text box above for further discussion of the impact of the law.

Incorporating the Cost of Greenhouse Gas Emissions in Evaluating Long-Term Investments

In 2004, the California PUC began requiring investor-owned utilities to account explicitly for the financial risk associated with greenhouse gas emissions in evaluating new long-term resource investments. The Commission recognized that regulation of greenhouse gas emissions was likely during the lifetime of new investments (which can be anywhere from 30 to 60 years or longer), and estimated a cost for those emissions. Utilities now use the PUC's estimated cost of \$9 per metric ton of CO₂, escalated at 5 percent per year, in evaluating all their long-term investment options.⁶⁰

CLEANER CARS AND TRUCKS

The single largest source of greenhouse gas emissions in the state is the transportation sector (41 percent of annual GHG emissions). The state is helping Californians drive cleaner cars and trucks through several specific policies:

Emissions Standards for Cars and Light Trucks

California is the first state in the nation to regulate greenhouse gas emissions from new passenger vehicles. Under Assembly Bill 1493 enacted in 2002, CARB adopted a standard in 2004 requiring these vehicles (beginning with model year 2009) to have lower emissions of CO₂ and other global warming pollutants.⁶¹ The standard is expected to reduce GHG emissions from new passenger vehicles by approximately 30 percent by 2016, saving consumers more than \$4 billion by 2020.⁶² Thirteen other states and Canada have adopted or are in the process of adopting similar regulations.⁶³ Automakers have challenged the standard in court, and the case was suspended pending a U.S. Supreme Court ruling on the Environmental Protection Agency's authority under the Clean Air Act to regulate CO₂ as a pollutant. In April 2007, the Supreme Court ruled that carbon dioxide is a pollutant under the Clean Air Act, clearing the way for a decision in the automakers suit on California's authority to regulate vehicle emissions.⁶⁴ Additional savings can be achieved by extending these standards beyond 2016 and expanding them to include larger trucks. For example, hybrid technologies could cut GHG emissions from larger trucks by more than 50 percent.⁶⁵

Plug-In Hybrids Can Reduce Emissions

A plug-in hybrid is a traditional hybrid-electric vehicle with a larger battery that can be charged through a standard electric outlet. This could significantly reduce emissions by making available more battery-stored energy from California's relatively clean power grid. Some companies are offering after-market vehicle conversions for existing hybrids. Customer demand for these options is being stimulated and communicated to auto makers through efforts like the Plug-in Hybrid Campaign.

Commercially available plug-in hybrid vehicles will be necessary to achieve significant reductions. Toyota recently announced an increase in its plug-in hybrid research.⁶⁶ Technologies and efforts like these are likely to be stimulated by California's proposed low-carbon fuel standard.

Requiring More Efficient Tires to Reduce GHG Emissions

Better tires enable the state to address emissions from cars already on the road. Under a 2003 law, the California Energy Commission is implementing a replacement-tire efficiency program to ensure that by 2008 replacement tires sold in California are, on average, as fuel efficient as the original tires of new vehicles.⁶⁷ This law is projected to reduce gasoline consumption by cars and light trucks in California by 3 percent by 2015, without sacrificing safety.⁶⁸ In the year 2015 alone, the rule will save more than 545 million gallons of gasoline, more than \$1.5 billion in fuel costs, and 4.8 million metric tons of CO₂.⁶⁹

LOW-CARBON FUELS

Low-carbon fuels offer another way to reduce emissions from vehicles, while providing consumers with more choices at the pump and protection from increasingly frequent gasoline price spikes. Low-carbon fuels can also help free California from its dependence on oil and carbon-intensive unconventional fuels, such as Canadian tar sands oil, whose extraction and refinement requires significantly more energy.

In January 2007, Governor Schwarzenegger issued an Executive Order calling on CARB to adopt a low-carbon fuel standard as one of its first actions under AB 32. If the standard is adopted as proposed, fuel providers will

be required to ensure that the mix of fuel they sell into the California market meets an increasingly strict life-cycle standard for global warming pollution emissions. By 2020, the standard will reduce the carbon intensity (the life-cycle GHG emissions, from the source to the gas tank, per unit of embodied energy) of California's passenger vehicle fuels by at least 10 percent.⁷⁰ The low-carbon fuel standard sets up a fair competition to reduce global warming pollution, without trying to pick the winners in advance. Companies would be able to comply with the standard using existing and emerging clean fuel technologies, including but not limited to cellulosic ethanol made from locally grown, sustainably managed, and renewable plant material; electricity used, for example, to charge plug-in hybrid vehicles; compressed natural gas; and hydrogen for fuel-cell vehicles. Fuel providers may also be able to purchase credits, either from traditional fuel suppliers that exceed the standard or from a new class of low-carbon fuel suppliers, such as electric utilities, ethanol producers, and hydrogen manufacturers.

By 2020, the low-carbon fuel standard is expected to:

- Cut global warming pollution from passenger vehicles by more than 13 million metric tons of carbon dioxide;
- Displace 20 percent of on-road gasoline consumption with low-carbon fuels, reducing gasoline consumption by roughly 3 billion gallons per year (equivalent to the output of 2.5 average-sized California refineries); and
- Triple, quadruple, or even quintuple the California renewable fuels market.⁷¹

SMART GROWTH

Designing communities so that Californians can walk, bike, or take public transit to reach most places they want to go can both significantly reduce emissions and improve residents' quality of life. Improving public transportation infrastructure and developing housing and jobs near transit hubs will provide Californians with more housing choices, reduce commute burdens, ease traffic congestion, and reduce emissions. Research on smart growth policies has shown that compact neighborhoods with good transit service generate as little as a third of the traffic associated with suburban sprawl neighborhoods.⁷² As a result, communities that create new smart growth neighborhoods will impose substantially lower infrastructure costs on the state. If all of California's new construction for just the next 10 years followed smart growth precedents already established, consumers would save more than \$2 billion each year in transportation expenses.⁷³

Californian policymakers are working to encourage smart growth in the state. At the regional level, a joint effort by Bay Area agencies is developing a set of initiatives to collectively address the interconnected issues of land use, air quality, and global warming.⁷⁴ Proposed state legislation would improve transportation planning models to explicitly address global warming pollution emissions, and require state and regional transportation planning agencies to show progress in meeting emission reduction goals and develop incentives to encourage more pedestrian-friendly and higher-density development.⁷⁵

WATER EFFICIENCY

California's water system is the single largest user of energy in the state, accounting for about 20 percent of gross electricity use and more than 30 percent of natural gas use.⁷⁶ California has a uniquely energy-intensive water supply, in large part because water is pumped over 2,000-foot high mountains to Southern California—the highest lift of any water system in the world. An aggressive water-use efficiency program would enable California to save approximately 5 million acre-feet by 2020—enough to meet the water supply needs of every household in Los Angeles County.⁷⁷ And as global warming further strains California's water supply, these water savings will become even more valuable.

