NOT GOING AWAY: AMERICA'S ENERGY SECURITY, JOBS AND CLIMATE CHALLENGES

HEARING

BEFORE THE

SELECT COMMITTEE ON ENERGY INDEPENDENCE AND GLOBAL WARMING HOUSE OF REPRESENTATIVES

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NOT GOING AWAY: AMERICA'S ENERGY SECURITY, JOBS AND CLIMATE CHALLENGES

WEDNESDAY, DECEMBER 1, 2010

HOUSE OF REPRESENTATIVES,
SELECT COMMITTEE ON ENERGY INDEPENDENCE
AND GLOBAL WARMING,
Washington, DC.

The committee met, pursuant to call, at 11:01 a.m., in room 210, Cannon House Office Building, Hon. Edward J. Markey (chairman of the committee) presiding.

Present: Representatives Markey, Blumenauer, Inslee, Herseth Sandlin, Cleaver, Hall, Sensenbrenner, Blackburn, and Capito.

Staff Present: Ana Unruh-Cohen, Morgan Gray, Jonathan Phillips, Jeff Sharp and Jonah Steinbuck.

The CHAIRMAN. Welcome. Welcome to the Select Committee on Energy Independence and Global Warming.

In April of 2007, the Select Committee on Energy Independence and Global Warming held its first hearing. At that inaugural gathering, we discussed the twin challenges of climate change and our dependence on foreign oil. Since that time, Congress passed new fuel economy standards. We made investments into renewable energy, advanced battery technology and efficiency measures that save families and small businesses money. The House passed a comprehensive energy and climate bill. The world, including China and India, committed to reduce carbon pollution in the Copenhagen Accord. Our troops continue to fight bravely in Iraq and Afghanistan, where our energy interests remain entangled. The Gulf of Mexico was sullied by BP's oil spill, which became the worst environmental disaster in United States history. And here in this committee, we discussed and debated it all, paving the way for informed action.

Over the last few years, the politics of energy have changed and shifted more times than we can count, yet what has not changed are the problems we face as a Nation and as a planet. Today's hearing is called "Not Going Away", a fitting title for issues that will be central to the health and survival of our planet and our economy for decades and centuries to follow. The national security challenges from our dependence on oil are not going away.

Today before our committee we have Vice Admiral Dennis McGinn, who was a witness at our very first hearing. He knows the price of our dependence on foreign oil borne out not in this rhetorical battlefield but in the theater of actual war where bullets and bombs are spent to defend or acquire barrels of oil.

The national security threats from climate change are not going away. During the first select committee hearing, we discussed the drought-influenced Somali conflict that led to Black Hawk down. A warming world exacerbated a military hotspot.

This September, we hosted the Pakistani ambassador to discuss his country's devastating floods. He discussed how his country diverted resources like helicopters away from fighting Al Qaeda to assist in the flood response. An increasingly destabilized climate will invariably lead to more of these destabilizing geopolitical events.

The economic security threats stemming from America's lack of an energy plan are not going away. China is pushing ahead with clean energy investment along with other emerging technologies to capture and store carbon from coal. Twice as much money was invested in clean energy in China as was invested by the United States last year. As we heard from the private investment community, this move by China will attract trillions in private capital money that could be invested in jobs here at home in the United States. And China is not alone. Germany, Japan, South Korea, and other countries recognize that dominating the trillion dollar market of tomorrow requires foresight and public investment today.

Regardless of our political party, we can all agree that second place in the clean energy race is not an acceptable goal for the United States, and the carbon pollution that we have already spewed into the atmosphere warming our earth is not going away. The pollution we emit today will still be in the atmosphere centuries from now. Every day that we wait to act to stem the tide of carbon emissions will be felt for decades and centuries to come as our planet warms and our weather patterns become less stable.

And, today, as the world's climate community gathers in Mexico, those of us who accept that cutting carbon pollution is this generation's responsibility are saying that we are not going away. We are not going away because the problems that climate change presents are too dangerous, too urgent for us to disappear into the abyss of cynicism and lost opportunity. We are not going away because China and India and Germany are not going away as competitors for global energy dominance. We are not going away because the national security threats from our continued dependence on foreign oil are not going away.

I would like to thank our witnesses for coming today, and I look forward to their testimony. Unfortunately, General Wesley Clark was unable to make it here today. We look forward to having him back here soon, and we will submit his testimony for the record.

[The statement of General Clark follows:]

General Wesley K. Clark

Testimony before the House Select Committee on Energy Independence and Global Warming

Wednesday, December 1, 2010

Chairman Markey, Ranking Member Sensenbrenner, distinguished members of the Committee, thank you for the opportunity to testify before you this morning.

In the summer of 1973, as an Army Captain on the faculty at West Point, I spent two months working the first sets of analyses of the "energy crisis" for the Pentagon. At a time when gasoline prices had quadrupled, and long lines extended into the streets at every service station, Americans seemed determined to take action. For my part, I analyzed the adverse consequences of our increasing dependence on foreign oil – that it would distort American foreign policy, that the funds expended might go to governments that were unstable or didn't support our interests, and that ultimately, US military forces might have to become engaged to defend or protect oil-producer governments. At a time when the US was ending its commitments in SouthEast Asia, this was disturbing. After the Yom Kippur War, in October, 1973, there was a rising call for American "Energy Independence"

Today, we can look back on the continuing failures of American government spanning the terms of seven Presidents, Republican and Democratic. Over this time we have been twisted and turned in our foreign policy by our pursuit of energy security, we have subsidized foreign governments inimical to our own interests, seen "petrodollars" diverted to corruption and terrorism, deployed hundreds of thousands of troops, and billions of dollars worth of materiel, fought the Gulf War, invaded Iraq, and remained engaged in a long term commitment in Afghanistan, at costs already exceeding a trillion dollars, all directly or indirectly due to our energy dependence. It makes all of those concerns expressed in the early 1970's seem a little understated.

And the costs of that dependence continue to grow. Today the American economy sits with over 16% unemployment, or underemployment. Yet even in this slack economy we will be sending over $300 billion dollars abroad this year to pay for American's thirst for petroleum. This is equivalent to a tax – a levy – a bounty of about $1,000 for every man, woman and child in America...money that is desperately needed within the American economy to create jobs, build communities, fund education, repair infrastructure, and give our children and grandchildren a future. Instead it is sent abroad to fund governments in places like Venezuela, Nigeria, and states on the Arabian peninsula. And then, we ask our military to

organize, train and equip our forces, and deploy to fight, or provide secure access to these petroleum resources? So, add to the $300 billion annual costs to the American economy in the defense budget for the "secure access" portion of the Defense Department budget – ships, aircraft, bases, Marines, ground troops, prepositioned equipment, exercises, and all the long-lead time procurement that goes with this. Then add another amount - $150-$200billion per year for the costs of the actual engagement in Iraq and the fighting in Afghanistan. Surely we are one of the most generous nations in history, not only purchasing oil abroad but organizing vast armed forces , equipped, trained, deployed and engaged in fighting which is directly or indirectly aimed at protecting some of he very nations to which we are remitting vast sums of money in exchange for oil and gas. And somehow, although we don't take the majority of our oil imports from the Gulf, nevertheless, we pay the vast majority of the costs for access there. Why should a nation struggling to create jobs and move its economy forward be spending hundreds of billions of dollars importing oil, when alternatives are available?

Of course, unlike 1973, we now understand that the greenhouse effect of carbon dioxide and other global warming gases is contributing significantly, and perhaps decisively, to long-term world wide climate change. We must address this, also as a threat to our national security. But however great this concern, as an American, I have to look first at our own country, and how we are squandering our near-term future.

Can a single Congressman or Senator of any party face the American people and say, yes, we must ask you each to pay a tax of $1,000 per person per year into the indefinite future, so that you can have access to foreign oil at the pump, and an additional other $1,000 or so that we can protect our oil companies' access to it...Sums totaling $15-$30 Trillion dollars over the next two decades ? Could they say this when we have real alternatives which will keep this wealth at home and strengthen our security in the process?

Members of the committee, although I served for 34 years on active duty in the Army, I am in the energy business today, serving on the boards of companies in the oil, gas, wind, solar, ethanol, unconventional fuels, and electric power space. The information I am providing comes from first hand business experience, not just policy research.

Today we are dependent on 10 Million barrels per day of imported petroleum and petroleum products, and, if the economy resumes growing perhaps 11 or 12 million barrels per day. Given the right policies, and without raising the costs on our taxpayers, and at the same time reduce the emissions of greenhouse global warming gases, I believe we can achieve energy independence. The key is in the transportation sector, where this imported oil is used. Here is what we should do:

First, continue the adoption of electric automobiles. While there may be some technical issues, the hold-up is primarily a problem of demand. The US government should back up its technology efforts with "demand-pull" Simply decide that after,

say, 2014, any light vehicle bought by the GSA or by State and local governments ,must be electric-powered. Mass production will lower costs and raise consumer acceptance, and so perhaps within two decades, half the vehicles on the road could be all-electric. The government should also establish a nationwide Renewable electricity Standard, and mandate that all charging stations must be renewable energy-supplied – the wind solar, and biomass technologies are there, and, given adequate demand, could create hundreds of thousands of American jobs. And while we're at it, to assure that private investment funds are available, can't we give the small investor in wind and solar the same tax treatment that is available to investors in oil and gas?

For the near term, though, most vehicles will continue to be liquid fuelled. Many technologies have a role to play. First, get the American people in on the fight: label fuel at the pumps to show where it comes from; With a little ingenuity, the credit card receipt at the pump could provide country-of-origin labeling to show who gets the money – Americans, or Venezuela, Mexico, Nigeria or other government oil companies.

Then work alternative sources of supply by opening up the market for consumer choice. Ethanol today (already 60% less carbon-intensive than gasoline) provides almost 900,000 barrels per day of fuel in America. Follow-through on the approval of E15 and promote the blender pumps across America to make richer ethanol blends available, and cellulosic ethanol will surely make it to the marketplace, in sufficient quantities to meet the 2007 legislative aim of 36 billion gallons per year – or about 2.4 million barrels per day, or even more. Biodiesel and synthetic diesel is already in demand by our Armed Forces; enable long-term procurement contracts, and we can save another 2-4 million barrels per day by relying on synthetic military fuels. Next, compressed natural gas; with the right policies we could save say 1-2 million barrels per day of imports by transitioning fleet vehicles to CNG. Gas-to-liquids and coal-to-liquids with carbon sequestration could produce, over a few years, additional millions of barrels per day of cleaner petroleum products, at a profit, given oil prices in the $75-$90 per barrel range, if we could rationalize and streamline our regulatory processes. Add in additional oil from shale and other unconventional sources, including revamped and environmentally-safer off-shore drilling, and we can replace all imported petroleum.

In the process, we will reduce reliance on increasingly carbon-intensive and ecologically risky conventional oils, and help clean up the environment. Now is the time to embark on this effort, with the price of oil high, the economy slack, and trillions of dollars of private investment capital looking for good returns.

In the 1960's America needed the challenge of putting a man on the moon; today our leadership needs to challenge America to become energy independent. This we can do.

The CHAIRMAN. Before I close, I would also like to thank the members of this committee and their staff for their service over the last two sessions of Congress. It has been an honor and a pleasure to explore and understand these global issues with each and every one of you, and I thank each of you on both sides of the aisle for your service to our country.

[The prepared statement of Mr. Markey follows:]

THE SELECT COMMITTEE ON
ENERGY INDEPENDENCE AND GLOBAL WARMING

"Not Going Away: America's Energy Security, Jobs and Climate Challenges"
Statement by
Chairman Edward J. Markey

In April of 2007, the Select Committee on Energy Independence and Global Warming held its first hearing. At that inaugural gathering, we discussed the twin challenges of climate change and our dependence on foreign oil.

Since that day, Congress passed new fuel economy standards. We made investments into renewable energy, advanced battery technology and efficiency measures that save families and small businesses money. The House passed a comprehensive energy and climate bill.

The world -- including China and India -- committed to reduce carbon pollution in the Copenhagen Accord. Our troops continue to fight bravely in Iraq and Afghanistan, regions where our energy interests remain entangled. The Gulf of Mexico was sullied by BP's oil spill, which became the worst environmental disaster in U.S. history. And here, in this committee, we discussed and debated it all, paving the way for informed action.

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invested in clean energy in China as was invested in the United States last year. As we heard from the private investment community, this move by China will attract trillions in private capital –money that could be invested in jobs here at home.

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And the carbon pollution that we have already spewed into the atmosphere, warming our Earth, is not going away. The pollution we emit today will still be in the atmosphere centuries from now. Every day that we wait to act to stem the tide of carbon emissions will be felt for decades and centuries to come, as our planet warms and our weather patterns become less stable.

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I would like to thank our witnesses for coming today and look forward to their testimony. Unfortunately, General Wesley Clark was unable to make it here today. We look forward to having him back here soon and will submit his testimony for the record.

And before I close, I would also like to thank the members of this committee and their staff for their service for the last two sessions of Congress. It has been an honor and a pleasure to explore and understand these global issues with you.

I would now like to recognize the Ranking Member of the Select Committee, Rep. Jim Sensenbrenner of Wisconsin.

The CHAIRMAN. I would now like to turn and recognize my friend, the gentleman from Wisconsin, the ranking member, Mr. Sensenbrenner.

Mr. SENSENBRENNER. Thank you very much, Mr. Chairman.

This hearing will be the last of the Select Committee; and, while I was initially skeptical of the Select Committee's mission, it ultimately provided a forum for bipartisan debate and an opportunity for House Republicans to share a different view on the pressing energy and environment issues that we currently face.

I would like to thank Chairman Markey for his fair and firm leadership of this committee. He has showed courtesy, respect for the rules, and a willingness to rise above partisanship. I consider respect for the rights of the minority to be a hallmark of great congressional leadership, and I commend Chairman Markey for giving us the resources and platform that we needed to express our ideas.

Chairman Markey and I disagree on policy choices, but we do agree that America needs to diversify its energy supply and increase our energy efficiency. When Senator Dodd of Connecticut gave his valedictory speech in the Senate yesterday, he made a comment saying that even though people can be friends and respect each other despite policy differences, a lot can get accomplished; and, unfortunately, there has been too little of this in this Congress as time has gone on.

I can say that I consider Chairman Markey a friend. I can say that Chairman Markey believes that what Senator Dodd has said is good for America in this respect, and I hope that in the Congress ahead, where there will be a partisan divide between the two ends of the Capitol building, that we will be able to establish respect for each other without compromising our policy ideals. Because the American people want action. The American people do respect positions that are opposite, and it is going to be a tough task ahead.

Now, I think that this select committee has shown a very, very wide division on how to approach our shared goals.

On Monday, the Wall Street Journal ran an article in a special report on energy which I am holding up so that everybody can see. On the red side are arguments that have been made and which have failed in the forum of domestic and international public opinion and on the green side there are ideas and advocacy on what looks like is achievable in the road ahead. And on the red side it says, old, set a high tax on carbon to make alternative energy sources more competitive; old, impose strict controls on carbon dioxide emissions; old, force wealthy countries responsible for most emissions to send money to help poorer ones adapt to the effects of climate change; old, use the United Nations to work out comprehensive agreements.

All of those were eloquently advocated by the chairman and people on the majority side of the aisle, and they have been rejected both in international forums and here in America.

Now, let's look at what is on the new side. New, invest in making new clean energy technologies cheaper; new, focus on modest emission reductions such as replacing old diesel generators; new, encourage development aid that helps poorer countries deal with the effects of drought or flooding, no matter what the cause; and, new, focus on agreement amongst the world's 20 largest economies.

All of these new things were advocated by the Republican minority on this select committee; and I believe that the select committee, unlike any other committee in Congress, was really the focus of the debate between what this article refers to as old and what this article refers to as new. And I would urge my friends on the other side of the aisle to forsake the old and embrace the new because I think in the years ahead we can make progress by looking forward rather than backward.

I yield back the balance of my time.

The CHAIRMAN. I thank the gentleman very much.

The chair now recognizes the gentleman from Oregon, Mr. Blumenauer.

The chair recognizes the gentleman from Washington State, Mr. Inslee.

The chair recognizes the gentlelady from South Dakota.

The chair recognizes the gentleman from New York, Mr. Hall.

Mr. HALL. Mr. Chairman, I just want to thank you for your leadership of this chairmanship and able guiding of this committee. It has been a privilege to serve and learn all the things I have learned from the witnesses over the last 4 years who have come before the select committee, and I will waive an opening statement.

The CHAIRMAN. I thank the gentleman very much. We thank the gentleman from New York for his incredible commitment to exploring these issues, raising them higher and higher as a national priority; and your service to our country is gradually appreciated. Thank you.

The chair recognizes the gentlelady from West Virginia. The gentlelady waives her time.

Opening Statement of Congressman Marsha Blackburn
Select Committee on Energy Independence and Global Warming
Hearing: "Not Going Away: America's Energy Security, Jobs and Climate Challenges"
December 1, 2010

I thank the Chairman for holding this hearing and I thank the witnesses for testifying before this committee.

All members on this committee agree that America should become energy independent. But the problem arises to what steps Congress take or not take to further this goal.

One significant issue is this country's dependence on foreign oil, which is a national security concern. The answer is not to take Americans totally off the use of fossil fuel as soon as possible through taxes or mandates. These actions would cause severe harm to both consumers and the U.S. economy.

Instead, the government should allow the access of resources available in this nation. One immediate action that could be taken is the Department of the Interior expedite permits for oil and gas exploration and return production to the American industries. It will promote jobs and keep money out of the hands of potential terrorist countries overseas.

Another issue is the growth of renewable energy. Renewable energy has the potential to serve a significant part of our energy infrastructure, but it cannot come through federal mandates. The government is not the proper arbiter of winners and losers in the marketplace. The private sector is the most efficient mechanism to determine which energy technologies will guide the future.

Mr. Chairman,

This hearing is probably the last one of the year for the committee. As members begin to prepare for next year, I urge them to contemplate on the messages sent by the voters this past November.

The public is becoming very wary of more government control of the private sector, and new energy mandates are not what they want. Instead, the federal government should remove regulatory hurdles to new technologies to unleash American entrepreneurship and innovation. This is how America will become energy independent.

Mr. CHAIRMAN. Let us turn then to our opening panel; and I will recognize Vice Admiral Dennis McGinn.

Admiral McGinn spent 35 years with the United States Navy as a naval aviator, test pilot, aircraft carrier commanding officer, and national security strategist. Since completing his service with the Navy, Admiral McGinn has been an active climate change and clean energy advocate in national forums, stressing the need to develop comprehensive solutions to create a sustainable global environment. Admiral McGinn testified at the very first hearing of the select committee, and he will be our first witness today.

We welcome you, sir.

STATEMENTS OF VICE ADMIRAL DENNIS MCGINN, U.S. NAVY (RET.); ROBERT F. KENNEDY, JR., CHAIRMAN, WATERKEEPERS ALLIANCE; RICHARD L. KAUFFMAN, CHAIRMAN OF THE BOARD, LEVI STRAUSS & CO.; PETER GLEICK, COFOUNDER AND DIRECTOR, PACIFIC INSTITUTE FOR STUDIES IN DEVELOPMENT, ENVIRONMENT, AND SECURITY; AND KENNETH GREEN, RESIDENT SCHOLAR, AMERICAN ENTERPRISE INSTITUTE

STATEMENT OF VICE ADMIRAL DENNIS MCGINN

Admiral MCGINN. Thank you. Thank you, Mr. Chairman. It is a privilege for me to be back before this committee. Mr. Sensenbrenner, great to see you again, sir, and all the members of the committee.

Since April 18, 2007, when I first appeared before this committee, I have been on the road a lot. I have traveled from Maine to California, from Alaska to Florida, from North Dakota to Louisiana and Texas; and I have been doing that to talk about these issues to the American people. And recognizing that there are always regional differences, regional assets, and liabilities related to energy or environmental challenges, the consistent thing that I brought from all of these travels and I share with the committee today is that the American people are concerned about energy security. They are concerned about environmental issues locally, regionally, and globally, including greenhouse gases.

The question, as it always is, is what do we do about it and how urgently should we do it. In 2007, at that hearing we had the then chairman of the CNA Military Advisory Board, General Gordon Sullivan, who was a witness and talked about the first report that the CNA Military Advisory Board put out. The Advisory Board consists of about a dozen or 15 retired generals and admirals from all four of the military services, including the Coast Guard and the National Guard, and came up with the consensus in that report that climate change was a threat to national security because it will act as a threat multiplier for instability in critical regions of the world.

This can be manifested in many different ways, but it occurred to me this summer when Pakistan had 20 million people affected by torrential monsoon flood, historical levels of flooding, that here is a nation that is nuclear armed, has an ongoing Taliban insurgency that threatens the stability of that government, and is essential to our success and the success of NATO in Afghanistan. And

we have 20 million people that are affected by severe weather, the type of scenario that was exactly in the minds of the Military Advisory Board when we said climate change is a threat to national security.

Another aspect of this was that the board recognized that our economy, energy, climate change, and national security are all inextricably linked. If you want to develop policies and solutions to address any one of those, you have to carefully think through the effects on all of the others.

So, as a result of that, we got together and put out a report in May of 2009 that focused on the energy aspect of these interlinked challenges. And our main conclusion in that report was unequivocal. America's energy posture constitutes a serious and urgent threat to our national security—diplomatically, economically, and militarily. In the military venue, we see it manifesting in Iraq with roadside bombs now in Afghanistan. We saw burning NATO fuel convoys that were along the Pakistan-Afghanistan border. We see from intelligence reports that petro dollars that are going to Iran are finding their way into the hands of the Taliban and al Qaeda and being used to buy the equipment and the very lethal projectiles and components that are killing and maiming our troops on a weekly basis over there. That money is coming from global purchase of oil, and the United States purchases one-quarter of that oil every year.

Diplomatically, we are trying to do something about preventing a nuclear armed Iran from emerging. Our leverage in the international diplomatic community is undercut by the fact that we use 25 percent of the world's oil every year and we sit on perhaps 3 percent.

And economically, make no mistake, the recession that we are hopefully and too slowly starting to come out of, has as a fundamental cause factor the tremendous cost of our addiction to oil in the past. In fact, if you go back in history, over the past four recessions, every one of them has been preceded within 6 months by oil spikes, oil price spikes.

This is not going to go away. We are going to come out of this recession. The economy of the world and the United States is going to heat up and so will the appetite for oil and so will return the volatile cycle but ever higher prices and ever scarcer availability, certainly over the next 10 years but perhaps even sooner than that. We have got to find ways to break that addiction.

Finally, in July of this year, the Military Advisory Board put out a report titled Powering America's Economy: Energy Innovation at the Crossroads of National Security Challenges; and the key finding of this report was that our economy and our national security are so inextricably linked. As we look at ways to deal with our deficit, as we look for ways to afford all of the priorities of America, one of the things that will be inevitably on the table is how much do we pay for defense. If you don't have a good and strong economy, you don't have a good and strong defense structure in armed services. So there is an inextricable link. And the fact that our energy choices in the past and certainly going forward are going to have a tremendous effect for the good or for not good on our economic strength is the key part.

The main recommendation from this report that was published in July of this year was simply that the United States Government should take bold and aggressive action to support clean energy technology innovation and rapidly decrease the Nation's dependence on fossil fuels.

Lastly, I want to share a quote from Admiral Mike Mullen, the Chairman of the Joint Chiefs of Staff. He addressed a Department of Defense energy forum on October 13th of this year:

"I am proud of the work that the men and women of the Department of Defense are doing, the work many of you are leading to ensure we turn our own energy security from a vulnerability to the strength that it could be. Few of us can argue that the need is not there. Many of us can see that the right technology is emerging, and I hope all of us can agree that the time for change is now."

He was addressing a Department of Defense armed services audience. His comments apply to every aspect of American society and the American economy.

And I would like to close my opening remarks, Mr. Chairman, Mr. Sensenbrenner, by a summary that I made 3 years ago on April 18th. I will simply quote.

"Mr. Chairman, thank you. This is an American challenge. It is one that Americans together will meet. It doesn't have partisan labels on it. The solutions are available today. They need to be guided by leadership and good policy which enables us to advance our energy efficiency and to increase our choices of clean, renewable fuels in order to create opportunity for our economy, create opportunity for our society, and raise our level of national security and to be a leader in the global sense in meeting these energy and climate challenges."

Thank you, Mr. Chairman. I request that my written statement be included in the record.

[The statement of Admiral McGinn follows:]

Statement of Vice Admiral Dennis V. McGinn, USN, Retired
Before the
United States House of Representatives
Select Committee on Energy Independence and Global Warming
"Not Going Away: America's Energy Security, Jobs and Climate Challenges"
11:00 a.m., December 1, 2010
210 Cannon House Office Building
Washington, DC

Chairman Markey and Members of the Committee, it is an honor to appear before you today to discuss the critically important topics of energy, climate change and national security.

I previously appeared before this Committee at your first hearing on April 18th, 2007. Since that time, I have had the privilege of serving with some of America's most distinguished and senior retired military leaders on the CNA Military Advisory Board, which produced three reports directly related to the topic of this hearing. The first report examined the national security threats of climate change, the second analyzed the national security threats of America's current energy posture, and our last report, released in July of this year, explored the growing challenges that link our nation's energy posture to our future economic and national security.

We are just beginning to emerge from one of the most serious global financial crises of our lifetimes. This understandably has focused our attention on jobs and near term fiscal issues. However, after several years of carefully examining climate change and the United States' energy use, and having spoken with many business and civic groups across our nation, it is clear to me that our economic, energy, climate change and national security challenges are inextricably linked. And it is also clear that our past pattern of energy use is responsible, in a significant way, for our economic situation today. For these reasons, we must take a long range, comprehensive view to develop effective national policies and make real and positive changes to the ways in which we power America. A rational clean energy and climate policy would be a positive economic and job creation driver, in contrast to the business as usual approach to fossil fuels that is the real job killer. By continuing our over reliance on fossil fuels and fearfully taking only small, incremental steps, we will not create the kind of future energy security, jobs and prosperity that the American people and our great Nation deserve. The time to act, and to act boldly, is now. It is not too late to turn these growing challenges into great economic opportunity.

Weakened national economies have temporarily reduced global demand and somewhat slowed the rising cost of oil. However, as this recession ends, the volatile and economically disruptive cycle of ever-higher energy prices will most certainly return. Population growth and projected per capita increase in energy consumption over the next twenty years will make fossil fuel supply and demand curves widely divergent unless we start now to diversify and change our energy posture.

This is the most critical and long term international security issue for the 21st century– it is an issue that stretches across geographical boundaries, over political divides, and one that will not go away until we decide to do something about it. Even so, our fossil fuel dependence will be with us for decades to come. However, without comprehensive clean energy legislation, market enhancing policies and decisive action by our nation, fierce global competition, instability and conflict over dwindling supplies of fossil fuels and increasing global warming will be a major part of the future strategic landscape. Moving expeditiously toward clean and sustainable energy choices can greatly lessen that danger, improve global and national economic security and help us to confront the seriously growing challenges of global climate change and energy insecurity.

I will now briefly discuss those challenges.

The CNA Military Advisory Board produced a report in 2007 called *"National Security and the Threat of Climate Change"*. Its principal conclusion is that climate change poses a serious threat to national security by acting as a "threat multiplier" for instability in some of the world's most volatile regions.

Climate change is different from traditional military threats, because it is not like having a specific enemy, a rapid and well-defined response timeline, or a clearly located crisis region to which we are responding. Climate change has the potential to create more frequent, intense and widespread natural and humanitarian disasters due to typhoons, flooding, drought, disease, crop failure and the consequent migration of large populations. These climate-driven severe weather events will magnify existing tensions in critical regions, overwhelm fragile political, economic and social structures, causing them to fracture and fail. The predictable result: much greater frequency and intensity of regional conflict and direct threats to U.S. interests and national security.

