Testimony of Richard C. Levin
President, Yale University
Committee on the Environment and Public Works
April 3, 2008

Thank you Chairwoman Boxer, Ranking Member Inhofe, and members of the Committee for this opportunity to discuss Yale's efforts to reduce its greenhouse gas emissions and advance sustainable development.

Let me begin by noting that there is no longer any doubt that we have a problem. The Fourth Assessment Report of the Intergovernmental Panel on Climate Change concluded last year that the evidence of global warming is "unequivocal."[1] The Panel, consisting of 2500 leading climate scientists from around the world, determined with "very high confidence that the net effect of human activities since 1750 has been one of warming."[2] And it concluded that "most of the observed increase in globally-averaged temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic GHG [greenhouse gas] concentrations."[3] The Panel concluded that, in the absence of corrective measures, global temperatures are likely to rise between 1 and 6 degrees centigrade by the end of this century, with the best estimates ranging between 2 and 4 degrees. Even a 1-degree increase in temperature will limit fresh water availability and cause coastal flooding in much of the world, but, as the Panel noted, economic, social, and environmental damages and dislocation will become much more consequential if global temperatures increase by more than 2 degrees.

Universities have an important role in the effort to curtail global warming. Much of the work on climate science that has led to the detection and understanding of climate change was done within our walls, and we have been at the forefront of modeling the economic, social, and environmental impact of rising global temperatures and sea levels. This work continues with increased focus and urgency. More recently, universities have begun to take the lead, along with enlightened corporations as well as municipal and provincial governments, in setting standards for carbon emissions that are substantially more restrictive than those adopted by national governments.

I want to devote the first half of my testimony to the work that universities are doing to improve our understanding of global warming and what can be done about it. In particular, I would like to highlight the ongoing efforts to demonstrate that substantial reductions in greenhouse gas emissions are both feasible and relatively inexpensive. Then I would like to conclude with some reflections on the policy issues addressed by S. 2191, the "American Climate Security Act of 2007."

The Role of Universities

So what roles should universities play in advancing sustainable development at the local and global level?

First, universities must continue to advance the science of climate change and its consequences. We will make further investments in science to refine our models of how climate change occurs and how it is likely to affect the economy and the environment. We will also sponsor policy research to illuminate the likely consequences of corrective actions. It is worth noting that nearly half of the 2500 scientists and policy experts who constitute the Intergovernmental Panel on Climate Change are based in universities.

Around the world there are many significant university initiatives directed toward advancing the science of global warming. The University of Tokyo, for example, is committed to a major reorganization of its scientific effort to create an entire division of sustainability. This is an exciting interdisciplinary approach that holds great promise.

A second major area of university involvement is energy technology. MIT's President, Susan Hockfield, declared in her inaugural address that alternative energy technology would be her institution's foremost research priority. MIT is devoting significant resources to this vast area of research, which includes not only developing carbon-free technologies such as solar, wind, and geothermal power, but also finding more efficient ways to use carbon-based fuels through improved building materials and design, as well as improved vehicle and power plant technologies.

MIT is not alone. The University of California, Berkeley and the University of Illinois recently received a $500 million commitment to fund alternative energy research from British Petroleum – the largest corporate gift ever made in support of university-based research.

A third important role for universities is to educate students who will go on to be future leaders and influential citizens of the world. At Yale we take this part of our mission extremely seriously. We have greatly expanded our teaching programs in the environmental area. We now have over 60 courses available to undergraduates, who can choose either environmental studies or environmental engineering as a major subject. The study of the environment and sustainability is now embedded in the curriculum of our graduate schools of business, architecture, and public health. And our graduate School of Forestry and Environmental Studies, which offers an interdisciplinary curriculum spanning science and policy, has for decades produced some of America's most influential environmental leaders. Today, the heads of many of our leading environmental organizations – including Environmental Defense, the Natural Resources Defense Council, and Conservation International, among others – are graduates of the School.

Finally, universities can demonstrate to the world that substantial reductions in greenhouse gas emissions are feasible and not prohibitively expensive. This fourth role of universities interacts with the third. In our efforts to demonstrate best practices in limiting carbon emissions, we are teaching our students, who are full participants in this campus-wide effort, how to be responsible citizens of the world. Together, we are learning how to balance near-term economic considerations against the long-term health of the environment and future human generations.