Reducing water demand is a highly cost-effective way to save energy because it can not only reduce energy used on site, but also saves all of the upstream energy associated with extracting, treating, and delivering water, as well as the downstream energy to treat and dispose of wastewater. Additionally, improving water-use efficiency will help ensure the availability of high-quality, reliable water necessary for the state's economy, especially for water-intensive industries like biotechnology.

California is already taking action to conserve water, but large untapped savings remain. In a historic 1991 Memorandum of Understanding (MOU), a group of urban water agencies and environmental organizations committed to develop and implement 14 conservation Best Management Practices (BMPs).⁷⁸ There are currently 384 signatories to the MOU. Some communities have made remarkable progress in improving water-use efficiency. For example, as a result of its conservation programs, the City of Los Angeles uses the same amount of water today that it did 25 years ago, despite adding almost 1 million new residents.⁷⁹ Still, a recent evaluation indicates that overall compliance rates with the BMPs remain

NRDC's Santa Monica Office: Water Efficiency in Action

NRDC's Leadership in Energy and Environmental Design (LEED) Platinum office in Santa Monica, California, utilizes state-of-the-art conservation and recycling measures to minimize water use in the dry southern Californian desert.

- Drinkable water is used only where necessary.
- Water from showers and sinks is recycled to use again in flushing toilets and landscape irrigation.
- Super-efficient bathroom fixtures like waterless urinals reduce water demand.
- Rainwater is collected and stored in underground cisterns for use in toilets and irrigation.

Photo credit: Timothy Street-Porter.



low, and that the state is not currently on track to achieve the substantial water savings potential that has been identified.⁸⁰ Close to 80 percent of the developed water supply in California is used by agriculture, so more accurate price signals and efficiency opportunities in this sector must be pursued as well. Other water management alternatives, such as water recycling and stormwater capture, can also have significant energy benefits by reducing reliance on energy-intensive sources of water.

California's Legislature and agencies are pursuing opportunities to conserve more water and reduce GHG emissions. For example, the California Energy Commission is quantifying the energy and pollution saving opportunities from water conservation and the California Public Utilities Commission is considering a \$10 million pilot program to fund integrated water and energy-efficiency projects through the investor-owned utilities.⁸¹

SUSTAINABLE FORESTRY

Forests can help remove global warming pollution from the atmosphere. In temperate climates, planting trees in deforested areas, protecting old growth and other endangered forest habitat, and managing forests using sustainable practices can all store carbon dioxide. Ultimately, global warming cannot be prevented without significant reductions in pollution from burning fossil fuels, but afforestation, conservation, and sustainable forestry practices in the state can help slow the build-up of carbon dioxide in the atmosphere and smooth the transition to a

clean energy economy. Forestry strategies have the potential to provide up to 18 percent of the emission savings needed to meet the 2020 limit while providing biodiversity and water quality benefits for the state.⁸²

In addition to these eight strategies, there are numerous additional opportunities to reduce California's global warming pollution and to provide important public health benefits. For example, accelerating recycling and diverting waste from landfills, manufacturing cement in a less energy-intensive way, and electrifying the diesel engines used in applications such as agricultural pumps, truck-idling, transportation refrigeration units, and ships in ports can significantly reduce emissions. Furthermore, since methane (the primary component of natural gas) is a potent global warming pollutant, reducing or capturing emissions from landfills, animal wastes, and leaks from natural gas pipelines and oil wells all offer substantial emission reduction opportunities as well. Region-wide emission reduction efforts are also underway. Five western governors and British Columbia recently formed the Western Region Climate Action Initiative to identify, evaluate, and implement ways to reduce global warming pollution emissions collaboratively.⁸³

MARKET-BASED PROGRAMS TO LIMIT EMISSIONS

AB 32 authorizes the California Air Resources Board (CARB) to use market mechanisms as part of the package of policies to meet the 2020 limit. While CARB may pur-

sue a variety of market mechanisms, including incentives and rebates, a program that creates an enforceable cap on emissions from certain sectors and allows covered entities to use certain types of market mechanisms to demonstrate compliance is among the most promising candidates. This type of program is commonly known as a “cap and trade” program, although trading may be minimal if allowances are auctioned.

AB 32 establishes a statewide emission limit that the state itself commits to achieve through a combination of implementing policies, whereas a cap and trade program creates an enforceable limit on emitters. If properly designed, this approach can push emissions lower than can be achieved through regulatory programs, lower costs, and stimulate innovation by providing companies with an incentive to exceed minimum requirements.

Limiting total emissions from specific sectors, through systems like a cap and trade program, is an important complement to the programs encompassed by the individual emissions reduction strategies discussed earlier. Solutions such as greenhouse gas performance standards and energy-efficiency standards are essential to overcoming market barriers and to spur technological innovations in targeted areas, and clearly will reduce emissions below forecasted levels. However, alone they do not ensure that California will hold emissions to its new statewide limit. Complementary emissions caps can limit the absolute level of total emissions and should be designed to help achieve greater emission reductions than standards alone.

Under a cap and trade program, CARB would set enforceable limits on the emissions from certain sectors, such as the electricity and natural gas sectors, refineries, and other significant emissions sources. The limits could become effective as early as 2012 and decline over time, helping California meet the statewide 2020 goal. As California determines whether to include this type of approach in its package of policies, the state has opportunities to learn from existing GHG market-based compliance programs in the United Kingdom, the European Union, and the Northeast states.

How Market Mechanisms Work

If a mandatory cap on emissions were established, CARB would distribute only enough permits to emit greenhouse gases (often called “allowances”) to meet the limit. The allowances could be auctioned, given away, or a combination of the two. At the end of each year, every emitter in the sectors included in the program would be required to hold enough allowances to cover their actual emissions (as

verified through CARB's reporting program). If an entity had reduced its emissions beyond the allowances it holds, it could sell the excess allowances to another entity that needs additional allowances to match its emissions. This opportunity to trade allowances provides an additional incentive for businesses to reduce their emissions, and at the same time the overall emissions cap ensures that the absolute emissions from the covered sectors is limited.

Offsets are sometimes allowed as a supplementary compliance mechanism in such cap and trade programs. Offsets are emission reductions generated by projects in sectors that are not capped. In some cap and trade systems, regulators allow offsets to be used in place of allowances for regulatory compliance. Offsets can provide an incentive for broader emission reductions, help spur innovation, and can help contain compliance costs. But ensuring that offsets produce real emission reductions is challenging as it is impossible to measure their effect directly. As such, it can be difficult to guarantee that an offset is reducing a specific amount of emissions beyond business as usual.

