

Managing Greenhouse Gas Emissions in California

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The California Climate Change Center at UC Berkeley
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EXECUTIVE SUMMARY

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Global climate change poses significant risks to the California economy. Recognizing and responding to these threats, Governor Schwarzenegger signed Executive Order # S-3-05 on June 1, 2005. This study includes eight independent reports assembled by two dozen experts to evaluate the economic implications of the Executive Order. It concludes that:

- Climate action in California can yield net gains for the state economy, increasing growth and creating jobs. Preliminary modeling indicates that just eight policies that were analyzed in detail can achieve almost half of the Governor's 2020 targets while increasing Gross State Product by about \$60 billion and creating over 20,000 new jobs.
- There are numerous additional climate action initiatives beyond those that have been modeled, many of which will also improve California's economy. The analysis thus far indicates that California can likely reach the Governor's 2020 targets with a net gain for the state economy.
- Voluntary measures, while helpful, are insufficient to yield the required reductions. Designing an effective combination of regulatory standards, market-based approaches (such as a well-designed cap-and-trade program) and innovation policies is the best way to cost-effectively manage greenhouse gas emissions in California.
- Technology innovation, spurred by a combination of regulations and incentives, will be needed to shift the economy over the long term away from carbon-based fuels and meet the 2050 targets. By acting now, California can gain a competitive advantage by becoming a leader in the new technologies and industries that will come into existence worldwide due to the common goal of reducing GHG emissions.

Economic Modeling

Methods. A new economy-wide forecasting model, the Berkeley Energy and Resources (BEAR) model, was used to study a subset of policy scenarios designed to help meet the greenhouse gas (GHG) emission reduction goals. BEAR is a detailed, computable general equilibrium model of California’s economy. It simulates demand and supply relationships across many sectors of the economy and tracks the linkages among them. It can thus be used to trace the ripple effects throughout the economy over time of new economic and technology policies.

The BEAR model was used to conduct a detailed, independent examination of policies based on the proposals from the Climate Action Team. The strategies are applied to different sectors of the economy, so the results for each sector can be reasonably interpreted as additive. Not all proposed policies could be studied with the available time and resources. Table ES-1 shows that further reductions beyond those analyzed here are possible and have yet to be studied.

Table ES-1. Climate Action Team Policies

Analyzed	Not Yet Analyzed	
Building Efficiency Vehicle Emission Standards HFC Reduction Manure Management Semiconductors Landfill Management Afforestation Cement Manufacturing	Diesel Anti-idling Renewable Portfolio Standard Solar Initiative Recycling Efficient Tires and Inflation Green Buildings Other New Vehicle Improvements Diesel Equipment Electrification Biodiesel and Ethanol Heavy Duty Vehicle Emissions Reduced Venting & Leaks in Oil/Gas	Combined Heat and Power Electric Sector Carbon Policy Forest Management Forest Conservation Fuels Management/Biomass Urban Forestry Water Use Efficiency Transportation Energy Efficiency Smart Land Use/Intelligent Transportation Enteric Fermentation

Results. The aggregate economic benefits of the eight policies analyzed here outweigh their costs, as shown in Table ES-2 and Figure ES-1. These results indicate the economic importance of indirect and linkage effects, which in this case tend to raise the economic benefits overall. Many GHG policies reduce energy use, which lowers spending on energy and allows the savings to be used on goods and services produced in California, increasing economic growth and employment. Furthermore, some of the spending that has been re-allocated to in-state use will be used to increase productivity through new investment and education. This effect will be compounded by state policies that promote the technological innovation and the use of new technologies. Because of our long experience with productivity growth in California, we know these benefits can transmit themselves across the entire economy, increasing competitiveness, profitability, and the standard of living.