I would like to illustrate how universities can reduce their carbon footprints by using Yale as a case study. But before I do, let me briefly outline the broader picture of sustainability at Yale. We have a comprehensive sustainability framework that includes protection of natural ecosystems, conservation of our water resources, recycling of materials, and the use of natural, locally grown food in our dining halls. We aspire to leadership in all of these dimensions of sustainability, and we hope to inculcate in our students a lasting consciousness of what it means to live on a planet with finite resources in full awareness of how human action today affects the future of both humanity and the natural environment.

Our sustainability program at Yale, in short, involves educating the next generation of leaders in our society to live in better harmony with the planet than prior generations. Our aspiration is to promote growing prosperity that is sustainable, in the sense that future generations will have no less opportunity to enjoy the fruits of the environment or the fruits of their own potential than we ourselves have enjoyed.

How did Yale set out on this path? First, we have always had a strong presence at Yale of environmentally conscious scholars and students. Just before the millennium, we created a task force, the Advisory Committee on Environmental Management, led by faculty, which was asked to suggest improvements in Yale's environmental practices. We then launched a series of small environmental projects and ultimately created an Office of Sustainability.

One of the events that significantly influenced me toward taking bolder action was a report prepared by three undergraduate students. These students thoroughly documented Yale's environmental practices and pointed the way toward what might be done in the future to improve our policies. The student report appeared just as we hired Julie Newman as our first Director of Sustainability. We now had a vision, which I embraced, and a leader thoroughly up to the task of moving the University forward. Today, Julie Newman not only coordinates Yale's efforts, but she has assumed a position of leadership in sustainability practices across the university community – regionally, nationally, and globally.

Now I would like to describe Yale's efforts to reduce its greenhouse gas emissions. I will start by noting that Yale employs more than 12,000 people, making us the third-largest private employer in our home state of Connecticut. There are 11,000 students on our campus and we have an annual budget of $2.5 billion. We are a large organization by any standard, large enough to be a model of responsible environmental practice for other universities and business organizations, large enough to demonstrate to political leaders that greenhouse gas reduction is feasible and affordable.

The centerpiece of our effort at Yale is our commitment to reduce the university's greenhouse gas emissions to 43% percent below our 2005 baseline by 2020, a goal within the range of estimates of what is required to keep global temperatures from rising 2 degrees centigrade. Our target is more ambitious than the goal adopted at Kyoto, but has a longer timeframe, 2020 rather than 2012.

The good news is that we have reduced our carbon emissions by 43,000 metric tons in the first two years of our program. That is a 17 percent reduction from our 2005 levels. This rapid process has given us confidence that we are going to achieve our reduction well before our 2020 deadline.

We have additional emissions-reducing projects currently planned for implementation within the next three years, the most important of which is a new co-generation plant on the campus of our School of Medicine. These projects will achieve an additional 17 percent reduction in our greenhouse gas emissions.

We plan to reduce our carbon footprint through a mix of conservation measures, the use of renewable energy on our campus, and direct participation in carbon offset projects. Some of the specific steps we have taken to reduce emissions are worthy of mention:

In the last two years, we have retrofitted the heating, ventilation and air conditioning systems in 90 of our roughly 300 buildings. Heating and lighting are managed by automated controls.

We have installed thermally efficient windows in many of our largest existing buildings, and in all of the new buildings we have constructed in the last decade.

We have acquired new power plant equipment and modified some existing equipment to achieve substantial savings in fuel consumption. We are using a mix of conventional and renewable fuels in our power plant and our campus bus fleet.

All of our new buildings, and even most of our renovations, have achieved a Silver rating or better from the Leadership in Energy and Environmental Design (LEED) Green Building Rating System. We are constructing a new home for our School of Forestry and Environmental Studies that is designed to be carbon-neutral. It is truly a marvel of green architecture, and it will be the second new building at Yale to gain the highest rating, LEED Platinum. Only 51 buildings worldwide have thus far achieved this standard; eleven of them are on university campuses. We are currently exploring, along with several sister institutions, an alternative standard for new construction that focuses more directly than LEED on greenhouse gas reduction.

