NO REASON TO WAIT

THE BENEFITS OF GREENHOUSE GAS REDUCTION IN SÃO PAULO AND CALIFORNIA

Contents

THE WILLIAM AND FLORA HEWLETT FOUNDATION

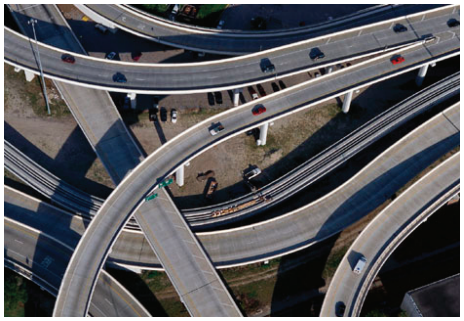
Published by the Hewlett Foundation, December 2005

For further information, please visit:
www.climatechange.ca.gov | www.ambiente.sp.gov.br | www.cetesb.sp.gov.br

FOREWORD

Under the United Nations Framework Convention on Climate Change, industrialized and developing countries have "common, but differentiated responsibilities" to address the problems posed by human-induced climate change. Brazil is exempted from mandatory reductions under the Kyoto Protocol, which establishes that greenhouse gas (GHG) emissions should be reduced among the industrialized-country parties by 5.2 percent from 1990 levels by 2012. The United States has signed, but not ratified, this Protocol. However, even in the absence of international reduction commitments, actions by states like São Paulo in Brazil and California in the United States are demonstrating that a broad scope exists for actions that go beyond "business as usual" and achieve significant savings in GHG emissions. And, most notably, these policies are yielding economic *benefits*, not the high costs that are often feared.

There appears to be a large opportunity for emission reductions that provide short-term economic and health benefits, and every attempt should be made to promote national policies and international cooperation that can help states, nations, and the world achieve these benefits. Increased coordi-



nation would help lessen the inefficiencies inherent in a fragmented response and would facilitate investment in lowest-cost GHG reduction opportunities. São Paulo and California have agreed to work together to identify and implement actions that can further reduce GHG emissions, increase energy efficiency, and reduce the emissions of other pollutants. This will involve cooperative efforts dealing with air quality, alternative fuels, energy efficiency, renewable energy, public transit, forestry, and educational programs. This collaborative program can provide benefits to other states as well, and may encourage the parties to the Framework Convention on Climate Change to take constructive steps that will facilitate such actions.

José Goldemberg
Secretary of the Environment
State of São Paulo, Brazil

Alan Lloyd
Secretary of the Environment
California, U.S.A.

EXECUTIVE SUMMARY*

What will it cost to reduce the threat of global warming? Can industrialized nations afford it? Shouldn't developing countries invest in economic development instead? The future of climate-change negotiations, and the future climate of the planet, hinge on the answers to these questions.

This report provides important real-world evidence that greenhouse gas emissions can be substantially reduced at a profit rather than a cost. The states of California and São Paulo—two of the largest states in the world—have been leaders in energy policies that reduce conventional air pollutants, greenhouse gases, and energy costs, thereby saving tens of billions of dollars.

The experience in these states should provide impetus to other state and national initiatives to develop aggressive, economical, and technically viable programs for energy efficiency and greenhouse gas reduction.

In the face of solid evidence of the dangers of human-induced climate change, the primary barrier to action has been concern about the economic cost of the actions required to significantly reduce greenhouse gas (GHG) emissions. This concern has convinced most industrialized countries to agree to only modest reductions in emissions under the Kyoto Protocol, and has led developing countries to largely reject any suggestion that they also assume responsibility for reducing GHG emissions.

But these positions are based in part on misperceptions of the true costs and benefits of emission reduction. The price tag in industrialized countries would indeed be staggering if abatement costs were as high as those used in some models (e.g., $100† per ton of carbon dioxide), but real-world



costs are turning out to be far lower—in fact, net economic *savings* often result from energy efficiency investments and demand-side management. For their part, developing countries could consider the possibilities of technology "leapfrogging"—that is, benefiting from the industrialized nations' learning curve by adopting new technologies after other countries have paid the early costs associated with their development.

The states of São Paulo and California provide two real-world examples of initiatives to promote energy efficiency, reduce air pollution, and reduce GHG emissions. Far from being costly, these initiatives are providing net economic benefits. These two states thus approach the challenge of GHG emission reductions not as a cost to be borne but as a practical strategy to benefit public health, energy security, and their competitiveness in the world economy.

*This report was prepared by Walter V. Reid (Stanford Institute for the Environment), Oswaldo Lucon (Secretaria de Meio Ambiente do Estado de São Paulo [SMA]), Suani Teixeira Coelho (SMA), and Patricia Guardabassi (SMA), with contributions from Hal Harvey and Joseph Ryan (William and Flora Hewlett Foundation) and Eileen Tutt (California Environmental Protection Agency). Translations by Robert Kozelka.

†Throughout this report, the dollar sign ($) refers to U.S. dollars and the dollar sign preceded by "R" (R$) refers to Brazilian reals.

SUMMARY | São Paulo

If ranked alongside entire nations on the basis of carbon dioxide (CO_2) emissions (excluding those relating to land use change), the state of São Paulo would be the 39th-largest source of emissions in the world. But GHG emissions per capita and emissions per unit of economic activity have been declining in the state of São Paulo since 1999 (see figure A). Programs now underway in São Paulo could achieve savings of some 60 million tons of CO_2 equivalent (tCO_2eq) annually over the next 20 years (see table A). These savings amount to more than two-thirds of the state's CO_2 emissions (excluding land use emissions) and will thus dramatically reduce the rate of emission growth. And the state is gaining net economic benefits from these programs.

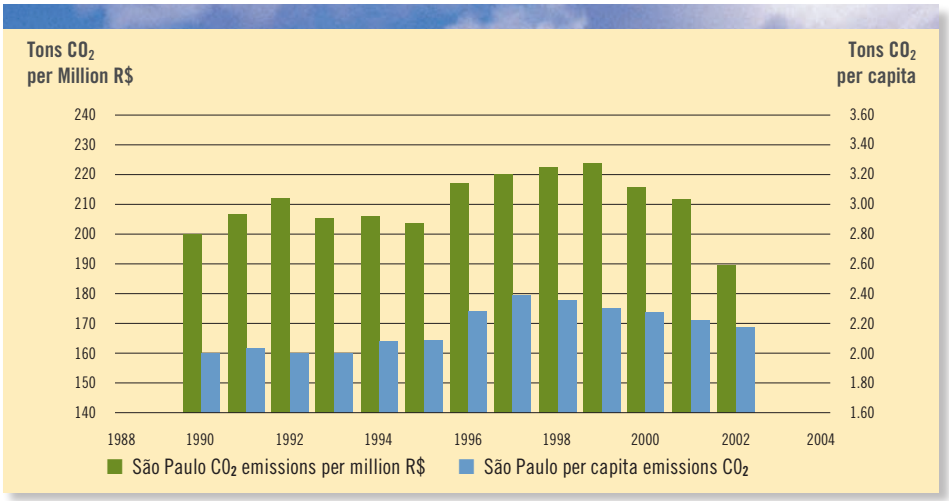


Figure A. Trends in São Paulo CO_2 Emissions (Excluding Land Use Change) since 1990 Per Unit of Gross State Product and Per Capita.
Source: São Paulo State Environment Agency.

STRATEGY	Annual GHG Emission Reduction (Million tons CO_2 equivalent)
Nationwide Programs	
Brazilian Alcohol Program (PROALCOOL)	6.8
National Program for Motor Vehicles Pollution Control (PROCONVE)	0.3 – 6
Alternative Sources of Energy Incentive Program (PROINFA)	1.6
São Paulo Strategies	
Reducing landfill emissions	12.3*
Land use carbon sequestration (Riparian Forest Program)	1.8
Biomass origin electricity	32.8
Total Potential Reductions	**55.6 to 61.3**

*Assumes full potential savings achieved.

Table A. Annual Emission Reductions Expected or Possible in the State of São Paulo under Selected State and National Programs.

SUMMARY | São Paulo

For example:

- The use of ethanol blended in gasoline (gasohol) resulted in avoided emissions of nearly 7 million tons of CO_2 (tCO_2) in São Paulo state in 2003. The use of ethanol, which is now less expensive than gasoline, has also reduced annual fuel costs for consumers by as much as $7.5 billion and reduced air pollution. Over the period 1980 to 2003, avoided emissions in São Paulo state due to use of ethanol totaled 82 million tCO_2eq.
- The national electricity conservation program (PROCEL) resulted in more than $5.25 billion of avoided investments in power plants (along with their associated GHG emissions) nationwide at a cumulative cost of only $127 million, an overall benefit-cost ratio of 40:1.
- São Paulo state encourages the reduction of GHG emissions by using landfill methane-gas emissions to generate energy. This reduces the need for other energy sources and converts methane to CO_2, which makes a much smaller contribution to global warming. If the full potential for landfill energy generation is achieved in the state, some 12 million tCO_2eq emissions would be avoided.
- As much as 1 million hectares of riparian area (equivalent to 120,000 km of rivers) has the potential to be reforested in the state. If even 20 percent of this potential is achieved, it would reduce GHG emissions by 36 million tCO_2eq over a period of 20 years while also delivering benefits associated with the protection of ecosystem services (such as water supply, water purification, and local climate regulation) from those watersheds.

SUMMARY | California

Ranked alongside nations, California is the 20th-largest source of net GHG emissions in the world. But while the U.S. national per-capita GHG emissions average 23 metric tons a year, Californians' per capita emissions are only about half that: 12 metric tons. This is due primarily to state policies that have encouraged the use of natural gas and renewable resources rather than coal, and that have promoted energy efficiency. Over the past 30 years, California's investments in energy efficiency programs and improvements in efficiency standards for buildings and appliances resulted in a roughly constant per-capita electricity consumption, while for the United States as a whole electricity consumption increased by nearly 50 percent. CO_2 emissions per capita in California have decreased by 30 percent since 1975, while U.S. per-capita emissions have remained essentially level (see figure B).

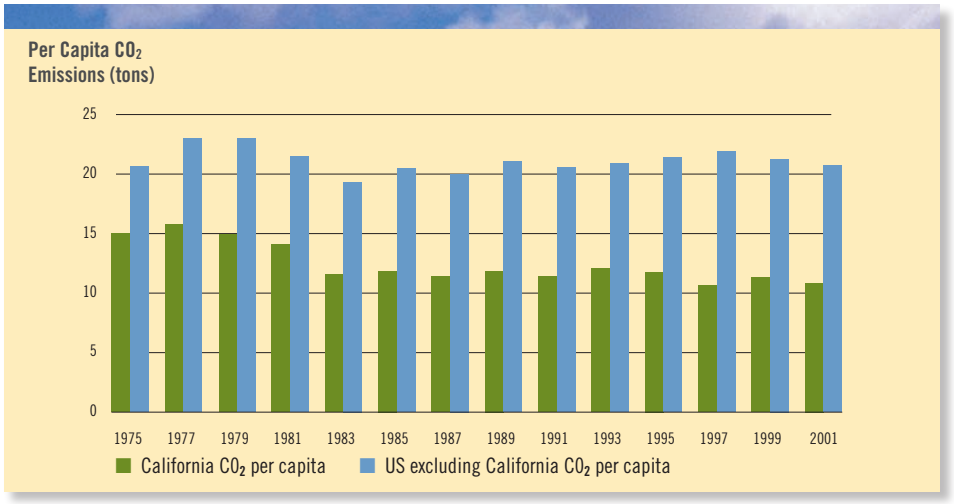


Figure B. Per Capita CO_2 Emissions for California and the Rest of the United States (Excluding California). CO_2 emissions per capita in California have decreased by 30 percent since 1975, while emissions in the rest of the United States have stayed constant.
Source: Oak Ridge National Laboratory.