Some may be surprised to hear former generals and admirals talk about climate change and energy threats... but they shouldn't be. In the military, you learn quickly that reducing threats and vulnerabilities is essential, well before you get into harm's way. As military professionals we were trained, and learned by hard experience, to make decisions when faced with seriously threatening situations, even when they were defined by somewhat ambiguous information. But in the case of climate change, the information is not ambiguous. The global and U.S. science community has reached a clear and fact-based consensus in

concluding that our earth is warming and that human activities are a significant contributor to climate change. There is no disagreement in peer-reviewed literature. Every major professional science society and organization in the world has issued powerful statements to this effect, including the National Academies of Sciences for every major country. The G8 and 5 other nations said in May of last year, "The need for urgent action to address climate change is now indisputable."

As military leaders, we base our decisions on trends, indicators and warnings, because waiting for 100% certainty during a crisis can be disastrous. And as we carefully consider the threat of climate change and energy to global security, these trends and warnings are clear; we need to take appropriate action.

Two years ago, the Intergovernmental Panel on Climate Change -- the world's leading scientific panel on climate change -- including more than 200 distinguished scientists and officials from more than 120 countries, including the U.S. – predicted widening droughts in southern Europe and the Middle East, sub-Saharan Africa, the American Southwest and Mexico, and flooding that could imperil low-lying islands and the crowded river deltas of southern Asia. [i]

Last year, global climate researchers revised those predictions, now forecasting that the planet could warm by as much as 6.3 degrees Fahrenheit by the end of the century even if the world's leaders fulfill their most ambitious climate pledges, a much faster and broader scale pace of change than the IPCC forecast just two years ago. [1]

Their other findings include that sea level could rise by as much as six feet by 2100 instead of 1.5 feet, as the IPCC had projected, and the Arctic Sea may experience an ice-free summer by 2030, rather than by the end of the century.

Let me give you some examples, from a military perspective, of what the future could be like if we fail to adequately address the causes and effects of climate change.

In Africa, projected rising temperatures will dramatically reduce water availability, soil moisture, arable land and food production. Combined with increased extreme weather events – climate impacts will act to accelerate the destabilization of populations and governments already dealing with more traditional causes of conflict. Climate-driven crises are already happening there. Lack of water and changing agricultural patterns are at the root of crises in Darfur and Somalia, present day examples of failed social structures and governments, leading to widespread humanitarian crises, conflict, piracy and terrorism.

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[1] United Nations Environment Program

In South and Central America – melting glaciers in Venezuela and the Peruvian Andes will directly impact water supplies and hydroelectric power. The Peruvian plains, northeast Brazil and Mexico will experience longer and more serious droughts. Land degradation and loss of food production will hit hard in Latin America – particularly Brazil whose economy is fueled by food exports – possibly leading to social disruptions and significant migration. We need only reflect on present immigration and security challenges along the U.S. southern border to get a glimpse of what the future could hold: immigration driven not by a search for a better economic life but in search of basic needs.

In Bangladesh, the growing threat of more frequent and intense typhoons in the Bay of Bengal has the potential for wiping out essential coastal agriculture and fishing areas, just as it did in 1991 resulting in the U.S. military led Operation Sea Angel. Greater and more prolonged coastal typhoon damage would create an unprecedented humanitarian crisis, which could drive literally millions of refugees northwest toward India in search of relief.

As the Himalayan glaciers recede, Asian nations like China, India and Pakistan will have to deal with internal and external unrest due to a much less reliable source of water from four great rivers --- creating floods at some times of the year, prolonged drought during others-- to meet the needs of growing populations. This past summer, we saw massive flooding in Pakistan that continues to affect more than twenty million people in a nuclear-armed nation, with an ongoing extremist insurgency that has direct bearing on the outcome of allied operations in Afghanistan. 40 percent of Asia's four billion people live within 45 miles of the coast – with coastlines and infrastructure that could be inundated by rising seas. Even the most modest projections of increased temperature and sea level rise include widespread flooding and loss of significant percentages of coastal delta farmland and heavily populated areas.

In the Middle East, the vast majority of highly diverse populations already depend on water sources external to their borders. A greatly increased competition for diminishing supplies of water for agriculture and basic human needs would significantly ratchet up tensions in this historically critical and politically unstable region.

These potential climate change effects will not just create crisis events happening far away from American soil or along our borders. Disasters like Hurricane Katrina in 2005 reveal, in a very stark way, how a natural disaster-caused humanitarian crisis can quickly lead to suffering, civil unrest and the need for a massive, expensive and sustained mobilization of resources. In fact today, more than five years after Hurricane Katrina produced widespread destruction along the Gulf Coast, thousands of people have not returned to their homes and hundreds of millions of dollars in damaged infrastructure remain.

As CNA Military Advisory Board member Vice Admiral Richard Truly said climate change is not like "some hot spot we're trying to handle." "It's going to happen to every country and every person in the whole world at the same time." [ii]

And while the effects of global warming create this potential environmental havoc, its principal dynamic will be to shift the world's balance of power and money.[iii]

Drought and scant water supply have already fueled civil conflicts in global hot spots like Afghanistan, Nepal and Sudan, according to several new studies. The evidence is fairly clear that sharp downward deviations from normal rainfall in fragile societies elevate the risk of major conflict.[iv]

Climate impacts like extreme drought, flooding, storm, temperatures, sea level rise, ocean acidification, and wildfires – occurring more frequently and more intensely across the globe -- will inevitably create political instability where societal demands for the essentials of life exceed the capacity of governments to cope. As noted above, fragile governments will become failed states, and desperation and hopelessness will drive whole populations to be displaced on a scale far beyond what we see today. And into this turmoil and power vacuum will rush paramilitaries, organized crime, extremists producing a highly exportable brand of terrorism.

Clearly the U.S. Military will be called to respond to these new threats -- mobilizing to meet the needs of humanitarian crises, like our response to the 2004 tsunami in Indonesia. At the same time, we will be confronted with more frequent resource based conflicts -- think oil-- in the most volatile regions of the world. Climate-driven disruption is such a viable threat that the Pentagon has already started to prepare contingencies for such scenarios, and focused on the issue in its 2010 Quadrennial Defense Review, as did the State Department in its Quadrennial Diplomacy and Development Review.

At the same time, -- and this is at the very nexus of climate change, energy and national security -- increasing demand for, and dwindling supplies of fossil fuels will add greatly to this instability, in many of the very same places worst hit by climate change.

In its second report, May, 2009, the CNA Military Advisory Board concluded that America's current energy posture constitutes a serious and urgent threat to national security -- militarily, diplomatically and economically. Further, this creates an ongoing unacceptable level of risk to our nation, exploitable by those who wish to do us harm.

Militarily, our dependence on oil stretches our military thin because we are obliged to protect and ensure the free flow of oil in hostile or destabilized regions

--even as our troops are on their third and fourth combat deployment in Iraq and Afghanistan. Protecting our access to foreign oil jeopardizes our military and exacts a huge price in dollars and lives.

Beyond assuring the free flow of oil, our nation's, and our military's inefficient use of fuel adds to the already great risks assumed by our troops. It reduces combat effectiveness and puts our troops – more directly and more often—in harm's way. Petro-dollars going into Iranian coffers have directly helped to finance our enemies in both Iraq and Afghanistan. The insurgents have used that money to buy communications, sensors and the most lethal components of improvised explosive devices and roadside bombs that continue to kill and maim our troops on a weekly basis.

Fuel convoys can stretch over great distances, traversing hotly contested territory and become attractive targets for enemy forces as we saw over the summer with burning NATO fuel convoys along the Pakistan border. Ensuring convoy safety and fuel delivery requires a tremendous diversion of money and combat force. [v] As in-theater energy demand increases, more assets must be diverted to protect fuel convoys rather than to directly engage enemy combatants and carry out the primary mission.

We saw this in Iraq and we are certainly seeing it again in Afghanistan where the tempo of military operations, the size of the force and its effectiveness is literally paced by our ability to get fuel when and where it's needed.

Outside the theater of combat, our country's dependence on oil undermines our foreign policy goals and US leverage because it entangles us with hostile regimes. The United States sent $386 billion dollars overseas in 2008, the beginning of our economic recession, to pay for oil; and too much of this money went to countries that are hostile to our interests. Last year, even in the depths of the recession, we sent more than a billion dollars a day out of our economy to pay for our oil addiction.

This oil dependence cripples our foreign policy and weakens our leverage internationally and limits our options. Much too frequently we find ourselves entangled with unfriendly rulers and undemocratic nations, simply because we need their oil. The difficulty of our international efforts to put an effective sanctions framework in place to prevent the realization of nuclear ambitions by Iran illustrates this limit to U.S. leverage.

But unlike what many believe -- it is not just foreign oil that jeopardizes our energy security. It is **all oil**. We simply do not have enough sustainable oil resources in this country to free us from the stranglehold of those who do. It is not environmental restrictions on oil exploration that are keeping us from energy independence; it is a fundamental problem of supply and demand that will grow more divergent over time. We cannot drill our way to sustainable energy

independence. The CNA Military Advisory Board concluded our dependence on **all oil** is a national security threat in part because the United States controls only 3 percent of the world's known oil reserves but uses over 25 percent of the world's oil supplies—we will never have enough domestic supply to meet our need for this fuel so we must deliberately and effectively wean ourselves from it and diversify our energy portfolio.

We also identified a series of converging risks posed by our fossil fuel dependence.

Economically --- It undermines our stability. As I noted earlier, our traditionally narrow approach to energy is a key part of our current financial crisis. We are heavily dependent on a global petroleum market that is highly volatile. In 2008, the year that the recession began, the per-barrel price of oil climbed as high as $147, and dropped as low as $40. But this price volatility is not limited to oil – natural gas and coal prices also had huge spikes that year. The benchmark Central Appalachian coal price hit $175 per short ton. While our ongoing economic downturn has caused those prices to come down, they still remain high and will inevitably begin to climb as the economy recovers. While this energy resource may be plentiful, it is increasingly difficult to access and, in addition to a high greenhouse gas footprint, has significant regional and local environmental impacts including ground water contamination, slurry spills and air pollution. When completely accounted for, the true economic and environmental costs of coal energy are very steep and must be factored in when developing a more comprehensive approach to energy for the U.S.

There are many who still say we cannot afford to deal with our energy issues right now. But if we don't address our long-term energy profile in significant ways, beginning now – future economic crises will dwarf this one. The oil price shocks of 1973-74, the late 1970s/early 1980s, and early 1990's were all followed by recessions.[vi] If oil prices rose to $200 per barrel, the U.S. would spend $1.5 trillion per year on oil, which would be equal to 22% of take-home pay (for all Americans who pay taxes)...In other words, the U.S. will be broke long before oil prices hit $200 per barrel, and the rest of the world would be sure to follow.[vii]

The bottom-line is we can invest now in changing our energy posture or pay much more later on, with far fewer options available. The current economic recession is beginning to end and U.S. energy demands will increase, the volatile cycle of fuel prices will become sharper and shorter because the market for fossil fuels will be shaped by finite supplies and increasing demand. Continuing the United States' pattern of energy usage in a business-as-usual manner creates an unacceptably high threat level to our economic security and, consequently, to our overall national security.

To further highlight this energy-economy-national security link, the CNA Military Advisory Board released its third report in July of this year, titled

"Powering America's Economy: Energy Innovation at the Crossroads of National Security Challenges". The major findings are quite clear and directly address the subject of this hearing:

- America's energy choices are inextricably linked to national and economic security
- The clean energy technology revolution presents great challenges and great opportunities
- Energy business-as-usual is not a viable option for the United States
- The Department of Defense can be a powerful catalyst of energy innovation

And the very first and most important recommendation of the report is a clear call to action by the President and Congress:

- The United States Government should take bold and aggressive action to support clean energy technology innovation and rapidly decrease the nation's dependence on fossil fuels.

On October 13th, Admiral Mike Mullen, the Chairman of the Joint Chiefs of Staff, closed his address to a DoD energy forum with these words:

"I'm proud of the work that the men and women of the Department of Defense are doing – the work many of you are leading – to ensure we turn our own energy security from a vulnerability to the strength it could be.

Few of us can argue that the need is not there.

Many of us can see that the right technology is emerging.

And I hope all of us can agree that the time for change is now."

While Admiral Mullen's comments are primarily focused on the Department of Defense, they apply across the board to America's energy security. Unless we take steps now, not later, to prevent, mitigate and adapt to our energy and climate challenges, the conflict over finite resources – from food to fuel – caused by rising energy demand and accelerating climate change will lead to a significant increase in conflicts, and in conflict intensity.

We need to carefully avoid the temptation to ignore these connections, and take only small steps to address narrow issues. Large, interconnected security challenges require bold, comprehensive solutions.

"We face," as the late John Gardner once said "a series of opportunities brilliantly disguised as unsolvable problems."

Members of the Committee, we must recognize we are at a pivotal moment in history, facing a Gordian knot unlike any the world has seen before. Those who say that now is not the time to act fail to recognize the gravity and urgency of our energy and climate change challenges – but they also fail to understand the tremendous economic **opportunity**.

There is a new multibillion-dollar revolution underway in clean technology around the world. And there is compelling evidence that clean energy policies are powerful economic drivers. To give just one example, precedent-setting statewide efficiency standards saved Californians $56 billion – the equivalent of $1000 per household – which were available to be spent on goods and services besides energy- and created 1.5 million additional jobs. Energy efficiency – the cleanest fuel that need never be mined, drilled or burned – represents a just barely tapped industry in our nation-creating a resource that holds enormous power for the entire United States and for all economies of the world.

The same is true for a whole host of clean and sustainable energy sources. There is general agreement that there is no "silver bullet" technology to meet our growing energy needs in an environmentally responsible way. However, there are a lot of "silver buckshot" approaches that can be effectively used to create a viable portfolio of future energy sources that are not reliant on greenhouse gas producing feed stocks and technologies. What is needed is the kind of energy policy structure that creates market certainty and invites significant public and private investment to significantly and rapidly scale up clean energy technologies. Absent new legislation that creates a clear market signal, it will be critical to maintain the Environmental Protection Agency's existing authority to regulate dangerous pollutants, including greenhouse gases. The United States can seize this opportunity to create jobs and bring our great innovation, technology infrastructure and private capital to the forefront with the right kind of legislation and policies.

Perhaps most important is the opportunity these challenges create for us to demonstrate, once again, the core values of America leadership to the world. How can we expect our enemies, or even our friends and allies, to understand the value of freedom and democracy if we are not actively engaged in protecting the essential air, water and soil that are its seeds? Ensuring that fragile democracies have the technologies needed to prevent, mitigate and adapt to climate change and to produce clean energy self reliance will help grow our economy and protect theirs. Most importantly, America's leadership and key partnership in addressing these truly global challenges will act as a powerful catalyst for international collaboration to better address a whole host of pressing issues. The United States has an opportunity and obligation to lead. We can untie the Gordian knot of economy, energy, climate and national security – and lead to much greater global security.

Members of the Committee, if we act with boldness and vision now, future

generations will look back on this as a time when we stopped clinging to the status quo and rose above narrow special interests and partisan divides to address the most pressing issues of this century. Through thoughtful dialogue, effective legislation and united action, we can transform daunting challenges to America into sustained security and prosperity, creating a better quality of life for our nation and for our world.

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[i] http://www.ipcc.ch/SPM6avr07.pdf KANTER, James and ANDREW C. REVKIN. "Scientists Detail Climate Changes, Poles to Tropics." *New York Times* (April 7, 2007). Jolis, Anne and Alex MacDonald. "U.N. Panel Reaches AgreementOn Climate-Change Report." *Wall Street Journal* (Apr. 6, 2007).

[ii] "Military on Climate Change" *Washington Post* (April 15, 2007).

[iii] Informed Reader column "How Global Warming Will Play With Investors" *Wall Street Journal* (March 9, 2007).

[iv] Revkin, Andrew "Global Warming Called Security Threat." New York Times (April 15, 2007) http://www.ciesin.columbia.edu/pdf/waterconflict.pdf .

[v] Vice-Admiral Dennis McGinn calls Energy Independence a "Silver Bullet", http://www.operationfree.net/2009/09/18/vice-admiral-dennis-mcginn-calls-energy-independence-a-silver-bullet/

[vi] DOE, http://www.eia.doe.gov/oiaf/economy/energy_price.html

[vii] Forbes, http://www.forbes.com/2008/06/23/crude-biderman-margin-pf-etf-in_tt_0623trimtabs_inl.html

The CHAIRMAN. It will. Thank you, Admiral, very much. It will be included without objection.

Our next witness is Dr. Peter Gleick. Dr. Gleick is an internationally recognized water expert and the cofounder and President of the Pacific Institute for Studies in Development, Environment, and Security, a nonpartisan research institute that works to advance environmental protection, economic development, and social equity.

Doctor, we welcome you. Whenever you feel comfortable, please begin.

STATEMENT OF PETER GLEICK

Mr. GLEICK. Thank you very much, Chairman Markey, Ranking Member Sensenbrenner, and committee members. I appreciate the opportunity to appear before you today.

My training and background is in the field of environmental science, hydrology, climatology, engineering. I have been asked to offer comments on the science of climate change and some thoughts about appropriate responses. My longer written testimony has been provided to the committee, and I would just like to make six brief points.

First, the science of climate change is clear and convincing that climate change is happening, happening rapidly, and happening because of human activities. Based on a combination of our understanding of basic laws of science, laboratory experiments, observations of the real world, mathematical and computer modeling, the science of climate change is compelling and strong. Emissions of greenhouse gases from human activities not only will change the climate but are already changing the climate. The evidence is now incontrovertible.

Second, despite continued efforts on the part of a small group of skeptics and deniers to mislead, misrepresent, and misuse the science, our understanding of human-caused climate change continues to strengthen and improve. There is nothing identified in recent efforts to discredit climate science that remotely changes these fundamental conclusions about climate change, and no credible alternative explanation has ever been offered that explains the science of what we observe around the world.

A recent letter from 255 members of the U.S. National Academy of Sciences, of which I am a member, was published in Science magazine in May. I have attached it with my testimony, and it addresses this area as well.

Third, every major international scientific organization working in the areas of geophysics, climate, geology, biology, chemistry, physics, human health, atmospheric sciences, meteorology, and every National Academy of Science of every country of the world, including our own, agrees that humans are changing the climate. Again, a list is attached with my written testimony. Conversely, there is no scientific body of national or international standing that rejects the findings of human-induced climate change.

Fourth, the Nation now only faces three options: mitigation, that is, reducing the emissions of greenhouse gases; adaptation, that is, dealing with the unavoidable consequences of climate change; and

suffering. The only question that remains is what combination of those three things are we going to experience.

The argument that all we have to do is adapt to climate change is simplistic. We have no choice but to do all three. If we do nothing to work on mitigation, the impacts of climate change will continue to accelerate and continue to become more and more extreme. We are now faced already with unavoidable climate change because we have already delayed too long to implement policies to reduce greenhouse gas emissions. In fact, it appears that many of our estimates of the rate of climate change have been too low, not too high, and that climate changes are happening faster than expected.

Fifth, a wide range of impacts, ranging from sea level rise to changing water availability to altered food production to human health effects from heat and spreading tropical diseases to very clear threats to our national security, as Admiral McGinn just talked about and as others have talked about, are already beginning to appear. These impacts will be costly to society, far more costly, I believe, than efforts to reduce emissions of greenhouse gases.

I offer one example in my testimony of the massive consequences expected simply from sea level rise along the California coast from an analysis my Institute did for the State of California. The value of infrastructure at risk along the coast of California from expected sea level rise is already $100 billion. There are 500,000 people in areas that are expected to be flooded from sea level rise, and that is one small impact in one small area of the world that we are going to have to deal with. Those costs are real, if badly quantified.

Finally, the good news is that there are smart and effective things that can be done immediately with a focus on energy policy, land use policy, and water policy. Robert Kennedy, Richard Kauffman, General Clark all offer concrete examples in their written testimony. These kind of options include national energy policy that you have been discussing for a long time. Focused on non-carbon energy sources with Federal financing, tax credit, loan guarantees, there are many different ways of approaching that problem.

We need environmental standards for greenhouse gas emissions, including not just carbon dioxide but methane, hydroflurocarbons carbons, and black carbon. We need to begin the process of adapting to unavoidable impacts of climate change through smarter land use and water use planning. If we act to slow climate change and the impacts turn out to be less severe than we predict, we will still have reduced our dependence on fossil fuels. We will have cut our export of money to countries that fund extremism and terror. We will have reduced our emissions of pollutant. We will have boosted our economy with new technologies and jobs.

But if we do nothing, as some argue we should do, and climate changes are indeed more severe than we expect, we will have made things far worse than they need to be. Congress should step up and do its job.

Thank you for the opportunity to provide this testimony. I would be happy to answer any questions that you may have.

[The statement of Mr. Gleick follows:]

Testimony of Dr. Peter H. Gleick for
The Select Committee on Energy Independence & Global Warming Hearing
"Not Going Away: America's Energy Security, Jobs and Climate Challenges."
Wednesday, December 1, 2010

Chairman Markey, Ranking Member Sensenbrenner, and Select Committee members. Thank you for the opportunity to testify today on America's ongoing struggle to deal with increasingly severe climate challenges and the risks and opportunity those challenges pose for the nation's energy and economic security.

I am the co-founder and director of the Pacific Institute in Oakland, California, an independent, non-partisan research and policy center addressing the questions of environment, economic development, and international security. My background and training is in the fields of environmental science, engineering, hydrology, and climatology. I am an elected member of the U.S. National Academy of Science. My full biography has been provided to the Subcommittee staff. My research on climate issues is supported by foundations and state and local agencies; none of my climate work is funded by corporations or federal agencies.

I'd like to make the following six points:

1. The science of climate change is clear and convincing that climate change is happening, happening rapidly, and happening because of human activities.

Scientific conclusions derive from an understanding of basic laws supported by laboratory experiments, observations of nature, and mathematical and computer modeling. Based on these lines of evidence, the science of climate change is compelling and strong, and has been for over two decades. That science tells us that emissions of greenhouse gases from human activities not only ***will*** change the climate, but are ***already*** changing the climate. The evidence is now incontrovertible, even if a small minority cannot accept it.

Like all human beings, scientists make mistakes, but the scientific process is designed to find and correct them. This process is inherently adversarial — scientists build reputations and gain recognition not only for supporting conventional wisdom, but even more so for demonstrating that the scientific consensus is wrong and that there is a better explanation. That's what Galileo, Pasteur, Darwin, and Einstein did. But no one who argues against the science of climate change has ever provided an alternative scientific theory that adequately satisfies the observable evidence or conforms to our understanding of physics, chemistry, and climate dynamics.

The science tells us – and has been telling us for over two decades – that:

- The planet is warming due to increased concentrations of heat-trapping gases in our atmosphere.
- Most of the increase in the concentration of these gases over the last century is due to human activities, especially the burning of fossil fuels and deforestation.

- Natural causes always play a role in changing Earth's climate, but are now being overwhelmed by human-induced changes.
- Warming the planet will cause many other climatic patterns to change at speeds unprecedented in modern times, including increasing rates of sea-level rise and alterations in the hydrologic cycle. Rising concentrations of carbon dioxide are making the oceans more acidic. And many other changes are seen to be happening.
- The combination of these complex climate changes threatens coastal communities and cities, human health, our food and water supplies, marine and freshwater ecosystems, forests, high mountain environments, and far more.

2. Despite continued efforts on the part of a small group of climate skeptics and deniers to mislead, misrepresent, and misuse the science, our understanding of human-caused climate change continues to strengthen and improve.

Here, in a nutshell, is **the best argument against global climate change**:

There isn't one.

There is nothing remotely identified in recent efforts to discredit climate science that changes these fundamental conclusions about climate change. Every recent independent review supports the message of my first point. A recent letter from 255 members of the U.S. National Academy of Sciences summarizes this issue and is attached as an addendum to this testimony.[1]

Climate change deniers have been trying hard to confuse the public and policy makers about climate change. But their claims about climate science and what we see in the world around us are based on ideology and bad science, not reality. Those few extreme policy makers and pundits who continue to deny the realities of climate change often point to "uncertainty" in the observations, models, and climate system itself that make perfect predictions impossible. Of course, climate scientists also talk about uncertainty all of the time -- it is a characteristic of the science, not an excuse for politicians to avoid taking action. What those who deny the reality of climate change don't acknowledge, in an example of selective one-sided argumentation, is that uncertainty cuts both ways. While there is always a non-zero possibility that climate changes will fall on the less severe end of the scale, there is a comparable possibility that climate changes will be far worse than we expect, with far more serious consequences to the planet.

And that's what's happening.

There is growing evidence from the real world that climate changes are accelerating faster than we originally feared and that impacts -- already appearing -- will be more widespread and severe than expected. This makes the arguments against taking actions against climate change not just wrong, but dangerous.

It's too late to avoid serious, damaging, human-induced climate change. For a variety of reasons ranging from ignorance to political ideology to commercial self-interest to inertia to intentional

[1] This letter was published in Science magazine on May 7, 2010.

misrepresentations and misdirections on the part of a small number of committed climate deniers, the United States and the rest of the world have waited too long to act to cut the emissions of damaging greenhouse gas pollutants. We are now committed to irreversible long-term and inevitably damaging consequences ranging from rapidly rising sea levels, far greater heat stress and damages, disappearing glaciers and snowpack, more flooding and droughts, and far, far more. It is still not too late, however, to slow the rate of these changes and to reduce the ultimate cost to the U.S. economy and public health.

3. Every major international scientific organization working in the areas of geophysics, climate, geology, biology, chemistry, physics, ecology, atmospheric sciences, and meteorology agrees that humans are changing the climate.

This includes every single National Academy of Sciences, including of course, the US NAS. (See the attached list.) Conversely, no scientific body of national or international standing rejects the findings of human-induced effects on global warming. Ignoring the massive weight of this consensus is irresponsible.

4. The nation now faces only three options -- mitigation, adaptation, and suffering.

That is to say we can only (1) work to reduce the severity of future climate change through efforts to cut or mitigate emissions of greenhouse pollutants; (2) work to adapt to unavoidable climatic change already locked into the system; and (3) suffer the consequences of changing climate. The only question is how much of each option we do. We are now faced with unavoidable climate changes because we (the world) have delayed too long to implement policies to reduce greenhouse gas emission. The impacts of unavoidable climate change are going to be significant and will grow in extent and severity the longer we continue to delay efforts to reduce greenhouse gases. In fact, it appears that many of our estimates of the rate of climate change have been too ***low***, not too ***high***, and climate changes are happening ***faster*** than expected.

As a result, in twenty more years, the Earth will be even hotter, sea levels will be higher and rising faster, water and food resources will be increasingly stressed, extinction rates will accelerate, and our forced expenditures for climate adaptation will be far, far greater than they would otherwise have been if efforts to reduce greenhouse gas emissions had been implemented earlier.

5. A wide range of impacts (ranging from sea level rise to changing water availability to altered crop production to human health effects from heat and spreading tropical diseases, etc.) are already beginning to appear.

These impacts will be costly to society -- very costly. Indeed, probably far more costly than efforts to reduce emissions of greenhouse gases. But we tend to focus on the latter costs alone, not the costs of adaptation and suffering.

For example, at the request of three California state agencies, the Pacific Institute recently completed a comprehensive assessment of the vulnerabilities of the California coast, population,

and infrastructure to accelerating sea-level rise. Over $100 billion in infrastructure (including buildings, power plants, airports, roads, wastewater treatment plants, hospitals, schools, police stations, and much more) and a population of nearly 500,000 people are currently at risk of increased coastal flooding, and the research estimated that adaptation costs just to protect existing infrastructure will run around $15 billion, plus high annual costs to maintain these protections. Other major areas and populations simply cannot be realistically protected and will have to be abandoned, with people forced to move over time. And this is just one small piece of the coming threats for one small part of the country. It is vital that efforts still be made to reduce greenhouse gas emissions, but we must also work to adapt to unavoidable impacts.