In several of our existing and new buildings, we have installed ground source heat pumps to help meet heating and cooling needs.

We have reduced aggregate electricity consumption by 10 percent in our residential colleges each of the last two years, by sponsoring a competition between the colleges. Part of this reduction is attributable to more conscientious behavior in turning off lights and computers, but we have also distributed thousands of compact fluorescent light bulbs. We intend to achieve another 5 percent reduction in student electricity consumption this year.

We are developing standards for the replacement of university-owned vehicles with hybrid models. As we replace the University's buses and trucks, we want to minimize fuel consumption and also use renewable fuels where possible.

We are experimenting with solar and wind power as part of our effort. We are installing solar panels on a number of our buildings, both existing and new. And we are installing small wind turbines in the windiest sections of our campus.

Nearly all of these projects require up-front investment, but the good news is that most of the actions we have taken to-date have brought sufficient energy savings to yield a positive economic return. Based on our experience, I am convinced that just about every large organization that carefully examines its energy sources and consumption will find many investments that have an economic payoff.

Nonetheless, some of the investments we are making, and some that we will make in the future, do incur some net economic cost. For example, our studies suggest that there is a significant premium associated with establishing LEED Gold as a minimum standard for new construction, relative to our current standard of LEED Silver. In part, this is why we are considering the development of an alternative standard more closely linked to carbon emissions.

Today, we usually pay a premium when we substitute renewable fuels for conventional fuels. That equation might change if there were a carbon tax to reduce greenhouse gas emissions. To evaluate such situations, we calculate what the net cost or savings would be in the presence of a $50 or $100 per ton carbon tax.

In some cases, we will invest to achieve carbon savings even at a modest net economic cost, in part to demonstrate the feasibility of new technologies and in part to encourage policy change that would price carbon correctly. Recognizing that some of the steps we are taking produce economic savings while others impose a cost, we believe that

we can reach our greenhouse gas reduction goal at a cost of less than one percent of our annual operating expenses. Indeed, in our most likely scenario, the net cost is closer to one-half of one percent of our operating expenses.

This is a price that we are more than willing to pay to achieve such a significant reduction in the Yale's carbon footprint. I would ask each individual in this room the following question: would you pay a tax of one half of one percent of income to save the planet? Perhaps I am an incorrigible optimist, but I believe that when asked this question most people would answer "yes."

I should mention that many of Yale's peer institutions also are aggressively reducing their carbon footprints. Cornell University, for example, has a project using lake water for campus-wide cooling, and the University of Pennsylvania has purchased wind power to meet 30 percent of its electricity needs. By the end of this academic year, we expect that every one of our sister institutions in the Ivy League (Brown, Columbia, Cornell, Dartmouth, Harvard, Princeton, and the University of Pennsylvania) will adopt its own concrete and achievable greenhouse gas reduction goal.

Yale is also encouraging three groups of international universities to become leaders in reducing carbon emissions. The International Alliance of Research Universities is working on defining common metrics and similar policy goals. At Davos this January, a group of more than 20 international universities convened at the Global University Leaders Forum to discuss adopting a common approach to reducing greenhouse gas emissions. And a week later, at the request of the Chinese Ministry of Education, Yale conducted a workshop for officials from China's top 30 universities that led to a joint declaration to improve both environmental education and environmental practices on their campuses.

As we consider the contributions that universities around the world might make in the effort to address climate change, we need to recognize that important differences in our histories and stages of development might dictate different goals. It would be unfair, for example, to expect universities in China and India to commit to reducing their greenhouse gas emissions to 10 percent below their 1990 levels, as Yale has done. Chinese universities have grown dramatically since 1990. National enrollments tripled between 1998 and 2003, and many individual campuses have more than doubled their size in the last decade. It seems unreasonable to expect institutions that have experienced two-, five-, or ten-fold increases in energy consumption since 1990 to turn back the clock. Nonetheless, these universities can still adopt ambitious programs to reduce emissions significantly below current levels.

I would hope that as universities around the world set aggressive goals for carbon reduction and pursue them successfully, our students, regardless of the degrees they earn and the career paths they choose, will leave with an appreciation of sustainability that will govern their behavior in the workplace and their lives as citizens.