AB 32 requires that if CARB allows the use of market mechanisms, they must, at a minimum, produce emission reductions that are real, permanent, quantifiable, verifiable, enforceable, and additional to any emission reduction that otherwise would occur. CARB must also ensure that any market mechanisms complement the state's other air pollution reduction efforts and help provide additional environmental and economic benefits to California. Finally, a market-based program in California must be accompanied by rigorous reporting requirements and strong enforcement, without which the incentive to reduce emissions would vanish, along with the market itself.

4. Innovation and Economic Opportunity

Other states—and, increasingly, the world—have witnessed California spearhead an industry and market growth for cutting-edge technologies and innovations, including semiconductors, computing and information technology, biotechnology, and e-commerce. The critical drivers of each of these trends—the talented and trained workforce, world-class knowledge infrastructure including universities and research centers, financial and professional resources, and the entrepreneurial and innovative culture—can readily be adapted to clean technology. For example, solar photovoltaics and efficient LED lighting are based on 40-plus years of semiconductors processing experience. Biofuels research and development draws from expertise and processes in the biotech sector. Web collaboration, commerce, and information technology enable efficient alternatives to travel, shopping, and commuting. California’s educated workforce can adapt and transfer skills to new “cleantech” job opportunities.

Generally, industry tends to underinvest in research, development, and demonstration (RD&D) when compared to the societal returns of such investments. This is especially true for environmental technologies because of weak incentives for private investment to provide public goods like a clean environment.⁸⁴ This underinvestment can be reversed as the ingredients for innovation mentioned above are brought to bear on clean technology.

There is already a business case for clean technology. Instead of being driven solely by regulations and tax incentives, clean technology has evolved to refer more broadly to business models and knowledge-based services, as well as technologies, driven largely by economic need.⁸⁵ Clean technology markets represent annual global

revenues greater than \$150 billion.⁸⁶ Before 2000, clean technology venture capital investment averaged approximately \$350 million per year, while from 2000-2003, annual outlays averaged more than \$1 billion.⁸⁷ AB 32, if implemented properly by connecting RD&D and market-based mechanisms, will combine “technology push” and “demand pull” policies that can ignite innovation and spur further investment in the clean technology industry.

California must now actively nurture the clean technology industry to ensure that the state becomes a net producer and nexus of clean technologies. RD&D of new technologies, university centers advancing global warming solutions, financing for innovative companies and products, and industry collaborations are four specific methods

that are stimulating clean technology breakthroughs and a clean energy economy in California. The sections below provide just a few examples of the many efforts throughout the state.

RESEARCH, DEVELOPMENT, AND DEMONSTRATION LEADS TO NEW TECHNOLOGY

AB 32 will bolster ongoing RD&D of new technologies that can help meet the state's GHG emission limits. California's entrepreneurs and researchers have both the experience and resources to deliver. The California Energy Commission's Public Interest Energy Research (PIER) program annually awards up to \$80 million, collected from the state's investor-owned utility customers, to sponsor the most promising public interest energy research. PIER funds research by partnering with organizations, individuals, businesses, utilities, and public or private research institutions.⁸⁸ For example, PIER recently funded a project with the University of California at Davis that developed a commercial biogas digester to convert restaurant waste to usable energy in San Francisco.⁸⁹

National labs in California are also contributing to the RD&D effort. The Lawrence Berkeley National Laboratory has a long history of researching and developing innovative energy solutions. Their Helios project is examining how solar energy can be harnessed using anything from microbes that generate electricity to better solar photovoltaic technology. The Environmental Energy Technologies Division has a wide breadth of research ranging from advanced battery technologies to energy efficient building materials.

Research funding for technologies that reduce GHG emissions is coming from the private sector too. For example, the Palo Alto Research Center (PARC) now has a dedicated clean technology research center. PARC is working to improve the efficiency of solar photovoltaic cells that generate electricity using the sun's rays, and to design intelligent networks that allow buildings to be operated more efficiently.⁹⁰ PARC is also exploring new ways to grow crops that will yield more biofuel potential, particularly for cellulosic ethanol. The Electric Power Research Institute, a joint effort funded by power utilities, is investigating how an intelligent grid may be able to allow numerous devices such as renewables, advanced electric meters, and plug-in hybrid vehicles to communicate in real time, helping to enhance grid reliability and diversification.

UNIVERSITY CENTERS EXPAND CLEAN TECHNOLOGY ACTIVITIES

The state's academic institutions are increasing their energy efficiency and clean energy efforts. The University of California at Davis and Stanford University have both recently opened centers dedicated to advancing energy efficiency. UC Davis won a competitive \$1 million grant from the California Clean Energy Fund (CalCEF), which will be matched with an additional \$1.5 million from leading California utilities to create the UC Davis Energy Efficiency Center.⁹¹ The Center will focus on developing and commercializing technologies that make buildings, transportation, food processing, and agriculture more energy efficient; it also intends to develop partnerships with California's efficiency industry, the utilities, and state regulators to help the industry meet its ambitious energy efficiency targets.

Stanford University received a \$30 million gift to establish the Precourt Institute for Energy Efficiency.⁹² The Institute will work to develop a deeper understanding of the forces shaping energy use and energy efficiency in buildings and vehicles, and improve energy efficiency technologies. In addition, the Institute will design and analyze policies and other practices that encourage economically attractive demand-side energy efficiency.

After a competitive selection process, BP chose the University of California at Berkeley to receive approximately \$400 million in funding over 10 years to improve conversion processes from biomass (plant materials) to biofuels. Initial research will likely focus on converting cellulosic plant material like switchgrass to ethanol.⁹³ Other institutions, such as the Bren School of Environmental Science and Management at the University of California at Santa Barbara, Caltech's Power, Environmental, and Energy Research center, Stanford's Global Climate and Energy Project, and UC Berkeley's Energy and Resources Group, are also researching clean energy technologies and environmental and energy policy.

Vocational training programs in community colleges are responding to projected clean technology workforce needs by providing hands-on training for the design and management of efficient building systems and renewable energy systems. A partnership between the California Energy Commission and De Anza College called the Statewide Energy Management Program helped initiate energy efficiency improvements and distributed energy projects in other colleges while providing curriculum to train students. The Economic and

Workforce Development Program through the California Community Colleges coordinates statewide efforts in building workforce training initiatives in partnership with industry and labor groups, and is developing a Silicon Valley Works (SVWorks) effort to anticipate and address future needs in the solar installation profession.⁹⁴

FINANCING INNOVATION GROWS BUSINESS OPPORTUNITIES

Financing the businesses that are developing global warming solutions is a critical piece of the long-term success of California's emission reduction efforts. The California Clean Energy Fund invests in emerging clean energy technology companies. CalCEF was established as part of PG&E's bankruptcy settlement; PG&E will dedicate \$30 million to the fund during the 2004-2008 period. The Fund is a non-profit entity, and it has selected several independent managers to make equity investments in companies that create technologies or products that will lead to decreased reliance on non-renewable fuels. Returns from investments will be reinvested in clean technology ventures. To date, the Fund managers have invested in companies like Tesla Motors, which is developing next-generation battery-powered vehicles, and Solarcentury, which provides building-integrated solar power solutions.⁹⁵