6. The good news is that there are smart and effective things that can be done immediately, with a focus on energy policy, land use policy, and water policy.

In particular, we need a national energy policy focused on renewable, non-carbon energy sources, with federal financing, tax credits, and loan guarantees for renewable energy and improved transmission. We need environmental standards for greenhouse gas emissions, including not just carbon dioxide but methane, hydrofluorocarbons (HFCs), and black carbon soot. And we need to begin the process of adapting to unavoidable impacts through smarter land-use and water-use planning.

If we act to slow climate change, and the impacts turn out to be less severe than we predict, we will still have reduced our emissions of pollutants, cut our economic dependence on fossil fuels from countries that fund extremism and terror, and boosted our economy with new green technologies and jobs. But if we do nothing, and climate changes are indeed more severe than we expect, we've made things far worse than they needed to be.

We've wasted more than two decades, passing the problem on to the next set of lawmakers and the next generations. Congress should take responsibility now and do its job.

Thank you for the opportunity to provide testimony to you today. I am happy to answer questions.

Addendum A to the Testimony of Dr. Peter H. Gleick for
The Select Committee on Energy Independence & Global Warming Hearing
"Not Going Away: America's Energy Security, Jobs and Climate Challenges."
Wednesday, December 1, 2010

Statements of Major Scientific Organizations on Climate Change[2]

Every major international scientific organization working in the areas of geophysics, climate, geology, biology, health, chemistry, physics, ecology, atmospheric sciences, and meteorology agrees that humans are changing the climate. This includes every single National Academy of Sciences, including the US National Academies. The partial list below summarizes the findings of these organizations, along with selections from those scientific and policy statements.

Academies of Science

Since 2001, all of the world's leading national science academies have issued declarations confirming anthropogenic global warming and urging the nations of the world act to reduce emissions of greenhouse gases. Signatories of such statements include the science academies of:

African Academy of Sciences
Australia
Belgium
Brazil
Cameroon
Royal Society of Canada
the Caribbean
China
Institut de France
Ghana
Leopoldina of Germany
Indonesia
Ireland
Accademia nazionale delle scienze of Italy
India
Japan
Kenya
Madagascar
Malaysia
Mexico
Nigeria
Royal Society of New Zealand

[2] Scientific organizations regularly issue updated and new science and policy statements. Check with each organization for the most current updates and for the complete text of each statement.

Russian Academy of Sciences
Senegal
South Africa
Sudan
Royal Swedish Academy of Sciences
Tanzania
Turkey
Uganda
The Royal Society of the United Kingdom
the United States
Zambia
Zimbabwe

Statements of The National Science Academies of the G8+5 nations (Brazil, Canada, China, France, Germany, Italy, India, Japan, Mexico, Russia, South Africa, the United Kingdom, and the United States).

It is unequivocal that the climate is changing, and it is very likely that this is predominantly caused by the increasing human interference with the atmosphere. These changes will transform the environmental conditions on Earth unless counter-measures are taken. (2007 Joint Academies Statement.)

The IPCC 2007 Fourth Assessment of climate change science concluded that large reductions in the emissions of greenhouse gases, principally CO_2, are needed soon to slow the increase of atmospheric concentrations, and avoid reaching unacceptable levels. However, climate change is happening even faster than previously estimated; global CO_2 emissions since 2000 have been higher than even the highest predictions, Arctic sea ice has been melting at rates much faster than predicted, and the rise in the sea level has become more rapid. Feedbacks in the climate system might lead to much more rapid climate changes. The need for urgent action to address climate change is now indisputable. (2009 Joint Academies Statement.)

Statement of the Network of African Science Academies

[The thirteen signatories were the science academies of Cameroon, Ghana, Kenya, Madagascar, Nigeria, Senegal, South Africa, Sudan, Tanzania, Uganda, Zambia, Zimbabwe, as well as the African Academy of Sciences.]
A consensus, based on current evidence, now exists within the global scientific community that human activities are the main source of climate change and that the burning of fossil fuels is largely responsible for driving this change.

Statements of Major Global Scientific Academies, Societies, and Associations

American Academy of Pediatrics

There is broad scientific consensus that Earth's climate is warming rapidly and at an accelerating rate. Human activities, primarily the burning of fossil fuels, are very likely (>90% probability) to be the main cause of this warming. Climate-sensitive changes in ecosystems are already being observed, and fundamental, potentially irreversible, ecological changes may occur in the coming decades. Conservative environmental estimates of the impact of climate changes that are already in process indicate that they will result in numerous health effects to children.

Anticipated direct health consequences of climate change include injury and death from extreme weather events and natural disasters, increases in climate-sensitive infectious diseases, increases in air pollution–related illness, and more heat-related, potentially fatal, illness. Within all of these categories, children have increased vulnerability compared with other groups.

American Association for the Advancement of Science (AAAS)

The scientific evidence is clear: global climate change caused by human activities is occurring now, and it is a growing threat to society. Accumulating data from across the globe reveal a wide array of effects: rapidly melting glaciers, destabilization of major ice sheets, increases in extreme weather, rising sea level, shifts in species ranges, and more. The pace of change and the evidence of harm have increased markedly over the last five years. The time to control greenhouse gas emissions is now.

American Association of Wildlife Veterinarians

There is widespread scientific agreement that the world's climate is changing and that the weight of evidence demonstrates that anthropogenic factors have and will continue to contribute significantly to global warming and climate change. It is anticipated that continuing changes to the climate will have serious negative impacts on public, animal and ecosystem health due to extreme weather events, changing disease transmission dynamics, emerging and re-emerging diseases, and alterations to habitat and ecological systems that are essential to wildlife conservation. Furthermore, there is increasing recognition of the inter-relationships of human, domestic animal, wildlife, and ecosystem health as illustrated by the fact the majority of recent emerging diseases have a wildlife origin.

American Chemical Society

Careful and comprehensive scientific assessments have clearly demonstrated that the Earth's climate system is changing rapidly in response to growing atmospheric burdens of greenhouse gases and absorbing aerosol particles. There is very little room for doubt that observed climate trends are due to human activities. The threats are serious and action is urgently needed to mitigate the risks of climate change.

The reality of global warming, its current serious and potentially disastrous impacts on Earth system properties, and the key role emissions from human activities play in driving these phenomena have been recognized by earlier versions of this ACS policy statement, by other major scientific societies, including the American Geophysical Union, the American Meteorological Society, and the American Association for the Advancement of Science, and by the U. S. National Academies and ten other leading national academies of science.

American College of Preventive Medicine

The American College of Preventive Medicine (ACPM) accept the position that global warming and climate change is occurring, that there is potential for abrupt climate change, and that human practices that increase greenhouse gases exacerbate the problem, and that the public health consequences may be severe.

American Geophysical Union

The Earth's climate is now clearly out of balance and is warming. Many components of the climate system—including the temperatures of the atmosphere, land and ocean, the extent of sea ice and mountain glaciers, the sea level, the distribution of precipitation, and the length of seasons—are now changing at rates and in patterns that are not natural and are best explained by the increased atmospheric abundances of greenhouse gases and aerosols generated by human activity during the 20th century.

American Medical Association

The AMA states that they support "the findings of the latest Intergovernmental Panel on Climate Change report, which states that the Earth is undergoing adverse global climate change and that these changes will negatively affect public health..." and "educating the medical community on the potential adverse public health effects of global climate change, including topics such as population displacement, flooding, infectious and vector-borne diseases, and healthy water supplies."

American Meteorological Society Council Statement

There will be inevitable climate changes from the greenhouse gases already added to the Earth system...there is adequate evidence from observations and interpretations of climate simulations to conclude that the atmosphere, ocean, and land surface are warming; that humans have significantly contributed to this change; and that further climate change will continue to have important impacts on human societies, on economies, on ecosystems, and on wildlife through the 21st century and beyond. Focusing on the next 30 years, convergence among emission scenarios and model results suggest strongly that increasing air temperatures will reduce snowpack, shift snowmelt timing, reduce crop production and rangeland fertility, and cause continued melting of the ice caps and sea level rise... Policy choices in the near future will determine the extent of the impacts of climate change. Policy decisions are seldom made in a context of absolute certainty. Some continued climate change is inevitable, and the policy debate should also consider the best

ways to adapt to climate change. Prudence dictates extreme care in managing our relationship with the only planet known to be capable of sustaining human life.

American Public Health Association Policy Statement

The long-term threat of global climate change to global health is extremely serious and the fourth IPCC report and other scientific literature demonstrate convincingly that anthropogenic GHG emissions are primarily responsible for this threat...US policy makers should immediately take necessary steps to reduce US emissions of GHGs, including carbon dioxide, to avert dangerous climate change.

American Physical Society

Emissions of greenhouse gases from human activities are changing the atmosphere in ways that affect the Earth's climate. Greenhouse gases include carbon dioxide as well as methane, nitrous oxide and other gases. They are emitted from fossil fuel combustion and a range of industrial and agricultural processes.

The evidence is incontrovertible: Global warming is occurring. If no mitigating actions are taken, significant disruptions in the Earth's physical and ecological systems, social systems, security and human health are likely to occur. We must reduce emissions of greenhouse gases beginning now.

American Quaternary Association

Few credible Scientists now doubt that humans have influenced the documented rise of global temperatures since the Industrial Revolution..." "the growing body of evidence that warming of the atmosphere, especially over the past 50 years, is directly impacted by human activity."

American Society for Microbiology

In 2003, the ASM issued a policy report in which they recommend "reducing net anthropogenic CO_2 emissions to the atmosphere" and "minimizing anthropogenic disturbances of" atmospheric gases:

Carbon dioxide concentrations were relatively stable for the past 10,000 years but then began to increase rapidly about 150 years ago...as a result of fossil fuel consumption and land use change. Of course, changes in atmospheric composition are but one component of global change, which also includes disturbances in the physical and chemical conditions of the oceans and land surface. Although global change has been a natural process throughout Earth's history, humans are responsible for substantially accelerating present-day changes. These changes may adversely affect human health and the biosphere on which we depend. Outbreaks of a number of diseases, including Lyme disease, hantavirus infections, dengue fever, bubonic plague, and cholera, have been linked to climate change.

Australian Coral Reef Society

There is almost total consensus among experts that the earth's climate is changing as a result of the build-up of greenhouse gases. The IPCC (involving over 3,000 of the world's experts) has come out with clear conclusions as to the reality of this phenomenon. One does not have to look further than the collective academy of scientists worldwide to see the string (of) statements on this worrying change to the earth's atmosphere.

There is broad scientific consensus that coral reefs are heavily affected by the activities of man and there are significant global influences that can make reefs more vulnerable such as global warming...It is highly likely that coral bleaching has been exacerbated by global warming.

Australian Institute of Physics

The AIP supports a reduction of the green house gas emissions that are leading to increased global temperatures, and encourages research that works towards this goal.

Research in Australia and overseas shows that an increase in global temperature will adversely affect the Earth's climate patterns. The melting of the polar ice caps, combined with thermal expansion, will lead to rises in sea levels that may impact adversely on our coastal cities. The impact of these changes on biodiversity will fundamentally change the ecology of Earth.

Australian Medical Association

The world's climate – our life-support system – is being altered in ways that are likely to pose significant direct and indirect challenges to health. While 'climate change' can be due to natural forces or human activity, there is now substantial evidence to indicate that human activity – and specifically increased greenhouse gas (GHGs) emissions – is a key factor in the pace and extent of global temperature increases.

Health impacts of climate change include the direct impacts of extreme events such as storms, floods, heatwaves and fires and the indirect effects of longer-term changes, such as drought, changes to the food and water supply, resource conflicts and population shifts.

Increases in average temperatures mean that alterations in the geographic range and seasonality of certain infections and diseases (including vector-borne diseases such as malaria, dengue fever, Ross River virus and food-borne infections such as Salmonellosis) may be among the first detectable impacts of climate change on human health.

Human health is ultimately dependent on the health of the planet and its ecosystem. The AMA believes that measures which mitigate climate change will also benefit public health. Reducing GHGs should therefore be seen as a public health priority.

Australian Meteorological and Oceanographic Society

Global climate change and global warming are real and observable ... It is highly likely that those human activities that have increased the concentration of greenhouse gases in the atmosphere have been largely responsible for the observed warming since 1950. The warming associated with increases in greenhouse gases originating from human activity is called the enhanced greenhouse effect. The atmospheric concentration of carbon dioxide has increased by more than 30% since the start of the industrial age and is higher now than at any time in at least the past 650,000 years. This increase is a direct result of burning fossil fuels, broad-scale deforestation and other human activity.

Canadian Foundation for Climate and Atmospheric Sciences

We concur with the climate science assessment of the Intergovernmental Panel on Climate Change (IPCC) in 2001 ... We endorse the conclusions of the IPCC assessment that "There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities" ... There is increasingly unambiguous evidence of changing climate in Canada and around the world. There will be increasing impacts of climate change on Canada's natural ecosystems and on our socio-economic activities. Advances in climate science since the 2001 IPCC Assessment have provided more evidence supporting the need for action and development of a strategy for adaptation to projected changes.

Canadian Meteorological and Oceanographic Society

The CMOS: endorses the process of periodic climate science assessment carried out by the Intergovernmental Panel on Climate Change and supports the conclusion, in its Third Assessment Report, which states that the balance of evidence suggests a discernible human influence on global climate.

Ecological Society of America (2010)

The Earth is warming -- average global temperatures have increased by 0.74 deg. C (1.3 deg. F) in the past 100 years. The scientific community agrees that catastrophic and possibly irreversible environmental change will occur if average global temperatures rise an additional 2 deg. C. Warming to date has already had significant impacts on the Earth and its ecosystems including increased droughts, rising sea levels, disappearing glaciers, and changes in the distribution and seasonal activities of many species.... Most warming seen since the mid 1900s is very likely due to greenhouse gas emissions from human activities...Swift and significant emissions reductions will be vital in minimizing the impacts of warming.

Engineers Australia (The Institution of Engineers Australia)

"Engineers Australia believes that Australia must act swiftly and proactively in line with global expectations to address climate change as an economic, social and environmental risk... We believe that addressing the costs of atmospheric emissions will lead to increasing our competitive

advantage by minimising risks and creating new economic opportunities. Engineers Australia believes the Australian Government should ratify the Kyoto Protocol."

European Academy of Sciences and Arts

Human activity is most likely responsible for climate warming. Most of the climatic warming over the last 50 years is likely to have been caused by increased concentrations of greenhouse gases in the atmosphere. Documented long-term climate changes include changes in Arctic temperatures and ice, widespread changes in precipitation amounts, ocean salinity, wind patterns and extreme weather including droughts, heavy precipitation, heat waves and the intensity of tropical cyclones. The above development potentially has dramatic consequences for mankind's future.

European Federation of Geologists Position Paper

The EFG recognizes the work of the IPCC and other organizations, and subscribes to the major findings that climate change is happening, is predominantly caused by anthropogenic emissions of CO2, and poses a significant threat to human civilization. It is clear that major efforts are necessary to quickly and strongly reduce CO2 emissions.

European Geosciences Union

In 2008, the EGU issued a position statement on ocean acidification which states, "Ocean acidification is already occurring today and will continue to intensify, closely tracking atmospheric CO2 increase. Given the potential threat to marine ecosystems and its ensuing impact on human society and economy, especially as it acts in conjunction with anthropogenic global warming, there is an urgent need for immediate action." The statement then advocates for strategies "to limit future release of CO2 to the atmosphere and/or enhance removal of excess CO2 from the atmosphere."

European Physical Society

The emission of anthropogenic greenhouse gases, among which carbon dioxide is the main contributor, has amplified the natural greenhouse effect and led to global warming. The main contribution stems from burning fossil fuels. A further increase will have decisive effects on life on earth. An energy cycle with the lowest possible CO2 emission is called for wherever possible to combat climate change.

European Science Foundation

There is now convincing evidence that since the industrial revolution, human activities, resulting in increasing concentrations of greenhouse gases have become a major agent of climate change. These greenhouse gases affect the global climate by retaining heat in the troposphere, thus raising the average temperature of the planet and altering global atmospheric circulation and precipitation patterns.

While on-going national and international actions to curtail and reduce greenhouse gas emissions are essential, the levels of greenhouse gases currently in the atmosphere, and their impact, are likely to persist for several decades. On-going and increased efforts to mitigate climate change through reduction in greenhouse gases are therefore crucial.

Federation of Australian Scientific and Technological Societies

Global climate change is real and measurable. Since the start of the 20th century, the global mean surface temperature of the Earth has increased by more than 0.7°C and the rate of warming has been largest in the last 30 years… Key vulnerabilities arising from climate change include water resources, food supply, health, coastal settlements, biodiversity and some key ecosystems such as coral reefs and alpine regions. As the atmospheric concentration of greenhouse gases increases, impacts become more severe and widespread. To reduce the global net economic, environmental and social losses in the face of these impacts, the policy objective must remain squarely focused on returning greenhouse gas concentrations to near pre-industrial levels through the reduction of emissions… The spatial and temporal fingerprint of warming can be traced to increasing greenhouse gas concentrations in the atmosphere, which are a direct result of burning fossil fuels, broad-scale deforestation and other human activity.

Geological Society of America

Decades of scientific research have shown that climate can change from both natural and anthropogenic causes. The Geological Society of America (GSA) concurs with assessments by the National Academies of Science (2005), the National Research Council (2006), and the Intergovernmental Panel on Climate Change (IPCC, 2007) that global climate has warmed and that human activities (mainly greenhouse-gas emissions) account for most of the warming since the middle 1900s. If current trends continue, the projected increase in global temperature by the end of the twenty first century will result in large impacts on humans and other species. Addressing the challenges posed by climate change will require a combination of adaptation to the changes that are likely to occur and global reductions of CO_2 emissions from anthropogenic sources.

Geological Society of Australia

Human activities have increasing impact on Earth's environments. Of particular concern are the well-documented loading of carbon dioxide (CO_2) to the atmosphere, which has been linked unequivocally to burning of fossil fuels, and the corresponding increase in average global temperature. Risks associated with these large-scale perturbations of the Earth's fundamental life-support systems include rising sea level, harmful shifts in the acid balance of the oceans and long-term changes in local and regional climate and extreme weather events. GSA therefore recommends...strong action be taken at all levels, including government, industry, and individuals to substantially reduce the current levels of greenhouse gas emissions and mitigate the likely social and environmental effects of increasing atmospheric CO_2.

Geological Society of London

The last century has seen a rapidly growing global population and much more intensive use of resources, leading to greatly increased emissions of gases, such as carbon dioxide and methane, from the burning of fossil fuels (oil, gas and coal), and from agriculture, cement production and deforestation. Evidence from the geological record is consistent with the physics that shows that adding large amounts of carbon dioxide to the atmosphere warms the world and may lead to: higher sea levels and flooding of low-lying coasts; greatly changed patterns of rainfall; increased acidity of the oceans; and decreased oxygen levels in seawater.

There is now widespread concern that the Earth's climate will warm further, not only because of the lingering effects of the added carbon already in the system, but also because of further additions as human population continues to grow.

Institute of Biology (UK)

"There is scientific agreement that the rapid global warming that has occurred in recent years is mostly anthropogenic, *ie* due to human activity." A "rise in sea levels due to melting of ice caps is expected to occur. Rises in temperature will have complex and frequently localised effects on weather, but an overall increase in extreme weather conditions and changes in precipitation patterns are probable, resulting in flooding and drought. The spread of tropical diseases is also expected." The IB recommends policies to reduce "greenhouse gas emissions, as we feel that the consequences of climate change are likely to be severe."

Institute of Professional Engineers (New Zealand)

Human activities have increased the concentration of these atmospheric greenhouse gases, and although the changes are relatively small, the equilibrium maintained by the atmosphere is delicate, and so the effect of these changes is significant. The world's most important greenhouse gas is carbon dioxide, a by-product of the burning of fossil fuels.

... Professional engineers commonly deal with risk, and frequently have to make judgments based on incomplete data. The available evidence suggests very strongly that human activities have already begun to make significant changes to the earth's climate, and that the longterm risk of delaying action is greater than the cost of avoiding/minimising the risk.

International Association for Great Lakes Research

While the Earth's climate has changed many times during the planet's history because of natural factors, including volcanic eruptions and changes in the Earth's orbit, never before have we observed the present rapid rise in temperature and carbon dioxide (CO_2).

Human activities resulting from the industrial revolution have changed the chemical composition of the atmosphere....Deforestation is now the second largest contributor to global warming, after the burning of fossil fuels. These human activities have significantly increased the concentration of "greenhouse gases" in the atmosphere.

As the Earth's climate warms, we are seeing many changes: stronger, more destructive hurricanes; heavier rainfall; more disastrous flooding; more areas of the world experiencing severe drought; and more heat waves.

International Council of Academies of Engineering and Technological Sciences

As reported by the Intergovernmental Panel on Climate Change (IPCC), most of the observed global warming since the mid-20th century is very likely due to human-produced emission of greenhouse gases and this warming will continue unabated if present anthropogenic emissions continue or, worse, expand without control. CAETS, therefore, endorses the many recent calls to decrease and control greenhouse gas emissions to an acceptable level as quickly as possible.

International Union of Geodesy and Geophysics

The IUGG concurs with the "comprehensive and widely accepted and endorsed scientific assessments carried out by the Intergovernmental Panel on Climate Change and regional and national bodies, which have firmly established, on the basis of scientific evidence, that human activities are the primary cause of recent climate change." The "continuing reliance on combustion of fossil fuels as the world's primary source of energy will lead to much higher atmospheric concentrations of greenhouse gasses, which will, in turn, cause significant increases in surface temperature, sea level, ocean acidification, and their related consequences to the environment and society."

International Union for Quaternary Research

Human activities are now causing atmospheric concentrations of greenhouse gasses - including carbon dioxide, methane, tropospheric ozone, and nitrous oxide - to rise well above pre-industrial levels....Increases in greenhouse gasses are causing temperatures to rise...The scientific understanding of climate change is now sufficiently clear to justify nations taking prompt action....Minimizing the amount of this carbon dioxide reaching the atmosphere presents a huge challenge but must be a global priority.

National Association of Geoscience Teachers

The National Association of Geoscience Teachers (NAGT) adopted a statement on climate change in which they acknowledge that "Earth's climate is changing [and] that present warming trends are largely the result of human activities"

NAGT strongly supports and will work to promote education in the science of climate change, the causes and effects of current global warming, and the immediate need for policies and actions that reduce the emission of greenhouse gases.

National Research Council (US) (2008)

There is a growing concern about global warming and the impact it will have on people and the ecosystems on which they depend. Temperatures have already risen 1.4°F since the start of the

20th century—with much of this warming occurring in just the last 30 years—and temperatures will likely rise at least another 2°F, and possibly more than 11°F, over the next 100 years. This warming will cause significant changes in sea level, ecosystems, and ice cover, among other impacts. In the Arctic, where temperatures have increased almost twice as much as the global average, the landscape and ecosystems are already changing rapidly.

Most scientists agree that the warming in recent decades has been caused primarily by human activities that have increased the amount of greenhouse gases in the atmosphere. Greenhouse gases, such as carbon dioxide, have increased significantly since the Industrial Revolution, mostly from the burning of fossil fuels for energy, industrial processes, and transportation. Carbon dioxide levels are at their highest in at least 650,000 years and continue to rise.

There is no doubt that climate will continue to change throughout the 21st century and beyond, but there are still important questions regarding how large and how fast these changes will be, and what effects they will have in different regions. In some parts of the world, global warming could bring positive effects such as longer growing seasons and milder winters. Unfortunately, it is likely to bring harmful effects to a much higher percentage of the world's people. For example, people in coastal communities will likely experience increased flooding due to rising sea levels. The scientific understanding of climate change is now sufficiently clear to begin taking steps to prepare for climate change and to slow it.

Royal Meteorological Society (UK)

The Fourth Assessment Report (AR4) of the Inter-Governmental Panel on Climate Change (IPCC) is unequivocal in its conclusion that climate change is happening and that humans are contributing significantly to these changes. The evidence, from not just one source but a number of different measurements, is now far greater and the tools we have to model climate change contain much more of our scientific knowledge within them. The world's best climate scientists are telling us it's time to do something about it.

Carbon Dioxide is such an important greenhouse gas because there is an increasing amount of it in the atmosphere from the burning of fossil fuels and it stays in the atmosphere for such a long time; a hundred years or so. The changes were are seeing now in our climate are the result of emissions since industrialisation and we have already set in motion the next 50 years of global warming – what we do from now on will determine how worse it will get.

Royal Society of New Zealand

The globe is warming because of increasing greenhouse gas emissions. Measurements show that greenhouse gas concentrations in the atmosphere are well above levels seen for many thousands of years. Further global climate changes are predicted, with impacts expected to become more costly as time progresses. Reducing future impacts of climate change will require substantial reductions of greenhouse gas emissions.

Royal Society of the United Kingdom

There is strong evidence that changes in greenhouse gas concentrations due to human activity are the dominant cause of the global warming that has taken place over the last half century. This warming trend is expected to continue as are changes in precipitation over the long term in many regions. Further and more rapid increases in sea level are likely which will have profound implications for coastal communities and ecosystems.

There is strong evidence that the warming of the Earth over the last half-century has been caused largely by human activity, such as the burning of fossil fuels and changes in land use, including agriculture and deforestation. The size of future temperature increases and other aspects of climate change, especially at the regional scale, are still subject to uncertainty. Nevertheless, the risks associated with some of these changes are substantial.

Society of American Foresters

Forests are shaped by climate....Changes in temperature and precipitation regimes therefore have the potential to dramatically affect forests nationwide. There is growing evidence that our climate is changing. The changes in temperature have been associated with increasing concentrations of atmospheric carbon dioxide (CO_2) and other GHGs in the atmosphere.

The Wildlife Society (international)

Scientists throughout the world have concluded that climate research conducted in the past two decades definitively shows that rapid worldwide climate change occurred in the 20th century, and will likely continue to occur for decades to come. Although climates have varied dramatically since the earth was formed, few scientists question the role of humans in exacerbating recent climate change through the emission of greenhouse gases. The critical issue is no longer "if" climate change is occurring, but rather how to address its effects on wildlife and wildlife habitats... "evidence is accumulating that wildlife and wildlife habitats have been and will continue to be significantly affected by ongoing large-scale rapid climate change." The WS statement calls for "reduction in anthropogenic (human-caused) sources of carbon dioxide and other greenhouse gas emissions contributing to global climate change and the conservation of CO2- consuming photosynthesizers (i.e., plants)."

World Federation of Public Health Associations

Noting the conclusions of the United Nations' Intergovernmental Panel on Climate Change (IPCC) and other climatologists that anthropogenic greenhouse gases, which contribute to global climate change, have substantially increased in atmospheric concentration beyond natural processes and have increased by 28 percent since the industrial revolution....Realizing that subsequent health effects from such perturbations in the climate system would likely include an increase in: heat-related mortality and morbidity; vector-borne infectious diseases,... water-borne diseases...(and) malnutrition from threatened agriculture....the World Federation of Public Health Associations...recommends precautionary primary preventive measures to avert climate change, including reduction of greenhouse gas emissions and preservation of greenhouse gas

sinks through appropriate energy and land use policies, in view of the scale of potential health impacts...

World Health Organization

There is now widespread agreement that the earth is warming, due to emissions of greenhouse gases caused by human activity. It is also clear that current trends in energy use, development, and population growth will lead to continuing – and more severe – climate change…The changing climate will inevitably affect the basic requirements for maintaining health: clean air and water, sufficient food and adequate shelter.

World Meteorological Organization

The WMO confirms the need to "prevent dangerous anthropogenic interference with the climate system." The WMO states that "scientific assessments have increasingly reaffirmed that human activities are indeed changing the composition of the atmosphere, in particular through the burning of fossil fuels for energy production and transportation…" "the present atmospheric concentration of CO_2 was never exceeded over the past 420,000 years…" and the IPCC "assessments provide the most authoritative, up-to-date scientific advice."