The cumulative effects of all of California's electric efficiency programs, including municipal utility and public agency programs and standards, amount to more than 10,000 MW and 35,000 GWh in savings through 2001. These savings are equivalent to the output of 20 500-MW power plants. At the same time, these policies have provided significant economic and health benefits.

For example:

- The state's existing building and appliance standards yielded net economic benefits of approximately $1,000 per person between 1975 and 1995, and saved individuals and businesses $56 billion through 2003.
- California's economy would have been 3 percent smaller ($31 billion) in 1995 if the gains achieved in energy efficiency in the industrial and commercial sectors during the previous 20 years had not been achieved.
- If energy intensity (the energy used per unit of economic activity) in the state had remained at 1975 levels, air pollution emissions from stationary sources in the state would have been about 50 percent greater in 1995.

California has been among the leading states in the United States to take action to address growth in GHG emissions, and in June 2005 the state governor issued an executive order calling for a reduction of state GHG emissions to 2000 levels by 2010, to 1990 levels by 2020, and to 80 percent below 1990 levels by 2050. A set of existing and planned policies and programs has the potential to substantially reduce the rate of emission growth while also yielding economic and health benefits (see table B).

STRATEGY	Annual GHG Savings (Million tons CO_2 equivalent)	
	2010	**2020**
Vehicle GHG Standards (Pavley Bill)	1	30
Accelerated Renewable Portfolio Standard	5	11
Investor Owned Energy Efficiency Programs	4	8.8
Natural Gas Efficiency Programs	1	6
Appliance Efficiency Standards	3	5
Fuel-efficient Replacement Tires and Inflation Programs	3	3
Million Solar Roofs	0.4	3
50 percent Statewide Recycling Goal	3	3
Diesel Anti-idling	1	2
Green Buildings Initiative	0.5	1.8
Reduced Venting and Leaks in Oil and Gas Systems	1	1
Total potential reductions	**22.9**	**74.6**

Table B. California GHG-Reduction Strategies that are Now Underway or Highly Likely to be Implemented.

For example:

- In September 2004, the California Air Resources Board adopted standards that aim to reduce GHG emissions from cars and light trucks by 18 percent in 2020 and 27 percent in 2030, yielding estimated emission reductions of 30 million tCO_2eq annually by 2020. Fuel savings will more than offset the cost of the added technology required, resulting in net savings of a minimum of $4.4 billion annually in 2020.

- In September 2005, the California Public Utilities Commission (CPUC) approved utilities' plans to provide $2 billion in consumer rebates and other efficiency incentives over the next three years. CPUC estimates that these programs will cut energy costs for homes and businesses by more than $5 billion over the life of the energy savings measures and reduce emissions by an estimated 3.4 million tCO_2eq by 2008.
- Existing building and appliance standards will save Californians a further $43 billion in utility costs by 2013.
- Motor vehicle emission standards are expected to cut ozone-forming pollution by about 6 tons per day in 2020.
- Current state policies to promote the use of renewable energy, combined with the growth of the renewable energy sector, will create an estimated 201,000 person-years of employment through 2017, with payroll benefits of $8 billion.

California's full implementation of the policies listed in table B would reduce growth in GHG emissions to 16 percent above 1990 levels in 2010 and 21 percent above 1990 levels by 2020 (see figure C). A Climate Action Team chaired by the Secretary of the California Environmental Protection Agency and composed of high-level representatives from key state agencies is now developing a set of recommendations for additional strategies to achieve the GHG reduction targets.

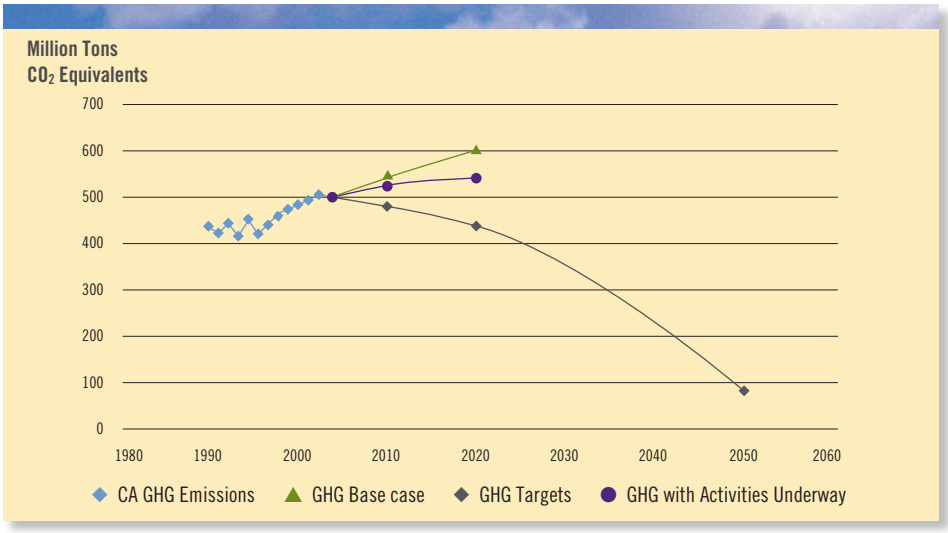


Figure C. California Greenhouse Gas Emission Trends. **Historical** ***data are plotted through 2002 based on the Inventory of California Greenhouse Gas Emissions and Sinks.*** **Base case** ***projection includes implementation of the state renewable portfolio standard, blending of ethanol in gasoline, and the 2005 update of state building standards, but does not include the implementation of the California vehicle GHG regulations (Pavley Bill).*** **Targets** ***are the state targets announced in June 2005.*** **Activities underway** ***are listed in table B.***
Source: California Energy Commission; Tellus Institute.

Reducing Emissions Pays Dividends

The experience of the states of California and São Paulo parallels that of many private companies, which increasingly recognize that GHG emissions are an indicator of an economically wasteful use of a limited resource. For example, BP added $650 million of value, for an investment of around $20

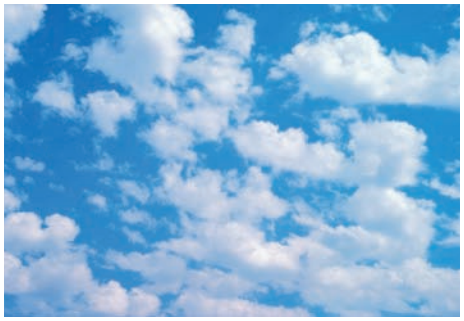


million, when it reduced its GHG emissions by 10 percent between 1998 and 2001.[1] Whether managing a company or governing a state, those in charge of policies and management systems should aim to achieve economic savings through more efficient use of energy and reduced emissions of pollutants. Leading companies are now taking aggressive actions to reduce emissions because of these economic benefits, and, increasingly, companies are discovering economic opportunities associated with the development and marketing of new technologies for emission reductions.

It is not surprising that cost-effective opportunities exist to reduce GHG emissions in most states. Relatively inexpensive and abundant energy over the last century provided little incentive for states to establish policies that would promote energy efficiency. Moreover, institutional arrangements sometimes pose barriers to the achievement of potential efficiency gains. For example, power producers may have little incentive to promote demand-side reductions in energy use (such as through energy-efficient appliances) since the producer does not gain the economic savings. But the experiences of California and São Paulo suggest that states can gain major benefits by aggressively pursuing these options.

States are pursuing these savings largely voluntarily because the economic, public health, and energy security benefits more than justify the initial investment. Fortunately, these actions also help to reduce the rate and magnitude of climate change—mitigating the harm it may cause to the regional economy. Nevertheless, these states and others would benefit significantly from national policies and international cooperation that would create a more efficient and less-fragmented response and would facilitate investment in the most cost-effective options. São Paulo and California have proven that the benefits of GHG reduction strategies outweigh the costs. The lesson for other states and nations is that there is no reason to wait to take similar actions.

SÃO PAULO



Introduction

Brazil is the fifth-largest source of GHG emissions worldwide (see table 1), mainly due to emissions resulting from land use change, although on a per capita basis it ranks number 34. The state of São Paulo accounts for approximately 27 percent of energy consumption in Brazil (see box 1). While total GHG emission data are not available for the state, its carbon dioxide (CO_2) emissions (excluding land use change) totaled 83 million metric tons in 2003, or nearly one-quarter of Brazil's total. Ranked alongside entire nations on the basis of CO_2 emissions (excluding land use change), the state would be the 39th-largest emitter.

São Paulo, with more than 40 million inhabitants in 2004 (almost one-fourth of the national total), is the most industrialized and urbanized state in Brazil.[2] In 2004, the gross state product (GSP) (R$591.6 billion, around $217 billion) accounted for 33.4 percent of Brazil's GDP. Between 1995 and 2004, Brazil's GDP and São Paulo's GSP grew at annual rates of 4.9 and 4.8 percent respectively. By 2004, São Paulo's economic growth had accelerated to 7.6 percent.[3] In 2002, carbon intensity (carbon emissions per unit of economic product) in São Paulo was 32 percent lower than the national average (515 tCO_2/R$ GSP and 762 tCO_2/R$ GDP respectively). GHG emissions per capita and emissions per unit of economic activity have been declining in the state of São Paulo since 1999 (see figure 1).[4]

As a developing country, Brazil does not have specific emission-reduction obligations, although as a signatory of the United Nations Framework Convention on Climate Change (UNFCCC), the country is committed to: a) develop national inventories of anthropogenic emissions by sources and removals by sinks of all GHG; b) formulate and implement regional programs to mitigate climate change; and c) promote and cooperate in the development of clean technologies.

Brazil faces serious threats associated with climate change. Climate change is likely to intensify climatic events such as El Niño and La Niña that directly affect Brazil.[5] Climate change is expected to increase the rate of biodiversity loss, increase the extent and frequency of drought, reduce crop yields, and, consequently, exacerbate poverty and socioeconomic problems. Brazilian agriculture, one of the nation's most important economic sectors, is particularly vulnerable to climate impacts.