But the ultimate test of our collective efforts will be in the sphere of national and international policy. Voluntary climate commitments alone will not suffice to achieve the greenhouse gas reductions needed to save the planet. At best, these voluntary efforts can help raise consciousness among citizens and demonstrate to policy-makers the feasibility and cost-effectiveness of setting ambitious goals to reduce carbon emissions. It is to the broader questions of public policy that I now turn.

Public Policy

There is an emerging consensus that to keep global temperatures from rising more than 2 degrees centigrade, atmospheric concentrations of greenhouse gases need to be stabilized in the range of 450 to 550 parts per million. In a widely noted report circulated in late 2006, Sir Nicholas Stern, the distinguished British economist and Treasury official, concluded that to reach this objective, global emissions of greenhouse gases would need to be reduced somewhere between 25 and 70 percent by 2050, depending on whether we aim for 550 or 450 ppm. Even the more modest target is a tall order, because the economy will be three to four times larger in 2050 than it is today.

The magnitude of the problem highlights one important fact: the solution *must* be global. Given current levels of emissions in the US and Europe, and the projected growth of the Chinese and Indian economies, we simply cannot make the reductions required on a global scale without the cooperation of the United States, the European Union, China, and India. If any one of these four economic powers refuses to participate in an international program to reduce carbon, we cannot succeed in stabilizing global temperatures. Any one holdout pursuing a business-as-usual strategy will make the cost of adequate global reduction prohibitive. I believe the US can and should lead by example.

There is a broad consensus among economists that the most effective way to stop global warming is to ensure that decentralized decision-makers – consumers and business enterprises – pay a price for greenhouse gas emissions. This can be done either directly, by imposing a tax on carbon, or indirectly, by creating a "cap-and-trade" mechanism – that is, by imposing limits on total emissions and issuing tradable allowances. A tax or cap-and-trade scheme can be imposed either upstream (at the source where petroleum, coal, or natural gas is extracted or converted to fuel) or downstream (in power plants, factories, or motor vehicles where greenhouse gases are emitted).

There is controversy about both issues: taxes v. quotas, upstream v. downstream. As an economist, I would enjoy exploring the nuances of these arguments in depth, but in the big picture neither of these questions is the most important. We can design taxes more or less efficiently and we can design a tradable allowance system more or less efficiently. And, although it matters, it does not matter that much whether we tax fuels or issue quotas at the source, or at the point of combustion and atmospheric release. What matters more is this: will we set taxes high enough or emissions quotas low enough to elicit a sufficient response?

If we set a carbon tax that is too low, or set emissions "caps" that are too high, we will fail to arrest global warming, and we will fail to minimize the net economic, social, and environmental cost of rising global temperatures.

Before commenting on the big question, let me make a couple of additional observations. First, whether one sets taxes or emissions quotas, most economists favor gradualism, for compelling reasons. Adjustment in the short run is much more costly than adjustment over a decade or two, when energy-inefficient capital equipment and motor vehicles can be phased out gradually in favor of more efficient alternatives. What is essential for the efficient operation of either a tax or a cap-and-trade regime is that individuals and businesses know what their taxes or allowances will be well into the future. A gradually rising tax on carbon or a gradually falling quota on carbon emissions that is credible will be sufficient to elicit socially optimal investment decisions, both in the deployment of existing technologies and in the development of new technologies. It is imperative that we act soon but it is not necessary to impose high taxes or low quotas immediately.

Second, although there are good theoretical and practical arguments on both sides of the question, in the context of reaching international agreement, a cap-and-trade scheme may have a decisive advantage over a carbon tax. Developing countries will strongly resist a uniform global carbon tax, which they would perceive as placing upon them an unfair burden; yet different taxes across nations would distort investment incentives. By contrast, agreement on a global cap-and-trade system could take account of a country's stage of development by assigning more stringent reduction targets to developed countries and less stringent ones to developing countries. Regardless of the equitable adjustments made in distributing national quotas, as long as allowances are tradable internationally, a uniform price for carbon will result, creating a solution that would be both equitable among nations and efficient in the allocation of investment.