Letter sent to the US Senate in October 2009 from:
American Association for the Advancement of Science
American Chemical Society
American Geophysical Union
American Institute of Biological Sciences
American Meteorological Society
American Society of Agronomy
American Society of Plant Biologists
American Statistical Association
Association of Ecosystem Research Centers
Botanical Society of America
Crop Science Society of America
Ecological Society of America
Natural Science Collections Alliance
Organization of Biological Field Stations
Society for Industrial and Applied Mathematics
Society of Systematic Biologists
Soil Science Society of America
University Corporation for Atmospheric Research

"Observations throughout the world make it clear that climate change is occurring, and rigorous scientific research demonstrates that the greenhouse gases emitted by human activities are the primary driver. These conclusions are based on multiple independent lines of evidence and contrary assertions are inconsistent with an objective assessment of the vast body of peer-reviewed science. Moreover, there is strong evidence that ongoing climate change will have broad impacts on society, including the global economy and on the environment. For the United

States, climate change impacts include sea level rise for coastal states, greater threats of extreme weather events, and increased risk of regional water scarcity, urban heat waves, western wildfires, and the disturbance of biological systems throughout the country. The severity of climate change impacts is expected to increase substantially in the coming decades.

If we are to avoid the most severe impacts of climate change, emissions of greenhouse gases must be dramatically reduced. In addition, adaptation will be necessary to address those impacts that are already unavoidable."

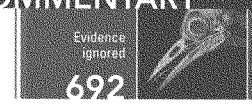
Addendum B to the Testimony of Dr. Peter H. Gleick for
The Select Committee on Energy Independence & Global Warming Hearing
"Not Going Away: America's Energy Security, Jobs and Climate Challenges."

Open Letter from 255 Members of the U.S. National Academy of Sciences
Science Magazine, May 7, 2010
"Climate Change and the Integrity of Science"

[See attached]

CORRECTED 14 MAY 2010; SEE LAST PAGE

COMMENTARY



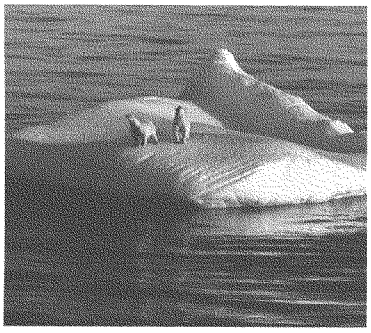
LETTERS

edited by Jennifer Sills

Climate Change and the Integrity of Science

WE ARE DEEPLY DISTURBED BY THE RECENT ESCALATION OF POLITICAL ASSAULTS ON SCIENTISTS in general and on climate scientists in particular. All citizens should understand some basic scientific facts. There is always some uncertainty associated with scientific conclusions; science never absolutely proves anything. When someone says that society should wait until scientists are absolutely certain before taking any action, it is the same as saying society should never take action. For a problem as potentially catastrophic as climate change, taking no action poses a dangerous risk for our planet.

Scientific conclusions derive from an understanding of basic laws supported by laboratory experiments, observations of nature, and mathematical and computer modeling. Like all human beings, scientists make mistakes, but the scientific process is designed to find and correct them. This process is inherently adversarial—scientists build reputations and gain recognition not only for supporting conventional wisdom, but even more so for demonstrating that the scientific consensus is wrong and that there is a better explanation. That's what Galileo, Pasteur, Darwin, and Einstein did. But when some conclusions have been thoroughly and deeply tested, questioned, and examined, they gain the status of "well-established theories" and are often spoken of as "facts."



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For instance, there is compelling scientific evidence that our planet is about 4.5 billion years old (the theory of the origin of Earth), that our universe was born from a single event about 14 billion years ago (the Big Bang theory), and that today's organisms evolved from ones living in the past (the theory of evolution). Even as these are overwhelmingly accepted by the scientific community, fame still awaits anyone who could show these theories to be wrong. Climate change now falls into this category: There is compelling, comprehensive, and consistent objective evidence that humans are changing the climate in ways that threaten our societies and the ecosystems on which we depend.

Many recent assaults on climate science and, more disturbingly, on climate scientists by climate change deniers are typically driven by special interests or dogma, not by an honest effort to provide an alternative theory that credibly satisfies the evidence. The Intergovernmental Panel on Climate Change (IPCC) and other scientific assessments of climate change, which involve thousands of scientists producing massive and comprehensive reports, have, quite expectedly and normally, made some mistakes. When errors are pointed out, they are corrected. But there is nothing remotely identified in the recent events that changes the fundamental conclusions about climate change:

(i) The planet is warming due to increased concentrations of heat-trapping gases in our atmosphere. A snowy winter in Washington does not alter this fact.

(ii) Most of the increase in the concentration of these gases over the last century is due to human activities, especially the burning of fossil fuels and deforestation.

(iii) Natural causes always play a role in changing Earth's climate, but are now being overwhelmed by human-induced changes.

(iv) Warming the planet will cause many other climatic patterns to change at speeds unprecedented in modern times, including increasing rates of sea-level rise and alterations in the hydrologic cycle. Rising concentrations of carbon dioxide are making the oceans more acidic.

(v) The combination of these complex climate changes threatens coastal communities and cities, our food and water supplies, marine and freshwater ecosystems, forests, high mountain environments, and far more.

Much more can be, and has been, said by the world's scientific societies, national academies, and individuals, but these conclusions should be enough to indicate why scientists are concerned about what future generations will face from business-as-usual practices. We urge our policy-makers and the public to move forward immediately to address the causes of climate change, including the unrestrained burning of fossil fuels.

We also call for an end to McCarthy-like threats of criminal prosecution against our colleagues based on innuendo and guilt by association, the harassment of scientists by politicians seeking distractions to avoid taking action, and the outright lies being spread about them. Society has two choices: We can ignore the science and hide our heads in the sand and hope we are lucky, or we can act in the public interest to reduce the threat of global climate change quickly and substantively. The good news is that smart and

effective actions are possible. But delay must not be an option.

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Notes

1. The signatories are all members of the U.S. National Academy of Sciences but are not speaking on its behalf.
2. Signatory affiliations are available as supporting material at www.sciencemag.org/cgi/content/full/328/5979/689/DC1.

Shifting the Debate on Geoengineering

AS DISCUSSED IN THE RECENT POLICY FORUM "The politics of geoengineering" (J. J. Blackstock and J. C. S. Long, 29 January, p. 527), there is growing recognition that avoiding dangerous climate change during the 21st century may require society to adopt geoengineering technologies to supplement CO_2 emission reduction efforts. Unfortunately, despite the essential role that CO_2 removal (CDR) and solar radiation management (SRM) technologies may play in reducing the risks of dangerous climate change, discussions of the necessary research and development [including the Policy Forum and others (*1*, *2*)] frequently turn into debates about the environmental costs and benefits of SRM. A more productive approach would shift the debate to comparing the relative costs and benefits of CDR and SRM.

CDR approaches are frequently discounted because, as Blackstock and Long explain, "technical challenges and large uncertainties [surround] large-scale CDR deployment." Although this may be true for human-built systems that capture CO_2 from air at ambient concentrations, there are other technologies based on biological carbon fixation that could be fast-tracked for rapid deployment during the next few decades (*3*). Most major international energy corporations are investing in algal-based biofuel technologies because of the tremendous production potential of algae relative to terrestrial energy crops (*4*). Commercial-scale production of algal biofuels will begin during the next 5 years, and rapid scaling up can be expected afterward if the economic incentives are favorable. However, becoming carbon negative will require society to develop plans for retrofitting existing coal-fired power plants and building future ones so that they can burn algal biomass and capture the emitted CO_2 for subsequent sequestration. The basic technologies described here are not novel; rather, I am proposing a conceptual rearrangement that may enable society to transition more gracefully

CORRECTIONS AND CLARIFICATIONS

Research Articles: "Doc2b is a high-affinity Ca^{2+} sensor for spontaneous neurotransmitter release" by A. J. Groffen *et al.* (26 March, p. 1614). Several author affiliations were not footnoted properly; three corrected affiliations follow. Y. Takai, Department of Biochemistry and Molecular Biology, Kobe University Graduate School of Medicine, Kobe 650-0017, Japan. J. G. Borst, Department of Neuroscience, Erasmus MC, University Medical Center, Rotterdam, 3000 CA, Netherlands. N. Brose, Max-Planck-Institut für Experimentelle Medizin, Abteilung Molekulare Neurobiologie, 37075 Göttingen, Germany.

Letters: "Oil and water do mix" by J. L. Kavanau (19 February, p. 958). Due to an editorial error, the title was incorrect. It should have been "Opposites attract."

Reports: "100-million-year dynasty of giant planktivorous bony fishes in the Mesozoic seas" by M. Friedman *et al.* (19 February, p. 990). The author Matt Friedman's affiliation should have been "Committee on Evolutionary Biology, University of Chicago, 1025 East 57th Street, Chicago, IL 60637, USA." The affiliation that was listed is his present address.

News of the Week: "*DSM-V* at a glance" by G. Miller and C. Holden (12 February, p. 770). In the sidebar, it was reported that the term "gender identity disorder" has been retained. In fact, a different term—"gender incongruence"—has been proposed.

Research Articles: "PRDM9 is a major determinant of meiotic recombination hotspots in humans and mice" by F. Baudat *et al.* (12 February, p. 836). M. Lichten was incorrectly listed as an author in references 18 and 19. The correct authors for reference 18 are C. Grey, F. Baudat, and B. de Massy; for reference 19, the correct authors are E. D. Parvanov, S. H. Ng, P. M. Petkov, and K. Paigen.

Reports: "Epigenetic transgenerational actions of endocrine disruptors and male fertility" by M. D. Anway *et al.* (3 June 2005, p. 1466). As clarification of the abstract to Anway *et al.*, the F_1 to F_2 generations were examined after vinclozolin treatment, and F_1 and F_2 generations were examined after methoxychlor treatment. To clarify data referred to in the last paragraph of the Report, serum testosterone measurements after vinclozolin treatment were shown in reference 21 (Uzumcu *et al.*) for the F_1 generation. Data for the F_1 to F_4 generations were subsequently published in Anway *et al.*, *J. Androl.* **27**, 868 (2006). Serum testosterone measurements after methoxychlor treatment were shown in reference 20 (Cupp *et al.*) for the F_1 generation, but measurements of the F_2 generation have not been published. The *Science* Anway *et al.* manuscript showed DNA methylation analysis after vinclozolin treatment, but the DNA methylation data after methoxychlor treatment have not been published.

The CHAIRMAN. Thank you, Doctor, very much.

Our next witness is Mr. Richard Kauffman. Mr. Kauffman is chairman of the board of Levi Strauss & Company. During his long career, Mr. Kauffman has had broad experience in capital markets and corporate finance and recently stepped down as the chief executive officer of Good Energies, one of the largest investors in renewable energy. We welcome you, sir.

STATEMENT OF RICHARD L. KAUFFMAN

Mr. KAUFFMAN. Thank you, Chairman Markey, Ranking Member Sensenbrenner, members of the committee. Thank you again for the opportunity to testify today.

My name is Richard Kauffman. I am indeed the chairman of the board of Levi Strauss, although I must say that I am not dressed that way today.

I would like to give you a view from the business community. Levi Strauss cares deeply about energy and climate change not just because we want to be a good corporate citizen but because of our business.

First, we rely upon an agricultural product, in this case cotton, to make 95 percent of our product. Extreme weather events in Pakistan have driven up prices of cotton 50 percent since July, 100 percent since the beginning of the year. So we are actually seeing prices that we haven't seen since Levi Strauss himself was around. Climate change puts consumers of agricultural products at risk for crop availability, quality, and pricing.

Second, climate change has a major effect on another part of our supply chain, our manufacturing facilities, which are already feeling the effects of extreme weather. Our products are manufactured in more than 45 countries, many of which are in the developing world that are expected to bear the risks of water shortage, such as India or Nicaragua, disease, such as in Cambodia, and flooding and saltwater intrusions, such as in Bangladesh and Vietnam.

Third, we care about climate change because of our brand. Levi Strauss, like many other American companies, is the beneficiary of globalization not only in terms of establishing a global supply network but in terms of demand for our products. Our biggest growth markets are outside the United States and in particular the developing markets of China, India, Russia, and Brazil.

I think we all recognize that Levi Strauss is an American brand. We respect the best of American cultural values: honesty, integrity, hard work, and the pioneer can-do spirit. These values speak to consumers around the world. But to the degree to which consumers see the U.S. as being resistant to the science of climate change and as wasteful of natural resources, our brand is at risk. I think all of us have had the experience, but young people in particular around the world care about climate change since it will affect them more than any of us in the room.

Fourth, our own people care about our being a leader in environmental stewardship. Like other companies, we are in a constant battle for talent. Great people make great companies. What we do to help make our products more sustainable helps us attract and retain the best people. When we have done a lifestyle assessment of our products and identify environmental impacts and we work

to address them, for example, educating consumers on how to care for their clothes more responsibly, including washing less or washing in cold water and line drying, we are not only reducing environmental impact but helping our people feel that their work has meaning.

Fifth, we also see commercial opportunity in addressing the challenges of energy and climate change. There are product innovations that offer more environmental benefits that will differentiate us from lower cost commodity suppliers. All companies have to deal with that issue of competing with commodity suppliers.

A good example of such products is our recently announced waterless jeans. A single jean uses over 10 gallons of water in its finishing process. The waterless jeans, as the name implies, can save over 90 percent of this water.

Another opportunity for us is energy efficiency. At a single distribution facility—and we have quite a number of them—we could save over $600,000 a year, a 33 percent savings at this site. The millions of dollars that we could save from energy efficiency we would be able to reinvest in our business.

Our goal as a company is to achieve carbon neutrality by reducing the amount of energy we use and moving to 100 percent renewable energy. The immediate short-term target is to reduce energy use in our globally owned and operated locations by 11 percent compared to 2007.

One of the problems we have in achieving our goal of carbon neutrality is uncertain and stop-start government policy and this can be measured in a lot of ways, from a failure to enact comprehensive climate and energy legislation to uncertainty about whether there will be an extension of the grant in lieu of tax credits for renewable energy we will be able to acquire and the cost of that energy.

And in terms of energy efficiency, we could do more faster and cheaper with Federal legislation that incentivizes utilities to work with us. Utilities generally still have the incentive to sell more electricity rather than invest in energy efficiency.

In terms of energy efficiency, there are substantial upfront costs we must make to invest that are difficult for us to finance. We see that the financing system for renewables and energy efficiency is not up to the task. And while we applaud government policy in supporting more R&D, the emphasis on innovation over deployment make it difficult for us to achieve our objectives by using good enough technology that is available today.

My experience as renewable energy entrepreneur has taught me a lot about the promise and perils of the business that I hope we can explore in questions and answers. Thank you very much.

[The statement of Mr. Kauffman follows:]

Testimony by Richard L. Kauffman, Chairman of the Board, Levi Strauss & Co. to the Select Committee on Energy Independence and Global Warming at hearing on "Not Going Away: America's Energy Security, Jobs and Climate Challenges"

December 1, 2010

Cannon House Office Building Room 210

My name is Richard Kauffman and I am Chairman of the Board of Levi Strauss & Co., one of the world's leading branded apparel companies. We do business in over 110 countries. I have been also, until recently, the CEO of Good Energies, a leading investor in renewable energy. Between these two roles, I can give you a perspective from the private sector on some of the issues we face in climate change and in adoption of renewable energy and energy efficiency.

Levi Strauss cares deeply about energy and climate change, not just as a good corporate citizen, but also because of our business:

1. Climate change has a major effect on our supply chain—from cotton to our manufacturing facilities located in countries already feeling the effects of extreme weather. Cotton makes up more than 95 per cent of our products, and as recent weather events in Pakistan have demonstrated--cotton prices have jumped more than 50 per cent since July—consumers of agricultural commodities are at risk for crop availability, quality and pricing. Levi Strauss manufactures our products in more than 45 countries, many of which are in the developing world that are expected to bear the risks of water shortage (India and Nicaragua), disease (Cambodia), and flooding and salt water intrusion (Bangladesh and Vietnam).
2. Levi Strauss, like other American companies, is a beneficiary of globalization, not only in terms of establishing a global supply network, but also in terms of demand for our products. Our biggest growth markets are outside of the

United States, including the developing markets of China, India, Russia, and Brazil. We are American brand. We represent the best of American cultural values: honesty, integrity, hard work, and the pioneer "can do" spirit. These values speak to consumers around the world, but to the degree that other countries see the US as being resistant to the science of climate change and as wasteful of natural resources, our brand is at risk. Young people, in particular, around the world care about climate change since it will affect them more than any of us in this room.

3. For decades, we have been a corporate leader in environmental stewardship. Our customers around the world expect no less of us. We were the first global apparel company to implement strict water guidelines in 1995. We have also done lifecycle assessments of our products to identify our most significant environmental impacts and how to address them, including implementing a comprehensive cotton strategy that addresses every stage of cotton production to minimize environmental impacts, ensure decent working conditions to farm workers and support economic development of farmers and focusing on educating consumers on how to care for their clothes more responsibly, including washing less, washing in cold water, line drying, and donating clothing to keep it out of landfills.
4. We also see opportunity in addressing the challenges of energy and climate change. There are product innovations that offer even more environmental benefits that will differentiate us from lower cost, commodity suppliers. A good example of such products is our recently announced Waterless Jeans. A

single jean uses over 10 gallons of water in its finishing process; the Waterless Jeans can save over 90 percent of this water. Another opportunity for us is energy efficiency. At a single distribution facility, we calculate annual savings potential of over $600,000/year, a 33 percent savings at this site. The millions of dollars that we could save we would be able to reinvest in our business.

Our goal is to achieve carbon neutrality by reducing the amount of energy we use and moving to 100 percent renewable energy. The immediate short-term target is to reduce energy use in our global owned and operated locations by 11 percent by 2011 compared to 2007.

One of the problems we have in achieving our goal of carbon neutrality is uncertain and stop and start government policy, from a failure to enact comprehensive climate and energy legislation to uncertainty about whether there will be an extension of the grant in lieu of the tax credits for renewable energy projects which will limit the amount of renewable energy we will be able to acquire and the cost of that energy. And in terms of energy efficiency, we can do more, faster and cheaper with federal legislation that incentivizes utilities to work with us. In addition, there are substantial upfront costs we must make to invest in energy efficiency that are difficult for us to finance.

Wearing my other hat, as the former CEO of Good Energies, a major investor in renewable energy and energy efficiency, I can give some perspectives on why Levi

Strauss has difficulty in achieving its objectives to achieve carbon neutrality through investments in energy efficiency and through purchases of renewable energy.

First some broader market problems:

1. Low natural gas prices. Shale gas exploitation has dramatically increased the amount of natural gas produced from existing and old fields. Renewables are a small percentage of installed capacity of electricity, but until recently were approaching half of incremental additions to capacity, with natural gas turbines accounting for the other large piece. That was with natural gas at $7/mcf. At $4/mcf, the calculation is different for utilities.
2. In contrast to most other recessions, this one has seen reductions in demand for electricity. It means that renewables have to compete in substitution market that is much harder than when utilities are searching for incremental capacity.
3. For those that are involved in making solar panels, as one example, lower cost Chinese manufacturers are gaining substantial market share; wind turbines and batteries loom as other area of vulnerability.
4. The U.S. is losing market share in financing of renewable energy projects to European and Asian banks that are developing experience in structuring projects. Some financing from Asia supports local manufacturers.

Without putting too fine of point on it, the wind industry in the US is struggling; the First Wind IPO was cancelled; only 4 GW of wind will be installed this year, down from 10 GW last year.

A number of domestic solar manufacturers are suffering, particularly those with innovative technologies, and manufacturers of energy efficiency devices for buildings are having a tough time as well.

Hence, rather than Congress contemplate ways to accelerate a growing industry, in fact, by some measures, the renewable energy industry in the U.S. has been moving backwards.

That's some of the bad news.

The good news:

1. There's lots of good technology around. And it resides in many different parts of the US, unlike Silicon Valley that was the center for IT innovation.
2. In spite of the problems above, there are meaningful potential opportunities to make money. Even with low natural gas prices, equity investors in wind and solar parks can get returns of around 9-12 percent for 20 years using proven technology with an investment grade counterparty. Given that Jack Meyer, who ran the Harvard endowment

for many years, has been saying that it will be difficult to earn more than 5 percent real returns on a portfolio, the 9-12 percent returns on renewable energy project investments ought to seem pretty attractive. Then there are energy efficiency investments. On a risk-return basis, energy efficiency in the US economy represents one of the great money making opportunities of all time. Given that more than 95 percent of energy is wasted by the time a simple electric pump does its work, you may get a sense of the hundreds of energy efficiency opportunities in lighting, motors, air-conditioning windows, appliances, and so on. Many of these investments have paybacks measured in months, not years. As commercial and residential buildings use 40 percent of energy in the US, the opportunity is immense. But even bigger is the efficiency opportunity in electricity generation. Utilities have to provide generation for peaks in demand. And providing for peak demand is very expensive to them (and to consumers). There's no reason, however, why someone's refrigerator, AC, washing machine and dishwasher need to run at the same time, but utilities need to provide peak electricity for all these appliances running at once. Shifting loads would represent a major cost savings for consumers and for utilities.

3. There's also money. Clean tech is the biggest part of the venture capital business. There are literally hundreds of new clean tech funds that have been founded. And away from venture capital, there are billions and billions of dollars waiting to be invested, from corporations that would

like to invest in energy efficiency, to individual savers that face the unpleasant choice of keeping their money in T-bills with no interest rates or risk putting money back into the stock market.

So what's the problem? There's money and a market opportunity.

The problem is that the money is one place and the incentives are in the other. In particular, we do not have a financial structure that is effective or efficient in promoting renewable energy production or energy efficiency adoption.

1. Tax credits. The USG gives incentives to renewables in the form of tax credits. Unfortunately for independent developers, tax credits do not provide direct value. Independent developers finance projects using the cash flows of the project itself. Depreciation of the equipment, and interest deductions from the debt shield most of the income for a big period of the project's life, so giving more tax credits in the form of the ITC doesn't help. It means that developers have to go to a tax equity partner in the form of a financial institution that wants to reduce its own taxes. Tax equity is very expensive 12-14 percent, after tax, and not widely available. And the PTC is even worse, since it requires tax equity participants to manage their tax position for up to 10 years. Tax based incentives reduce current cash flows to equity for as much as 8-10 years, making it much less attractive to equity investors in projects. The cash

grant program has been a lifeline to independent developers, even with low gas prices. The start-stop nature of tax credit policy for renewables—in comparison to the FIT used internationally—makes investing in US projects less attractive.

2. Bank debt for projects. Projects are funded with bank debt, even though the projects are long-dated assets. Since banks are funded with short-term instruments and deposits, banks have been moving away from giving long term loans to most industries, where the bond market serves as the source of long term funds. The buyers of long dated bonds are investors, such as insurance companies or pension funds that have long dated liabilities and therefore want to hold long dated assets. These institutions ought to be the natural holder of long-term project debt, but are not because the paper does not exist. So we have a situation where banks are reluctant lenders to projects, but where there are billions in pent up demand from investors that are looking for long-term yields. Big -but not too big--projects can now get bank debt and smaller projects are having difficulty getting credit.
3. And the situation will likely get worse under proposed new bank capital reserve requirements. Under these rules, the amount of capital that will need to be reserved against below investment grade or marginal investment grade assets is very substantial. Banks will therefore only lead to those borrowers who can give the banks lots of other revenues.

Independent developers and smaller companies will have a tough time getting credit.

4. A similar situation exists on project equity. The money is there, but obstacles prevent from flowing to where it is needed. While there are billions of dollars in funds eager to invest in wind and solar projects, the yield requirements of these funds exceed the yields the projects can offer. Infrastructure funds typically target 15-20 percent returns while, as noted above, returns the projects can deliver are less, 9-12 percent. Hence, even though these are objectively attractive rates of return, projects that could be built, aren't being built because developers can't find equity at these lower levels. (Although they can from Chinese sources if Chinese equipment is used). However, if there were the ability to create public vehicles for projects –such as an MLP or a REIT-such a public vehicle would reduce the required yields since institutions are demanding a premium yield for illiquidity. A public vehicle would also permit individual investors to participate in long term, low risk, high yield assets. More wind and solar parks would be built, more people would be put to work, by creating more scale in the industry, costs will continue to come down, and individual savers will save more.
5. And the same problem exists in funding energy efficiency investments in buildings. There is a quick payback from such investments, but on residential properties it is difficult to get banks to lend because of the relationship between the efficiency loan and the mortgage on the

property. Lending to energy efficiency projects also requires specialized expertise but it is not possible to get a license to form a specialized bank. Big companies such as Johnson Controls and United Technologies have ample technology and energy efficiency solutions for building owners, but they are not banks and so they don't put up the money to make the investments, either. There are lots of energy service companies and manufacturers of energy efficiency equipment that could greatly expand their businesses if there were ways that efficiency could be financed, including the possibility of leasing equipment.

6. Utility incentives generally still favor production over investments in efficiency. Even the efforts at decoupling may not go far enough to create enough incentives to lead the drive to load shifting. While there are substantial economic gains as higher cost generating facilities are closed, utilities would have to incur write-offs of the equipment and would only take these steps if shareholders got to share in the benefits of the efficiency gains, not just ratepayers. As things stand, there are often few incentives for utilities to innovate, even though the current utility business model is challenged by slow demand growth, difficulty in getting rate increases and in capital requirements for replacing aged generation and transmission capacity. A number of technology companies—from large companies such Google and Cisco to a host of smaller software and hardware manufacturers—are eager to partner with utilities to build the smart grid that would enable load shifting. That there have only been a

couple of million smart meters is less a technology problem and more that regulatory structure is standing in the way of market opportunity,

Some final words about innovation, jobs and China. As much of the recent VC experience in renewable energy has sadly demonstrated, creating more companies without adequately developing end markets puts the innovation deployment cart and horse backwards. We know from the PC industry where computer chips are ever cheaper and have greater performance that innovation follows commercialization, not the reverse. Moore's Law is not an independent law of physics but rests on the role of markets; without a vibrant market into which to sell integrated circuits, the shape of the performance curve would look very different. However, in renewable energy technology, we keep waiting for breakthrough technology that will achieve cost parity with conventional sources before deployment. Because most renewable energy technology is by definition capital intensive, much of cost reduction per unit produced stems from manufacturing scale advantages; these manufacturing scale advantages will rely more on extant manufacturing capabilities in other industries than on fundamental underlying renewable energy technology. A good example is the wind turbine where costs have declined dramatically; large market opportunities created by favorable European electricity rates encouraged established industrial players—in this case Siemens and General Electric—to enter the market with initially "good enough" technology, and through these firms' manufacturing and engineering expertise, they were able

to produce larger and larger windmills at lower costs per watt. In the U.S., we have instead directed policy attention to innovation over deployment. Providing government funding to an early stage technology company makes a good photo op, but without large scale markets, the barriers to cost competiveness are nearly insurmountable since the manufacturer has to find a technology solution that is cost competitive without manufacturing scale benefits. Maintaining policies that rely on this nearly insurmountable innovation problem is the reasons why the last eight Presidents have been unable to make progress in renewable energy penetration. In the US, we struggle to develop domestic markets. The US solar industry has been growing, although more thanks to state initiatives than to the federal government. The U.S. industry, though, is still tiny in comparison with other countries; this year, U.S. solar installations will be less than one-sixth of Germany. Putting innovation ahead of deployment creates dozens of companies developing new technologies vainly hoping they can survive the "Valley of Death" until they can reduce costs enough to gain enough scale, while Chinese companies use scale of "good enough" technologies to lower costs faster. Reducing costs isn't just technology. Nearly half of solar's cost is in its installation; because the industry in the U.S. is not at scale, installation costs are much higher here than in markets where there has been more experience. It often seems far easier for companies to get US Government financing for innovative technology than for building technology that already works. We aren't likely going to "out Chinese the Chinese" is commodity solar module costs, but were we to develop a large domestic market, we might be surprised by innovative, non-commodity products (imagine, as an example, a "smart roof" which had a

system of solar, energy efficiency monitoring and wiring) that might be developed, with lots of jobs created in train. Even Chinese solar manufacturers are looking to open facilities here as US markets expand. Getting the right financing structures in place will develop markets, and with markets will we have greater innovation and jobs.