	GHG Emissions (Tons CO_2 equivalent)					CO_2 Emissions	
	Excluding land use (millions)	Land use (millions)	Total (millions)	Rank (total)	Emissions per capita	Rank (per capita)	(Million tons CO_2) excluding land use
United States	6,924	-403	6,521	1	23	12	5,762
China	4,942	-47	4,895	2	4	119	3,474
European Union (25)	4,714	-21	4,693	3	10	53	3,819
Indonesia	495	2,563	3,058	4	15	25	286
Brazil	842	1,372	2,214	5	13	34	328
Russian Federation	1,919	54	1,973	6	14	29	1,540
India	1,837	-40	1,797	7	2	159	1,008
Japan	1,333	4	1,338	8	11	51	1,225
Germany	989	0	989	9	12	41	837
Malaysia	169	699	868	10	37	4	124
Canada	675	65	740	11	24	11	521
United Kingdom	660	-2	659	12	11	44	558
Mexico	511	97	608	13	6	91	385
Italy	531	-3	528	14	9	65	447
Korea (South)	525	1	526	15	11	45	470
Ukraine	517	0	517	16	11	52	348
Myanmar	82	425	508	17	11	50	9
France	512	-6	506	18	9	69	364
Australia	491	4	496	19	26	8	332
California (2002 data)	**494**	**-20**	**474**		**12**		**411**
Iran	439	8	447	20	7	80	298
South Africa	413	2	414	21	9	64	345

Table 1. Greenhouse Gas Emissions in 2000. Total GHG emissions are not available for São Paulo so it is not included in this table. The São Paulo state CO_2 emissions (excluding land use) were 83 million tCO_2 in 2003, which would place it as the 39th largest emitter of CO_2. Data are for 2000, except in the case of California, where data are reported for 2002. Greenhouse gas equivalent emissions are based on emissions of CO_2, CH_4, N_2O, PFCs, HFCs, and SF_6.

Source: World Resources Institute, 2005. Climate Analysis Indicators Tool (CAIT) Version 2.0. WRI, Washington D.C. (http://cait.wri.org/); For California: Bemis, Gerry, and Jennifer Allen, 2005. Table A-4 in: Inventory of California Greenhouse Gas Emissions and Sinks: 1990 to 2002 Update. Publication CEC-600-2005-025, California Energy Commission, Sacramento, California.

Box 1. São Paulo State Energy Consumption

The state of São Paulo accounted for 27 percent of Brazil's energy consumption in 2000, the highest of any Brazilian state. Industrial energy use accounted for 34 percent of the total and transport accounted for 30 percent. São Paulo state contained some 13 million vehicles in 2003, with 7 million in the São Paulo Metropolitan Region alone.

Industrial energy demand is met from several sources. Biomass residues, fuel oil, diesel, liquefied petroleum gas, process residuary fuels, and, more recently, natural gas are all used as sources of process heat. Electricity is generated primarily by hydropower, supplemented with some thermal power derived from fossil fuels and sugarcane bagasse. As opportunities for further hydropower development become more limited, continued growth in energy demand is being met by other sources. Two particularly promising sources are the use of sugarcane biomass in cogeneration plants within the sugarcane agroindustry, and the use of natural gas in thermoelectric and cogeneration plants. Overall, renewable energy sources (of which hydropower accounts for roughly 50 percent) supply approximately half of the state's energy needs.

Within the transport sector, fossil fuels (diesel and gasoline) supply most energy. However, ethanol use is being expanded by the growing number of flexible fuel vehicles (FFVs) (700,000 units sold in Brazil since mid-2003), which are replacing dedicated fuel (ethanol or gasoline) vehicles. Even the gasoline-dedicated cars have run on a nationally mandated 25-percent ethanol blend since 1980. FFVs leave fuel choice to the end-user and avoid problems in case of shortages of any fuel. FFVs are currently running entirely on ethanol because of its lower price. Natural gas is also increasing in importance as a fuel for transportation in both passenger cars and public transport vehicles.

Sources: Rei, F., O. Lucon, S.T. Coelho, and J. Goldemberg, 2004. In: Network of Regional Governments for Sustainable Development, A nrg4SD report for COP10, NRG, Spain (www.nrg4sd.net/Download/Events/Other/COP10FinalReport.pdf); Secretaria de Meio Ambiente do Estado de São Paulo, 2002. Chapter 3: Energy and Transportation. In: Agenda 21 in São Paulo (http://www.ambiente.sp.gov.br/agenda21/ag21sp/ag21sp.htm).

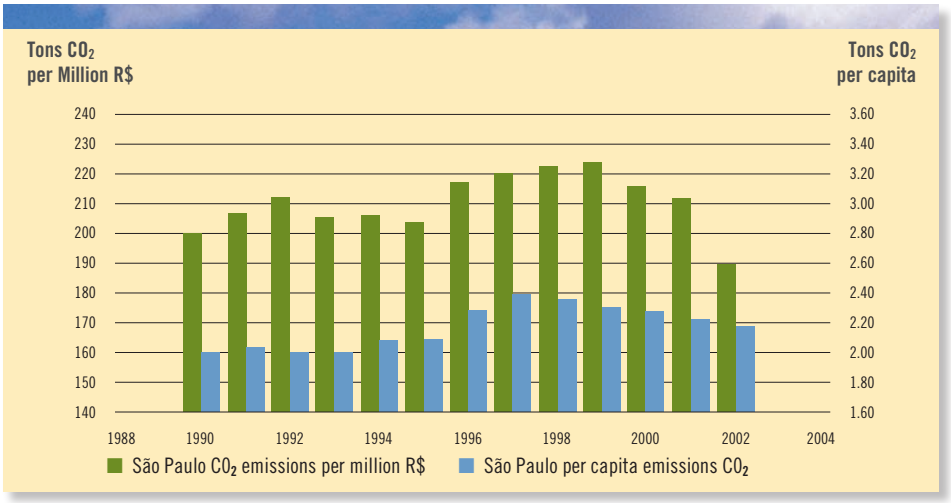


Figure 1. Trends in São Paulo CO_2 Emissions (Excluding Land Use Change) Since 1990 per Unit of Gross State Product and per Capita.
Source: Secretaria de Meio Ambiente do Estado de São Paulo data.

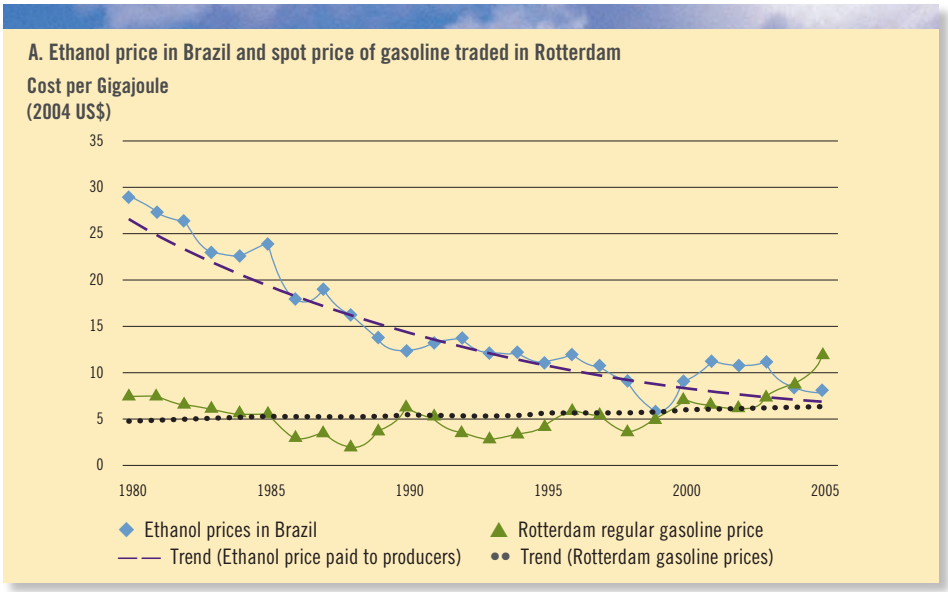
A number of national and state policies and programs that have helped to reduce the rate of growth of GHG emissions in the state of São Paulo are described below.

National Policies with Emission Reduction Benefits

Several national policies have helped the state of São Paulo limit GHG emissions.

- **Brazilian Alcohol Program (PROALCOOL).**[6] PROALCOOL was established in 1975 with the goal of reducing oil imports by replacing gasoline with ethanol produced from sugarcane as a motor vehicle fuel. It has become the most important commercial biomass energy program in the world. Most of the world's ethanol is produced from sugarcane, mainly in Brazil. Between 1975 and 2005 production of ethanol in Brazil increased from 0.6 to 15 million cubic meters. Ethanol is used in cars as an octane enhancer and oxygenated additive to gasoline blended in a proportion of 25 percent anhydrated ethanol (in a mixture called gasohol) or in dedicated hydrated ethanol engines. In 2003, the emission of 6.8 million tCO_2 was avoided in the state of São Paulo due to the gasoline replacement by ethanol.[7] Over the period 1980 to 2003, avoided emissions in São Paulo state due to the use of ethanol totaled 82 million tCO_2eq.

  Since February 1999, prices for ethanol have not been subject to government control and have fallen to 60 to 70 percent of the price of gasohol due to significant reductions in production costs. Because of policies that promoted increased production and increased production efficiency, ethanol is now an international commodity fully competitive with gasoline (see figure 2). In 2003, auto manufacturers began to produce flexible fuel vehicles (FFVs) that could use any blend of ethanol or gasoline. A minimum of 25 percent ethanol is mandatory, but FFVs can use 100 percent ethanol or any other mixture in between. Given the current relatively low price of ethanol, most FFVs are now ethanol-powered. Ethanol production generates 36 more jobs per unit of energy produced than coal, 50 more than hydropower, and 152 more than the oil industry. A job can be created in the ethanol industry in Brazil at a cost of $15,000, one of the lowest industrial job costs in the country.



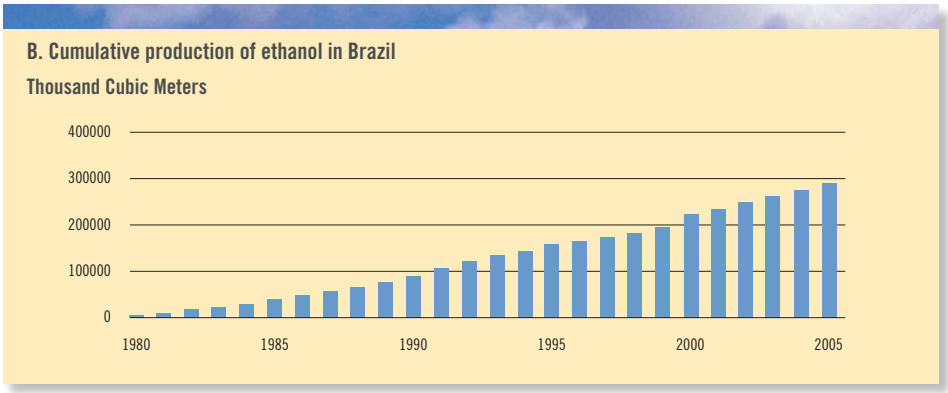


Figure 2. Learning Curve: Competitiveness of Brazilian Sugarcane Ethanol with Rotterdam Gasoline.

