

**U.S. Senate Committee on Environment and Public Works
Testimony for August 14, 2007 Hearing on:**

How Green Tech Will Help the Economy

by

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Senator Boxer and other members of the Senate Committee Environment and Public Works Committee, I greatly appreciate the invitation to appear before you today.

I am a professor of environmental economics and policy at Director of the California Climate Change Center in the Goldman School of Public Policy. Since the Center was established four years ago, my colleagues and I have been working on various aspects of climate change and its implications for California, including the potential adverse impacts to California's economy, society and ecology, and also the policies that California needs to adopt to reduce our greenhouse gas emissions in an effective manner and at a tolerable cost.

Climate change and global warming are the greatest environmental policy challenge that we face today not only because of the scale and magnitude of the problem but also because of its complexity and novelty. However, climate change is also a great opportunity because it inevitably will force a substantial change in how we generate and use energy throughout our economy, and this will require major technological innovations. If this is done right, with the right policies in place, and also with a degree of good fortune, it can become a source of economic growth for California and for the United States.

The first point to be made is that governmental action needs to be taken. Voluntary measures, while helpful, are not going to solve the problem. From an economic perspective, greenhouse gas emissions are an example of an externality, like other forms of pollution, and voluntary measures by those who emit the pollutant will be insufficient to yield the required reduction in pollution.

The second point is that is that, as noted above, global warming is more complex than other problems of pollution which Congress has dealt with in the past, and it will require a broader set of policy measures.

In my observation, many economists have tended to view global warming through the prism of the nation's highly successful experience in dealing with sulfur dioxide (SO₂) under Title IV of the Clean Air Act Amendments of 1990. Through the cap and trade system introduced under Title IV, we achieved a 50% reduction in emissions at a cost substantially less than had been anticipated. Because of its success, this has been seen by some economists as a precise template for dealing with greenhouse gas emissions. I disagree. While I believe that emission trading needs to be part of the policy mix in dealing with greenhouse gasses, by itself it will not solve the problem of greenhouse gasses: a broader approach, with a more explicit focus on technology innovation and adoption, is required.

How did Title IV emission trading solve the problem of SO₂? The emissions cap was applied to individual generating units, and they responded in several ways. Owners of power plants responded by changing operations – by modifying combustion, switching from high- to low-sulfur coal, and by changing the order of dispatch across different facilities—and by end of pipe treatment, installing scrubbers to remove emissions post-combustion. What should be noted is the strategies *not* used. Energy conservation and demand management played essentially no role in the reduction of SO₂. Renewable energy sources played no role. New combustion technologies played no role. What was done involved known and mature technologies. There was some experimentation and innovation in plant operation, but technological innovation in the sense we normally think of played no role in the events post 1990.

With greenhouse gasses there is a very different situation. There is no low CO₂ coal; fuel switching with biomass is a possibility but this can only be done on a limited scale and this is not a mature technology. There is no post-combustion scrubber that can readily be applied to an existing coal-fired generating unit. There is the potential of carbon capture and sequestration, but this is not a mature technology in electricity generation. Renewable sources of electricity will play an important role. Maybe nuclear will ultimately play an important role, especially if the disposal problem can be solved effectively. With electricity generation per se, the focus for greenhouse gasses is clearly on new technology and its cost-effective incorporation in the design of new power plants.

Moreover, with greenhouse gasses, unlike SO₂, we cannot expect to solve the problem by focusing on electricity generation alone. Electricity generation accounts for about 2/3 of all SO₂ emissions in the United States. With greenhouse gasses, by contrast, electricity generation accounts for only about 1/3 of emissions and in California it accounts for only 1/5 of emissions. The majority of emissions are due to other sources, among which transportation looms very large. For these other sources, too, technological innovation will play a major role, for example through innovations such as hybrid vehicles or cellulosic ethanol for vehicles.

Greenhouse gasses differ from SO₂, also, in the time frame of the problem. As you know, Governor Schwarzenegger has set two policy goals for California: by 2020 to reduce our greenhouse gas emissions back to their level in 1990, and by 2050 to reduce our emissions 80% below their level in 1990. The second goal – at least, a reduction roughly of that order of magnitude and on that time frame – needs to be met by all of the developed countries if a severe and dangerous increase in the global atmospheric concentration of CO₂ is to be avoided. This will require profound innovation to permit as substantial restructuring of energy use in the modern economy.

There are, thus, two policy objectives for greenhouse gasses, short-term and long-term. The short-term objective is to deploy existing and near-term technologies to roll back emissions to their level of 1990. The long-term objective is to stimulate innovation and investment in new technologies for a major decarbonization of the future economy.

In short, for greenhouse gasses, unlike SO₂, innovation will play a central role if we are to meet the short- and long-run policy objectives.

Another important difference for the short-term policy objective is energy conservation and behavioral change. As noted earlier, these played essentially no role in the reduction of SO₂ but they will be crucial for meeting California's 2020 goal for greenhouse gas reduction.

In this context I would like to draw your attention to California's remarkable success in promoting energy conservation through the regulatory programs of the California Energy Commission (CEC), which was established 30 years ago. Over that period of time, electricity use per capita in the United States has increased by about 50%; in the Western states, it has increased by about 2/3. In California, however, it has not increased at all. My colleague Professor Max Auffhammer in the Department of Agricultural & Resource Economics at Berkeley and I are currently conducting a study to pinpoint the reasons for this striking divergence; it seems clear that at least part is attributable to California's unique history in regulating appliance efficiency through the CEC: it is an example of regulation-induced innovation.

This brings me to the economics of greenhouse gas reduction. As part of a larger study on Managing Greenhouse Gas Emissions in California, co-directed with my colleague Professor Alex Farrell and issued in January 2006, my colleague Professor David Roland-Holst conducted a study of the economic cost to the California economy of reducing greenhouse gas emissions in California. The January 2006 analysis focused on a set of emission reduction regulations which together accounted for about half of the 2020 reduction target. In August 2006, he released an updated analysis accounting for all of the 2020 emission reduction target; it combines the regulatory strategies in his earlier report with an emission trading system covering the remainder of the economy and bringing about attainment of the full 2020 target. His analysis uses the BEAR model, currently the most disaggregated and sophisticated computable general equilibrium model of the California economy. His August 2006 report finds that meeting the 2020 cap can stimulate the state's economy. He projects the cap to boost annual Gross State Product

(GSP) in 2020 by \$60 billion and create 17,000 new jobs. If the emissions trading system is implemented so as to create direct incentives for innovation, by using revenues from the sale of emission permits to finance innovation, he estimates the gains to be even larger: \$74 billion in GSP and 89,000 new jobs.

His analysis is restricted to California, which is different in certain respects from the national economy. But, some key features of his analysis for California are certain to carry over to the national economy, in particular his finding that greenhouse gas emission reduction contributes to economic growth in three important ways:

- 1) Energy efficiency increases consumer purchasing power and puts money into the economy, stimulating job growth and incomes.
- 2) Policies that enable firms to invest in new technologies stimulate innovation, which is the most important long term source of growth in income and employment.
- 3) Policies that promote energy efficiency also reduce our dependence on imported fuels that are an important threat to our economic security.

Thank you for your consideration.