Biographical Sketch

Richard L. Kauffman is Chairman of the Boar d of Levi Strauss & Co., a leading global apparel company and one of America's most storied brands. He recently stepped down as the Chief Executive Officer of Good Energies, after having built it as one of the largest investors in renewable energy. Since 2007, Richard led $750MM in equity investments in over 30 renewable energy technology companies and solar and wind project developments. He also served on the board of Q-Cells, one of the world's largest producers of solar cells.

Richard Kauffman was previously a Partner of Goldman Sachs where he was chairman of the Global Financing Group, a member of the firm's Partnership Committee, Commitments Committee, and Investment Banking Division Operating Committee. Before joining Goldman Sachs, he was vice chairman of Morgan Stanley's Institutional Securities Business and co-head of its Banking Department. Prior to assuming this position, Mr. Kauffman was vice chairman and a member of the European Executive Committee of Morgan Stanley International.

He is a member of the board of The Brookings Institution, Alvin Ailey American Dance Theater, the New York Philharmonic, Yale School of Management Board of Advisors, and Co-Chairman of the Advisory Board of the Center for Business and the Environment at Yale. He is a member of the Council on Foreign Relations.

The CHAIRMAN. Thank you, Mr. Kauffman, very much.

Our next witness is Kenneth Green. Mr. Green is a resident scholar at the American Enterprise Institute for public policy research. He has studied public policy involving risk, regulation, and environment for over 16 years.

We welcome you, sir. Whenever you are ready, please begin.

STATEMENT OF KENNETH GREEN

Mr. GREEN. Thank you, Chairman Markey, Ranking Member Sensenbrenner, members of the committee. It is a pleasure to be back with you again.

I am Dr. Kenneth Green of the American Enterprise Institute, a resident scholar there for going on 5 years now. My training is in the environmental sciences. I hold a doctorate in environmental science and engineering from UCLA, and I have twice served as an expert reviewer for reports of the Intergovernmental Panel on Climate Change, the United Nations' IPCC.

Thank you for inviting me to testify on what continues to be an important question of the day: How can we best manage the risks involving America's energy security, jobs, and climate challenges? Thank you also for the job security suggested in the title of this session: Not Going Away. If it did go away, so would my job security.

First and foremost, I believe that it is critical for America that we shift our focus from mitigation of greenhouse gas emissions toward an agenda of building energy and climate resilience. Whether you believe that climate change is a looming disaster or whether, as I believe, it is a real but modest threat, there is really no rational argument for continuing to focus on mitigation of greenhouse gas emissions in the near or midterm. And that is because, despite the claims of renewable energy and efficiency rent seekers—for that is what they are—we do not have the technologies needed to significantly curb greenhouse gas emissions without causing significant economic destruction, and the money and attention we are spending on mitigation is largely wasted. Even if we shut the United States and the EU off, the savings on the greenhouse gas emissions would be overcome by emissions from China, which is now the world's largest greenhouse gas emitter. So the environmental benefit of our mitigation would be precisely zero.

The fact of the matter is, also, mitigation is immiseration. Let us start with what was mentioned earlier, the legislation that was passed in the House, cap and trade, which, while seemingly dead, could come back to haunt us in the future under other guises such as buried in clean energy standards.

For an emission treaty to work, certain conditions must apply. You need readily available technology to capture emissions or less-emission-intensive input fuels. We do not have those with greenhouse gases.

You need a single regulatory jurisdiction. We do not have that.

You need a single trading currency that can't be manipulated. We do not have that.

We need the ability to confirm emission reductions and a manageable number of actors, preferably uniformly distributed; and you need to auction all permits to prevent rampant corruption of the

scheme by seekers and special interests. We had those conditions for sulfur dioxide, which is why acid rain trading worked, but we don't have them for carbon dioxide.

And even the economists who develop emissions trading for pollution control have acknowledged that it is not a suitable vehicle for controlling greenhouse gases. All that instituting cap and trade or, for that matter, a carbon tax would do is raise our energy costs, raise the costs of our goods and services, make our economy less productive, and make us less competitive internationally.

The same is true of EPA's misguided efforts to use regulation to force down emissions of greenhouse gases. There are few, if any, affordable ways to do this. That is why it has proven so intractable in Europe and elsewhere. The methods of mostly switching to natural gas from coal are expensive and will render many businesses uncompetitive both domestically and internationally.

We hear about efficiency gains. The idea that there are massive efficiency gains just laying around is an economic fallacy. There are not $100 bills laying on the ground to get picked up by actors who internalize that value. If they have to go to the government to do something, it is because it doesn't really make sense for them to do it without the government. It is not actual real efficiency. It is faux efficiency.

My extended remarks, of course, will cover more things. What I want to say, though, is if we shouldn't regulate and we shouldn't institute cap and trade, what should we do? And, in fact, there is a very ambitious agenda of what we can do.

First and foremost, though, we should stop making things worse. Right now, governments incentivize people to live in climatically fragile areas. If they are flooded out of a coast, we rebuild them on the same coast. If they have a drought area, we subsidize bringing water in to remedy their drought. Government as an insurer of last resort is a risk subsidizer.

Infrastructure was mentioned earlier. And one of the things I wanted to talk about—I am running out of time, I am afraid. But we do build infrastructure. Governments are great at building infrastructure. But they don't price it. Therefore, there is no pricing signal to tell you what the risk to the infrastructure is from climate change.

If our infrastructure was fully priced, the infrastructure that was mentioned earlier in California, for example, and sea levels rise, you get two things that happen: One, you have a price signal to tell you what to do about it, to reroute the highway, elevate the highway, put up seawalls along the highway and pass the cost onto the commuters on that road, which would move those away who can't afford the value at risk. The same is true of our water infrastructure. The same is true of our electrical infrastructure. We are making the issues much worse because of the way government manages our infrastructure, and that should change.

The same is true of zoning. If the climate changes and people seek to move north, they will face a welter of zoning restrictions, national parks, State parks, and other barriers to entry. And this is particularly true of poor people who have faced difficulties moving into areas that are zoned and highly regulated and which have higher prices.

Finally, I will say that we should trust in resilience but tie up our camel. I think the government should redirect research funds into geo engineering and into carbon capture technologies. Those will give us an option in case the worst case scenarios are correct but not cost us an arm and a leg and sacrifice our economic growth in the meantime.

I would like to point out somebody recently from the Tyndall Center in the U.K., one of their scientists, said that in order to really deal with climate change the developed world—the entire developed world—must forgo 20 years of economic growth. Does anyone realistically think that is going to happen? I don't think so. And I think it is a waste of time and money and energy to focus on attempting to do what will not be done.

I have submitted extensive remarks for the record as well as two policy studies backing up my comments, and I look forward to your questions.

[The statement of Mr. Green follows:]

Statement before the House Select Committee on
Energy Independence and Global Warming

"Not Going Away: America's Energy Security, Jobs and Climate Challenges."

Dr. Kenneth P. Green

Resident Scholar

American Enterprise Institute

December 1, 2010

The views expressed in this testimony are those of the author alone and do not necessarily represent those of the American Enterprise Institute.

Chairman Markey, Ranking Member Sensenbrenner, Members of the Committee:

Thank you for inviting me to testify today on what continue to be important questions of the day: how can we best manage risks involving America's energy security, jobs and climate challenges?

I have submitted to the record two AEI policy studies on the issue before us today, which are a small part of the research that underpins my comments.

First and foremost, I believe that it is critical for America that we shift our focus from mitigation of greenhouse gas emissions toward an agenda of building energy and climate resilience.

Whether you believe that climate change is a looming disaster, or whether, as I believe, it is a real but exaggerated threat, there is no rational argument for continuing to focus on mitigating greenhouse gas emissions in the near and even mid-term.

It is time policymakers recognize that despite the claims of renewable energy and efficiency hucksters, we do not have the technologies needed to significantly curb greenhouse gas emissions without causing massive economic disruption.

And the money and attention that we are spending on mitigation efforts is largely wasted – even if we shut the U.S. and the EU down completely, the trajectory of emissions from China and India will negate the environmental benefit of our self-sacrifice in only a few years.

The fact is, mitigation is immiseration.

Let's start with cap-and-trade, which, while seemingly dead, could come back to haunt us in the future, or under other guises.

For emission trading to work certain conditions must apply: you need readily available technology to capture emissions, or less emission-intensive input fuels. You need a single regulatory jurisdiction; you need a single trading currency that can't be manipulated; you need the ability to confirm emission reductions; you need a manageable number of actors, preferably uniformly distributed; and you need to auction all permits to prevent rampant corruption of the scheme by rent-seekers and special interests.

Those conditions allowed emission trading in sulfur dioxide to work, but they are virtually non-existent when it comes to carbon dioxide. Even the economists who first developed the theory and practice of cap-and-trade have said that it is not a suitable mechanism for greenhouse gas control. It hasn't worked in Europe, and it won't work here.

All that cap-and-trade will do is raise energy costs, and raise the costs of goods and services. This will reduce consumption, leading to job losses and weaker international competitiveness for US firms.

The same is true of EPA's misguided efforts to use regulation to force down emissions of greenhouse gas emissions. There are few, if any, affordable, economically sustainable ways for major power producers or consumers to accomplish that task. The methods available to them (mostly a matter of switching from coal to natural gas for producing energy and fueling boilers) will render many businesses uncompetitive both domestically and internationally. The idea that there are efficiency gains just laying around for

companies to capture is a form of economic delusion. The ground is not littered with twenty and hundred dollar bills. Firms are not so stupid as to leave real potential gains from efficiency uncaptured.

Some people like to call those who doubt any part of the climate change canon "deniers." Well, the real deniers are those who continue to deny fundamental economic reality: mitigating carbon emissions is costly, will harm our economy, will lead to greater unemployment, and will prolong the worst economic conditions many of us can remember.

In fact, we'll likely make things worse through the unintended consequences of thoughtless policies. As the New York Times recently observed, while environmental groups and federal agencies are constraining domestic coal use, the coal is being exported to China, and because of the transportation, more emissions, not less are released into the atmosphere. The administration's de facto moratorium on domestic oil and gas production, along with attacks on Canada's tar-sand oil, will almost certainly result in greater, not lesser imports of oil from countries that dislike us, that fund our enemies, and that wish us harm.

So, if we shouldn't regulate, and we shouldn't institute emission trading, what can we do that is positive, reduces risk, and offers social benefits? First, we should stop making things worse. That is, we should remove the misguided incentives that lead people to live in climatically fragile areas such as the water's edge, drought-prone locations, flood-prone locations, and so on.

At present, our federal and state governments exacerbate this risk-taking by acting as the insurer of last resort. When people who live at water's edge or in a flood plain are hit by storms or floods, governments intervene not only to rescue them and their property if possible, but then to provide rebuilding funds to let the people build right back where they are at risk. We are currently doing this in New Orleans, where people are re-building in an area that is still at risk from storm surges and levee failure.

As Charles Perrow observes in his book Our Next Catastrophe: "State-mandated pools have been established to serve as a market of last resort for those unable to get insurance, but the premiums are low and thus these have the perverse effect of subsidizing those who choose to live in risky areas and imposing excess costs on people living elsewhere."

Programs that subsidize climatic risk-taking should be phased out as quickly as possible, in favor of fully-priced insurance regimes. Rebuilding after disasters in climatically fragile areas should be discouraged. Eliminating risk subsidies would show people some of the true cost of living in climatically risky areas, and would, over time, lead them to move to climatically safer places where they can afford to insure their property and safety.

Another area we might profitably examine is our infrastructure. We currently build and manage our infrastructure with blithe disregard to pricing and sustainability; energy efficiency, or environmental resilience. For example, governments are good at building highways, but generally fail to incorporate a market-based pricing mechanism.

Thus, no price signal exists to show whether a highway should be elevated, re-routed, or abandoned, and no revenue stream is created to allow for any major changes. The same is true of fresh-water infrastructure, wastewater infrastructure, electricity, and other infrastructure. Establishing market pricing

of infrastructure would automatically and continuously steer people and investment away from climatically fragile areas, dramatically reducing the costs of dealing with climate variability.

And consider our water supply. Full pricing of water and full privatization of the water supply, drinking water plants, and wastewater treatment plants would ameliorate many climatic risks incrementally over time, including flooding, seawater intrusion, and coastal and river pollution from storm runoff. Charging the full price for water, from supply to disposal, would create a price signal for consumers regarding the real risks they face living in hydrologically sensitive areas and create incentives for conservation while producing a revenue stream to allow for expanded capability or the securing of alternative supplies. At some point, again, high prices could simply lead people to move away from areas that are hydrologically costly, such as cities dependent on a single winter snow pack that shrinks or a single major river that suffers reduced flow.

Another area where we are making things worse for ourselves is in zoning, and regulatory constraints on urban growth and migration. If the climate warms, and people want to move northward, they will, in many cases, find a welter of zoning regulations, federally protected lands, state-protected lands, anti-growth policies, and so forth that will hinder an adaptive response to climatic change. Restrictive zoning increases the costs of housing and construction, which could make it impossible for many people to move according to climate conditions: this is especially true of the poor.

Finally, I would suggest that we trust in resilience, but tie up our camel. In the event that climate change does tend toward higher estimates put forward by the United Nations and other groups, it is reasonable to consider insurance options that might help deal with such climate changes. Such options might include government investment in geoengineering research, investment in research and development to advance technologies allowing the removal of greenhouse gases from the atmosphere

Thank you for allowing me to speak to you today. I look forward to your questions.

The CHAIRMAN. Thank you, Dr. Green; and we will include your studies in the record.

Let me now turn and recognize the gentleman from Oregon, Mr. Blumenauer.

Mr. BLUMENAUER. Thank you, Mr. Chairman.

It is interesting to think about where we are ending up. I, for one, have appreciated the opportunity over the last 4 years to work with you and the committee in constructing a record and hearing from distinguished panelists such as we are graced with today. Nothing to me suggests that 10 years hence people are going to feel like these were exaggerated concerns, that somehow government did too much during this period. I fear that 10 years hence the consensus will be we made a start in the House, there was aggressive effort, but that we have fallen short of the mark.

I listened again to Dr. Green, and I do agree with him in one area, that we are not appropriately pricing the risks, that government is involved because we would like to help everybody. Having spent a lot of time dealing with flood insurance reform over the years, we subsidize people to be in harm's way, and we put them back afterwards, and that is wrong, and it is going to create a problem. But we have any number of Federal policies where we are paying people lavishly to grow cotton in the desert and then paying off Brazilian cotton farmers because we cheat internationally. A whole host of these things are going to come into play, and I think we will be making some significant changes.

But the record that has been developed is replete with references that the cost of making these adjustments are a tiny fraction of what is to be expected that we will be contending with because of the problems that our witnesses have pointed out. And, in fact, it is not 20 years of growth that will lose. It is perhaps a fraction of a percent of GDP which may be redirected if we undertake the right policies.

I conclude these hearings feeling actually a little more encouraged, even though we haven't done what we should have. I am encouraged because of what we are hearing from business. Mr. Kauffman, I appreciate very much both what you have done and what you have said. We are seeing businesses understanding the opportunities and the risks, and have been moving forward, not waiting for government. We have seen over 1,050 communities that haven't waited for the Federal government, that have started ahead with their own climate policies. This includes my own hometown of Portland, Oregon, which is essentially Kyoto compliant at this point and people can still earn a living and get across town. We are watching what is happening with the community of faith, with education in the communities and, frankly, with a lot of other governments.

Part of my concern listening to Mr. Green, is his notion that we shouldn't do anything because there are other problems that are growing in India and China and that our actions will make no difference. First of all, this is not accepted scientific fact. If we move to mitigate and make a change, it does make a change. It doesn't maybe offset others' pollution entirely. But looking at what governments are doing in Brazil and Mexico, in China with stronger envi-

ronmental standards than we have in some areas, I am heartened by what we have encountered.

Last but not least, there is nothing that suggests that we shouldn't move forward with a more rational energy policy, rational water policy, even if you didn't believe in climate change. In terms of national security, in terms of not wasting energy, in terms of getting the economics right, the case is compelling.

I am wondering if, Mr. Kauffman, you could comment briefly on what you are seeing in the business community even in the absence perhaps of appropriate pricing signals from the Federal Government. What do you see now that we may be able even in this more restricted climate you will face politically in Congress, things—simple things to do that would reinforce your interests and things that you think are opportunities?

Mr. KAUFFMAN. If I understand your question, what are the things that Congress can do?

Mr. BLUMENAUER. That you think either in a scaled down—that might be helpful in making the initiatives you talked about possible.

Mr. KAUFFMAN. Well, I do think that there is much more to be done in terms of a focus on energy efficiency. I am afraid I don't agree with Dr. Green. I do think that there are actually lots of dollars that are on the ground, but there are lots of market failures that could be addressed. I don't want to go into all of them. But I think efficiency is an area.

I also think, as I say, on the financing side—and maybe this is one example I could talk about in terms of energy efficiency—there is some terrific energy efficiency technology that works that is available today off in little companies that are trying to go up against giants. They can't offer a leasing product to the market, they can't get financing, and the challenge with that is that the person often at a company that is responsible for the capital budget is different from the person responsible for the operating budget. So it seems very kind of prosaic, but it really creates a lot of issues.

So the ability to create a financing vehicle that would help energy efficiency would go a very, very long way to accelerating energy efficiency and it really, really does pay for itself and it will help the economy.

Mr. BLUMENAUER. Thank you.

Dr. Gleick, you have referenced the scientific consensus which I believe was reflected in our record, notwithstanding Dr. Green's notion that we have to forego 20 years of economic development and that it really would make no difference what the United States did because other countries are polluting more. Do you want to make a brief reaction to that, which seems to fly in the face of your testimony and research?

Mr. GLEICK. Yes, I would be happy to.

There are a number of things with which Dr. Green and I don't see eye to eye. That is one of them. The United States is still a massive emitter of greenhouse gases. There is no doubt that anything we do to reduce greenhouse gas emissions will have an effect on the ultimate concentration of greenhouse gases in the atmosphere and the extent and severity and speed of climate change.

Certainly, without a global agreement to reduce emissions, we will not turn emissions around, but we have the enormous opportunity just from a technical side of slowing the rate of climate change and that by itself has a huge economic value. That is a critical issue.

I don't often tell jokes at congressional hearings—and I am not an economist—but there is a classic economics joke about an economist walking down the street with his little girl. And the little girl—they are holding hands, and the little girl says, daddy, there is a $20 bill on the ground. And the economist says, don't be silly, dear. If there was a $20 bill on the ground, someone would have found it already.

And the truth is the potential for efficiency improvements, as you have said already yourself and as Mr. Kauffman has said, are enormous. The ability to improve the efficiency with which we use energy in this country, do the things we want to do with much less energy, and I would argue water efficiency as well, which has an enormous greenhouse gas savings as well, is largely untapped. We have made progress in that area, but there is enormous progress to be made. And it is far, far cheaper to do that than for the Federal Government to be spending money on expensive, unreliable efforts to sequester carbon. The cost benefit of expenditures at the Federal level on efficiency versus carbon sequestration are very different. I am not saying don't do research, but we should do research in that area as well.

The CHAIRMAN. The gentleman's time has expired.

By the way, our final witness, Robert F. Kennedy, Jr., has been delayed on the tarmac at La Guardia because of this violent weather that is going up and down the east coast. He is still trying to arrive for the hearing.

Let me turn and recognize the gentlelady from Tennessee, Mrs. Blackburn.

Mrs. BLACKBURN. Thank you, Mr. Chairman.

I appreciate all of you being here with us, and I appreciate that this is our final hearing. We thank you for the leadership that you have shown.

I think that we can agree that we—quite frankly, I have never met anyone that wants to pay more on their utility bill. We are all seeking better ways to use and to conserve and to achieve energy efficiency. I think the underlying question is, do you do that at the expense of American jobs? And that is something this committee has looked at and I think in the next Congress we will continue to look at.

Dr. Green, I will have to say you have a friend in me. I may be the only one on this panel that is in agreement with what you have to say.

Mr. Kauffman, first for you, what percentage of Levi jeans are manufactured in the U.S.?

Mr. KAUFFMAN. We do comparatively little manufacturing in the United States.

Mrs. BLACKBURN. And primarily that manufacturing is held where?

Mr. KAUFFMAN. It is outside the United States. That is the nature of the global apparel industry. We would like to manufacture more in the United States.

Mrs. BLACKBURN. What percentage of that is in China?

Mr. KAUFFMAN. What percentage of——

Mrs. BLACKBURN. Of your manufacturing.

Mr. KAUFFMAN. I don't know the exact percentage.

Mrs. BLACKBURN. And then what percentage of Levi jeans are marketed in the U.S.?

Mr. KAUFFMAN. Well, in terms of the United States, the United States is our biggest single market. But, as I said before, the growth of our business is outside the United States. It grows more rapidly than in the United States.

Mrs. BLACKBURN. Thank you for that.

You talked a little bit about clean energy and VC capital. Let me ask you this. Are you familiar with the experiences of the Spanish government's efforts to subsidize renewable energies over the past several years and the results of those efforts? And do you think the U.S. government should look at Spain as a model to imitate?

Mr. KAUFFMAN. I don't think that we should—yes, I am familiar with it, and I don't believe the United States government should emulate that experience. Do you want me to explain why?

Mrs. BLACKBURN. That is fine, but I am running out of time. So let us make it fast if we can.

Mr. KAUFFMAN. In part, the Spanish government changed the rules of the game, and that is one of the problems that the United States has had as well.

Mrs. BLACKBURN. So uncertainty of regulation and uncertainty of policy.

Mr. KAUFFMAN. That is correct.

Mrs. BLACKBURN. We hear that a lot from companies.

Okay, Dr. Gleick, I wanted to ask you, how can you talk about green jobs as a way to boost our economy in light of the colossal failures in Europe where each green job in Spain costs 2.2 jobs elsewhere in the economy and each green job in Italy cost 6.9 jobs in the industrial sector and 4.8 jobs across the entire economy?

Mr. GLEICK. Let me first say I am not an economist. I am not familiar with the statistics you are using and their source or their quality.

I do believe that the potential for jobs in new American technologies in energy efficiency, water efficiency, renewable energy technology, non-carbon technology, whatever it is, is very significant. Obviously, you don't want those jobs to come at the expense of other jobs, but I think that is probably a fallacy. I think we are probably smart enough to develop new jobs without losing old jobs.

Mrs. BLACKBURN. Dr. Green, how do you respond to that?

Mr. GREEN. Well, this is the Hayek's fatal conceit, that somehow, despite all experience elsewhere, that somehow we just have the ability to centrally plan the economy in a way to make jobs in this sector or that sector and create them on net. It is a fallacy that has been badly, many times, debunked.

I am familiar with the studies you mentioned in Spain and Italy. I am not an economist, also. I play one on TV sometimes, but that is about as close as it gets. Those studies are quite robust. In fact,

the Spanish government recently acknowledged that the 2.2 job study that you pointed out is accurate. They are cutting their subsidies to wind and solar power, and rampant corruption has been discovered in the Spanish example, especially of solar power, where some of the criminal cartels moved heavily into solar power and were using diesel generators to sell solar power, quote, unquote, at night to the Spanish government at a fixed rate higher than the competitive sources of energy. These things are, frankly, boondoggles. They are promoted by rent seekers, and this has been shown time after time after time.

Mrs. BLACKBURN. Thank you. I have some other questions and I will submit those for written response. Thank you.

Mr. MARKEY. We thank the gentlelady very much. The chair recognizes the gentleman from Missouri, Mr. Cleaver.

Mr. CLEAVER. Thank you, Mr. Chairman. I have, unfortunately, a meeting that I must chair beginning at 12 noon. And I did want to have the opportunity to thank you in leading us in what I consider to be a great and important information gathering. And I appreciate all of your comments today and your willingness to provide us with information. We received it from scholars and thoughtful men and women from all over the world, actually, and I appreciate it.

I look at this whole issue a little, perhaps differently. In a book that I read, frankly, often, there is a little-read line that says: The Earth is the Lord's and everything that is in it.

We are, in a real sense, only squatters, not owners. It is our responsibility to care for the Earth. And we have no more right to change the climate of Earth than we have the right to change the thermostat in another person's home. And I think that in the years to come, one of the great questions will be—and I can see television clips of it, I probably won't be around—of people denying that the Earth is warming or denying that humans are the cause. And I have looked at TV program special documentaries on things in the past how they show people saying this won't happen and so forth. And I hope for my children and my children's children that what we have attempted to begin will, in future days, rise to the surface of national consciousness, and certainly the Congress, and we will find ourselves taking an appropriate stand.

Thank you so much, Mr. Chairman, for everything that you have done in leading this committee.

Mr. MARKEY. And thank you. And thank you for everything that you are doing in Kansas City to make it a model for the installation of the energy efficiency and renewable energy that I think will ultimately be the model for the country, and we thank you for your great leadership as well.

The chair recognizes the gentleman from Washington State, Mr. Inslee.

Mr. INSLEE. Thank you. Just one comment as we wrap up our hearing and our work of this committee. I want to thank my colleagues for working on this. If some archeologist happens to dig up the records of this committee 100 years from now, some of us will be shown to have been right and some of us will have been shown to be wrong. And none of us knows that for sure, but I want to thank all members for working on this important issue.

I want to thank Dr. Gleick for being here, who is the author of a great book, "Bottled and Sold, The Story Behind Our Obsession with Bottled Water." My wife has turned me on to that work, and I enjoy it very much.

Dr. Gleick, tell me, why do you think there has been a group of folks that refuse to accept this, you described as uncontroverted science? And I think that is an accurate description given that every scientific group of any esteem has recognized this phenomenon as uncontroverted at this point. Why do you think there is any discussion to the contrary in our society today?

Mr. GLEICK. Thank you, Congressman. I was wondering where that copy of the book had been sold. Thank your wife for me.

I am very reluctant to get into motive. I don't think it is useful for me——

Mr. INSLEE. Let me ask a different question then. What do you think is the most successful dialogue when you have had dialogue with people who have expressed doubts about that clear science? What do you think is most successful in a dialogue in that regard?

Mr. GLEICK. When I talk to people who are unsure about the science of climate change or skeptical, don't believe it is happening, I do like to find out why they believe that. Sometimes it is ignorance; they don't know anything about the science, they haven't read the science, they don't know where to go for good information. Sometimes it is ideological. They just don't want to believe that humans could possibly change the climate of something as great as the planet. Sometimes it is fear about what we might have to do to change emissions of greenhouse gases. There is concern about economics, there is concern about politics, there is concern about government versus nongovernmental action.

There are a lot of things that drive it. And I find that people are willing to be convinced about the science when they understand that there is still plenty to debate on the policy side that the fact that the climate is changing, the fact that humans are changing the climate is a reality doesn't necessarily dictate what the response should be. There is a lot of difficult discussion that, frankly, you in Congress have to deal with about what to do about it, about where to put the effort on mitigation versus adaptation versus not doing anything.

Mr. INSLEE. So one thing, I hope you will have license to be vocal. We need the scientific community to step up to the plate here and be vocal on the issues. There is a tendency to be academic and we understand that, and that is important. But there is a time to be vocal, too. I hope you and your fellows will be vocal.