Source: DATAGRO, Plinio Nastari Consultoria e Participações S/C Ltda., http://www.datagro.com.br/r_home.php, updating material from Goldemberg et al, 2004, Biomass and Bioenergy, vol. 26/3, pp. 301–4.

- **National Program for Motor Vehicle Pollution Control (PROCONVE).** PROCONVE is a national program created in 1986 by the National Environment Council (CONAMA) to control pollutant emissions from mobile sources mainly by establishing emission limits for new vehicles. Although PROCONVE was established principally to reduce air pollution, it has also helped to reduce GHG emissions. Between 2010 and 2020, cumulative CO_2 emission reductions in the state of São Paulo resulting from this program are expected to be between 2.6 to 57.2 million tCO_2 under various plausible scenarios.[8]
- **Alternative Sources of Energy Incentive Program (PROINFA).** PROINFA is designed to promote the use of renewable sources of energy, including biomass, wind, and small hydropower. Full implementation of the program will reduce Brazil's emissions by 11 million tCO_2. As of October 2005, the state of São Paulo had contracted 257 MW in biomass-to-

electricity projects.[9,10] These contracted and planned projects in São Paulo will reduce emissions by roughly 1.6 million tCO_2eq.

- **National Electricity Conservation Program (PROCEL).** PROCEL, established at the end of 1985, funds energy efficiency projects carried out by state and local utilities, state agencies, private companies, universities, and research institutes. Eletrobras/PROCEL estimated in 2003 that its cumulative activities had resulted in savings equivalent to 4.6 percent of electricity use in Brazil.[11]

São Paulo Emission Reduction Initiatives

São Paulo established the São Paulo State Program for Climate Change (PROCLIMA) in 1996 and has also promoted a series of related policies and programs at the national level, such as a program for the control of ozone-depleting chemicals and the National Program for Motor Vehicle Pollution Control described above. Five of the most important state policies and programs that result in GHG savings are described here (see summary in table 2).

STRATEGY	GHG Emission Reduction (Million tons CO_2 equivalent)	Notes
Nationwide Programs		
Brazilian Alcohol Program (PROALCOOL)	6.8	2003 emissions avoided in the state of São Paulo
National Program for Motor Vehicles Vehicles Pollution Control (PROCONVE)	0.3 – 6	Expected average annual reductions in the state of São Paulo over the period 2010 to 2020.
Alternative Sources of Energy Incentive Program (PROINFA)	1.6	Reduction in state of São Paulo based on contracted and planned projects.
São Paulo Strategies		
Reducing landfill emissions	12.3*	Assumes full potential landfill methane capture at GHG savings equal to those projected for Aterro Bandeirantes project.
Additional transportation emission reductions	–	Not estimated
Program for Reduction of Emissions to Atmosphere (PREA)	–	Not estimated
Land use carbon sequestration (Riparian Forest Program)	1.8	Annualized reductions over 20 years assuming 20% of the potential area is reforested (36 million tCO_2eq over 20 yrs).
Biomass origin electricity	32.8	Annual reductions excluding savings achieved through PROINFA.
Total	**55.6 to 61.3**	

Table 2. Brazil and São Paulo Strategies That Will Achieve GHG Emission Reductions.

- **Reducing landfill emissions.** In 2004, São Paulo emitted approximately 950,000 tons of methane from municipal solid waste and 25,000 tons of methane from wastewater treatment, representing about 1 percent of Brazil's net GHG emissions and averaging approximately 7 kilograms of methane per person per year. Even though 95 percent of the population in urban areas is reached by waste collection services, improper disposal of waste in open areas still prevails in most municipal districts, aggravating methane emissions from decomposition.

  São Paulo encourages the reduction of GHG emissions by improving waste disposal areas and landfills and by using the landfill gas to generate energy. The generation of electricity from methane gas reduces the need for other sources of energy and also converts the methane to CO_2, which has a global warming potential less than 5 percent that of methane. The potential for electricity production on São Paulo state landfills could reach 340 MW. One such project, Aterro Bandeirantes, is already operating. This $20 million project, to be funded in part through the Clean Development Mechanism (CDM), will produce 22.6 MW of power and will save an estimated 16.1 million tCO_2eq between 2004 and 2024.[12]

- **Reducing transportation emissions.** The most significant GHG emission savings in the transport sector are being achieved through the use of ethanol fuels as described above. São Paulo state is the source of 60 percent of the nation's ethanol production.[13] To meet the growing demand for ethanol, the area of sugarcane in São Paulo is projected to grow by 4 million hectares by 2010, corresponding to the production of approximately 14.8 billion liters of ethanol. This expansion is expected to occur without deforestation, with sugarcane replacing other crops and livestock.

  The state is exploring a number of other opportunities for further reduction of air pollution and GHG emissions. The São Paulo Metropolitan Region has in place an Integrated Transport Plan that is designed to increase mobility and increase the share of public transportation (buses, train, and subway). In São Paulo city, the public transportation system is testing hybrid diesel-electric vehicles. Each fleet of 1,000 diesel buses emits 100,000 tons of carbon each year. (There are currently nearly 20,000 buses used for public transportation in the São Paulo Metropolitan Region.[14]) Hybrid technology can abate part of these emissions, generating CDM credits. São Paulo is currently testing 12 hybrid buses that reduce fuel consumption and carbon emissions by 20 to 30 percent and local pollutant emissions by 80 percent. São Paulo is also planning to expand the fleet of electric trolleybuses in the capital's metropolitan region.[15]

Finally, the state is exploring the use of rapid transit corridors to reduce emissions and transportation costs (traffic jams increase the operating cost of buses in São Paulo city by about 16 percent).[16]

- **Program for Reduction of Emissions to the Atmosphere (PREA).** São Paulo state issued a decree in 2002 that established a 5-year renewable licensing process for stationary sources of air pollutants. It corrected the previous "right to pollute" of older enterprises, some of which were licensed nearly 30 years previously. Such companies are required to gradually reduce their emissions, either by updating technologies or shutting down facilities. This program to reduce air pollution from industrial sources was significantly expanded in 2004 with the passage of legislation (Decree 48.523) that permits new industrial licenses in areas that have not met air quality standards only if sufficient abatement credits are first obtained from the government. The emissions currently regulated under this legislation are NO_x, SO_2, PM_{10}, CO, and nonmethane volatile organic compounds. In the future, indicative air-quality targets will be applied, allowing better management of sources during license renewal and providing an incentive for cleaner production and fuels.

  Emission abatement credits are based upon mass balances and determined by third party measurement of criteria pollutant emissions before and after any environmental improvement. Emission reductions are converted into credits, which can be used to license new processes in nonattainment areas. The abatement credit trading is conducted by the private sector through bilateral contracts, without interference from government, which in turn is responsible only for monitoring the emission reductions and overseeing the conversion of emission reductions into abatement credits. In a second phase, expected to start in late 2007, the heaviest-polluting existing facilities will be required to reduce their emissions, based on the inventory of sources and air quality information.

- **Land use carbon sequestration (Riparian Forest Program).** Between 1962 and 1992, the area of forest cover in São Paulo declined from 7.2 million hectares to 3.3 million hectares, but forest cover then began to increase and reached 3.5 million hectares in 2000.[17] As much as a further 1 million hectares of riparian areas (equivalent to 120,000 km of river courses) has the potential to be reforested in the state, which would represent a total of 180 million tCO_2eq over a period of 20 years. In order to promote this restoration, São Paulo state has developed an integrated program involving research, technology improvement, demonstration projects, and capacity building that is being supported

by a 4-year, $7.75 million Global Environment Facility grant. The state of São Paulo has also taken steps to regulate the use and exploitation of natural resources to reduce land use emissions, including: (a) the creation of several protected areas in the Atlantic Rainforest, (b) legislation providing reforestation incentives in riparian zones, and (c) legislation phasing out the practice of sugarcane burning.

- **Biomass origin electricity.** São Paulo state is promoting the use of renewable energy. The state has the potential to generate an estimated 2,300 MW of power through sugarcane-bagasse-based electricity.[18] This would result in avoided emissions of 34.4 million tCO_2eq per year (or 32.8 million tCO_2eq excluding savings achieved through PROINFA).

The state of São Paulo is also exploring other actions that would help to reduce GHG emissions, including:

- Development of ambitious new-model vehicle emission standards (PROCONVE Phase 7), including standards for heavy-duty vehicles and introduction of On Board Diagnostics and On Board Monitoring systems.
- Legislation to implement inspection and maintenance programs for vehicles and increase vehicle owner responsibility for modifications or conversions that increase emissions.

Costs and Benefits

Although the strategies listed above will play a significant role in reducing the rate of growth of GHG emissions in São Paulo, almost all the strategies are justified in terms of their economic and public health benefits even if GHG emission reductions are not considered.

Brazil's alcohol program (PROALCOOL), for example, was initially established in large part to promote energy independence, but it provides a number of benefits in addition to GHG emission reductions. In particular, local air pollution lessened significantly with the introduction of ethanol as a fuel. The use of ethanol as an additive in gasoline (to produce gasohol) results in a significant reduction in vehicle lead emissions. The elimination of lead additives in gasoline resulted in a 92 percent decline in lead concentrations in the São Paulo Metropolitan Region, from 1.4 $\mu g/m^3$ in 1978 to less than 0.10 $\mu g/m^3$ in 1991, well below the 1.5 $\mu g/m^3$ national quality standard. Vehicles powered by pure hydrated ethanol also eliminate sulfur emissions, thus mitigating atmosphere acidification, as well as avoiding emissions of carcinogenic substances such as benzene, olefins, formaldehydes, and other polycyclic and aromatic components found in fossil fuels. Alcohol-powered vehicles predominantly emit acetic aldehyde, which has a carcinogenic effect nearly 10 times less than that of benzene. At the current relative

prices of gasoline and ethanol, PROALCOOL also provides significant economic savings to consumers, reducing annual fuel costs for consumers by $7.5 billion in São Paulo in 2003.[19]

Over the period 1997 to 2000, the National Program for Motor Vehicle Control (PROCONVE) resulted in net benefits to public health in São Paulo of over 4,500 avoided deaths and 5,500 avoided hospital admissions, which were valued at $2.9 billion to $4.0 billion.[20] Between 2000 and 2020, the PROCONVE program is expected to result in almost 10,000 avoided hospital admissions and more than 8,800 avoided deaths attributed to air pollution, with an economic value of $4.8 billion to $6.7 billion. The state of São Paulo's Integrated Transport Plan is expected to result in an additional 2,277 avoided hospital admissions and 1,800 avoided deaths from 2000 to 2020, with a value of $1.7 billion to $2.3 billion.