There are also many for-profit venture capital funds in the state investing in clean technology, like Nth Power, Khosla Ventures, Expansion Capital, Vantage Point Venture Partners and Kleiner Perkins Caufield & Byers. Between 2002 and 2006 California secured \$2.1 billion, or 26 percent of the total clean technology funding for North America.⁹⁶ California led the way in clean technology venture investments in 2006, bringing in a total of \$1.13 billion (including \$510 million in the third quarter alone), a 127 percent increase from its 2005 total.⁹⁷ The investment in California companies is in part due to the state's environmental leadership. Ninety-one percent of surveyed venture capitalists who fund clean technologies say that pro-environment policies, like AB 32, can be a significant factor in bringing new business and investment to a state, and 79 percent say that such policies are a prominent factor in their funding decisions.⁹⁸

In 2004, the state's two largest public pension funds—the California Public Employees' Retirement System (CalPERS) and the California State Teachers' Retirement System—committed \$1.5 billion to investments in clean technologies and environmentally responsible companies to improve long-term financial returns.⁹⁹ So far, CalPERS

has set aside \$200 million for investments in clean technology solutions that are more efficient and less polluting than existing technologies, and \$500 million has been earmarked for investment in stock portfolios that are environmentally responsible.¹⁰⁰

SPURRING KNOWLEDGE TRANSFER

Competitions, conferences, and publications recognizing the next generation of clean technologies help spur public interest while also facilitating the diffusion and sharing of innovative concepts. These low-cost, high-impact activities help engender collaborations and allow technologies and their proprietors to gain experience on their path to commercialization.

Competitions can also provide meaningful assistance to particularly promising candidates. The California Cleantech Open is an annual competition to find and implement the best business plans that will further California's clean technology industry while enriching the state's other industries. Competitors submit business plans by category: energy efficiency, smart power, renewable energy, transportation, and water management. The winners receive \$50,000 in cash and another \$50,000 in the form of office space and legal, accounting, and public relations services to get their enterprises off the ground.¹⁰¹ The X-Prize Foundation, known for its manned commercial space flight competition, recently announced an automotive X-Prize. The goal is to inspire a new generation of super-efficient vehicles that will help break our addiction to oil and stem the effects of climate change.¹⁰² The size of the prize is still being determined, though it will likely be in excess of \$10 million.¹⁰³

Knowledge transfer can be accelerated through existing relationships and professional networks. Incubators such as the Environmental Business Cluster (EBC) in San Jose are proven habitats that provide entrepreneurs access to resources and seasoned professionals dedicated to jump-starting young companies and setting them on a path for long-term growth. Since 1994, the EBC has helped more than 120 businesses commercialize and market their products and services. Through incubation partnerships with the U.S. Department of Energy's National Renewable Energy Laboratory (NREL) and the PIER Program, the EBC operates one of the largest private technology commercialization programs in the United States for clean and renewable energy start-ups.

5. Case Studies in Global Warming Leadership

Meeting the emission limits set forth in AB 32 will help California become more efficient and competitive in the global economy. Competitiveness drives business thinking, whether it's through reducing overhead or operating costs or differentiating a company or product to the customer. As companies mature, there is a critical need to continue innovating in order to maintain a competitive edge. The additional motivation provided by AB 32 sends a clear signal to entrepreneurs that technologies that reduce global warming pollution will be in demand and can be profitable.

In addition, the State of California recently created the Economic and Technology Advancement Advisory Committee (ETAAC) to evaluate incentives that will attract (and retain) investment in California and support the development and advancement of game-changing technologies.¹⁰⁴ Further business climate improvements in tax policy, for example, can encourage businesses to expand within the state.

As primary industries shift to address global warming emissions, so do the secondary industries that serve them. These sectors, such as telecommunications, legal, healthcare, and general manufacturing, depend in part on their proximity to customers in California, and so are motivated to act as well. Law firms and banks are expanding their expertise to work with clients in the clean technology sector and taking steps to offer tailored intellectual property, lending, and investment services. Through actions such as offsetting the GHG emissions associated with employee travel, buying "green" power, and institutionalizing sustainable purchasing practices, companies develop their corporate citizenship and connect with

like-minded customers. These shifts can be seen rippling through the supply chain.

Many California businesses are taking action to address global warming both in response to California policies and to innovate on the world stage. The case studies presented here highlight examples of companies that are standouts in:¹⁰⁵

■ **Reducing emissions at company facilities.** Many companies invest in energy-efficiency improvements for their facilities and purchase renewable energy or build on-site generation to reduce their burden on the power grid, lower their energy bills, and reduce pollution emissions. "Green" power purchasing, where an entity supports additional generation from renewable resources by buying the environmental attributes, has grown dramatically. Voluntary green power purchasing nationwide grew 62 percent from 2003 to 2004 and 37 percent from 2004 to 2005.¹⁰⁶

■ **Delivering products and services to the marketplace that cut pollution.** Many companies have a more significant impact on global warming by reducing

emissions associated with the use of the products they sell than in their own facilities. Whether a company is selling a new clean energy technology or simply making their existing products more energy efficient, these advances help position them to compete in the new carbon-constrained economy worldwide.

■ **Corporate leadership on global warming.** Many companies recognize that it will take the combined effort of the private sector, citizens, and the public sector to curb global warming. These businesses are urging policymakers to limit global warming emissions, pledging to lead the pursuit for solutions, and helping employees cut their emissions through programs such as transit incentives and clean car rebates.

The case studies in this section provide examples of how businesses in California are reaping benefits from cutting their global warming emissions, including specific actions that other businesses can take to help the environment and their bottom line.

ADVANCED MICRO DEVICES

Advanced Micro Devices, Inc. (AMD) is a global provider of innovative processing solutions in the computing, graphics, and consumer electronics markets with headquarters in Sunnyvale, California. Its annual Global Climate Protection Plan, first published in 2001, focuses on designing energy-efficient products, partnering with government and industry in leadership initiatives, and reducing the energy use and greenhouse gas emissions associated with manufacturing, design, and administrative operations.¹⁰⁷

Energy-Efficient Products and Facilities

AMD is seeking ways to increase the energy efficiency of its products and provide greater customer value by getting more “performance per watt” from its microprocessors. The company is also using technology to make data centers—which are energy-intensive—more efficient. Worldwide electricity use for servers and associated equipment doubled between 2000 to 2005, primarily due to growth in the total volume of servers in operation.¹⁰⁸ Total electricity used by servers represented approximately 1.2 percent of total U.S. electricity consumption in 2005, and total U.S. power demand drawn by servers in 2005 (including associated infrastructure) was equivalent to about ten 500 MW power plants, according to a study funded by AMD.¹⁰⁹ AMD's Opteron™ processor reduces energy costs for these server processors by 30 to 50 percent through design and power management features,

including matching power draw to immediate computing needs.