Mr. Kauffman, you were talking about the need for financing mechanisms, particularly for efficiency and deployment of things that are ready to go now. We tried to pass a green bank to try to help finance the sort of first commercial-scale plants of a lot of these technologies. Could you give us some thoughts on what a financing mechanism could be for efficiency or those first new technologies and production?

Mr. KAUFFMAN. Okay. Thank you. One of the issues about financing efficiency is just one of the questions about who has the relative legal standing of the efficiency loan relative to the mortgage. And so Great Britain has actually been able to solve that by

putting it on the utility bill. And so I think there are some financing structures that can be used, but fundamentally the problem is right now when we think about trying to finance energy efficiency, we have, first, that problem. And the other thing is if, in some cases, if you are using innovative technology, you think that would require a kind of specialized financing entity. Well, you couldn't get a bank license to do that, so we have bank regulations that are opposed to that.

The other issue, broadly, in terms of some of the financing problems, is the proposed new capital rules for banks which will have the effect, not because of this reason, it is an unintended consequence of reducing the amount of credit that will be made available to below investment grade or marginal investment grade companies, unless they can generate a lot of business for the bank because the amount of capital needs to be reserved against those assets are very high.

Mr. INSLEE. Just so you know, we are working on the pace bond issue that will do exactly what Britain has done essentially. And if you have any influence with Freddie or Fannie right now, we have been trying to browbeat them into doing the right thing. Thank you for that insight.

Dr. Green, I want to ask you about this issue. When you have an empty pop can and you are driving the car, do you throw it out the window?

Mr. GREEN. Well, first of all——

Mr. INSLEE. That should be easy. That is a yes or no.

Mr. GREEN. Well, I don't have a car. So the answer would have to be no.

Mr. INSLEE. If you had a car, would you throw it out the window?

Mr. GREEN. Of course not.

Mr. INSLEE. Why not?

Mr. GREEN. Mostly because it would be littering.

Mr. INSLEE. Now, you realize that even though you don't throw it out the window, somebody else might throw theirs out the window anyway. You can't stop other people from throwing theirs out the window. Right? But you decide, because it is unethical to do that, you just don't do that. Right?

Mr. GREEN. Right.

Mr. INSLEE. Doesn't that logic, isn't that logic, shouldn't it be the same for all of us on the planet at this point to have an ethic of not polluting even though others somewhere else may do so? And if that should be the ethic, would you not urge the U.S. Congress to ask America to lead in that direction? Isn't that the same reason we don't throw junk out our window?

Mr. GREEN. No. And the reason is this: As was mentioned earlier, that we are stewards of the planet. That is true. There are, however, at this point in time billions of people living in abject energy poverty. They are starving to death, they are dying of lung disease because they are using wood and dung fires. They are leveling the rain forests and destroying massive amounts of ecosystems because they are poor.

If we raise the cost of energy, we raise the cost of everything. We slow the development and the elevation of those people out of poverty. And I think that is a much more important moral imperative

than banging our head against the wall of litigation, which will not produce significant environmental benefits and will only impose significant costs.

Mr. INSLEE. So you say just keep throwing the cans out the window as long as somebody else wants pop. And I just disagree with you with that, and I will close with that. Thank you, all of our panelists.

Mr. MARKEY. I thank the gentleman very much. And now we will recognize the gentleman from New York, Mr. Hall.

Mr. HALL. Thank you, Mr. Chairman. Thank you to our panelists all.

Dr. Green, I was listening to NPR on the way in this morning. They were talking about interviewing some insurance executives who would say that their industry has already decided that the science is in, and they agree with you, and so do I, that we shouldn't—governments shouldn't keep paying to rebuild houses on the Outer Banks or, you know, flood plains, places where they will obviously be destroyed again by another storm or another flood. But what they have done, in fact, many insurance companies, is withdraw completely from the market in south Florida and the Bahamas and places that they have taken a beating.

When Hurricane Frances and Jeanne came through the Bahamas, they lost so much money that most insurance companies have completely pulled out. So that is a statement, a market statement in which the people on the show who were being interviewed are saying that the markets will arrive at the conclusion before the governments do, and I think people do as well.

I just want to address a couple things that were said by the gentlelady from Tennessee, who I am sorry is not here any longer, and others. The idea that some of us on this committee or some of those who feel that we need to take action to prevent the worst-case scenario of climate change want to forego 20 years of economic growth. That is just not true. None of us said that. That is something being stated for us or imputed to my—first of all, I don't think that is the choice. That is a false choice.

I will tell you a couple quick stories in the little bit of time before we have to vote. I think those were votes on the floor looming.

One of my case workers, who handles veterans issues in the district in the Hudson Valley, asked me to come over in October to her house to see her husband's low head hydro project. He had come to a workshop that we held with some people who deal with low head hydro. And DOE's Web site, in fact, has 4,000 small dams and waterfalls listed in New York State alone that are unused, many of them powered mills of the previous century, and the water is going—tons of water a second going over and being wasted. And these are not dams that can be removed because downstream has been developed. There are houses and restaurants and marinas and other things downstream.

So these are opportunities for huge numbers of people to be employed. All the trades people. It would be mechanics and sheet metal workers and electrical workers and on and on, and engineers, lawyers to deal with the liability issues when you have an orphan dam and so on. But Idaho National Laboratory of our DOE, not a lefty environmental group by any means, estimates greater

than 1,200 megawatts in New York just by harvesting the water that is already falling over existing infrastructure, some of which needs to be upgraded.

Now, my staffer's husband, who I went up to their house, has—they don't have a waterfall, but they have a little stream about this wide that runs down their property and maybe about a 70-foot drop from the top of their property to the lower part, and he decided, after going to our workshop, that he was going to try something, and he dug a trench, created a little pool up at the top with some boulders to get a little depth of water in the stream, put a grate with a screen on it to keep debris from clogging it and a 6-inch plastic pipe buried under the ground down to about 70 feet less elevation and landed into what looks like a doghouse, but you open it up, looks like a big blue motor there upside down. He is running it backwards. He put the blades on it and split one pipe into four pipes to blow water at the four blades as they turn around in, and the motor is acting as a generator running backwards and he is using a quarter of the power to power their entire house. He could power three other houses. They are selling power back into the grid from the project that he did because his eyes lit up when he got the information that this was possible and that other people were doing it.

As for the other 4,000 in New York and many more thousands in New England, these are one of the untapped, unused regional resources. The Midwest doesn't have the geography, the topography to have these kinds of waterfalls or dams or stream flows, but they have other things. And I think we really do need to diversify and use all these things. And my experience and the studies that I have seen show that these jobs are real, that, in fact, the more decentralized our power is, the more people are hired. It is capital intensive projects are the big goal of national gas or nuclear plants. They are really good for the banks that lend the money and then get the interest on it. Labor intensive, job producing are the many decentralized and mostly renewable projects that are available, like these 4,000 low head hydro sites in New York.

Lastly, I just want to say there is another staffer I am very proud of who is with the Wounded Warrior project, did two tours in Afghanistan, was stop-lossed for 287 days on his second tour, a medic with a paratrooper unit, a fabulous guy. Josh Van Sanders is his name, and I spent a good deal of time riding around in the car with him and going to events, and as chairman of the Subcommittee on Veterans Disabilities, we had a lot to talk about. He is also a Purple Heart recipient. But he said that one time he was on a mountaintop exchanging fire. His unit was exchanging fire with a Taliban unit on another mountaintop, and the Taliban unit was solar powered and our unit was using a diesel generator. And he said, that is wrong. You know? They don't have to worry about the supply chain and the tankers blown up in the paths coming across from Pakistan.

So we can make the sensible choices, whatever the reason is, whether you believe that the climate is warming or not, there are many reasons to want to do these same things. And I think that we should try to cooperate, and I hope the next Congress will do so.

Mr. Chairman, thank you for your leadership of this committee. And I yield the rest of my time.

Mr. MARKEY. Again, I can't thank the gentleman enough. There has been no more conscientious and committed person to ensuring that this issue is dealt with in a historically responsible way than you have been. We thank you so much for your service.

Mr. Kennedy's plane has just landed. So what I think might be appropriate for him, just to make sure that we recognize his efforts, is that I am going to deliver my closing remarks right now with this panel here. And then, at the conclusion of my remarks because there are six roll calls pending on the House floor right now, we will then stand in recess so that Mr. Kennedy can testify himself, perhaps an hour and 15 minutes from now, to the committee so the record will be complete with all of those who had been intending to testify.

So I want to close by thanking Speaker Nancy Pelosi who created this select committee. She did so with her grandchildren in mind, hoping to ensure that the world we leave behind is safe, prosperous, and filled with all the natural treasures that God intended. I want to thank my friend, ranking member Jim Sensenbrenner, for his bipartisan cooperation in the way in which we conducted business, the way in which we went to countries around the world, China, India, and many other places to study this issue. We may have disagreed on what the remedies are to deal with the issue, but we traveled, we conducted these hearings with a measure of bipartisanship that I believe is a model for how these important historic debates should be conducted.

The select committee held over 75 hearings. We have focused on developing solutions to end our dangerous addiction to foreign oil and create millions of new clean energy jobs. The select committee looked to domestic energy resources, new technologies, and efficiency measures that cut waste and save consumers money. The select committee brought in hundreds of the world's leading energy and national security experts, from military generals, energy CEO's, Nobel Prize winning scientists, private-sector inventors and entrepreneurs and innovators who are creating the next generation of clean energy technology. Each and every energy industry had a seat at our table, from giants like oil and coal, to startups like the solar innovators at 1366 technologies and synthetic genomics who have traveled the globe in search of fuel-producing algae. Their message is clear: If Congress can provide regulatory certainty and an even playing field, then we can unleash American innovation and harness our technological advantage.

While some in Congress may question the science of global warming, the rest of the world does not. The members of this committee met with world leaders from Germany, China, India, and other nations large and small. Our members from both sides of the aisle represented the United States in this global conversation on energy and climate with dignity, substance, and class.

As I said in my opening statement, the politics may change, but the problem isn't going away. To illustrate this point, I want to share with you a few numbers. Number one, 1.3 trillion. That is the amount of money consumers have shipped overseas for foreign oil since the select committee was created in 2007. Imported oil

represents nearly half of our trade deficit. This massive transfer of wealth is an albatross on our economy and a boon for terrorist activities around the globe. As long as foreign oil continues to jeopardize our national security and economic security, our work in Congress is not done.

Number two, 738 billion. That is the amount of money China plans to invest in clean energy over the next decade. This will create jobs that should be created here in the United States. We have the technological advantage. We have the entrepreneurial might. But unless we generate the political will, we will continue to lose our innovation and manufacturing edge. Losing the jobs race with China is not an outcome that any of my colleagues would support.

Number three, $4. In the summer of 2008, that was the price of gasoline that focused this Nation like a laser on finding alternatives to oil. As the global economy recovers, China and India continue to grow and supplies remain tight. It is inevitable that these prices will return. Consumers should not be forced to suffer for our inaction.

And, number 4, finally, is the number one. We have one planet. We all share it. We are all responsible for it. 2010 is on track to be the hottest year on record following the warmest decade on record. We have heard the warnings from scientists. We have seen the damage with our own eyes. Some day our children and grandchildren will read the record of the select committee. Maybe they will watch our hearings on YouTube. They will see a respectful and rigorous debate and an unprecedented understanding of the problem.

Whether or not they see action taken on the solutions remains to be seen. But trust me, it is a fight that is far from over. A fight that they will most certainly be watching to see what decisions we make in order to make sure that we have not passed on this problem to generations yet to come.

So we thank each of our witnesses for their participation in this final hearing and with the thanks of the committee, we will now stand in recess and we will return at the conclusion of the roll calls.

[Recess.]

Mr. MARKEY. The Select Committee on Energy Independence and Global Warming is reconvened to hear its final witness. And we could have no more distinguished American than Robert F. Kennedy, Jr. He was delayed because of a violent storm that went up the East Coast that made it impossible for him to make it earlier today, but I felt it was very important for him to be able to present his testimony to this committee so that it is part of a permanent record that will document the need for aggressive, urgent action to deal with this issue.

Mr. Kennedy is the chief prosecuting attorney for the Hudson Riverkeeper and president of the Waterkeepers Alliance, an environmental organization that protects the ecological integrity of the Hudson River and its tributaries.

Throughout his career, Mr. Kennedy has been a champion of environmental issues and has established a reputation as a successful historic defender of the environment. He has been named one of Time Magazine's heroes of the planet. He is a hero to me as well.

We welcome you, Mr. Kennedy. Whenever you feel comfortable, please begin.

STATEMENT OF ROBERT F. KENNEDY, JR.

Mr. KENNEDY. Thank you very much, Mr. Chairman. And thank you to the other members of the committee and thank you for reconvening here to accommodate the difficulties that I had this morning. I want to thank you first of all, Mr. Chairman, for your years that you put into service in this committee and that you brought to us, and the ideologic views that you have to this country. And as you know, as I know, it should not be a partisan issue and I hope it does not become a partisan issue over the coming years. There is no such thing as Republican children or Democratic children. Our country ought to be the leaders of the world on this, these issues; and instead, we are looking at the future by staring at a rearview mirror, and it is not good for our country and it is not good for the world.

I want to just make one brief remark to this committee, because yesterday the New York State Legislature, New York State Assembly—and you have my written remarks and I am going to depart from those. But yesterday, the New York State Assembly passed a bill that was previously passed by the New York State Legislature to establish a moratorium on natural gas drilling in New York State.

This is a controversial area. Sheldon Silver, who is the chair of the Assembly in New York State, said that they got more calls on this bill than they have on any other bill. They had hundreds of bills to consider yesterday. It is a bad sign for the natural gas industry, it is a bad sign for our country. We have a thousand trillion cubic feet of natural gas that have become available for the past couple of years. There is so much distrust in the grassroots community of the natural gas industry, and of the regulators, that this bill has become necessary.

It is not good for our country. We should be replacing the coal. We have 320 gigawatts of build capacity for coal in this country. We have 450 gigawatts of natural gas capacity. The coal capacity is used 99 percent of the time, the gas capacity is used between 37, 38 percent of the time. And that is not good for the environment, it is not good for jobs, it is not good for our country. And it is because of the reckless drilling protocols that are being employed by the lowest producers in the natural gas—the lowest cost producers in the natural gas industry. They are doing bad things, and they don't have to.

There are three problems with natural gas with fracking. One is a water management problem. There are technological solutions. They should be required to do close-looped systems and they should be required to have transparency in their drilling fluids. That would solve the problem of water management.

Number two, there is a problem with migration of methane, not from the target formations, but usually from high pressure–low pressure formations that the drop well goes through as it is trying to reach the target formation. And the reason that migrates up and blows up the houses or catches the faucets on fire or contaminates drinking water is because of poor casing protocols. NRDC has

worked with the gas industry to develop very, very high-quality casing protocols that would prevent those kinds of migrations. Those ought to be the law in all the States. We ought to have Federal regulations of that. Then we need very, very strong Federal enforcement.

Number three, the industrialization of the landscapes. And that can be dealt with—and this is controversial, in the environmental community too—but in my view, the best way to do that is through pooling, saying we can do this horizontal drilling. We don't need to have 40 or 50 wells per square mile. You can have a single well per county in many places. And it increases the revenues that the industry gets, it increases the revenue of the landowners and of the people of that community.

That is all I am going to say about that. We need government action on this in order to free up this vast reservoir, because natural gas isn't just a good replacement for coal. It is also a natural companion for wind and solar. It gets rid of the variability problems and lets wind and solar deliver baseloads to the utilities. So we need to do that, and I hope that this committee will consider that in the future. It is a critical issue. Republicans and Democrats ought to get together on this.

The big issue and the issue that you have been working on for years, that this committee is trying to solve, is the issue of our dependence on carbon and on the decarbonization of American society, which is good for our country. Put aside the environmental issues. Everything we have got to do to deal with global warming are things we ought to be doing anyway, for the sake of our national prosperity, for the sake of building jobs, for the sake of our national security, our energy security, our independence, and our international leadership.

We are borrowing $1 billion a day today, mainly from nations that don't share our values. In order to spend $1 billion to import oil into this country, again largely from nations that don't share our values, we are—through our deadly addiction to oil—we are funding both sides of the war against terror. And we give about $1.3 trillion in subsidies to the oil industry every year. If you doubt that figure, look at Terry Tamminen's new book, "Lives Per Gallon," direct Federal subsidies through the oil depletion allowance, then the indirect subsidies, the military expenditures, the crop damage, the air damage, et cetera, et cetera.

We give about half a trillion a year, half a trillion to the nuke industry, about 1 trillion—nobody has ever done the calculations—to the coal industry. And these have allowed the incumbents to dominate the marketplace which otherwise would be dominated by renewables.

We have extraordinary renewables in this country. We are the best in the world. My home in Mount Kisco, New York is powered by geothermal. We could do that with virtually every home in our country outside of the major cities we have, that we are number two in solar resources in the world. The Scientific American just did a study saying that if we were to harness the solar in an area that is 75 miles by 75 miles in desert southwest, we could power 100 percent of the existing grid. The Great Plains States, the Saudi Arabia of wind. We have enough wind in Montana, North Dakota,

and Texas to provide 100 percent of the energy grid of North America three times over, even if every American owned an electric car. The problem is developing a marketplace that is rational in this country.

People have said to me for years, What is the biggest answer to environmental problems? I have always said, Free market capitalism, true free market capitalism, which we do not have in the energy sector, and we don't have much in this country anymore. But the energy sector is almost completely based on a kind of corporate crony capitalism model that is funded by subsidies to the big incumbents.

We need to develop a grid system in this country. And I know your prejudices against a national unified grid because of the ease with which that would facilitate coal power into New England when we already have a New England extraordinary wind resource that we ought to be exporting. But we need a grid system. We need a grid system, whether it is regional grids or national unified grids, that are going to create a marketplace that is governed by rational rules, rather than having 50 different public utility commissions in 50 different States, each with its own arcane, Byzantine set of rules, a vulcanized set of rules that restricts access to the grid.

We need a system that creates a rational marketplace that coordinates the public interest with the marketplace rules. And right now we have a marketplace—we need a marketplace that does what a market is supposed to do—which is to reward good behavior, which is efficiency, and to punish bad behavior, which is inefficiency and waste.

Today we have a marketplace in the energy sector that is governed by rules that were rigged by the incumbents to reward the dirtiest, filthiest, most poisonous, most destructive, most addictive fuels from hell, rather than the cheap, clean, green, abundant, and wholesome and local fuels from heaven. We need to reverse that dynamic. We need a market system.

You know, I have my home—I have geothermal in my home and I have two solar systems. My home, 24 hours a day, produces more energy than it uses. It is a power plant. I ought to be able to sell that back on the grid and get market rates for it. We need a grid system that will turn every American into an energy entrepreneur, every home into a power plant, power our country based upon American ingenuity, resourcefulness, human energy, what Franklin Roosevelt called American industrial genius, rather than Saudi Arabian oil. We can do that in our country. And let me give you two examples of when we have done this before.

In 1979, the Federal Government created an alternate grid in this country that connected every American home to the Internet. A year after that, the CEO of IBM in 1980 said that personal computers were a dead-end technology. And there were a lot of other computer companies that we knew about back then that made that same bet, that are no longer around today or moved out of the computer business, companies like Honeywell and others.

Now, today most of us have PCs, and the reason is we created a national marketplace that rewarded their use. And what happened to the cost of information, of bits and bytes? It plummeted

to virtually zero. That is what is going to happen to electrons in this country as soon as we build a national grid for energy.

In 1996, we created a national unified grid for telecommunications. Bill Clinton signed the Telecommunications Act. He told all the baby bells, you have got to unify your lines. You can no longer restrict access to anybody. The lowest cost providers can prevail in the marketplace. And that triggered a telecommunications revolution in this country, and all of these little gadgets that we now have like I-phones are the offspring of that revolution.

But what happened to the cost of telecommunications? Well, yesterday afternoon I was watching TV with my children. I saw an ad on TV by a company called Vonage, by a company that promises unlimited long distance overseas and local telephone calls for $19. Well, that is practically free. Two months ago, I made a call from Miami to London that cost $74. That is the old way. The new way is free telecommunications forever, because we created that national marketplace.

As soon as we create a national marketplace for electrons, we build out that grid system so that every American can participate and sell and buy energy on the grid and have a rational marketplace with rational drivers, we are going to have essentially free energy forever in this country.

Two weeks ago on Wednesday, one of my companies—I am on the board of the biggest green-tech venture capital firm in this country, Vantage Point. I also work as a special adviser to Starwood Energy, which is one of the largest players in transmission construction field and generation field. Two weeks ago we broke ground on one of the largest power plants ever built in this country, which is Bright Sources power plant, which you know well, because you helped get this done in the Mohave Desert. We are going to complete construction in 2 years. It is 2.7 gigawatts, and we have power purchase agreements with the two biggest utilities in California. A typical nuke plant, as you know, is about 1,000 megawatts, so it is about 2½ times the size of a nuke plant. Well, we are going to build it in 2 years. A nuke plant will take, who knows, 20 years to build. A coal plant and a nuke plant costs 15 to $20 billion a gigawatt. This plant costs $3 billion a gigawatt. A coal plant takes 10 years to build and a coal plant costs 3 billion a gigawatt, the same as an oil plant, the same as ours. But once you build our plant, once Bright Source builds its plant, it is free energy forever because the photons are hitting the Earth every day for free. All we have to do is build the infrastructure to harvest them and put them in the lines; then it is free energy forever.

Once you build that coal plant, now the big costs are just starting because you have got to go cut down the Appalachian mountains, ship them across the country in railcars, burn the coal, poison every fish in America with mercury, acidify the oceans, acidify the high peaks of the Appalachians, poison, kill 60,000 people a year, according to EPA's Web site, from ozone and particulates, and all the other hidden costs of coal.

Once you build an oil plant, now you have got to go to Saudi Arabia, punch holes in the ground, bring up the oil, refine it expensively, genuflect to the sheiks who despise democracy and are hated by their own people, get in periodic wars that cost $4.3 tril-

lion, according to OMB—that is what this one is going to cost over the next 20 years—bring it across the Atlantic, with a military export that Exxon doesn't pay for, but you and I pay for, then spill it all over the Gulf, spill it all over Valdez, burn it, and poison everybody in America.

So the big costs of oil occur after you build that $3 billion plant. Once you build that solar plant, it is free energy forever.

Here is the math. We use 1,000 gigawatts a day of peak demand in our country; 500 of those are carbon-based. So to replace the 500—wind is even cheaper than solar. So to replace those 500 gigawatts, if we had the transmission system, it is going to cost about $1.5 trillion—that is less than the Iraq war—to give us a decarbonized economy that will bring us free energy forever.

Let me just say one last thing. In 1929, just before the stock market crash, the Dow Jones industrial average was at 385. In 1942, 13 years later, it was at 85. So the stimulus package we now call the New Deal put millions of Americans to work, left millions of Americans—kept them in their homes, kept millions of farmers in their farms, kept 1,000 banks from closing. But it did not—it was not robust enough to restore the American marketplace economy.

Then, a year before Pearl Harbor, Franklin Roosevelt made his biggest stimulus package ever, which was the preparation for World War II. And he gave a famous radio speech, and my grandfather was a part of this because he was part of the shipbuilding industry that built more tonnage of ships than had ever been done in history. But Franklin Roosevelt said to this country, We are going to build 50,000 airplanes a year. His aides later admitted that just before the radio address, he had picked that number out of thin air. The year before, we had built 2,800 aircraft in this country; he said we are going to build 25,000 tanks a year, we are going to build a ship a day, we are going to build a battleship every 3 months, an aircraft carrier every 6 months. We are going to do it until the war is over and won, and on and on. People laughed at him. He was ridiculed by editorials from the left and from the right. They said no industrial mobilization of this kind has ever happened in the history of the world. How are we going to do it here? He has overpromised, he has overcommitted.

But Roosevelt went to Detroit and told the automakers, You are not building cars anymore. You are building tanks and aircraft and half tracks and amphibious vehicles and bombs and detonators. Within 6 weeks, they retooled their factories. Within 6 months, they had met his goals. Within 12 months, they had surpassed them.

The following year we built 96,000 aircraft in this country. You had full employment; 160,000 women went to Detroit and found jobs where they had been black-balled before; 200,000 blacks went to Detroit and found jobs. And that full employment created aggregate demand for this country, which stimulated the marketplace and then made us the richest country on Earth, with half the wealth in the world, for the next 50 years.

We have the opportunity to do that same thing now by transforming our country into a green-tech economy, to employ thousands of people, to build pylons across the country and string wires

down the existing railroad tracks and right-of-ways to create a national grid system, and to build off the coast of New England, the Google grid that is being contemplated today, to employ thousands of people building solar thermal plants in the desert southwest, erecting wind turbines on every farm in the Midwest that wants them, to go—teams of tens of thousands to go into people's homes to pressure-test the homes, to spray in cellulosic insulation. And, at the end of that we will have a system in place that gives our country free energy forever, and that will be the largest tax break in the history of the world. A permanent tax break. Because that is the biggest cost to American enterprise, the cost of our energy. And if we can eliminate that or reduce it significantly, we all of a sudden become the greatest competitor on the global marketplace.

And that is the way we need to start thinking about this country. Instead of starting thinking about all the impediments to doing this and all the things that are going to go wrong, we need to start adopting a view of this country that has been the traditional view, which is an idealistic view, a hopeful view, a view that can allow our children to have a future that they can embrace, and us to be something that we can give them that we can be proud of. Thank you very much.

[The statement of Mr. Kennedy follows:]

Testimony of Robert F. Kennedy, Jr.
President
Waterkeepers Alliance
before the
Select Committee on Energy Independence and Global Warming
December 1, 2011

Thank you, Chairman Markey and Ranking Member Sensenbrenner, for the opportunity to testify today on the critical choices facing our nation regarding energy independence and global warming. My name is Robert F. Kennedy, Jr. and I appreciate the opportunity to share my experience and perspective on this vital issue. We stand now on the cusp of a new global era, one that will be defined by the international race to build the energy systems of the future. There are three drivers to this race: economic security, national security, and environmental security. Around the globe, the race is on to develop the technologies of tomorrow that will foster new economic growth, allow the freedom to power that economy with homemade energy, and reduce the dangerous pollution that threatens public health and environmental stability. I believe whichever nation wins this race will hold the reins of power for decades to come. I want that nation to be ours—and I believe it will be.

America has become the envy of the world by rejecting false choices—the false choice of economic growth versus labor rights; the false choice of jobs versus clean water and air; the false choice of private enterprise versus public health. Time and again, America has chosen to invest simultaneously in the three pillars of a strong economy, good paying jobs, and a cleaner environment. That choice lies at the foundation of America's great strength.

But right now, faced with our next great challenge as a nation, I'm hearing the same old story from many big corporations and trade association lobbyists. They are saying we can't do it again. They claim that cleaning up pollution will send jobs overseas, that government programs will stifle innovation, that addressing global warming will cost too much. These are the same sky-is-falling claims we heard when it was time to stop acid rain, when it was time to take lead out of gasoline and paint or toxic pollution out of our waterways.

But the sky never fell. And industry's cost estimates have proven grossly exaggerated time and again. We've proven that America can build an economy that is second to none at the same time it delivers quality of life that is the envy of the world. That in fact, the two go hand in hand. Look at the 40 year history of the Clean Air Act, a bipartisan law put in place to clean up air pollution. Analyses show the benefits of the Clean Air Act outweigh the costs by as much as a 40-1 margin, with an estimated $21.7 trillion in net benefits to the American people.[1]

The big polluters want you to think that we can't do it again, but I still believe in America. We can lead the 21st Century and build a new prosperity that extends the America Dream to all segments of our society. But we can't do that by ignoring the realities we face or succumbing to

[1] Environmental Protection Agency, 1997. The Benefits and Costs of the Clean Air Act, 1970 to 1990. http://www.epa.gov/oar/sect812/1970-1990/chptr1_7.pdf

the politics of false choices. The stakes are simply too high. The threat of global warming is too real, energy independence too urgent, and the economic potential of clean energy too great.