The electricity savings and additional generation that resulted from power plant improvements under PROCEL resulted in approximately $5.25 billion of avoided investments in new power plants and transmission and distribution facilities nationally. The cost for achieving these benefits over this period was only $127 million, resulting in an overall benefit-cost ratio of 40:1.[21]

The Program for Reduction of Emissions to the Atmosphere (PREA), within the industrial sector in São Paulo, is also expected to provide significant economic savings. In Brazil it is estimated that savings of 8 to 15 percent are achievable in Brazilian industry based on cost-effective measures such as replacing oversized motors, improving transmission systems, replacing overloaded internal lines and transformers, correcting low power factors, and reducing excessive peak loads.[22] Additional savings of 7 to 15 percent could be achieved by using efficient motors and variable-speed drives; improving the efficiency of electrical furnaces, boilers, and electrolytic processes; and through greater use of cogeneration.

The state's reforestation projects also provide many other social and environmental benefits, including job creation, the protection of ecosystem services (water purification, flood regulation, local climate regulation) and the protection of biodiversity.

CALIFORNIA

Introduction

The United States is the largest source of net GHG emissions in the world, accounting for more than 16 percent of net emissions, and it is the sixth-largest source of emissions per capita (see table 1 (page 12)). In 2002, California was responsible for 474 million tCO_2eq of net GHG emissions,[23] representing 7.3 percent of total U.S. emissions. If ranked alongside nations, California is the 20th-largest source of net GHG emissions in the world. Most of California's emissions (81 percent) are produced from the combustion of fossil fuels. The transportation sector is the single largest source of emissions, accounting for 41 percent, followed by industrial emissions (23 percent) and electricity generation (20 percent).[24]

Although California's total emissions are larger than those of any state but Texas, California has relatively low carbon emission intensity. In 2001, California ranked fourth-lowest among U.S. states in carbon emissions per capita and fifth-lowest in CO_2 emissions from fossil fuel consumption per unit of gross state product. While national annual per-capita GHG emissions average 23 metric tons, Californians' per capita emissions are only about half that: 12 metric tons (see table 1 (page 12)). California's low carbon intensity is due primarily to state policies beginning in the 1970s that have encouraged the use of natural gas and renewable resources and promoted energy efficiency.

California is at risk of major harm from climate change. Rising sea levels will likely erode valuable coastline property and threaten California's extensive deltas; changes in temperature and in the availability and quality of water will affect the state's agricultural sector; changing climate will increase heat-related mortality; and pest infestations as well as temperature and water-availability changes will degrade California's forests and micro-climates.

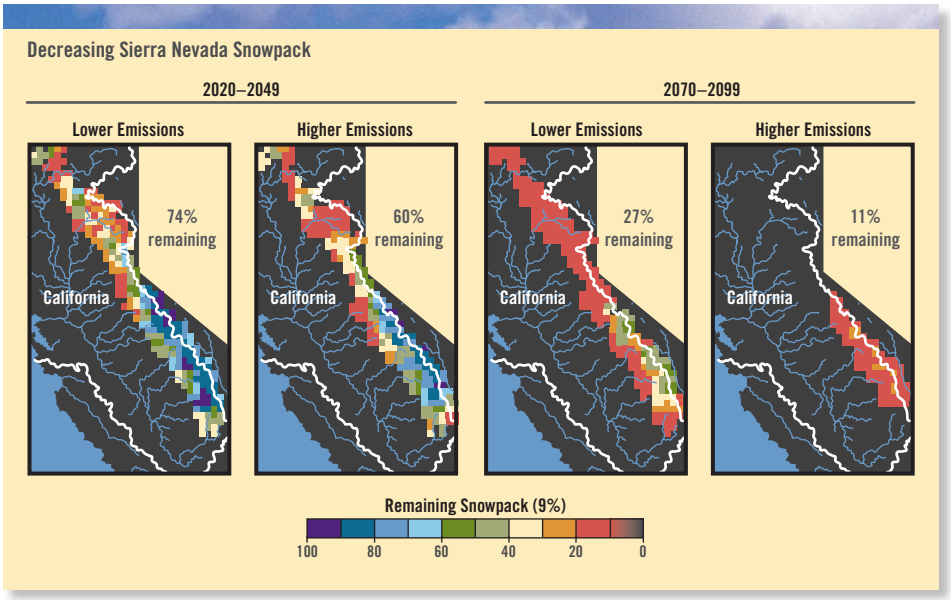


Figure 3. Projected Change in Snowpack in California Resulting from Climate Change. By the end of the century, Sierra Nevada snowpack could be reduced to less than a third of current levels, even under a lower-emission scenario. This figure shows projections of spring snowpack in the Sacramento-San Joaquin watershed, which provides water to about 28 million agricultural and urban users in California. (Based on climate projections from the HadCM3 climate model.)

Source: Union of Concerned Scientists, 2004. Climate Change in California*: Choosing Our Future. UCS, Berkeley, California.*

California has been among the leading states within the United States to take action to address growth in GHG emissions, and in June 2005 Governor Schwarzenegger issued an executive order calling for a reduction of state GHG emissions to:

- 2000 levels by 2010;
- 1990 levels by 2020; and
- 80 percent below 1990 levels by 2050.

Important state policies and programs that have helped to reduce growth in GHG emissions in the past 20 years, or that are now being put into place to achieve these new emission reduction targets, are described below.

California's Energy Policy Achievements

California has a long history of innovative energy policies that have resulted in cost-effective improvements in energy efficiency and increased reliance on clean energy sources. Investments in energy efficiency have provided a cost-effective means for the state to meet growing power needs. Efficiency investments are also faster, since the addition of new power-generation sources requires much longer lead times, and cleaner, reducing emissions of both conventional pollutants and GHGs.

GHG emission growth has been sharply limited by these policies. CO_2 emissions per capita in California have decreased by 30 percent since 1975, while U.S. per capita emissions have remained essentially level[25] (see figure 4). Between 1990 and 2000, while California's population grew by 4.1 million people (a 14 percent increase) and its GSP grew $572 billion

(a 73 percent increase),[26] total state GHG emissions rose only 12 percent. California's GHG emissions have thus declined significantly per unit of economic activity since 1990 (see figure 5).

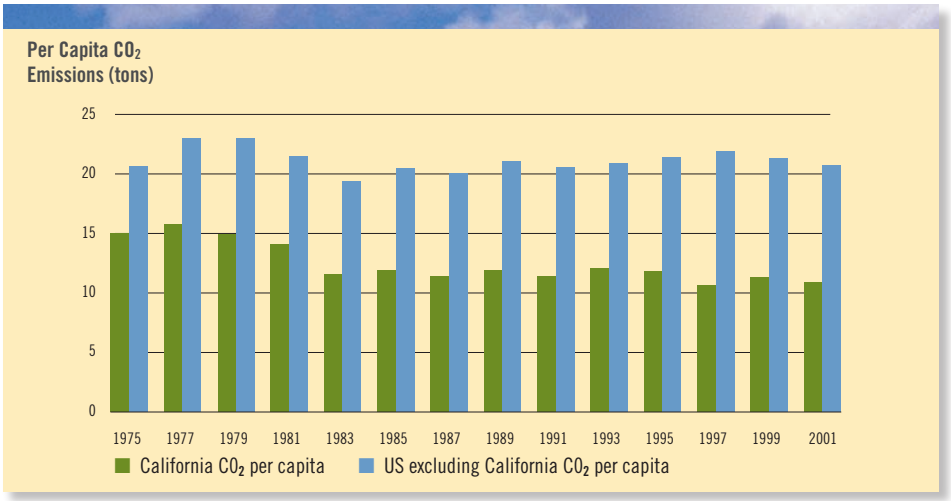


Figure 4. Per Capita Carbon Dioxide Emissions for California and the Rest of the United States (Excluding California). CO_2 emissions per capita in California have decreased by 30 percent since 1975, while emissions in the rest of the United States have stayed constant.

Source: Oak Ridge National Laboratory, 2005 (cdiac.esd.ornl.gov/trends/emis_mon/stateemis/emis_state.htm).

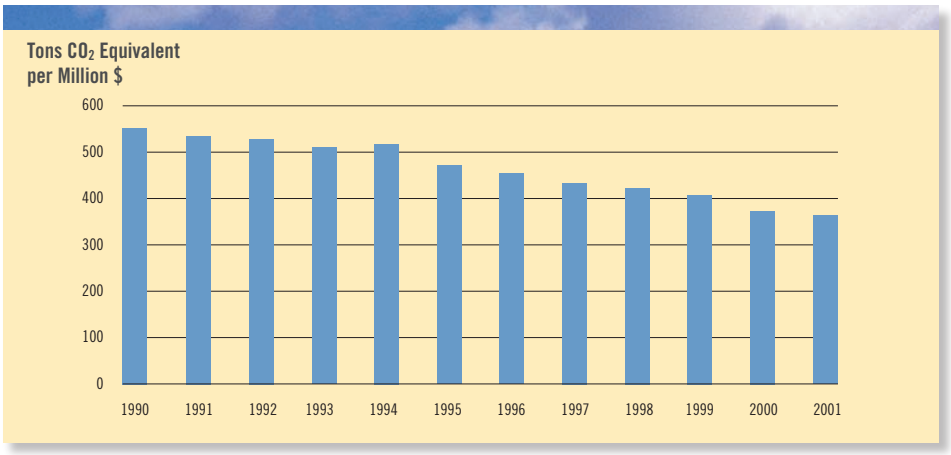


Figure 5. Trends in California GHG Emissions (Excluding Land Use Change) since 1990 per Unit of Gross State Product.

Source: Population and economic data from Rand (http://ca.rand.org/stats/). Emissions data from Bemis, Gerry, and Jennifer Allen, 2005. Inventory of California Greenhouse Gas Emissions and Sinks: 1990 To 2002 Update. Publication CEC-600-2005-025, California Energy Commission, Sacramento, California.

Californians consume less electricity per person than the residents of any other state. Over the past 30 years, California's investments in energy efficiency programs and improvements in efficiency standards for buildings and appliances resulted in roughly constant per-capita electricity consumption, while in the United States as a whole electricity consumption increased by nearly 50 percent[27] (see figure 6). Approximately 1 percent of each investor-owned utility customer's electric bill and 0.7 percent of each natural gas bill supports the energy-efficiency public benefit programs. California's efficiency initiatives have made a substantial contribution to slowing the growth of electricity and natural gas use over the past 26 years. The cumulative

savings from all of California's electric efficiency standards and programs, including municipal utility and public agency programs, amount to more than 10,000 MW and 35,000 GWh through 2001. These savings are equivalent to the output of twenty 500-MW power plants[28] (see figure 7).