AMD has also designed their energy-efficient AMD Athlon™ 64 X2 dual-core processors for PCs to create less heat and noise while maintaining exceptional performance for home and business applications. In March 2005, EPA awarded AMD's Cool'n'Quiet™ technology for desktop PCs with ENERGY STAR® Special Recognition for advancing energy-efficient computer technologies.

In 2005, AMD's operations in Sunnyvale implemented energy-efficiency improvements, including variable frequency drives; new chillers; upgraded temperature control systems; and other heating, ventilation, and air conditioning (HVAC) adjustments that resulted in a total of 1,072 MWh saved. In addition, the conversion of three existing process vacuum loops in a laboratory into a single loop resulted in annual savings of 80 MWh. Combined, these energy-efficiency measures represent annual savings of approximately \$170,000.¹¹⁰ The company also reduces greenhouse gas emissions through its Commute Alternatives program, which provides shuttles to several regional passenger rail lines, saving more than 14,500 vehicle miles traveled in 2005.

Pioneering Industry Initiatives

AMD has partnered in voluntary environmental stewardship initiatives, including the Green Grid consortium, the EPA's Climate Leaders program, ENERGY STAR®, the Green Power Partnership, and the PFC Reduction Partnership for the Semiconductor Industry.

■ In February 2007, AMD helped create and joined the Green Grid consortium, a group of key leaders in the data center industry who are interested in lowering the overall consumption of power in data centers and business computing centers around the globe.

■ AMD was the first member of the semiconductor industry to join the Green Power Partnership. AMD set an EPA Climate Leaders goal to reduce greenhouse gas emissions, normalized for production, to 60 percent of 2002 levels by 2007. By the end of 2005, AMD had reduced normalized emissions to less than 50 percent of 2002 levels, meeting and exceeding their goal ahead of schedule.

■ AMD has made significant reductions in perfluorocarbon (PFC) and energy use in their manufacturing processes.¹¹¹ AMD set and achieved a goal to reduce absolute PFC emissions to 50 percent of 1995 levels to support the World Semiconductor Council's worldwide goal of a 10 percent reduction in PFC emissions by 2010.

AMD is also catalyzing future clean technology innovation by supporting the California CleanTech Open, an annual nationwide clean technology business plan competition.¹¹² The AMD Smart Power Prize encourages innovative ways to reduce energy consumption through networking technology. AMD also supports Plug-In-Partners, a national initiative to demonstrate demand for flexible-fuel plug-in hybrid electric vehicles.

AMD Highlights

- Annual Global Climate Protection Plan finds and implements greenhouse gas reduction strategies in products, R&D, manufacturing, and employee activities.
- Develops energy-efficient products to reduce the energy consumption in data centers and in business and personal computers.
- Improves facility efficiency and offers commute alternative programs for employees that reduce emissions and save money.
- Participates in partnerships that support continued energy-efficiency innovations.

BETTER ENERGY SYSTEMS

Berkeley-based Better Energy Systems was founded in November 2001 to help power the mobile electronic devices that were starting to spread around the globe. The company produces Solio, a portable solar charger for handheld electronic products. Better Energy Systems' mission is to put renewable energy into the hands of the modern, everyday consumer.

Solio is about the size of a large mobile phone and fans out into three "blades," each of which has a built-in solar panel, allowing users to "plug into the sun" to charge their devices. The compact design provides enough power to charge most small mobile devices, from phones and GPS units to iPods and digital cameras. Its internal, high-capacity battery stores power for up to one year, allowing people to take power with them wherever they go. It can also charge from a wall socket when needed.

Better Energy Systems is reducing the environmental impact of the product itself by letting customers send the lithium-ion battery back for recycling and replacement. Better Energy Systems also minimizes the impact of manufacturing with intelligent product design and by purchasing carbon offsets. The company has analyzed the source of every component in Solio and made sourc-

ing decisions based in part on suppliers' environmental performance. A "cradle to cradle" assessment of Solio that evaluates toxic inflows and outputs at every stage of a product's life led to the design of a less toxic, healthier, and more environmentally friendly product. While Better Energy Systems currently uses recyclable plastic in the Solio and recycled content in its packaging, the company is also planning to do a complete green overhaul of the packaging for an upcoming product line.

Better Energy Systems Highlights

- Offers a photovoltaic charger that uses solar energy to charge handheld electronic devices.
- Conducted a "cradle to cradle" assessment of supply chain and manufacturing process to make products environmentally responsible.

CISCO

Cisco is a worldwide leader in networking that enables people to connect, communicate, and collaborate with more than 57,000 employees worldwide and 15,000 located at its San Jose headquarters. The company is committed to reducing greenhouse gas emissions through energy-efficient operations and products, and by using the network as the platform to optimize energy use as it relates to buildings and their systems.

Reducing Emissions from Facility Operations

In 2006, Cisco reduced CO₂ emissions from its operations by about 60,000 metric tons. Cisco's energy consumption and greenhouse gas emissions intensity (emissions per revenue) fell by 11.4 percent during 2006. Cisco achieves these emission reductions through energy-efficiency improvements, renewable energy purchases, using green features in building design and operations, recycled water use, employee education, and commute alternatives. All energy use is tracked and used to calculate the greenhouse gas emissions of each Cisco site on a monthly basis.¹¹³ Some of Cisco's specific actions include:

- Evaluating and implementing energy-efficient measures in remodeling and expansion projects. In 2006, Cisco installed reprogrammed variable air volume boxes in the heating, ventilation, and air conditioning system, and variable frequency drives on water pumps, saving 5.4 million kilowatt-hours of electricity, more than 2,000 metric tons of greenhouse gas emissions and approximately

\$780,000 annually.¹¹⁴ And it is testing an automated power management system to automatically switch-off unused equipment in laboratories, which is expected to provide energy savings of about 20 million kWh.

■ Cisco was the 11th largest purchaser of renewable energy in 2006 through the U.S. EPA's Green Power Partnership. With the additional renewable energy purchased in January 2007, the total amounts to 124 million kWh of renewable power, or 21 percent of its total use, most of which was used in San Jose.¹¹⁵

■ Only recycled water is used for landscape irrigation, which accounts for approximately 30 percent of Cisco's water consumption, saving more than 81 million gallons of fresh water each year and the energy embedded in the conserved water (see the water efficiency section of this report on page 13).

■ The Cisco Connected Real Estate (CCRE) initiative uses information technology to improve building efficiency and to manage and integrate other building systems. CCRE also allows twice the number of employees to work per area, compared to a traditional office environment, and enables employees to work from a variety of locations, reducing the need for office supplies and equipment while decreasing construction costs and electricity use. The company is also improving efficiency through the integrated design, monitoring, and control of building-management systems, which can deliver an annual energy savings of 5 percent while providing a 15 percent reduction in annual maintenance costs.