Climate Security

The impacts of global warming are already being felt and the worst is yet to come. Heat-trapping pollution is disrupting the climate on which our prosperity is based. As global temperatures rise we are witnessing more severe floods, droughts, and wildfires; we are witnessing rising sea levels and increased ocean acidity; and we are witnessing increased risk of food insecurity and the spread of infectious disease. These consequences of our reliance on fossil fuels have already begun in many parts of the world, including here at home. But they will become increasingly severe until we transition to a clean energy economy.

Make no mistake; this is not a matter of conjecture. The U.S. National Academy of Sciences, the body established by Congress in 1863 to provide expert advice to the federal government, reviewed the evidence earlier this year and concluded that climate change is happening, is caused by humans and "poses significant risks for—and in many cases is already affecting—a broad range of human and natural systems." Furthermore, all of the allegations leveled against climate scientists last year based on a handful of stolen email messages have been thoroughly debunked in a series of independent reviews.

Meanwhile, the damages from extreme weather events made more likely by global warming continue to mount. Just this year the floods in Pakistan killed thousands and displaced millions while the heat wave and wildfires in Russia resulted in more than a thousand premature deaths and disrupted global food supplies. The United States was relatively lucky, but not immune. More than 50 Americans were killed by floods in Iowa and Tennessee this spring. More than 150 U.S. weather stations tracked by NOAA for long-term climate monitoring recorded their hottest summer ever this year. Not only was it hot during the day, but it didn't cool off as much as it used to at night, with 278 weather stations setting an all time record high for night time temperatures this summer. This is a particular threat to the health of our senior citizens and vulnerable communities that can't escape the heat.

Public health leaders have recognized the threat posed by global warming to the health of our citizens. The American Medical Association, the American Academy of Pediatrics, the American Lung Association, the American Public Health Association, and dozens of other health organizations wrote to Congress earlier this year warning that "As temperatures rise, more Americans will be exposed to conditions that can result in illness and death due to respiratory illness, heat- and weather-related stress and disease carried by insects. These health issues are likely to have the greatest impact on our most vulnerable communities, including children, older adults, those with serious health conditions and the most economically disadvantaged."[2]

Military leaders have recognized that the impacts of global warming threaten our nation's overall security by putting at risk our public health, economic stability, and national security. It is an

[2] Letter from the American Academy of Pediatrics et al., November 18, 2010 (attached).

urgent and growing crisis that must be addressed. Fortunately, the solution to this crisis—a clean energy future—will also help rebuild our economy while providing energy security, a vital component of national security.

Energy Independence and National Security

America's dependence on oil is a threat to our national security and our economy. Growing demand and shrinking domestic production means America is importing more and more oil each year - much of it from the world's most unfriendly or unstable regions. The United States spends nearly $1 billion a day on foreign oil. That's more than $200,000 per minute -- $13 million per hour—of American dollars flowing to fuel foreign economies, not our own. Much of this national treasure is feeding hostile regimes directly or indirectly. And our excessive dependence on oil drives up global oil prices, enriching Iran by an extra $100 million per year.

Adding insult to injury, burning oil exacerbates global warming, which military and intelligence experts including the Pentagon, the State Department, and the CIA recognize poses serious environmental, social, political and military risks. Climate change is often cited as a "threat multiplier," adding new layers of instability to already unstable scenarios—like food shortages or population migration.

In 2009, the CNA Military Advisory Board concluded that "overdependence on imported oil—by the U.S. and other nations—tethers America to unstable and hostile regimes, subverts foreign policy goals, and requires the U.S. to stretch its military presence across the globe." As such, a "major shift in energy policy and practice is required."

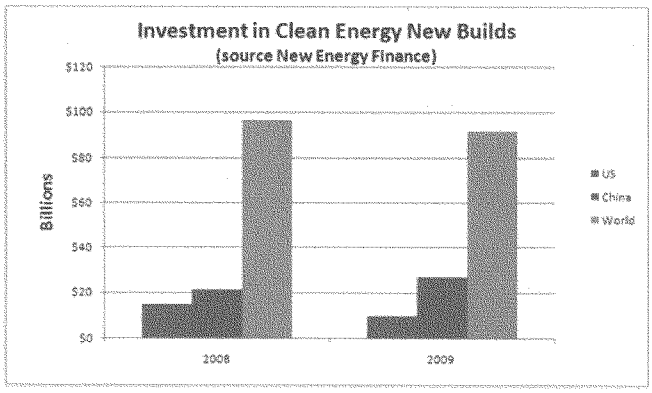
That major policy shift will mean breaking our addiction to oil. With only three percent of known oil reserves, we cannot drill or import our way to energy independence. The only real solution is to reduce our demand for oil and therefore the economic and security risks of dependence on imports. It starts with increasing the efficiency of our cars and trucks, and developing more renewable sources of energy.

Clean Energy and Economic Security

We have an opportunity to become the leaders of the new energy economy, and capture the jobs that will come with it, but only if we take decisive action now. The race has already begun and China and Germany and India aren't waiting for us to overcome political gridlock. They are barreling ahead building the energy economy of the future. For example, in 2009, China announced a plan to invest $738 billion in clean energy over the next decade, while the U.S. still has no long-term clean energy strategy.[3]

According to Bloomberg New Energy Finance, China is currently ranked number one in clean energy asset investment and last year outspent the US nearly three to one on new build renewable energy projects (see graph below):

[3] http://www.businessweek.com/news/2010-07-20/china-may-spend-738-billion-on-clean-energy-projects.html



If we continue to delay our own commitment to the clean energy economy, the U.S. will lose its competitive position in global markets for products that were originally developed here. Instead of leading the clean energy market, we will lurch from dependence on foreign oil to dependence on foreign solar energy modules.

This is not due to a lack of domestic renewable energy resources. We have abundant wind, solar, and bioenergy potential. What we lack is a coherent policy. Trillions of investment dollars are waiting on the sidelines. These dollars will be invested once there are clear signals about the clean energy future. These clear signals can be provided by Clean Air Act standards, strong domestic Renewable Energy and Energy Efficiency Standards (RES, EERS), and federal support for efficiency standards and codes. Energy efficiency alone can reduce our nation's energy bill $1.2 trillion by 2020 while creating almost 1 million new jobs, according to McKinsey and Company. And a report released by the Blue Green Alliance (BGA) and the Renewable Energy Policy Project showed that a 10-year effort to introduce 185,000 megawatts of renewables – the rough equivalent of a 15 percent RES – had the potential to create 850,000 jobs with $160 billion of investments in manufacturing.

How Do We Get There?

The failure to complete a comprehensive clean energy and climate bill means we must effectively use the tools in hand to cut emissions and drive clean energy investment while continuing to press for legislation to enhance these tools and make them more comprehensive.

Despite setbacks in Congress, the administration has taken important steps to address global warming upon which we can build. Since taking office less than two years ago, President Obama laid the groundwork for a clean energy economy that will make America more prosperous and secure while dramatically reducing emissions of carbon dioxide, methane, and other greenhouse gases that are warming the planet.

The administration has taken many significant actions, using its authority to improve the gas mileage and cut the emissions of new cars and trucks; bring down the cost of highly insulated windows; promote renewable energy such as wind and solar; and foster energy efficiency. Each of these steps will lower energy costs and cut carbon emissions either directly or by reducing the need for the electricity production that is responsible for more than a third of our nation's greenhouse gases.

Taken together, these administrative actions are set to cut carbon emissions in the United States by hundreds of millions of tons per year over the next two decades. Clearly, they are no substitute for the legislation we need to help reduce our national carbon footprint and drive investment in clean energy. They are, however, an important start.

Exercising Administrative Authority

As we look for new opportunities to pass climate and clean energy legislation, we need to use – and defend – the laws already on the books – principally the Clean Air Act – that direct the executive branch to curb dangerous pollution and move us to a cleaner energy future.

In 2007, in a landmark case brought by states and environmental organization, the U.S. Supreme Court ruled that carbon dioxide and other greenhouse gases are "air pollutants" and must be curbed under the Clean Air Act if the Environmental Protection Agency (EPA) determines, based on the science, that they endanger public health or welfare. In December 2009, after an exhaustive science-based analysis, the EPA found that emissions of carbon dioxide, methane, and four other greenhouse gases are reasonably anticipated to endanger both the health and welfare of current and future generations.

The Clean Air Act is a genuine American success story and one of the most effective tools in U.S. history for protecting public health. It has sharply reduced pollution from automobiles, industrial smokestacks, utility plants and major sources of toxic chemicals and particulate matter since its passage in 1970. The law has saved tens of thousands of lives each year by reducing harmful pollutants that cause or contribute to asthma, emphysema, heart disease and other potentially lethal respiratory ailments. In economic terms, the Clean Air Act has saved tens of trillions of dollars by keeping Americans out of hospitals and in schools and on the job. And it has helped create new industries and green jobs that annually generate billions of dollars in revenue.

Building on this success story, the EPA has already taken several steps to begin reducing carbon emissions through the Clean Air Act, beginning with motor vehicles. In future steps, the EPA needs to address the carbon pollution of the nation's electric power plants and other big industries.

Feeding Our Fuel Tanks and Minding Our Tailpipes

Our cars and trucks make up a majority of the transportation sector, which is responsible for 27 percent of carbon emissions in the United States. We can cut those emissions by 80 percent by 2050 by using cleaner and more fuel-efficient vehicles, improving public transit, and designing

communities that reflect the way people choose to live, work, and shop.

In April of this year, the EPA and the National Highway Traffic Safety Administration (NHTSA) issued a clean car standard that requires new cars and light trucks to cut their carbon emissions 30 percent compared to vehicles of just a few years ago, and get on average 35.5 miles per gallon of gas by 2016. These standards build on California's landmark clean car law. This measure will cut carbon emissions by nearly 1 billion tons over the lifetime of the cars produced under the standards, while saving some 75 billion gallons of oil. That will save an average of $3,000 for each car owner, reduce our need for imported oil, and make a down payment on the carbon reductions we need to turn back climate change. But we need to go even further and set a goal of 60 miles per gallon for passenger cars by 2025.

By next July 2011, the EPA and the NHTSA plan to issue similar carbon pollution and fuel economy standards for new medium- and heavy-weight commercial trucks and buses, beginning with model year 2014.

The standards are expected to cut carbon emissions by a total of 250 million tons—saving more than 21 billion gallons of fuel—over the life of the vehicles produced during the first five years of the program.

Taking Stock of Industrial Carbon Emissions

More than half of the carbon dioxide, methane and other greenhouse gases generated in this country come from about 10,000 large coal-fired power plants, refineries, cement makers, and other industrial users of large amounts of fossil fuels.

In 2007 Congress directed EPA to require large facilities to monitor and report that pollution. Last January, the EPA began requiring owners of these facilities to document their greenhouse gas emissions. Beginning early next year, we will have the first annual, facility-level picture of our country's heat-trapping pollution.

This will provide a national inventory of industrial greenhouse gas emission levels—a tool that can be used by businesses and the EPA—to help determine how to reduce those pollutants cost effectively.

Also, beginning in January 2011, the largest new and expanded facilities will have to show that they are using the best available and affordable technology to reduce greenhouse gas emissions. For the first half of the year, this measure will apply only to new and expanded facilities that are already required to use best technology to reduce emissions of other air pollutants, such as sulfur dioxide, and that will also increase their yearly output of greenhouse gases by 75,000 tons or more.

Beginning next July, the same must be shown for any new facility that will kick out 100,000 tons or more in greenhouse gases per year, or any expanded existing facilities that will increase their annual greenhouse gas emissions by 75,000 tons or more.

These are first steps toward treating greenhouse gases like the destructive pollutants they are, identifying the sources of those pollutants, and, eventually, enforcing limits on them. EPA needs to build on this beginning by setting national performance standards for both new and existing power plants and other industrial categories that contribute most to our country's carbon pollution.

Repowering with Renewable Energy

America needs to accelerate the transition of its power generation system to clean and homegrown renewable electricity that we can harness from the sun, wind and other renewable resources. An immediate step Congress should take to help this transition is extending the Treasury Grant Program (TGP) for renewable electricity projects. Congress should also enact a Renewable Electricity Standard (RES) to support the transition over the longer term.

The TGP, also called the "Section 1603 Program," has been critical to the continued construction of renewable electricity projects across the country during the recession. The program unfortunately expires at the end of this year. Congress enacted the TGP as an alternative to the Section 48 federal renewable investment tax credit, which become essentially worthless to businesses as a result of the recession. According to a Lawrence Berkeley National Laboratory study released earlier this year, the TGP may have enabled as much as 2,400 MW of wind power projects (equivalent to about 5 power plants), which is estimated to have supported over 55,000 jobs. The economic factors that led to problems with the Section 48 tax credits are still present, so it is critical that Congress extend the TGP for two years.

An RES, which requires electricity providers to supply a minimum percentage of the power they sell from renewable resources, is essential to cleaning up our power generation sector. The standard would also save consumers money on their energy bills and create clean energy jobs. According to an analysis by the Union of Concerned Scientists, a 20 percent by 2020 RES would achieve $31.8 billion in cumulative savings by 2030 and generate 185,000 jobs by 2020. Congress should enact an RES that requires electricity providers to supply 20 percent of their power from renewable resources by 2020, and 25 percent by 2025.

Building Better Light Bulbs, Windows, and Motors

Residential and commercial buildings account for roughly 40 percent of the nation's energy use, 70 percent of national electricity consumption, and—through the coal-fired generators that produce half of our electricity—a huge share of the country's carbon emissions.

In order to reduce demand for electricity and directly shave our carbon footprint, the administration, through the U.S. Department of Energy (DOE), has issued new standards aimed at improving the efficiency of the equipment we use in our daily lives at home and on the job. This program was established by Congress in the 1970s in recognition of well-documented

market barriers to cost-effective energy efficiency and it is paying large dividends in reduced energy costs and air pollution.

In May of this year, the DOE instituted a program to link builders, architects, renovators, and other high-volume buyers of windows directly to more than 40 suppliers of energy-efficient windows. The program gives these buyers the advantages of volume pricing, helping to bring down the windows' cost—the main barrier to using energy-efficient windows. New highly-insulating windows can reduce heat loss by up to 40 percent, saving on heating bills and keeping homes cooler in summer, therefore also reducing air conditioning costs.

The DOE has set a new residential water heater standard. Encouraging heat pump technology, which saves up to 50 percent on energy use when compared to conventional water heaters, the standard will cut carbon dioxide emissions by 160 million tons and save consumers $10 billion in energy use over the next 30 years.

In August, NRDC and other energy efficiency advocates negotiated an agreement with major appliance manufacturers belonging to the Association of Home Appliance Manufacturers (AHAM) on new, more stringent energy efficiency standards for home appliances. Products meeting the new standards will cut the typical household's electricity use by 6 percent, saving consumers nearly $30 billion in electricity costs for products purchased by 2030, according to an analysis by the American Council for an Energy-Efficient Economy. The DOE estimates that his agreement could reduce carbon dioxide emissions by 550 million tons over the same period, while saving enough energy to power 4 out of every 10 homes in the country for a year.

Owners of manufactured housing (modular homes and the like) typically pay $1,600 for electricity and gas each year. Over 30 years, the total bill for those utility costs will likely equal the cost of the home itself. In February, the DOE began developing standards aimed at improving the energy efficiency of such homes, which are becoming increasingly popular in retirement communities. Because they are built in factories under controlled conditions, small improvements in building design and construction process can make a big difference in the overall energy efficiency of manufactured homes, thereby capturing the vast potential for reducing energy use.

In March, the DOE established minimum efficiency standards for small—1/4 horsepower to 3 horsepower—electric motors, used in a multitude of applications on common equipment ranging from air conditioners and refrigerators to air compressors and drills. The new standards apply to all electric motors—domestic or imports—sold in this country after March 2015. The efficiency gains will cut carbon emissions by 112 million tons between 2015 and 2045, as much as 25 million cars produce in one year. By 2045, these standards will eliminate the need for eight new 250-megawatt power plants.

In addition, President Obama has directed federal agencies to walk the talk. In October 2009, the President ordered federal agencies to set specific sustainability goals. Last January, on the basis of those plans, he committed the federal government to cutting its carbon emissions 28 percent by 2020. Beginning that year, all new federal buildings must produce as much energy as they use through cogeneration, solar panels, heat recapture, and other means. Obama has also directed all

federal agencies to reduce carbon emissions from indirect sources such as employee commuting and travel by 13 percent by 2020.

Building the Clean Energy Economy

These are encouraging measures, and provide a roadmap for how we can take America forward into a clean energy future. But they are incomplete. Further progress over the next few years is critical if we are going to win the international race.

But it's not the policies alone that matter. There is a deeper question that will determine our success or failure as a nation. We have a choice to make, a choice whether we believe America can no longer lead, and must only follow. I believe we can lead. I believe success depends on rejecting those voices wedded to the status quo and a policy of denial.

We cannot let the naysayers stand in the way of EPA doing its job to clean up air pollution, setting higher efficiency standards, and choosing renewable energy over the dirty fossil fuels of the past.

We must reject the pessimists who think America's ability to innovate is over. I believe America can unlock the clean energy promise of tomorrow, and I know the American public is looking to its leaders to help make that promise a reality, to once again believe in America's ability to deliver a strong economy and breathable air; to have good local jobs and healthy communities; to create domestically produced, cleaner, safer energy; to move forwards, not backwards.

Mr. MARKEY. I thank you so much for that incredible statement that you made. In a lot of ways, we are going to be challenged, from the end of this hearing on, for 2 years to ensure that this vision of what our country can become remains in front of the American people. Because ultimately as you are saying, what we need to do is to inject Darwinian paranoia, inducing competition into the energy marketplace.

We have to make sure that the energy giants, just as the telecommunications giants, feel the threat of smaller, more nimble, more cost-efficient ways of communicating or generating electricity, generating energy generally, to enter into this marketplace.

And that is ultimately what the Waxman-Markey bill is intended to accomplish. It was modeled on the telecommunications laws of the 1990s. I happened to be the chairman of the committee that passed them, and it turned that into a different reality. And as you are saying, Wang Digital, and many other large companies that were household names no longer exist because they did not understand the change that was taking place. They did not have to go out of business, but they did not evolve. They did not see this future.

I think that the attitude that the coal companies have, the attitude that the oil companies have, is that they can stop progress indefinitely. But I don't believe they are right. I do believe there is a green generation out there in the same way that there was a suffragette movement that rose up to get the vote for women, and the same way that the young people went south to be part of the movement to bring the vote to disenfranchised African Americans in the South. There is a new green generation out here. And as each year goes by, they are going to be pressing for the change that has to take place, and I do think it is going to happen.

So I am still an optimist, as I know you are. We know that this is inevitable. We know that this change has to take place. But it will take place, because technology always triumphs.

And the question for America, from my perspective, is not whether or not technology is going to triumph, but whether America will be the country that is number one, looking over its shoulder at number two and three in the world. Or, are we just importing things that say "made in China," "made in Germany, "made in India, "made in Brazil," made in countries all over the word?

But we decided, because of the oil and coal industry, that we are going to tie the hands of entrepreneurs, our venture capitalists, our young people, to be able to be the global leaders. That is the challenge.

And what this hearing, this last hearing of the Select Committee on Energy Independence and Global Warming, needed ultimately was this kind of inspirational vision which you give us, Mr. Kennedy, of what the future can be, and will be, because we are going to make it our future. Each and every revolution has taken years to happen, but at the end of the day, I think truth does triumph.

So if you can—and I would ask you to just relate to—a little bit about this vision that you laid out for us and what happened in the Gulf of Mexico this spring and summer in terms of the two alternative paths that our country can travel over the next generation.

Mr. KENNEDY. Well, the two are connected. And actually, what people need to understand is this is part of the cost of oil, the same way that the Gulf War is part of the cause of our addiction to oil.

You know, and the Bush administration, the most recent Bush administration was kind of coy about this not being an oil war. The original Bush administration was not coy. They said—in fact, they had to explain to the American people why are we going to war to stop Iraq, one dictatorship, from invading Kuwait, another dictatorship? Why is that a concern of the American people? And he proffered at that time what he called the Bush Doctrine, which was that the United States had a right to intervene in the affairs, the sovereign affairs of other countries, to protect the vital interests of our oil lines. So that was the justification for that war.

And the second Gulf War, which we are now still involved in, grew out of the failure of Saddam Hussein to obey the treaties from the first Gulf War.

So clearly this is a cost of oil. But it is not the only cost of oil. And I said, you know, I will refer you again to Terry Tamminen's book, "Lives Per Gallon," where he—Terry Tamminen just stepped down as head of California EPA, and he scrupulously, meticulously inventories the vast raft of subsidies that we hand over to the oil industry every year. And they include crop damage, they include human health damage, the cost of all that. They include the direct Federal subsidies, like the oil depletion allowance, which is about $5 billion a year, but also all these indirect subsidies. And among those are the cost to our country of the Gulf oil spill. And it is hard to even calculate what that cost will be.

We are finding now that—yesterday there was an announcement that seafood from the Gulf is in fact contaminated with dangerous levels of hydrocarbon. The government has tried to gloss over this fact by doing tests which are smell tests, you know, to try to smell hydrocarbons in the fish. Of course you can't do that. And the consumers in the Gulf have been saying, Wait a minute. We want to know more than just the smell test. Well, now a number of groups have gone out, including NOAA, and done these tests and found out there are high levels of contamination in fish from all over the Gulf. So that is going to be part of the legacy of the oil industry to our country.

Let me just talk about some of the subsidies of coal. The National Academy of Sciences in August of last year, and the National Research Council, both research arms of the Federal Government, completed a 10-year study where they found that every freshwater fish in the United States is now contaminated with mercury. Well, that is a cost of coal to our country. When coal says, Oh, we are only 11 cents a kilowatt hour, they are not telling you that every fish in our country is now contaminated with mercury.

If you go to EPA's Web site, there are two studies on there, one by the Harvard School of Public Health that says that ozone and particulate emissions from coal-burning power plants kill 60 million Americans every year. That is 20 times the number of people who were killed in the World Trade Center attacks, but not just once, year after year after year. And that is part of the cost of coal. A million asthma attacks, a million lost workdays.

Another more recent study on EPA's Web site estimates the cost of ozones and particulates to the public health system in this country to be $156 billion a year. You have got people out there complaining about the cost of ObamaCare. Well, if you want to eliminate all the costs of national healthcare in this country, just get rid of ozone and particulates from coal-burning power plants. That is $156 billion a year. You have got acid rain.

You know, I live 2 hours south of the Adirondacks. I take my kids fishing and camping and kayaking and swimming up there and recreating. The oldest protected wilderness on the face of the Earth has been protected forever as wild since 1988. One-fifth of the lakes in the Adirondacks is now sterilized from acid rain. That is the cost of coal, which has also destroyed the forest cover from the high peaks of the Appalachians, from Georgia to northern Quebec.

If you fly over the Appalachians today, you will see a national disgrace. I flew over, not long ago, the Cumberland Plateau. We are literally cutting down the Appalachian Mountains. During the Bush administration, we flattened 1.4 million acres, an area larger than the State of Delaware. We have buried 2,000 miles of rivers and streams, according to EPA. We have cut down 500 of the largest mountains in West Virginia, these historic landscapes where Daniel Boone and Davy Crockett roamed. Well, these were all parts of the cost of coal that they don't tell you about when they say it is only 11 cents a kilowatt hour.

If you really added up the price of coal, you would find that it was the most catastrophically expensive method ever devised to boil a pot of water. And we can do it a lot cheaper with solar and wind, and we can keep our country healthy and we can keep it independent, and we can create a lot more jobs.

Mr. MARKEY. So let's move to solar and wind, if we could. Everybody knows that there is a Moore's law for semiconductors, and it told us that today's iPhones would be more powerful than the last generation's supercomputers. But there is also a Moore's law for solar photovoltaics as well. Every time deployment of solar photovoltaics doubles, the cost of solar falls by 18 percent. So you can see, going back to 1978 when it was $5 a kilowatt hour, as production globally doubled we are now down to maybe 23, 24 cents a kilowatt hour, but on this track to ultimately, by the year 2020, have it be competitive with coal, because the marketplace works.

Over the last 2 years, the cost of solar has dropped by 50 percent, 5–0 percent, in 2 years, and the industry expects it to drop by another 50 percent over the next few years. So the markets play a huge role in this phenomenon, because Moore's law is not an independent law of physics; but it rests on the role of markets, because without a vibrant market into which you sell integrated circuits, the shape of the performance curve would look very different. And so that is the same thing that is true for solar. It is the marketplace that creates the incentive for the physics to have the breakthroughs that then reduce the cost.

Could you expand now a little bit on your own personal experience, using the companies that you work with or other observations that kind of reflect this reality in terms of what is happening out in the marketplace?

Mr. KENNEDY. I mean, kind of the collateral accessory that I would add to that is that the country that creates the infrastructure for solar or for wind is going to own the technologies that the rest of the world wants to buy.

And you look at Germany which now has the largest deployment—Germany has solar because it was one of the first ones to develop feed-in tariffs for solar. And Germany has the largest deployment in the world of solar, but it has less sunlight than Alaska.

I just came back from China. And When you go into—I toured all the major solar photovoltaic plants in China, which is now a Chinese industry. The interesting thing was they are using American infrastructure in their factories. Their furnaces are made by GT Solar, which you and I talked about before, which is a New Hampshire union company. And they have dozens of them in every factory. Their fusion furnaces are made by Dispatch, which is a Minnesota company. And those are technologies that were developed at a time when they were encouraging solar through rational policies from the Federal Government. We had companies all over this country that were developing new ways of creating solar. And a lot of those are still viable, they are still the marketplace leaders.

But in the last 8 years, you have seen Germany take over that. So about three-quarters of the infrastructure in these Chinese plants is German-made. And Germany is now losing its lead because the Chinese are so aggressively moving forward. The Chinese have committed, as you know, $738 billion. They are spending three times what we are right now. They are going to increase their wind deployment over the next 5 years by 20,000 percent. They are increasing their solar deployment by 1,200 percent. They see this as the arms race of the future. They know whoever controls this industry is going to be the winner on the world economic stage. And they are moving aggressively to do it, and we are sitting on our hands over here.

But now a lot of that original technology, that innovation technology is being developed in China. All the major research labs are moving to China. They are going to own that technology.

So what I am saying is the country that creates the infrastructure—when I was a little boy, I went to Europe with my father in the 1960s. Everybody wanted to own an American car because we made the best cars in the world. Everybody wanted an American car. They had contempt for their own cars and they all wanted an American car. Why is that? Because we built a national highway system. We built the infrastructure that made—you know, building cars and a marketplace for those cars right here at home, something that was advantageous for local industries. So we owned the automobile industry. We developed all of the modern innovations for the automobile industry here in this country. And we sold them later to the Japanese, et cetera, as they improved their infrastructure.

But the countries that have the infrastructure—and what that means today when it comes to solar, when it comes to wind, it means the rational economic incentive system that encourages or incentivizes the quick adaptation, the rapid adaptation of wind and solar. Whoever has the best legal infrastructure and incentive and

marketplace infrastructures for quick adaptation is also going to be the nation that owns the technologies that they are going to be selling to the rest of the world, because that is part of the industry.

The CHAIRMAN. So here is what I would ask then, Mr. Kennedy. Let us have you give us the last word for the Select Committee on Energy Independence and Global Warming. What is it that you want this committee, this Congress to know.

Mr. KENNEDY. The Republicans now control Congress. A lot of them talk about free-market capitalism. And I have said for many years, the free market is something that will give us the advantage in these areas. But the marketplace is not a god. It is a tool. It is like a hammer. You wouldn't worship a hammer. You would use it to build something that was good for your children.