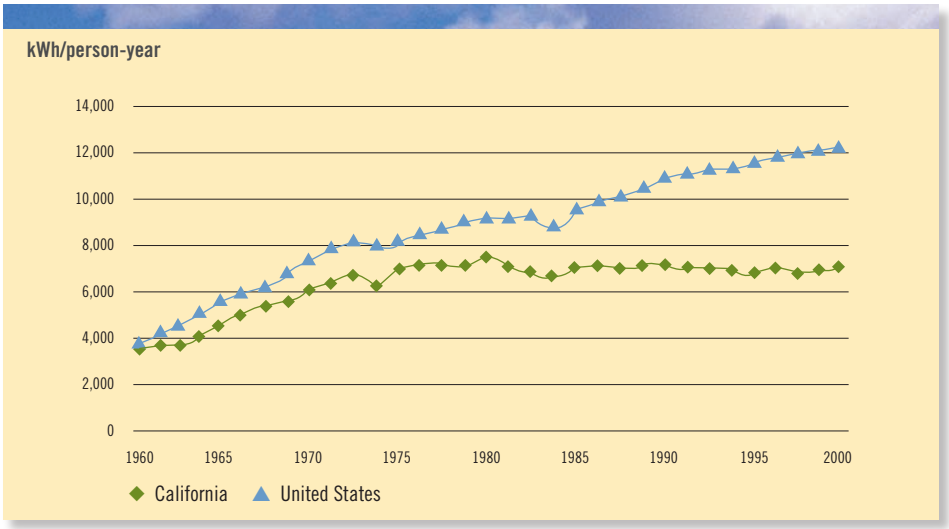


Figure 6. California Total per Capita Electricity Use, 1960 to 2001. Per capita use remained constant in California over the period 1975 to 2001, while for the U.S. as a whole per capita use grew by 50 percent.

Source: California Energy Commission, 2004 based on data obtained from: http://www.eia.doe.gov/emeu/states/sep_use/total/csv/use_csv.html.

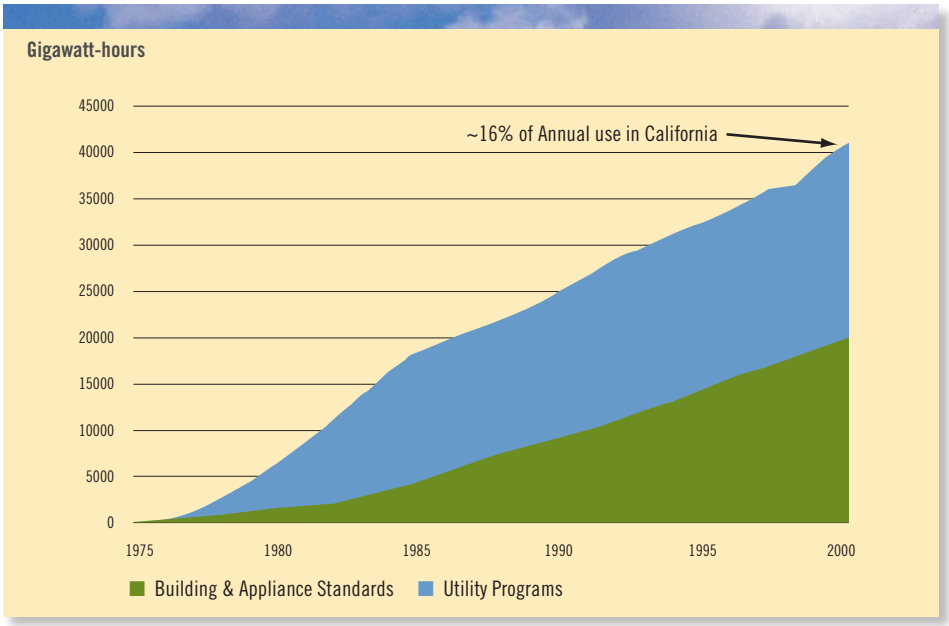


Figure 7. Annual California Energy Savings from Efficiency Programs and Standards Adopted Prior to 2001. The California Energy Commission estimates that the state's existing building and appliance standards have saved individuals and businesses in California $56 billion through 2003.

Source: Brown, Susan, 2005. Global Climate Change. Publication CEC-600-2005-007, California Energy Commission, Sacramento, California. Also: http://www.energy.ca.gov/title24/. To 2002 Update. Publication CEC-600-2005-025, California Energy Commission, Sacramento, California.

California Emission Reduction Initiatives

California already has put in place a number of programs and policies that will substantially reduce the rate of growth in GHG emissions; however, these will not be sufficient to meet the longer-term targets that the state set in 2005. Under a "base case" projection, California GHG emissions would be expected to grow to around 610 million tCO_2eq by 2020, a 26 percent increase over 2000 levels and 37 percent over 1990 levels. The growth in emissions would be higher were it not for several recently enacted policies, including the state's Renewable Portfolio Standard (which mandates that 20 percent of retail electricity be obtained from renewable resources by 2017); 5.7 percent ethanol blending in gasoline supplies as of 2003; and the 2003 revisions to the state's building standards (which come into effect in 2005).

A set of new policies and programs that have recently been established (or have been proposed and are very likely to be implemented) have the potential to substantially reduce the rate of GHG emission growth (see table 3).

STRATEGY	Annual GHG Savings (Million tons CO_2 equivalent)	
	2010	**2020**
Vehicle GHG Standards (Pavley Bill)	1	30
Accelerated Renewable Portfolio Standard	5	11
Investor Owned Energy Efficiency Programs	4	8.8
Natural Gas Efficiency Programs	1	6
Appliance Efficiency Standards	3	5
Fuel-efficient Replacement Tires and Inflation Programs	3	3
Million Solar Roofs	0.4	3
50 percent Statewide Recycling Goal	3	3
Diesel Anti-idling	1	2
Green Buildings Initiative	0.5	1.8
Reduced Venting and Leaks in Oil and Gas Systems	1	1
Total potential reductions	**22.9**	**74.6**

Table 3. California GHG-Reduction Strategies That Are Now Underway or Highly Likely to Be Implemented.

Source: Bailie, Alison, and Michael Lazarus, 2005 Draft. California Leadership Strategies to Reduce Global Warming Emissions. Tellus Institute, Massachusetts. Brown, S., 2005. Global Climate Change. Publication CEC-600-2005-007, California Energy Commission, Sacramento, California. Climate Action Team briefing materials, September 2005.

- **Vehicle GHG standards (Assembly Bill 1493, Pavley).** In September 2004, the California Air Resources Board adopted standards that aim to reduce GHG emissions from cars and light trucks by 18 percent in 2020 and 27 percent in 2030, yielding estimated emission reductions of 30 million tCO_2eq annually by 2020. These standards become effective with the 2009 model year.

- **Accelerated Renewable Portfolio Standard.** California's Renewable Portfolio Standard (RPS) requires that 20 percent of electricity sales by investor-owned utilities comes from qualifying renewable resources by 2017. Most of the state's publicly owned utilities have adopted plans to meet or exceed this target. The state now plans to accelerate the RPS to deliver 20 percent of retail electricity sales from renewables by 2010 and 33 percent of sales by 2020. This accelerated program will yield estimated emission reductions of 11 million tCO_2eq by 2020.
- **Investor-owned utility energy efficiency programs.** Since the 1970s, California utilities and state agencies have aggressively pursued demand-side efficiency programs. In December 2004, the California Public Utilities Commission (CPUC) required utilities to use a "carbon adder" with an initial value of $8 per ton to reflect the amount of CO_2 that would be emitted by an electricity generating unit under the terms of a contract. This adder represents an estimate of the likely future cost of purchasing CO_2 offsets to comply with future mitigation regulations and encourages utilities to shift investments toward lower-emitting resources, such as efficiency and renewable sources, and away from high-emitting resources such as conventional coal. The CPUC recently adopted the most aggressive goals in the United States for electricity and natural gas efficiency savings for the state's three major investor-owned utilities for the period 2006 to 2013. These programs will yield estimated emission reductions of 9 million tCO_2eq by 2020.
- **Natural gas efficiency programs.** Natural gas efficiency improvements in the industrial sector and buildings will be expanded in coming years, producing GHG emission savings of an estimated 6 million tCO_2eq by 2020.
- **Appliance efficiency standards.** California adopted aggressive state appliance-efficiency standards in 2002 that have now been emulated in a number of other states. Additional efficiency standards for appliances not yet covered have been proposed by the California Energy Commission. An estimated 5 million tCO_2eq in emissions reductions are expected to be achieved by 2020 through the implementation of these standards.
- **Fuel-efficient replacement tires and inflation programs.** Low-rolling-resistance tires and the maintenance of adequate tire pressure can reduce fuel consumption by 2 percent. The state is exploring the launch of a public outreach campaign to maintain tire inflation at manufacturers' suggested levels. In addition, a new tire rating system for rolling resistance could be instituted to encourage the purchase of fuel-efficient replace-

ment tires. This strategy will yield estimated emission reductions of 3 million tCO_2eq by 2020.

- **Million solar roofs.** A rebate program is being established to encourage the construction of 1 million new solar homes within 13 years and provide commercial installations with rebates through 2007. This program will yield estimated emission reductions of 3 million tCO_2eq by 2020.
- **50 percent statewide recycling goal.** Forty-eight percent of the municipal waste stream is now recovered through waste-reduction and recycling programs, less than the statutory mandate for each jurisdiction to maintain a diversion of 50 percent of all waste from landfilling. A number of steps are being considered to achieve the mandated goal, which will also reduce GHG emissions.
- **Diesel anti-idling.** Reduced idling times and the electrification of truck stops can reduce diesel use in trucks by about 4 percent, with major air quality benefits.
- **Green buildings initiative.** A recent Executive Order directs state agencies to reduce energy use in state buildings 20 percent by 2015 and calls upon the private sector to achieve comparable reductions. California's new and renovated state buildings will meet nationally recognized standards, making them among the greenest buildings in the world.
- **Reduced venting and leaks in oil and gas systems.** Strategies to reduce methane lost to the atmosphere in oil and gas production, processing, transmission, and distribution are being evaluated.

The full implementation of the policies listed above (see table 3) would reduce growth in GHG emissions to 16 percent above 1990 levels in 2010 and 21 percent above 1990 levels by 2020 (see figure 8). This represents about 40 percent of the reductions below the base case projection needed to meet the 2010 target, and 45 percent of the reductions needed to meet the 2020 target announced in 2005. A Climate Action Team, chaired by the secretary of the California Environmental Protection Agency and composed of high-level representatives from key state agencies, is now developing a set of recommendations for additional strategies to achieve the GHG reduction targets. The report of the Climate Action Team will be presented to the governor and legislature in January 2006.