So, how high a carbon price do we need? To reduce annual global emissions 25% by 2050, the *Stern Review* finds that we would require a carbon tax (or a market price of tradable emissions allowances) in the range of $350-400 per ton of carbon by 2015, rising to more than $600 per ton by 2050. Fortunately, my Yale colleague, William Nordhaus, demonstrates convincingly that Stern's estimate is too high. Nordhaus' own model indicates the same reduction in emissions can be achieved by a carbon price that rises gradually from $35 per ton in 2015 to about $100 per ton in 2050.

But can we be confident that a 25% global reduction in carbon emissions by 2050 is enough? Martin Weitzman, the Harvard economist, highlights this question by pointing out that we may be missing the boat if we set emissions goals and price carbon according to "expected" or "best guess" scenarios when in fact there is a huge penumbra of uncertainty surrounding the quantitative effect of carbon emissions on temperature, and similar uncertainty surrounding the impact of rising temperature on human well-being, broadly, and the economy, more narrowly. Perhaps, he suggests, we should price carbon as if we were taking out insurance against the most catastrophic scenarios, rather than paying for the "expected" or "most likely" consequences of global warming. This approach would yield a carbon tax significantly in excess of Nordhaus' range, though probably still below Stern's. The principal of gradualism, however, suggests that one would adjust slowly to paying high insurance premiums, and invest along the way in acquiring, through better science, knowledge that would permit a narrowing of the range of uncertainty.

Finally, there remains the question: is the cost to society of reducing carbon emissions so high as to be politically infeasible? Our best economic estimates suggest that it will cost between one-half of one percent and one percent of global output to reach reduction goals in the neighborhood of 25% by 2050. Voluntary efforts at Yale and elsewhere are demonstrating that the low end of that cost range may be achievable. Again I ask: is a tax of one-half of one percent too big a price to pay to save the planet? I think not.

But there is an even more convincing refutation of the proposition that fighting global warming is too costly, and it is this: we have already experienced something that looks very much like a carbon tax, and a very large one. In fact, we have demonstrated that we can absorb a carbon tax as high as the one that Stern's model dictates. In 2002, the price of crude oil averaged $25 per barrel. Today it is close to $100 per barrel, an increase of $75 per barrel. If, counterfactually, the demand for crude oil were perfectly inelastic, a $600 per ton tax on carbon, the tax recommended by Stern in the year 2050, would increase the price of crude oil by about $70. And of course demand is not perfectly inelastic, so the actual effect of a carbon tax on the price of oil would be considerably below this level. A carbon tax at the more realistic level proposed by Nordhaus – $100 by 2050, would increase the price of oil by less than $12 a barrel.

I am not saying that we already have a carbon tax, because a proper carbon tax would apply equally to coal, natural gas, and other sources of combustible carbon. But I am saying that we have over the past five years absorbed an increase in the price of oil more than six times larger than the increase we are likely to need to curtail global warming.

What have we learned from this "natural experiment" with oil prices? Let me note just two lessons. First, until the recent credit crunch in the United States – an event largely unrelated to the increase in oil prices – the world economy has prospered. Despite the fact that all are importers of oil, Europe and the United States have experienced robust growth since 2002, while China and India have shot out the lights. So it is clear that we have the capacity to absorb a carbon tax. Second, just as our economic models of climate change predict, investment in alternative energy technologies has accelerated dramatically in response to rising oil prices. Venture capital investment in clean technology in the United States has increased by a factor of 11 since 2003, and "clean-tech" investment as a share of all venture capital funding has grown from just over 1% to 12%.

I hope the Members of the Committee will take heart in the knowledge that universities around the globe are advancing the science of climate change and its consequences, developing new carbon-free and energy-efficient technologies, educating the next generation to a new consciousness about sustainability, and demonstrating to the world that reducing greenhouse gas emissions is both feasible and affordable. I commend the Committee for its thoughtful consideration and approval of legislation that would establish a national system for reducing carbon emissions. Our future depends upon it.

---

[1] Intergovernmental Panel on Climate Change, *Fourth Assessment Report: Synthesis Report Summary for Policymakers*, 2007, p.1

[2] *Ibid*., p. 4.

[3] *Ibid*., p. 5.