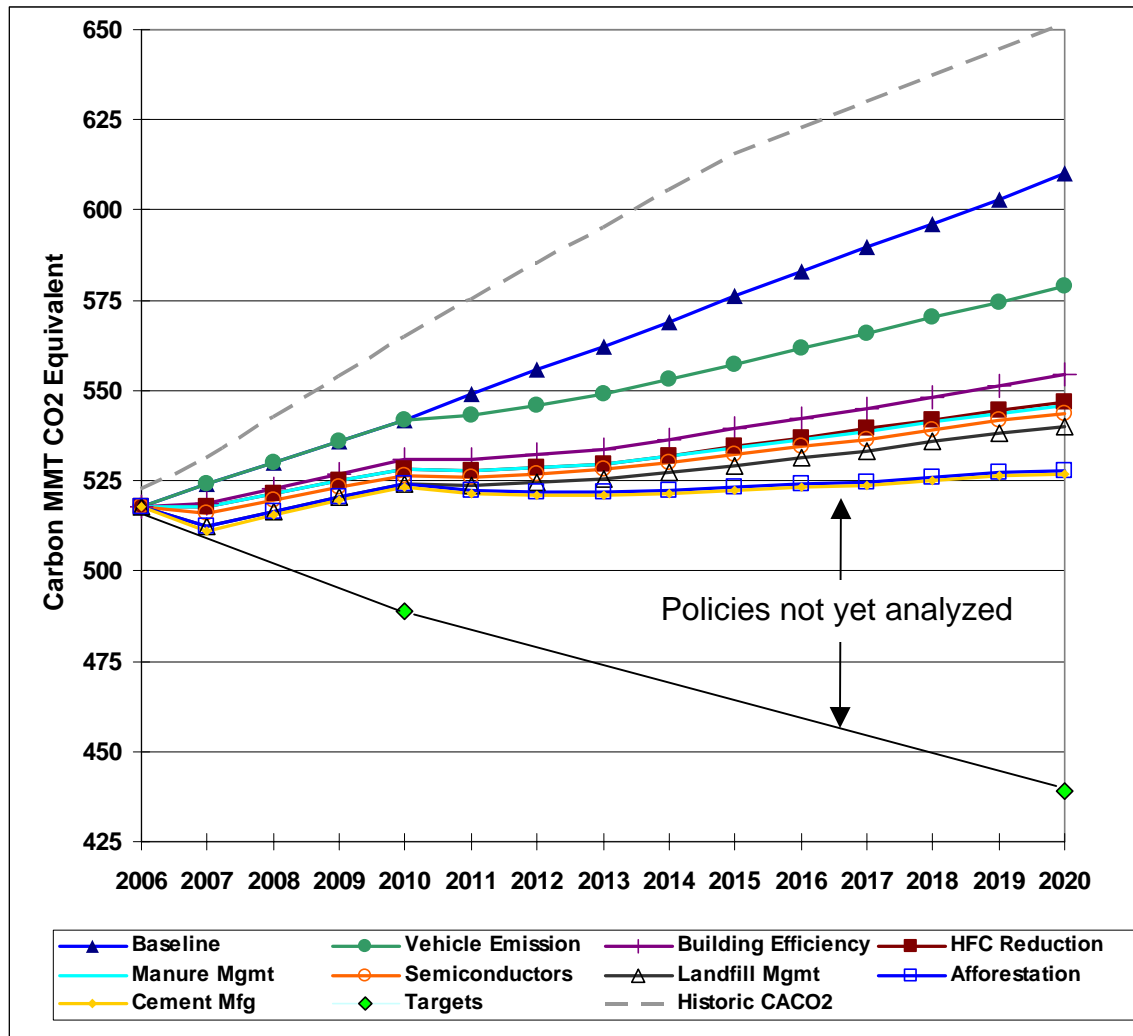
We also know that there are many more low-cost options for the 2020 goals that are not included in the scenarios evaluated here by the BEAR model. For instance, some types of renewable energy are cost-competitive now, such as wind power, and the rapid rise in the installed capacity of renewables will bring experience and economies of scale, both of which will lower their costs in the future. In addition, combined heat and power technologies may reduce both energy consumption and GHG emissions. Furthermore, numerous technologies to reduce GHG emissions at low costs are currently being developed in laboratories both public and private, and can be expected to move to the marketplace in response to climate policies.

Table ES-2: Implications of Analyzed Climate Policies

2010						
Scenario	CO ₂ Emission Reduction		Economic Benefit (Cost)		Labor Gain (Loss)	
	Amount (MMTCO ₂ E)	Fraction of Goal (%)	\$ Billions	% GSP	Thousands	% Total Employment
Baseline	542		1,830		18,243	
Vehicle Emission	0.4	-1%	0.89	0.05%	2.78	0.02%
Building Efficiency	-11	-20%	4.01	0.22%	8.04	0.04%
HFC Reduction	-3	-5%	-0.23	-0.01%	-0.83	0.00%
Manure Mgmt	0	0%	0.00	0.00%	0.01	0.00%
Semiconductors	-2	-3%	0.15	0.01%	-1.39	-0.01%
Landfill Mgmt	-2	-4%	-0.21	-0.01%	-0.90	0.00%
Afforestation	0	0%	0.00	0.00%	-0.12	0.00%
Cement Mfg	-1	-2%	0.33	0.02C	0.74	0.00%
Combined	-19	-35%	4.95	0.27%	8.34	0.05%
2020						
Scenario	CO ₂ Emission Reduction		Economic Benefit (Cost)		Labor Gain (Loss)	
	Amount (MMTCO ₂ E)	Fraction of Goal (%)	\$ Billions	% GSP	Thousands	% Total Employment
Baseline	610		2,429		20,519	
Vehicle Emission	-31	-18%	50.26	2.07%	21.73	0.11%
Building Efficiency	-24	-14%	13.75	0.57%	14.26	0.07%
HFC Reduction	-8	-5%	-4.60	-0.19%	-6.80	-0.03%
Manure Mgmt	-1	-1%	0.01	0.00%	0.08	0.00%
Semiconductors	-2	-1%	0.85	0.03%	-4.61	-0.02%
Landfill Mgmt	-4	-2%	-0.86	-0.04%	-3.06	-0.01%
Afforestation	-13	-7%	-2.15	-0.09%	-3.53	-0.02%
Cement Mfg	-1	0%	1.55	0.06%	2.28	0.01%
Combined	-83	-49%	58.80	2.42%	20.35	0.10%

Source: Roland-Holst, Chapter 2. Forecasts from the BEAR model.