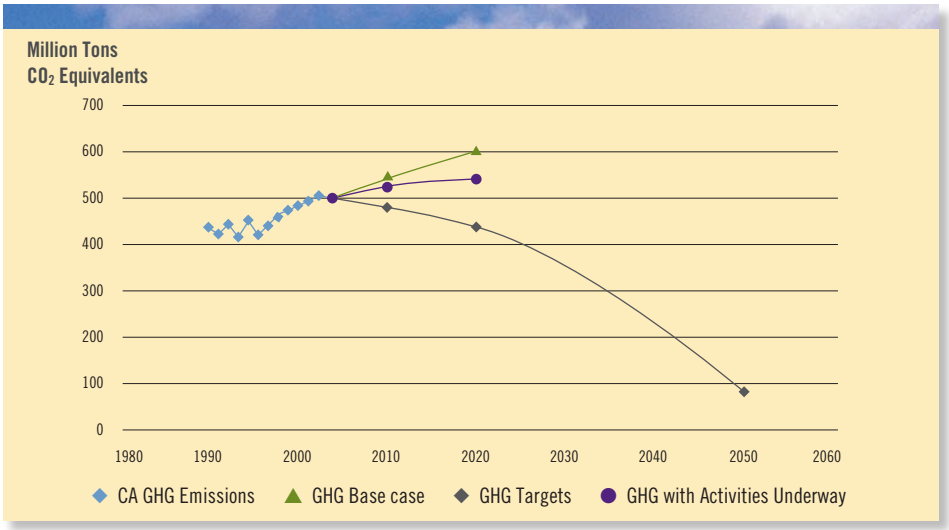


Figure 8. California Greenhouse Gas Emission Trends. **Historical** *data are plotted through 2002 based on the Inventory of California Greenhouse Gas Emissions and Sinks.* **Base case** *projection includes implementation of the state Renewable Portfolio Standard, blending of ethanol in gasoline, and the 2005 update of state building standards, but does not include the implementation of the California vehicle GHG regulations (Pavley Bill).* **Targets** *are the state targets announced in June 2005. Activities underway are listed in table 3.*

Source: Historical: Bemis, Gerry, and Jennifer Allen, 2005. Inventory of California Greenhouse Gas Emissions and Sinks: 1990 to 2002 Update. Publication CEC-600-2005-025, California Energy Commission, Sacramento, California. Base case: Bailie, Alison, and Michael Lazarus, 2005 draft. California Leadership Strategies to Reduce Global Warming Emissions. Tellus Institute, Massachusetts.

Strategies being considered include:

- Adoption of new vehicle GHG standards beginning in the 2017 model year
- Hydrofluorocarbon reduction strategy
- Manure management practices
- Semiconductor industry targets to reduce perfluorocarbon emissions
- Natural-gas flaring reduction projects
- Biodiesel blend fuels
- Heavy-duty-vehicle emission reduction measures
- Additional energy efficiency measures beyond the 2013 goals
- Landfill methane capture
- High recycling
- Forest management and reforestation projects
- Travel reduction measures

One policy now being pursued that will have relatively limited impact on the attainment of the 2010 and 2020 goals but could feature prominently in the attainment of the 2050 goal is the creation of the "hydrogen highway" in California. In January 2004, the governor announced his intent to ensure that by the end of the decade every Californian has access to hydrogen fuel along the state's major highways, with a significant and increasing percentage of that hydrogen produced from clean, renewable sources. The state is now providing $6.5 million in funding for hydrogen demonstration projects, including the establishment of up to three hydrogen fueling-station demonstration projects and assistance to the state to lease and purchase hydrogen vehicles.[29]

The Climate Action Team is also considering a set of different implementation options, including:

- Establishment of emission caps for industrial sectors with trading of emission reduction credits to promote the most efficient reductions.
- Establishment of GHG emission fees, with the proceeds potentially to be used to provide incentives or otherwise fund emission reduction projects.
- Voluntary emission-reduction programs.

For all these options, the Climate Action Team has indicated that some degree of mandatory reporting will be necessary to ensure accurate accounting of emission reductions.

Costs and Benefits

Although it is commonly assumed that strategies to reduce GHG emissions will result in economic costs, in California they have actually produced net economic benefits. Improvements in energy efficiency in the industrial and commercial sectors between 1975 and 1995 provided net economic benefits of $875 to $1,300 per capita.[30] Had these gains in energy efficiency not been made, the state's economy would have been 3 percent smaller ($31 billion) in 1995.[31] The California Energy Commission estimates that the state's existing building and appliance standards saved individuals and businesses in California $56 billion through 2003.[32] These policies also provided health and employment benefits. If energy intensity in the state had remained at 1975 levels, air pollution emissions from stationary sources in the state would have been approximately 50 percent greater in 1995.[33] A 2004 review of 13 studies in the United States and Europe examining employment related to clean energy technologies concluded that the renewable energy sector created more jobs per unit of energy delivered than the fossil fuel sector.[34]

There is still substantial scope for additional net economic benefits associated with further investments in GHG reductions and energy efficiency. A recent study concludes that California could quadruple annual investments in energy efficiency (from $243 million per year to $1 billion per year) and still achieve savings in energy use that would be less expensive per unit of energy than investment in new power production.[35] The California Energy Commission estimates that existing building and appliance standards will save Californians a further $43 billion in utility costs between 2001 and 2013.[36] Similarly, fuel savings that will be achieved due to the motor vehicle GHG emission standards (Pavley Bill) will more than offset the cost of the

added technology required, resulting in net savings of $4.4 billion in 2020 based on gasoline costs of $1.74 per gallon[37] (see figure 9). The savings would be much larger if gasoline prices remain close to their current levels (roughly $2.50 per gallon). The proposed diesel anti-idling measures would also provide savings of up to $575 million net present value through 2013 to California businesses as a result of fuel savings and reduced engine maintenance costs.[38] In September 2005, the CPUC approved utilities' plans to provide $2 billion in consumer rebates and other efficiency incentives over the next three years. CPUC estimates that these programs will cut energy costs for homes and businesses by more than $5 billion over the life of the energy savings measures and reduce global warming pollution by an estimated 3.4 million tCO_2eq by 2008.[39]

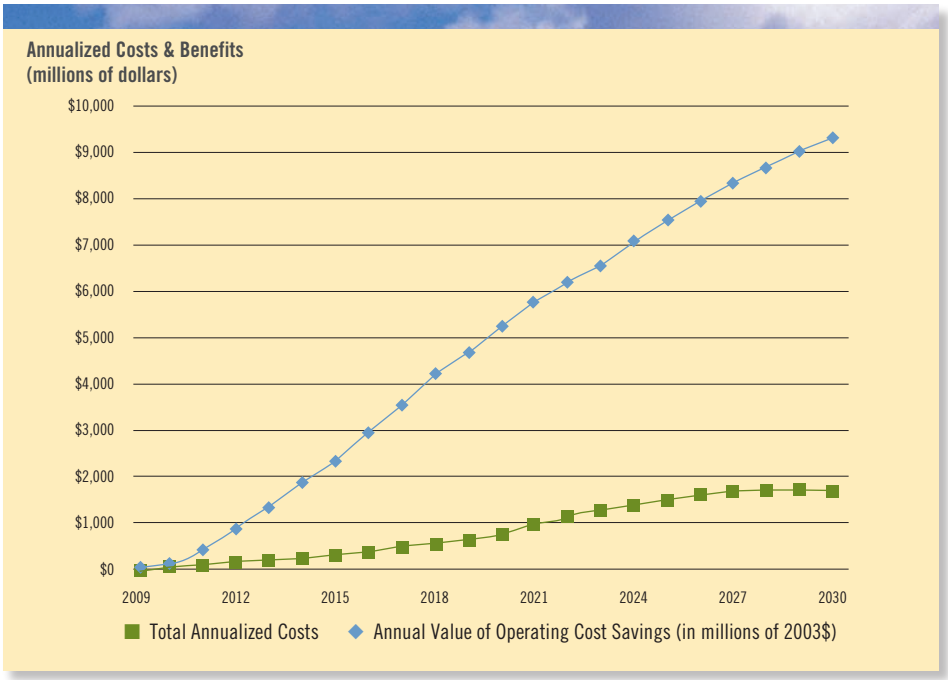


Figure 9. Estimated Costs and Benefits of California Vehicle GHG Standards (Assembly Bill 1493, Pavley). Costs result from additional technology required to achieve the emission reduction standards. Benefits shown here are operating cost savings associated with reduced fuel consumption and do not include additional potential economic benefits associated with reduced air pollution. The gasoline price used in these estimates was $1.74 per gallon, much less than the current price of nearly $2.50 per gallon; thus, the benefits would be much greater if prices remain at current levels.

Source: California Air Resources Board, 2004. Staff Report: Initial Statement of Reasons for Proposed Rulemaking, Public Hearing to Consider Adoption of Regulations to Control Greenhouse Gas Emissions from Motor Vehicles. August 6, 2004. California Environmental Protection Agency (http://www.arb.ca.gov/regact/grnhsgas/isor.pdf).

These new policies will also continue to provide health and employment benefits. For example, the motor vehicle emission standards are expected to cut ozone-forming pollution by about 6 tons per day in 2020.[40] The current Renewable Portfolio Standard (20 percent of electric generation from renewable sources by 2017) will create an estimated 119,000 person-years of employment for Californians over the lifetimes of the plants built through 2017.[41] Jobs from steady growth in the use of solar panels would add 2,700 person-years of employment. Overseas renewable energy markets would

create an estimated additional 78,000 person-years of employment for Californians from 2003 to 2017. This overall job growth for the renewable sector (201,000 person-years of employment through 2017) would have payroll benefits of $8 billion.[42]

Finally, California's targets for GHG emission reductions and the associated programs to provide incentives for achieving these targets are expected to stimulate greater technological innovation within the state. California industry is already a leader in clean energy technology and is well positioned to play a major role in meeting the growing worldwide demand for clean energy technologies as countries increasingly act to reduce GHG emissions (see box 2).

Box 2. California: A Leader in the Clean Energy Industry

The market for clean energy technologies is growing rapidly:

- The wind power industry has been growing worldwide at the rate of 40 percent annually from 1995 through 2002. Wind power is expected to more than double within five years and grow to a $60 billion industry by 2020.
- Geothermal power is projected to grow by 50 percent by 2010 and 230 percent by 2020 to a $35 billion industry.
- Production of solar panels is still small, but is growing at nearly the same rate as wind power. Manufacturing capacity of solar photovoltaics is expected to more than double by 2010 and become a $30 billion to $40 billion industry by 2025.
- Sales of fuel cells for the large power generation sector are expected to reach $25 billion by 2020, and sales of small and portable fuel cells could reach $6 billion. In addition, sales of fuel cells for vehicles are projected to reach $75 billion by 2020.

California companies are well positioned to control significant market share in their industries:

- Three globally competitive wind-power companies are located in California.
- Three of the world's biggest geothermal power companies are located in California.
- Two of the largest photovoltaic plants in the world are in California.
- The two U.S. cities most aggressively pursuing photovoltaic growth—Sacramento and San Francisco—are in California. Los Angeles has also initiated an aggressive solar rebate program that has attracted manufacturing capacity to the city.
- California is home to the world's premier research and development consortium for fuel cells for vehicles, the California Fuel Cell Partnership. This expertise will be directly useful to the growing market for fuel cells for electricity generation.
- Many of the first fuel-cell demonstration projects were located in California, and direct sales of commercial fuel cells have now begun.

Source: Heavner, Brad, and Bernadette Del Chiaro, 2003. Renewable Energy and Jobs: Employment Impacts of Developing Markets for Renewables in California. Environment California Research and Policy Center, Sacramento, California.