Further, Cisco is seeking Leadership in Energy and Environmental Design (LEED) green building certification for many of its new and existing buildings. Over the next few years, the company also plans to install an on-site photovoltaic system at its headquarters and implement a program to progressively shut down nonessential equipment during periods of peak energy demand, such as during heat waves. Employee education and outreach on energy conservation has saved an estimated 8.75 million kWh and 3,300 metric tons of global warming pollution emissions. The company's "Carbon to Collaboration" commitment aims to reduce emissions by 10 percent through a \$20 million investment in technologies that will reduce the need for employee travel.¹¹⁶

Energy-Efficient Products

Cisco also seeks to reduce greenhouse gas emissions by making its products more energy efficient. In 2006, it established an internal cross-functional working group to focus on design for energy efficiency, covering all aspects

of its products, including efficient power supplies to minimize energy losses while assuring reliability, intelligent power distribution systems to improve efficiency, technologies that eliminate inefficient energy conversions, and cooling fans with temperature-specific speed controls. Many of Cisco's product lines have been able to dramatically increase the performance per watt over time. The 7200 series product line, for example, uses the same capacity power supplies today as it did 10 years ago, while performance has increased tenfold.

Cisco is also partnering with Lawrence Berkeley National Laboratory (LBNL) and other data center owners on a Datacenter Demonstration Program facilitated by the Silicon Valley Leadership Group to evaluate higher performance, lower energy use data centers. There are significant opportunities to improve the efficiency of data centers; for example, LBNL studies show that by using direct current rather than alternating current power, data centers could reduce electricity use between 10 and 20 percent.

Looking ahead to challenges in our physical surroundings, the Cisco Connected Urban Development initiative is helping cities use and embed technologies, such as radio frequency identification (RFID), wireless communication, and broadband into transportation systems, to ensure that traffic on streets and roads is as efficient as movement of traffic on the Internet.

Cisco Highlights

- Addresses the global warming emissions associated with the use of its products by providing efficient and high-performance technologies and seeking innovative applications of network-based technologies to provide a holistic impact.
- Tracks energy use and greenhouse gas emissions of each Cisco site on a monthly basis to evaluate progress toward an annual goal.
- Reduces global warming emissions from the company's facilities through energy-efficiency improvements, renewable energy purchases, green building design, use of recycled water, and providing employee education and commute alternatives.

JOHNSON & JOHNSON

Johnson & Johnson (J&J) is a broad-based health care company with more than 130,000 employees worldwide that provides medical devices and diagnostics, consumer and personal care products, and medicines and nutritional

products. J&J set a corporate goal of achieving a 7 percent absolute reduction in carbon dioxide (CO₂) emissions from facilities worldwide by 2010, compared to a base year of 1990. By 2006, J&J exceeded its goal, achieving nearly a 17 percent reduction in CO₂ emissions, while sales grew 372 percent between 1990 and 2006.¹¹⁷

To achieve this emission reduction, J&J has invested in efficiency improvements in its facilities. It is a top purchaser of renewable energy in the U.S. EPA's Green Power Partnership, and plans to reduce the CO₂ emissions of its vehicle fleet by 30 percent per mile driven by 2010.¹¹⁸ Operating companies are held accountable to corporate efficiency goals and are internally recognized and awarded for outstanding energy efficiency and environmental performance. Each company subsidiary pursues its own strategies to achieve GHG reductions. For example:

- ALZA Corporation in Mountain View captures landfill gas for use in cogeneration to produce both electricity and heat for the company's six largest buildings;
- Neutrogena, based in Los Angeles, installed one of the first commercial solar power systems in California in 2001;
- Fuel cells, wind turbines, and biomass are used to generate energy at other sites.

Funding assistance for energy-efficiency and greenhouse gas reduction projects beyond each site's funding ability is available through a corporation-wide CO₂ capital funding pool.

J&J Pharmaceutical Research and Development Achieves Best Efficiency Performance

Johnson & Johnson Pharmaceutical Research & Development, L.L.C. (J&J PRD), whose 450 employees in La Jolla conduct research that supports the pharmaceutical business units of J&J worldwide, was recognized in 2006 as having the best overall efficiency performance of any J&J site. In its chemistry laboratories, the company ensured that fume hoods were not oversized, installed variable air volume controllers, and kept fume hoods closed when not in use, reducing the associated electricity use by 60 percent (2,000 MWh annually). J&J PRD has also decreased its energy use through efficient heating, cooling, lighting, and better building controls. In a survey following the upgrades, scientists responded positively to the better function, aesthetics, and comfort achieved by this portfolio of facility improvements. In addition, the La Jolla site's new building is Leadership in Energy and Environmental Design (LEED) certified, resulting in one-third less energy consumption than California's building standard.

To further reduce its emissions, J&J PRD has a 203 kW solar photovoltaic system and a 2.2 MW cogeneration system. This has reduced the site's annual CO₂ emissions by 10,000 metric tons, equivalent to the annual emissions of approximately 2,000 cars.¹¹⁹ The cogeneration system uses natural gas to produce 95 percent of the site's electrical power, while also using the byproduct heat to run absorption chillers and boilers. This equipment reduces energy consumption and the associated greenhouse gas emissions by approximately 40 percent. The solar power system, one of the largest in the region, helps reduce the site's electrical demand by an additional 10 percent at peak times. California state incentives helped fund 18 percent of the cogeneration project and provided \$650,000 for the solar power system. The site purchases renewable energy certificates for 100 percent of any remaining electrical demand.

J&J PRD also helps lead the local chapter of the U.S. Green Building Council and the new San Diego Regional Sustainability Partnership, and participates in other community-related environmental activities.

J&J Highlights

- Holds subsidiary companies accountable to corporate efficiency goals and provides funding assistance from a corporation-wide CO₂ capital funding pool.
- Implements efficiency improvements to cut emissions, lower energy bills, and improve employee comfort.
- Purchases renewable energy power and operates on-site solar photovoltaic generation.
- Increases power generation efficiency with cogeneration units that generate power and useful heat on-site while increasing power supply reliability.

MIASOLÉ

Miasolé is a Santa Clara-based manufacturer of solar cells and modules. The company aims to bring down the cost of photovoltaic (PV) energy generation, simplify the installation process, and broaden the applications of PV technologies. Miasolé has developed an efficient, high-throughput manufacturing process that can produce miles of flexible, lightweight, and durable photovoltaic sheets, which can be integrated into the roofs and facades of buildings or deployed in large-scale stand-alone projects to generate emission-free power for whole communities.

Miasolé is a prime example of the technology transfer taking place in Silicon Valley as the solar industry builds upon the region's extensive expertise in semiconductor manufacturing. The company's core team is redirecting its more than 20 years of experience in high-volume thin-film deposition toward the challenge of producing PV products. Miasolé seeks dramatic cost reductions through its thin-film deposition processes, just as its team did for hard disk and optical filter manufacturing in the 1980s and 1990s.