Figure ES-1: GHG Trends Under Analyzed Policies



Source: Roland-Holst, Chapter 2. Forecasts from the BEAR model.

Policy Response

Policy action is needed to address the challenge of climate change in California because it is an externality whose harmful consequences the free market will otherwise ignore.

Voluntary Measures. While helpful, there is no evidence that voluntary measures provide sufficient incentives to attain the Governor’s targets. Efforts to improve public and corporate knowledge about GHG emission reduction possibilities and to encourage their voluntary adoption will foster responsible citizenship, empower those with the most detailed information to take cost-effective action, and can encourage innovation. However, the evidence shows that the practical, on-the-ground results of education, information, and voluntary approaches to environmental protection have been limited, and many of the supposed benefits of voluntary approaches may have occurred anyway due to other regulatory forces and economic trends.

Market-Based Policies. Often the most economically efficient approach to addressing externalities such as climate change is to bring the harmful effects *into* a market setting. Among the most powerful policy tools for doing this are cap-and-trade programs, which are particularly attractive for many GHGs because they are well-mixed worldwide. A cap-and-trade program is not necessarily a substitute for sectoral regulations or performance standards; in fact, if well designed, it can complement regulations and leverage their effectiveness, spreading their impact beyond the regulated sector and offering an incentive for additional emission reductions. Cap-and-trade programs provide strong incentives for the adoption of new low-GHG technologies, as well as some incentives for innovation. We believe that including a cap-and-trade program as part of the overall policy package is critical to achieving the Governor's targets at low cost. Specific recommendations for program design are outlined in Box ES-1.

Box ES-1. California Cap-and-Trade Program Recommendations

A careful evaluation of past policy experience and the relevant economics literature suggests that a successful cap-and-trade program in California will have the following characteristics:

- California should require reductions of GHGs under a mandatory emission cap.
- The program should aim for broad coverage; all gases and economic activities that can be monitored at low cost should be included.
- The initial distribution of allowances should embrace both efficiency and equity dimensions by involving an auction and also allocating some allowances for free.
- Unlimited use of banked allowances should be a central design feature.
- California should facilitate linkage of its GHG cap-and-trade program with others and promote symmetric treatment in the buying and selling of allowances.
- Emission offsets provide an opportunity for cost-savings and economic development, and thus should be included under conditions that reduce the prospects for fictional emissions reductions and inefficient revenue transfers.
- California should not use safety valves because they undermine the cap, incentives for technological innovation, and the prospects for linkage but instead rely on banking, offsets and linkage to minimize the potential for high allowance prices.
- The program should be designed in a manner that avoids inequitable regional impacts or risks to public health.
- By balancing auctions and free allocations, it will be possible to compensate particularly affected communities or industries yet still keep the overall cost to the economy low and create some stimulus for innovation.
- Making large GHG emitters as well as load serving entities for electricity and natural gas the points of compliance can minimize leakage of emissions and economic activity out of the state.

New Technologies. Innovation will be essential to meeting the Governor’s targets, especially meeting the mid-century target, which requires a profound refashioning of the economy away from carbon-based fuels. Such a major technological advance to support environmental goals will require additional policy action. The analysis of innovation highlights the conclusion that investment in R&D by private industry invests is less than would be optimal for society at large – perhaps only one half to one quarter the optimal amount. Government support for research and development and other “technology push” programs have been effective in the past, but they are usually not sufficient to drive innovation, in part because many innovators are interested in working on a technology only if they perceive that there will be a market for it. Thus, “demand pull” policies such as environmental regulations as well as technology incentives are highly effective in spurring innovation to reduce environmental impacts like climate change. A cap-and-trade program is one type of “demand pull” approach; while it undoubtedly will help California to meet the 2020 target, is not likely to be sufficient by itself to induce the type of technological innovation needed to meet the Governor’s mid-century goal. Designing an effective combination of market-based regulations, regulatory standards, and innovation policies is an important issue for policy research in California.

Leadership. By adopting the policies evaluated in this study, California can demonstrate leadership in action by achieving the GHG mitigation goals set by the Governor. Globally, increasing GHG emissions are assumed to be essential to a growing economy. This is not true in California. The state can take an historic step by demonstrating that reducing emissions of GHG can accelerate economic growth and bring new jobs. Moreover, exercising leadership in this area plays to California’s comparative economic advantage in the US and world economies as a first-tier innovation economy. California can gain a competitive advantage by acting early in the new technologies and industries that will come into existence worldwide around the common goal of reducing GHG emissions.

Future Research.

The challenge of managing GHG emission reductions in California (and globally) is significant, creating both immediate and long-term research needs. Among the most important near-term research needs is to extend the economic analysis conducted here to additional emission reduction strategies, and to improve the existing modeling capacity for advanced energy systems. In addition, designing appropriate policies to meet the Governor’s targets will require better understanding of the behavioral aspects of energy consumption. Finally, technological and policy research is needed in order to invent and deploy the new energy system and other technologies needed to mitigate climate change.