COLLABORATIVE ACTIONS

The states of São Paulo and California have taken the actions described here independently of each other. However, collaboration between these states could greatly enhance the economic, environmental, and public health benefits that the two states can obtain as they work to reduce GHG and other emissions.

The similarities between the two states with respect to energy, pollution, and climate-change issues are striking. Each is responsible for the largest portion of its nation's economic production—approximately 15 percent (California) and 35 percent (São Paulo) of national gross domestic product. Each is the most populous state in its country—and among the most populous in the world—with more than 35 million residents. Each is home to the region with the greatest air pollution in its country—the Greater Los Angeles area and San Joaquin Valley in California and the São Paulo Metropolitan Region in São Paulo. Each is particularly vulnerable to the threat of global climate change. And each is a leader in the introduction of alternative fuels in pursuit of lowering local pollutants and GHG emissions.

Moreover, each state has recognized that, far from being economically harmful as has long been feared, strong actions to reduce pollution and promote energy efficiency have been highly cost effective. These two states thus approach the challenge of GHG emission reductions not as a cost to be borne but as a strategic opportunity to benefit their economies and public health.

The states have agreed to collaborate in the following areas of technical assistance:

1. **Air quality:** Both states recognize that clean air is vital to economic viability and for the health of their residents. São Paulo has embarked on a project to clean its air through a process similar to that of the Federal Clean Air Act in California. The California Environmental Protection Agency (Cal-EPA) will work with the São Paulo State Environmental Secretariat (SMA) to help in the implementation of this project.

COLLABORATIVE ACTIONS

2. **Greenhouse gas emissions and energy efficiency:** Both states have enjoyed considerable economic benefits from energy efficiency gains and pollution reduction. The clear economic self-interest of past experience leads both states to work together to share methodologies and research results. SMA will work with Cal-EPA to provide information on Brazil's ethanol program and current research into biofuels. The two states will establish an information exchange program on the progressive introduction of ethanol, either in flexible fuel vehicles or in gasoline-dedicated vehicles. California will provide information to assist in the development of the São Paulo mass transport system, especially in terms of the potential for using natural gas as a substitute for diesel fuel and the provision of ultra-low-sulfur diesel to dedicated bus corridor fleets. The states will share information on fuel efficiency programs including the PROCEL program, "feebates," and eco-labeling in São Paulo and appliance standards, utility programs, and building codes in California. And the states will develop an information-exchange initiative on electricity cogeneration from solid biomass and on the energy recovery of landfill gas.
3. **Bus Rapid Transit:** In both states, transportation is the primary cause of air pollution. Plans to reduce vehicle emissions overall must include an increase in the use of public transportation. Bus Rapid Transit (BRT) is a flexible, cost-effective complement to light rail. BRT is a mature technology that provides subway-like efficiency and comfort but at a cost that is an order of magnitude less than many rail systems. Successful BRT systems are already operating throughout the Americas and in parts of Asia. São Paulo is home to the most experienced BRT design specialists in the world. The SMA will help introduce planners and the public in California to the potential for BRT in California cities and provide technical assistance to cities interested in developing such systems.
4. **Forestry:** Both states are stewards of vast forest lands that are important as carbon sinks and as storehouses of biodiversity. São Paulo and California will share information and methodologies for preserving state forest stocks and recovering deforested areas.

Joint action at a subnational level between states like California and São Paulo are by no means an alternative to the need for broad international agreements on emission reductions. But international processes involving all nations can proceed no faster than the slowest country. For individual states like São Paulo and California, there is no reason to wait to take steps that both address the need for GHG emission reductions and provide short-term economic and public-health benefits.

NOTES

[1] Lord Browne (BP CEO), 2003 Speech to the Institutional Investors Group, Gibson Hall, Bishopsgate, 26th November.

[2] Fundação Sistema Estadual de Análise de Dados (SEADE), 2005. Secretaria de Economia e Planejamento, Governo do Estado de São Paulo (http://www.seade.gov.br).

[3] Fundação Sistema Estadual de Análise de Dados (SEADE), 2005. PIB Paulista 2003 e 2004. Secretaria de Economia e Planejamento, Governo do Estado de São Paulo (http://www.seade.gov.br/produtos/pib/pibpaulista2003_2004.pdf).

[4] São Paulo State Secretary (SMA) calculations. Sources GDP data (for SP): SEADE Foundation, 2005. São Paulo GSP: http://www.seade.gov.br/produtos/pib/index.php and http://www.seade.gov.br/produtos/pib/pibpaulista2003_2004.pdf. GDP for Brazil: IBGE, 2005, http://www.ibge.gov.br/home/estatistica/economia/contasregionais/. Exchange rates: Brazilian Central Bank, Annual report 2004, Vol. 40, ISSN 0104-3304 Brasília, p. 16, http://www.bcb.gov.br/htms/banual2004/rel2004p.pdf (current prices divided by yearly averaged U.S. dollar buying rate). Energy consumption: SP Energy Balance, http://www.energia.sp.gov.br/index1.htm, and Brazilian Energy Balance, www.mme.gov.br/download.do?attachmentId=1288&download.

[5] Intergovernmental Panel on Climate Change, 2001. *Climate Change 2001: Synthesis Report*. Cambridge University Press, Cambridge, UK. P. 271.

[6] Goldemberg, José, Suani T. Coelho, Plínio M. Nastari, and Oswaldo Lucon, 2004. Ethanol learning curve—the Brazilian experience. *Biomass and Bioenergy*, vol. 26/3, pp. 301–4.

[7] Secretaria de Meio Ambiente do Estado de São Paulo data and calculations.

[8] Pinheiro, Flavio Cotrim, et al., 2004. *Integrated Environmental Strategies (IES) in São Paulo, Brazil*. National Renewable Energy Laboratory, United States (http://www.epa.gov/ies/documents/brazil/brazilfinalreport.pdf).

[9] PROINFA, 2005. Eletrobrás website (http://www.eletrobras.gov.br/mostra_arquivo.asp?id=http://www.eletrobras.gov.br/downloads/EM_Programas_Proinfa/proinfa_contratos1.pdf&tipo=proinfa).

[10] Ministry of Mines and Electricity, 2005 (www.mme.gov.br/programs_display.do?chn=920).

[11] Programa Nacional de Conservação de Energia Electrica, 2005 (http://www.eletrobras.gov.br/procel/site/oprograma/resultados.asp).

[12] Clean Development Mechanism Executive Board Project Design Document, July 2004.

[13] Data from UNICA, 2005 (http://www.portalunica.com.br/files/estatisticas/estatistica1709.htm).

[14] Pinheiro, Flavio Cotrim, et al., 2004. *Integrated Environmental Strategies (IES) in São Paulo, Brazil*. National Renewable Energy Laboratory, United States (http://www.epa.gov/ies/documents/brazil/brazilfinalreport.pdf).

[15] Roitberg, José, 2005. Governo do Estado de São Paulo incentiva o uso de ônibus menos poluente. *New Motorage Electronic Magazine* (VII):286, 8 February 2005 (in Portuguese) (http://www.newmotorage.com/nova/materia.asp?id=186).

[16] Rei, F., O. Lucon, S.T. Coelho and J. Goldemberg, 2004. In: Network of Regional Governments for Sustainable Development, A nrg4SD report for COP10, NRG, Spain (www.nrg4sd.net/Download/Events/Other/COP10FinalReport.pdf).

[17] Ibid.

[18] Ibid.

[19] Secretaria de Meio Ambiente do Estado de São Paulo data and calculations.

[20] See note 14.

[21] Programa Nacional de Conservação de Energia Electrica, 2005 (http://www.eletrobras.gov.br/procel/site/oprograma/resultados.asp). Brazilian reals converted to U.S. dollars at October 2005 exchange rate.

NOTES

[22] World Energy Assessment (WEA), 2000. *World Energy Assessment: Energy and the Challenge of Sustainability*. United Nations Development Programme, New York.

[23] Bemis, Gerry, and Jennifer Allen. 2005. *Inventory of California Greenhouse Gas Emissions and Sinks: 1990 to 2002 Update*. Publication CEC-600-2005-025, California Energy Commission, Sacramento, California.

[24] Ibid.

[25] Oak Ridge National Laboratory; data compiled from: Blasing, T.J., C.T. Broniak, and G. Marland, 2004. Estimates of Annual Fossil-Fuel CO2 Emitted for Each State in the U.S.A. and the District of Columbia for Each Year from 1960 through 2001, In: Trends: A Compendium of Data on Global Change, Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy (cdiac.esd.ornl.gov/trends/emis_mon/stateemis/emis_state.htm).

[26] Data from Bureau of Economic Analysis, U.S. Department of Commerce, 2005 (http://www.bea.gov/bea/regional/gsp/).

[27] California Energy Commission, 2003. *Public Interest Energy Strategies Report*. Publication 100-03-012F, California Energy Commission, Sacramento, California.

[28] Ibid.

[29] Information available at: http://www.hydrogenhighway.ca.gov/

[30] Bernstein, Mark, Robert Lempert, David Loughran, David Ortiz, et al., 2000. *The Public Benefit of California's Investment in Energy Efficiency*, prepared for the CEC, Rand report MR-1212.0-CEC (http://www.rand.org/publications/MR/MR1212.0/).

[31] Ibid.

[32] Brown, Susan. 2005. *Global Climate Change*. Publication CEC-600-2005-007. California Energy Commission, Sacramento, California. See also http://www.energy.ca.gov/title24/.

[33] See note 30.

[34] Kammen, Daniel M., Kamal Kapadia, and Matthias Fripp, 2004. *Putting Renewables to Work: How Many Jobs Can the Clean Energy Industry Generate?* RAEL Report, University of California, Berkeley.

[35] Rufo, M., and F. Coito, 2002. *California's Secret Energy Surplus: The Potential for Energy Efficiency*. Xenergy Inc., for the Energy Foundation and the Hewlett Foundation (http://www.ef.org/documents/Secret_Surplus.pdf).

[36] See note 27.

[37] Brown, Susan. 2005. *Global Climate Change*. Publication CEC-600-2005-007. California Energy Commission, Sacramento, California.

[38] Bailie, Alison, and Michael Lazarus, 2005 draft. *California Leadership Strategies to Reduce Global Warming Emissions*. Tellus Institute, Massachusetts.

[39] California Public Utilities Commission, September 22, 2005 press release (http://www.cpuc.ca.gov/PUBLISHED/NEWS_RELEASE/49757.htm). See also statement of Commissioner Susan P. Kennedy, Item 30: 2006-2008 *Energy Efficiency Program Funding*, September 22, 2005 (http://www.cpuc.ca.gov/PUBLISHED/REPORT/49756.pdf).

[40] Brown, Susan. 2005. *Global Climate Change*. Publication CEC-600-2005-007. California Energy Commission, Sacramento, California.

[41] Heavner, Brad, and Bernadette Del Chiaro, 2003. *Renewable Energy and Jobs: Employment Impacts of Developing Markets for Renewables in California*. Environment California Research and Policy Center, Sacramento, California.

[42] Ibid.