Solar power has the potential to provide large benefits for California's economy and environment, largely because the rooftop and distributed installation industry is inherently local. The PV market is growing at more than 35 percent annually, and analysts predict that it will be a \$15 billion to \$20 billion global market by 2010, creating thousands of new jobs. The reduced impact to the environment is just as significant. For every megawatt-hour of electricity generated by PVs in California, nearly half a metric ton of CO₂ is avoided. Moreover, Miasolé's thin-film technology is less energy intensive to manufacture and requires less than 50 percent of the energy payback period (the length of time a system has to be operational to generate the electricity used to manufacture it) compared to some silicon-based modules.¹²⁰

In 2005, solar power generated less than 0.2 percent of California's energy.¹²¹ With the state's ample sunlight, locally produced solar energy can be a strategic tool for addressing global warming and meeting future energy demand growth. Studies indicate that if PVs were installed on all of California's residential and commercial roof space, up to 75,000 MW of solar photovoltaics could be added.¹²² Miasolé expects its PV technology to be cost-competitive with the electricity grid by 2015 or earlier, displacing fossil fuel-based generation and dramatically reducing the associated greenhouse gases.

Silicon Valley businesses, utilities, and community colleges are working together to ensure the long-term sustainability of the local PV industry. They recognize that PV installation costs are highly site-specific and can be greatly reduced through more uniform municipal permitting, standards, and a trained workforce. Miasolé participates in the SolarTECH Coalition, a business-to-business collaboration that is systematically evaluating industry needs in installation standards, equipment performance standards, utility interconnections, building permits, and education and training. Participants will help identify hurdles in the overall solar installation process and work to streamline the process and reduce the cost to customers.

Miasolé Highlights

- Develops innovative manufacturing processes to reduce the cost of solar photovoltaic power.
- Utilizes California's entrepreneurial talent and existing technological expertise to develop clean energy technologies.
- Collaborates with other businesses in the industry to reduce PV installation costs and ensure long-term sustainable growth of the industry.

NEW RESOURCE BANK

New Resource Bank, which opened in San Francisco on September 19, 2006, was founded by entrepreneurs and green business leaders. Its goals are to set a new standard in customer service while doing more with depositors' money by financing sustainable resources in the community. Since its grand opening, the bank has provided financing to many innovative business clients in sectors such as clean technology, organic foods, green building, and green consumer products. The bank also has depositors from dozens of states in addition to California.

The bank finances sustainable resources in the community by offering a greater knowledge of green business sectors and providing financing expertise to help conventional customers become more sustainable. New Resource Bank also offers everyday banking services such as checking and cash management to individuals, businesses, and non-profit organizations so depositors can help finance sustainable resources simply by doing everyday banking.

Greener Banking Funds Green Innovation

One of the primary market barriers to continued growth of the clean technology industry is customer and project financing. Unique lending programs launched by New Resource Bank include a "more money at a lower cost" approach to financing green buildings that incorporate design leadership. By offering lower interest rates and higher loan values for green projects, the bank helps offset higher initial costs, if any, associated with green projects and enhances a developer's profitability. The bank has financed a number of green real estate developments and smart-growth projects. These projects incorporate features that include energy-efficiency, green designs, smart growth principles for density and transportation, and even neighborhood improvements, such as the Southside Lofts in Berkeley, a mixed-use commercial and residential development on the site of a former liquor store.

Beyond the monetary incentives, the bank also fosters education and partnerships to help people reduce their environmental impact. For example, the bank's office has been built to LEED Gold certification, and the bank's senior vice president for construction and real estate has invited conventional developers to seminars to learn about the advantages of building green. The increased energy efficiency of green buildings can lead to a reduction of global warming pollution by 28 percent, and, when combined with renewable energy, can lead to a 36 percent reduction in emissions.¹²³

Through an innovative partnership with SunPower Corporation, New Resource Bank promotes residential solar energy installations by offering customers financing to make the cost of owning solar about the same as paying a monthly electric bill. Two kilowatts of solar panels on a home can avoid 28 metric tons of global warming emissions during its operating life time.¹²⁴

The leadership of New Resource Bank has extensive experience in clean technology, green buildings, and other industries, as well as an understanding of the benefits and risks of investing in such projects. They recognize the financial gain from supporting green projects, which often have decreased risk. Many traditional banks see only the higher initial costs of green projects and do not fully understand their long-term benefits. New Resource Bank believes that the sustainability movement is now a market movement and is taking advantage of the growing niche. The bank's goal is to connect and foster the growing community of environmental entrepreneurs by providing financial and educational support.

New Resource Bank Highlights

- Offers preferred financing for green projects over traditional projects.
- Offers financing to make the cost of owning a home solar system about the same as paying a monthly electric bill.
- Demonstrates the value of green building through its LEED Gold-certified headquarters and by offering information to developers on the benefits of green buildings.
- Seeks to make its lending consistent with depositors' values by financing sustainable resources in the community.

PACIFIC GAS AND ELECTRIC

Pacific Gas and Electric (PG&E) company, California's largest utility, has emerged as a leader in addressing global warming thanks to two standout policies. First, PG&E uses a comprehensive approach to reduce its environmental impact, while continuing to provide reliable and affordable energy services to customers. Second, PG&E encourages its peers to match its performance and encourages policy-makers to adopt policies that can create a level playing field and raise the bar on the entire industry's performance.

Providing Customers with Energy-Efficient Options

PG&E provides electric and natural gas energy services to approximately 15 million people throughout a 70,000-square-mile service area in northern and central California. The electricity PG&E provides is already significantly cleaner than that of other utilities. For every kilowatt-hour sold, PG&E's portfolio emits approximately two-thirds less global warming pollution than the nationwide average.¹²⁵ And PG&E continues to make significant investments in energy efficiency and renewable resources to make its portfolio even cleaner.

Since 1998, PG&E's energy-efficiency programs have saved nearly 1,000 MW—the equivalent of two large power plants—providing net savings to customers of \$1.4 billion and at the same time cutting pollution equivalent to the output of 300,000 cars.¹²⁶ Building on that successful record, in 2006 PG&E embarked on its most aggressive efficiency effort yet. Over the three-year period from 2006 to 2008, PG&E plans to invest nearly \$1 billion to save customers \$2 billion by avoiding another 600 MW, cutting the global warming pollution equivalent to the annual emissions of 250,000 cars.¹²⁷ PG&E also magnifies the direct savings from its programs by supporting efficiency standards for new buildings and appliances in California and nationally.

PG&E invests in renewable energy to further reduce its global warming pollution and stabilize energy prices for customers. Currently, 12 percent of the electricity PG&E supplies is from renewable sources.¹²⁸ The company is signing contracts for more renewable energy every year to reach the 20 percent goal set out in the state's Renewable Portfolio Standard. These new investments include contracts for wind power, as well as innovative technologies like "cow power" (natural gas produced at dairies) and

solar thermal electricity generating facilities.¹²⁹ It is also leading demonstration efforts to show how plug-in hybrids can send battery energy stored at night back into the electricity grid during the day.¹³⁰

Spreading the Message to Customers and Policymakers

In addition to reducing the company's own emissions, PG&E is also offering its customers an opportunity to voluntarily reduce emissions through its new ClimateSmart program. Customers who enroll in ClimateSmart will pay approximately 3 percent more each month, and PG&E will invest these funds in emission reduction projects equal to the customers' emissions. By the end of 2009, PG&E's goal is to remove 2 million tons of carbon dioxide from the air through this program, equivalent to the global warming pollution from 350,000 cars in a year.¹³¹

PG&E also became a charter member of the California Climate Action Registry in order to increase the transparency of information available on greenhouse gas emissions. The company was the first investor-owned utility to certify and publicly report its greenhouse gas emissions in the registry in 2002. PG&E was also a leader in recognizing that its greenhouse gas emissions represent a significant financial risk to its customers and shareholders, and it was the first utility in California to include an estimated cost of those emissions in evaluating investment decisions.

Most recently, PG&E was the only utility to support both of California's new landmark global warming laws: AB 32, which makes California the first in the nation to limit statewide global warming pollution, and Senate Bill 1368, which ensures that all California utilities avoid risky long-term investments in coal generation that vents its global warming pollution to the atmosphere. PG&E is also calling on Congress to adopt similar practical solutions to global warming.¹³²

Through these forward-looking investments and policies, PG&E is positioning itself for success in a carbon-constrained world. The utility was recently ranked second among western region electric utilities in business customer satisfaction and posted the nation's largest gains from the previous year.¹³³

PG&E Highlights

- Invests in energy efficiency and renewable energy to make its portfolio cleaner and lower customer bills.
- Offers customers a way to voluntarily reduce emissions through its ClimateSmart program.
- Reports the company's greenhouse gas emissions through the California Climate Action Registry.
- Supports statewide and national legislation to limit global warming emissions.

6. Conclusion

California is committed to leading the effort to curb global warming and to growing a solutions-driven industry. Implementation of AB 32 over the next five years will require a concerted effort to increase energy efficiency, develop renewable resources, and foster new industries that can achieve this dual environmental and economic goal.

AB 32 will not only provide public support for innovation but also help attract and leverage private sector innovators and resources for which publicly supported RD&D is insufficient. With continued leadership and action from policymakers, businesses, and residents, California can tackle the biggest environmental challenge of our time while bringing jobs, efficiency, and economic opportunity to the state.

Successfully addressing global warming will require the rest of the nation to take action as well. California can serve as an example, but now it is up to other states and Congress to set an emissions reduction framework nationally that also invigorates the competitiveness of businesses and the national economy.

Appendix A:

Global Warming: An Overview

Heat-trapping pollution is collecting in the atmosphere like a thickening blanket, trapping the sun's heat and causing the planet to warm up. Burning gasoline, coal, and natural gas produces these heat-trapping greenhouse gases (GHGs), primarily carbon dioxide (CO₂).¹³⁴ As the buildup of GHGs in the atmosphere continues, global average temperatures continue to rise.

The National Academies of Science in 11 countries, including the United States, have concluded that "human activities are now causing atmospheric concentrations of greenhouse gases...to rise well above pre-industrial levels. Carbon dioxide levels have increased from 280 parts per million (ppm) in 1750 to over 375 ppm today—higher than any previous levels that can be reliably measured (i.e., in the last 420,000 years). Increasing greenhouse gases are causing temperatures to rise; the Earth's surface warmed by approximately 0.6 centigrade degrees (approximately 1°F) over the twentieth century."¹³⁵

Scientists say that unless steps are taken now to reduce global warming emissions, average temperatures could rise another 4 to 11 degrees Fahrenheit by the end of the century.¹³⁶ This will have far-reaching effects, including rising sea level and flooding in coastal areas; more frequent and intense heat waves; more frequent droughts and wildfires in some regions, and more floods in other regions as rainfall patterns change; spread of disease as disease-carrying mosquitoes expand their range; and species pushed to extinction. Many of these changes are already being seen now:

- The 10 hottest years on record have all occurred since 1990.¹³⁷
- Global warming has more than doubled the likelihood of heat waves like the one that killed more than 15,000 people in Europe in 2003.¹³⁸
- Twenty percent of the Arctic ice cap has melted since 1979, and at least half of the ice cap is projected to melt by the end of this century, along with a significant portion of the Greenland Ice Sheet.¹³⁹ This will cause a loss of arctic habitat and sea level rise.

Appendix B: Global Warming Effects in California

Unless immediate action is taken, scientists say that global warming will harm California's economy, environment, and public health. Forecasts for the state reflect a range of assumptions and estimate that temperatures in California are expected to rise between 3°F and 10°F over the course of the century, putting Californians at risk.

Higher temperatures will mean less snow. The snowpack in the Sierra Nevada mountains serves as critical storage in maintaining the state's water supply. The snow that is stored in the high peaks during the winter ensures an adequate water supply during the dry California summers and allows for the production of electricity during valuable peak periods. In the next 50 years, California's snow pack is expected to decrease by 10 to 40 percent. By 2100, the Sierra snowpack may be nearly gone. This will significantly reduce the state's ability to supply water to its residents and to support its \$68 billion agricultural industry.^{140, 141}

The sea level rise of between 4 and 28 inches predicted to result from global warming will also create problems for California. It will allow salt water to intrude into some underground drinking water aquifers, making them useless for drinking and irrigation and further exacerbating the state's water supply challenges.¹⁴² Sea level rise will also create stronger storm surges that propagate farther into the Sacramento River Delta and put additional strain on the already vulnerable levee system.

Moreover, increased temperatures in the state will significantly threaten public health. Global warming will lead to an "increase in frequency, duration, and intensity of conditions conducive to air pollution formation, oppressive heat, and wildfires."¹⁴³ The number of extreme heat days, like the heat wave during the summer of 2006 in which more than 100 people died, is expected to increase significantly. Higher temperatures will also increase smog and make it even more difficult to meet air quality standards across the state. And the number of large wildfires that destroy Californians' homes and properties every summer may increase by 35 percent by mid-century and by 55 percent by the end of the century.¹⁴⁴

Endnotes

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include methane emissions from petroleum and natural gas extraction, transmission, storage, and marketing; landfill emissions; and waste water treatment. Industrial GHGs also include nitrous oxide emissions from waste combustion, municipal waste and industrial fuel use, including wood. Finally, industrial GHGs include high GWP gases used as substitutes for ozone-depleting gases and in semiconductor manufacturing.

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