And what we have to do is build marketplace incentives that create competition and create that ferment and incentivize. The market is an economic engine, but it has to be harnessed to a social purpose. And the social purpose in this case would be what do we want as a country. We want energy independence. We want national security. We want economic independence and we want prosperity. How do we do that? We create it by creating rational market incentives that encourage people to invest in solar and wind, which is economic independence, which is going to create local jobs, which is going to use local resources, rather than having to get our resources from the Gulf. So I would say that would be the best future for our country, to live up to the values that we have espoused since the beginning of our history.

The CHAIRMAN. Thank you, Mr. Kennedy. And thank you for your eloquence and thank you for your continued commitment to raising the profile of this issue so that Congress, the States, individuals, take the action which we need. The politics may have changed, but the problems have not changed. We have to continue to work to make sure that we solve the problems that you have brought before our committee.

Since this select committee was created 4 years ago, we have imported $1.3 trillion of oil into our country. It represents about half of America's trade deficit and it goes largely to countries that are not our friends. The Chinese have announced that they are going to spend $750 billion over the next 10 years on solar and wind and developing that as an economic engine of growth.

In the 1960s, we had the space race. Now we have a jobs race. Who will, which country will control these jobs, this manufacturing sector? The United States cannot sit on the sidelines. The price of a gallon of gas is going back up to $4 a gallon. It is inevitable. And when that happens, consumers in America are going to turn to Congress once again and say, What were you people doing? Why didn't you put something in place that can break our dependence on OPEC's ability to tip us upside down at the gas pump and make us pay this $4 or $5 again?

And ultimately, it will be the green generation that is following on this generation of politicians, and they are going to ask the question, Why didn't you protect this one planet that we have? Why didn't you understand the interrelationship, the interconnectivity of all people on the planet?

That is what this select committee has tried to do over the last 4 years, to raise these issues, to show how they are all interconnected, how it all goes to our national security, our economic security, our environmental security and how ultimately it is a moral issue. God created this planet. Our responsibility is to pass it on better than we found it. Maybe just a small bit better, but better than we found it be.

And right now, the baby boomers, this generation of political leaders, has failed. They have failed all subsequent generations. So we cannot stop. We have a responsibility to stand up to, to fight these interests that want to keep us addicted to fuels which harm our environment, harm our national security, and harm our ability to create a new generation of jobs for American workers.

That is my personal commitment. That is what I am going to be doing for the rest of my career here in Congress and for the rest of my life. And I am going to join with you, Mr. Kennedy, and millions of others out there who are committed to this same cause.

I thank you for your great service to our country and I thank all of you who have helped us over the last 4 years to create this incredible record, led by Speaker Pelosi who made this her flagship issue 4 years ago. And 35 miles per gallon as an average fuel economy was considered to be impossible in January of 2007. Now people realize that it might be the best thing that can happen economically for General Motors or Nissan or all of these companies that are in this electric car revolution.

The same thing is going to happen in every area of American economic competitiveness once we get the right market-based incentives on the book. I thank everybody for everything they have done to help us, the staff especially, over the last 4 years. With that, this hearing is adjourned.

[Whereupon, at 2:10 p.m., the committee was adjourned.]

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Responses from Dr. Peter H. Gleick to additional questions from the Select Committee on Energy Independence and Global Warming

December 3, 2010

Dear Select Committee,

Thank you very much for the opportunity to respond on the record to additional questions, submitted from the Minority. In particular, the nature of the questions shows clearly the challenges in dealing with the unavoidable consequences of climate change, and the continued misunderstanding and misrepresentation of science from some members of Congress, and I appreciate the ability to respond in the hopes that this kind of misunderstanding and misrepresentation will end.

Questions from the Minority:

1) *You state, "If we act to slow climate change, and the impacts turn out to be less severe than we predict, we will still have reduced our emissions of pollutants." At what cost is this acceptable? Is it worth an aggregate income loss in the US of $6.8 trillion from 2009 to 2029? Is it worth job losses of nearly 3 million manufacturing jobs in 2029? [Source of numbers: Heritage Foundation]*

You stipulate a number and ask how I can justify it. I reject the stipulation: This question implies that any "act" to slow climate change will lead to these costs. These particular numbers come from a partisan organization, not an independent source or an academic source or a peer-reviewed source. I therefore reject the strawman argument "is it worth job losses of xxx" when "xxx" is an assumption not supported by evidence.

Moreover, there are many policy decisions that can be made that are low cost that would still slow the rate of climate change and reduce the ultimate social, economic, and environmental damages to the United States. Your job as policymakers is not to reject **all** action, but to identify the proper action and the weigh the relative costs and benefits. Please look at all the economic assessments of the costs and benefits of climate responses, not just those that favor one ideological point of view.

2) *How can you talk about green jobs as a way to boost our economy in light of the colossal failures in Europe, where:*
   - *Each green job in Spain cost 2.2 jobs elsewhere in the economy;*

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- *Each green job in Italy cost 6.9 jobs in the industrial sector and 4.8 jobs across the entire economy.*

Thank you for the opportunity to address these claims, made in one witness's written testimony and in a question at the actual Hearing. It appears that these numbers are wrong and have previously been discredited. In particular, the US Department of Energy and independent academic analysts have rejected these numbers:

The Department of Energy's National Renewable Energy Laboratory stated (http://www.nrel.gov/docs/fy09osti/46261.pdf#page=4) that the Spanish study

> *"represents a significant divergence from traditional methodologies used to estimate employment impacts from renewable energy. In fact, the methodology does not reflect an employment impact analysis.* ***Accordingly, the primary conclusion made by the authors -- policy support of renewable energy results in net job losses -- is not supported by their work." [Emphasis added.]***

The paper further concluded that experience from Spain, even if the numbers had been right, would not necessarily apply in the United States – indeed, it would behoove Congress to set policies that learn from mistakes made elsewhere:

> *"The recent report from King Juan Carlos University deviates from the traditional research methodologies used to estimate jobs impacts. In addition, it lacks transparency and supporting statistics, and fails to compare RE technologies with comparable energy industry metrics. It also fails to account for important issues such as the role of government in emerging markets, the success of RE exports in Spain, and the fact that induced economic impacts can be attributed to RE deployment. Finally,* ***differences in policy are significant enough that the results of analysis conducted in the Spanish context are not likely to be indicative of workforce impacts in the United States or other countries."***

Finally, an analysis from the Wall Street Journal also suggested that these numbers are not appropriate. The *WSJ*'s Keith Johnson challenged the results in a piece on March 30, 2009, as did an analysis by Professor James Heintz from the University of Massachusetts, Amherst.

I understand why these numbers are attractive to some members of Congress and some conservative interest groups: they suggest that the costs of action to address climate change may be higher than the costs of inaction. Unfortunately, it appears that the numbers quoted above are wrong – the product of misleading analysis, incorrect methods and studies, and ideology rather than independent assessment.

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3) *You say that, "In fact, it appears that many of our estimates of the rate of climate change have been too low, not too high, and climate changes are happening faster than expected." So what you're admitting here is that your history of predicting climate change has been consistently wrong. Why should we believe you have it right now?*

This question shows a clear misunderstanding of climate science, the nature of uncertainty, and science in general. Science evolves as we learn more, and in fact, the history of climate science is remarkably consistent – over thirty years of intensive science has only strengthened the evidence for growing, dangerous, anthropogenic climate change. Despite the best efforts of scientists to disprove or weaken the science arguments around climate change, skeptics and deniers have both failed to shake the science, as my written testimony says, and they have failed miserably to produce any alternative explanation that fits our understanding of basic science, actual observations, and mathematical and computer modeling.

When our best understanding of the nature of climate science improves, and when that science suggests that climate forecasts (not "predictions") show **accelerating** climate change, it is irresponsible to ignore the science (which says things are worse than we expect) and argue that the improvements in our understanding are a reason for inaction. When we learn new information about the worsening illness of a medical patient or when new information says that illness is worse than we expected, is the proper response to ignore the doctors and the science? No, it is to accelerate efforts. We will constantly be improving and refining our information about climate change. It is the job of Congress, as policymakers, to take the best information and make policy, not to pretend that changes in the information or inevitable uncertainties are reasons for inaction. **The scientific community has long argued that despite uncertainties, enough information is available for policy makers to take actions.** If new information later suggests changes in policy, later policymakers will be responsible for taking that into account.

4) *You make assertions based on computer models of the climate that cannot be validated, and in fact, have been shown to be flawed in peer-reviewed literature. Dr. Gerald Dickens, of Rice University says that "In a nutshell, theoretical models cannot explain what we observe in the geological record," and "There appears to be something fundamentally wrong with the way temperature and carbon are linked in climate models." This was published in Nature Geoscience last year. Why should we bet our future on your computer models?*

The first sentence is false. Computer models of the climate are well validated and supported by overwhelming peer-reviewed literature. This question misrepresents the science, selectively

quotes from a single paper, and sets up another "straw man argument:" the "peer-reviewed literature" is massive and in line with the conclusions presented in my written and oral testimony. You are misrepresenting the conclusions of the work by Dr. Dickens, who was addressing paleoclimatic records from 55 million years ago, and feedback mechanisms that are already including in current climate models. The question of the relative effects of natural climate forcings and human forcings in previous periods and the current period is extensively addressed by hundreds, if not thousands, of peer-reviewed scientific papers. Indeed, the "peer-reviewed literature" is the basis for the fact that every single national and international scientific organization of any note supports the conclusions of the climate community. The "straw man" argument that we are betting the future on computer models should be rejecting. It is equally likely – in fact more likely given what the science tells us – that if Congress continues to fail to act on greenhouse gas emissions, you are "betting the future" by ignoring the science.

5) *Given your support for adaptation efforts, which include an acknowledgment of the vulnerabilities of the Californian coast and population to sea-level rise, do you concur with Dr. Green's proposals, which include phasing out the subsidization of climate risk-taking, privatization of the nation's drinking water supply, and establishing market pricing of infrastructure?*

The argument that we must improve our ability to adapt to unavoidable climate change is made in my own written testimony. We must certainly reduce vulnerabilities to sea-level rise and many other aspects of unavoidable climate change that will result from Congress's failure years ago to work to reduce emissions of greenhouse gases. One possible tool is improved market pricing of certain resources and infrastructure, and I agree that these can be very useful approaches if properly applied. The argument of Dr. Green for privatizing the nation's drinking water supply is, however, an ideological and ill-conceived and poorly thought-out proposal, and I disagree with it. My own work is focused on water resources, including many publications on the pros and cons of private water systems (these are listed in my publications list on my CV, submitted with my original written testimony). That work concludes that there is **no valid argument for privatizing the nation's water system** – indeed, our current water system (approximately 85% public and municipal systems; 15% private systems) shows clearly no compelling economic, efficiency, or service quality advantages of private systems over public systems. In addition, the complete failure of private water systems in the 1800s in the United States is what led directly to our current public design. Dr. Green, and the organization he works for, routinely and systematically promotes privatization and free markets for all resources as an ideological solution, not a solution for which there is factual or analytical support, and I consider his use of the issue of climate change as an argument for pushing turning national resources over to the private sector to be disingenuous. Moreover, I find it ironic that Dr. Green in his written testimony to the Select Committee can on the one hand push for markets for water and other

resources, while simultaneously rejecting similar markets for carbon and other pollutants. This is an ideological inconsistency.

I personally support both appropriate economic tools and approaches such as the elimination of inappropriate economic signals, smart pricing, and correcting distorting subsidies, as well as the continued use of government tools such as regulatory methods and financing support under certain conditions. No single, narrow set of solutions will suffice.

Moreover, Dr. Green's other major point in his written and oral testimony (that efforts to mitigate greenhouse gases is a complete waste of time and resources and should not be pursued), is worse than illogical – it is dangerous. Without efforts to slow greenhouse gas emissions and reduce the speed and severity of climate change, any efforts to "adapt" will ultimately be overwhelmed and swamped by increasingly severe consequences and exponentially increasing economic costs to the United States and its citizens. **This approach is like trying to give medical aid to someone in a burning house without bothering to try to put out the fire.**

6) *Given that the NAS' membership is about 2500, why is the NAS letter only signed by 255 members of the Academy, representing about 10%? How many of those who signed actually have climate-related expertise?*

This question shows a gross misunderstanding of the letter and how it was produced, while simultaneously ignoring the **content** of the letter. It also suggests ignorance of the official position of the National Academy of Sciences (as the letter itself clearly notes, the letter is not the official position of the Academy but the personal opinion of the signatories).

Specifically: not all NAS members were asked to sign. The letter was circulated to a small subset of National Academy members, over a short period of time – with a focus on those members and sections with expertise in climatology, hydrology, ecosystems science, biology, geology, and climate-related fields. Of those asked, the vast majority elected to sign, including more than a dozen Nobel Laureates.

Finally, if the purpose of the question is to find out if, or imply that, the other 90% of NAS members do not support the science of climate change, that is false. The position of the National Academy of Sciences itself is extraordinarily clear in support of the strength of climate science, as seen in all of the publications and public statements of the Academy, and in the Congressional testimony of National Academy members and the President of the NAS – all of which are on record.

Thank you for the opportunity to add these answers to the official record.

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Dr. Peter Gleick
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Richard L. Kauffman Replies to Follow Up Questions from the Select Committee on Energy Independence and Global Warming Hearing, December 1, 2010

1) In your testimony, you state that low-cost Chinese manufacturers of solar panels are gaining market share. What has caused these costs to be lower in China as compared to the U.S.?

   There are several reasons that Chinese manufacturers have lower cost positions:
   -Low cost sources of silicon. Chinese silicon manufacturers have built plants at lower costs and more quickly than Western suppliers.
   -Lower labor costs
   -Lower plant and equipment costs
   -Access to ample and inexpensive financing for expansion and for supporting solar projects for customers

2) What percentage of Levi jeans are manufactured in the U.S.?

   Levi Strauss & Co. manufactures jeans in 45 countries around the world including the US. We sell our products in 110 countries. While the company does not publicly disclose the exact percentages of individual country manufacturing, the US percentage is very minimal as is the case with most US apparel manufacturers.

3) You link the recent flooding in Pakistan to increased cotton prices – are you suggesting climate change was responsible for Pakistan's tragic floods, and thus responsible for Levi having to pay more for cotton?

   Obviously, no one can say that a single weather event is caused by climate change. I believe my testimony was clear on the point that extreme weather events—which scientists predict will be a consequence of climate change— may have major impacts on the costs of agricultural commodities.

4) Do you begrudge the discovery and development of shale gas because the lower cost of natural gas makes renewable energy more costly?

   Not at all. While natural gas finds help energy independence and has lower carbon content than coal, my point was simply that it made the challenges for renewables greater. Other countries may not have the benefits of so much natural gas and therefore will put more emphasis on renewable development, which could harm the US in a growth industry if it chooses not to participate in the industry's development.

5) Can you explain where the investment climate for renewable energy currently stands in Europe? Isn't it the case that once European governments cut back their

expensive feed-in tariffs and other subsidies, private investment in the renewable energy sector faltered? Doesn't this indicate that renewable energy jobs are purely taxpayer subsidies and not sustainable in the long-term?

In spite of changes in some of the FIT regimes, the investment climate in Europe is superior to that in the US. First, the FIT regime is a direct payment, based on a sovereign credit, available to anyone who can fulfill the contract. The support is not based on tax credits which requires often requires friction costs to attract tax equity partners; the support is available to retail as well as international investors; and the system does not require the same degree of project finance complexity that exists in the US. In addition, European banks lend to projects where US banks lend much less. The decline in FIT tariffs actually shows how effective the regimes have been in lowering costs for renewable electricity through the benefits of scale. Wind and solar generation in Europe are at or are close to grid parity in several regimes without subsidy.

6) Isn't the very nature of venture capitalism to take risks on new technology? Where's the capitalism in asking the federal government provide a guaranteed market?

Venture capitalists are willing to back new technology and have demonstrated their willingness to do so. The problem is that without scale, it is very difficult for technological innovation alone to achieve cost-competitiveness in a commodity industry such as energy. There are many examples where the government has provided a market for new products, enabling an emerging technology to get to scale, and thereby achieve self-sustainability. Government purchases of the KC-135 gave Boeing the scale it needed to develop the 707; similarly, defense purchases of IT gave the industry the scale it needed to develop commercial markets sooner and more cheaply.

7) If clean technology is already the biggest part of the venture capital business, then why do you need additional government subsidies to further prop up an industry that doesn't appear self-sustainable?

As the European example of solar and wind demonstrate, costs of renewable generation have declined significantly through scale benefits that have resulted from government support programs to a point where the needed subsidies to achieve grid parity are modest in several countries. Hence, I do not agree with the supposition that the industry cannot be self-sustainable after a modest period of government support. The support the renewable energy industry receives is much less than the traditional energy business receives, even though the oil, gas and coal industries have already achieved scale. Moreover, in energy efficiency, we need to recognize that there are multiple market failures that prevent technology solutions with a high payback from being adopted. First, utilities have no incentives to invest in efficiency since they are compensated based on the amount

of energy they sell. Second, agency problems exist where the building owner and tenant are often two separate parties. Third, there is a lack of financing available to fund energy efficiency that prevents energy service companies from making retrofit investments and new technology companies from offering lease structures.

8) Are you familiar with the experiences of the Spanish government's efforts to subsidize renewable energies over the past several years, and the results of those efforts? Should the U.S. government look to Spain as a model to imitate?

Yes, I am familiar with the Spanish government's efforts and would not suggest that the US government look to Spain as a model. In contrast to Germany's consistent efforts—which has a number of merits which the US could use as a model—Spain changed the rules of the game abruptly which led to a number of negative consequences.

THE SELECT COMMITTEE ON
ENERGY INDEPENDENCE AND GLOBAL WARMING

December 2, 2010

Dr. Green:

Following your appearance in front of the Select Committee on Energy Independence and Global Warming, members of the committee submitted additional questions for your attention. I have attached the document with those questions to this email. **Due to time constraints please submit responses by next Friday, December 10th.** Responses may be submitted in electronic form, at sarah.butler@mail.house.gov. Please call with any questions or concerns.

Sarah Butler
Chief Clerk
Select Committee on Energy Independence and Global Warming
(202)225-4012
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Questions from the Minority:

1) What environmental benefits would we expect to see if the US drastically reduced its emissions?

There are several reasons why, in my opinion, the U.S. would realize very few environmental benefits from even drastic reductions in domestic greenhouse gas production.

The first reason is that I believe that the risks of climate change have been serially exaggerated for political reasons. While I believe that climate change is real, and that it is partly influenced by the greenhouse gases, I believe that the impacts of such change, which will play out slowly over many decades and centuries are likely to be modest. As I believe that the overall risk is modest, the potential for gains from GHG reduction are also modest.

The second reason I believe we would realize little potential benefit is that while it is true that the U.S. is a major emitter of such gases, the real growth in GHG emission is taking place in the developing world, which will consume whatever high-carbon fuels we forego, as is now taking place with U.S. coal, which is being exported to China as we increasingly prevent its use here. As the New York Times recently reported, this dynamic perversely increases the total flux of GHG's to the atmosphere because in addition to burning the coal, it has to be shipped on diesel ships half way around the world.

A third reason I believe there would be little benefit is because it is a fallacy to think that the U.S. <u>can</u> drastically reduce its emissions, or could endure the cost of actions attempting to do so. Let's not forget that Tom Wigley, a scientist with the National Center for Atmospheric Research, acknowledged that meeting the Kyoto targets of a 6% reduction in GHG emissions from a 1990 baseline, a target that the US could not achieve, would have averted only 0.07 ℃ of warming by the year 2050, an amount too small to measure. More recently, Kevin Anderson, Director of of the UK's Tyndall Center for Climate Change Research argued that the only way to reduce global emissions of greenhouse gases enough to forestall predicted climate change while allowing the developing countries to develop would require the complete cessation of economic growth in the developed world, to be enforced through rationing. (Louise Gray, "Cancun climate change summit: scientists call for rationing in developed world" The Telegraph, November 29, 2010)

2) Is mitigation the most cost effective way to combat climate change?

No, I do not believe so. Estimates of mitigation costs in the United States are between 1% and 3% of GDP. I have read more than a few such studies, and am inclined to believe more in the high end than the low: the only people pushing low-end claims are those pursuing climate policies. U.S. GDP growth is already insufficient for economic recovery from the recent financial crisis. Deducting another 3% would be, I believe, deeply irresponsible. A superior response, I believe, would be to increase people's adaptive capabilities both here and abroad. That would best be done through the elimination of risk subsidies, proper pricing of climatic risks to infrastructure, the institution of property rights and the rule of law in countries that lack such institutions, and other measures I outlined in "Climate Change: The Resilience Option," a policy study that I submitted to the record as part of my testimony.

3) You state that you believe climate change is real, but only poses a modest threat. Can you explain the basis for that belief?

My belief that climate change is real comes from my education in environmental science. It has been known for 150 years that certain gases block the passage of long-range radiation, and trap heat in the atmosphere. My belief that anthropogenic climate change only poses a modest threat comes from studying the work of MIT's Richard Lindzen, and University of Alabama's Roy Spencer and John Christy, who have shown that the sensitivity of the atmosphere to greenhouse gas emissions is at the low (to extremely low) end of the IPCC's estimated sensitivity range. I attach a power-point presentation in which Dr. Lindzen explains the reasons for believing in a low climate sensitivity. A lay description can be found in a column Dr. Lindzen wrote for the Wall Street Journal, entitled "The Climate Science Isn't Settled," on November 30, 2009. Dr. Lindzen also testified regarding this issue to the House of Representatives on November 17, 2010. His testimony can be found here:

http://democrats.science.house.gov/Media/file/Commdocs/hearings/2010/Energy/17nov/Lindzen_Testimony.pdf. Dr. Roy Spencer's work on climate sensitivity can be found here: http://www.drroyspencer.com/. Another article, by Stephen B. Schwarz of Brookhaven National Laboratory, published in the peer-reviewed literature supporting arguments for a low climate sensitivity can be found here: http://www.ecd.bnl.gov/steve/pubs/HeatCapacity.pdf.

Global Warming – Sensibilities and Science

Richard S. Lindzen
Alfred P. Sloan Professor of Atmospheric Sciences

Third International Conference on Climate Change
June 2, 2009

Warning: This talk will include simple equations

A pdf of this talk will be available upon request from rlindzen@mit.edu

Primary modes whereby climate science supports alarmism:

1)Triage

2)Opportunism of the weak

3)Free riding

2

Who is and isn't alarmed?

Ordinary people seem to retain an healthy degree of skepticism about the importance of this issue, but so-called 'elites' don't seem to.

David Brooks, the *New York Times* columnist, discussing Republican Party reformers, claims that "they tend to take global warming seriously, not only on its merits, but in the belief that conservatives cannot continue to insult the sensibilities of the educated classes and the entire East and West Coasts."

3

What are the questions at issue?

Is the increase of atmospheric CO_2 from about 280 ppmv to 380 ppmv since the beginning of the industial age widely questioned? Not really.

Is the claim that global mean temperature anomaly has irregularly increased by 0.5-0.8C during this period widely questioned? Not really.

(However, the irregularity of the change does imply an important role for natural variability.) Indeed, warming, cooling, and change, in general, are natural features of the climate. **The mere existence of change tells us nothing beyond this.**

The serious questions involve quantitative issues

Is the warming sufficiently large to exclude natural origin?

Is the sensitivity of climate such that we might reasonably expect such large warming in the future as a result of human activities?

Is the net impact of such warming likely to be beneficial or detrimental?

Are the proposed policies of relevance to climate per se?

The public discussion of the global warming (or the peculiarly relabeled climate change) issue has generally conflated the non-serious and serious issues to the detriment of significant meaning. Gore's powerpoint presentation exemplifies this intentional and misleading confusion.

Note that just as the existence of change per se is no cause for alarm or even surprise, neither is the fact that some part of such change must certainly be due to man's activities. 5

Indeed, the iconic claim of the IPCC AR4, that most of the change of temperature over the period since 1954 was due to man, would, even if true, hardly support alarm.

However, once one looks at the argument presented by the IPCC, one readily sees how embarrassing the claim really is.

6

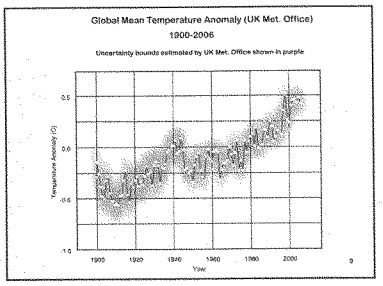
What was done, was to take a large number of models that could not reasonably simulate known patterns of natural behavior (such as ENSO, the Pacific Decadal Oscillation, the Atlantic Multidecadal Oscillation), claim that such models nonetheless accurately depicted natural internal climate variability, and use the fact that these models could not replicate the warming episode from the mid seventies through the mid nineties, to argue that forcing was necessary and that the forcing must have been due to man.

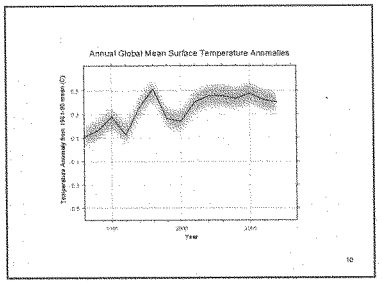
The argument makes arguments in support of intelligent design sound rigorous by comparison. It constitutes a rejection of scientific logic, while widely put forward as being 'demanded' by science.

7

Equally ironic, the fact that the global mean temperature anomaly ceased increasing by the mid nineties is acknowledged by modeling groups as contradicting the main claim of the so-called attribution argument (Smith et al, 2007, Keenlyside et al, 2008). The behavior of the temperature anomalies is readily seen in the records of any of the official IPCC sources.

8



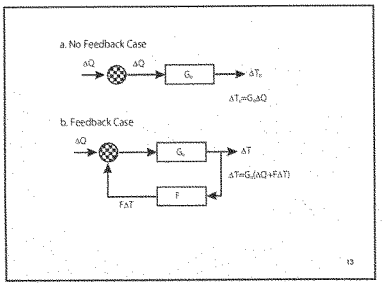


Note that the failure of the models to predict the cessation of warming in the mid 90's (except for a bump associated with a major El Nino event in 1998), does not disprove the possibility of significant anthropogenic warming. What it does disprove is the claim that the data provides evidence that recent warming is mostly due to man. To repeat, the IPCC claim, itself, is hardly alarming. Alarming, consequences depend on the confluence of many things besides warming, and are generally implausible under any circumstances.

11

This finally brings us to the fundamental question of climate sensitivity. Here again, the IPCC relies on existing poorly performing models to argue that sensitivity to a doubling of CO_2 could be anything from 1.5 to 5C based on the claimed range of results from different models. However, in normal science one would want an independent observational test of model results. As it turns out, such a test is eminently possible.

12



$$\Delta T_0 = G_0 \Delta Q,$$

$$\Delta T = G_0(\Delta Q + F\Delta T),$$

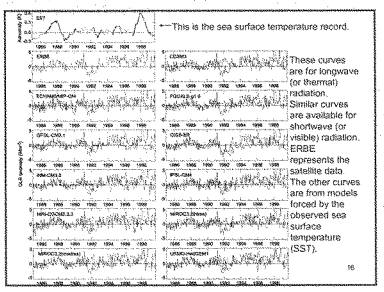
$$\Delta T = \frac{\Delta T_0}{1 - f},$$

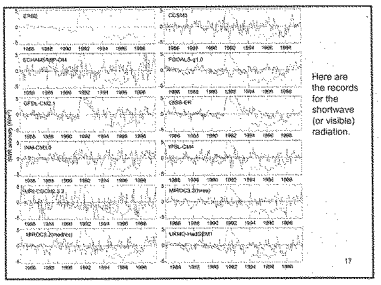
where f = G_0F is the feedback factor. The net feedback is positive for 0 < f < 1, and negative for f < 0. The feedback parameter F is $-\Delta$Flux/ΔT, assuming the same incoming radiation in the system. The negative sign is because increased outgoing flux means energy loss. For example, with ΔT = 0.2 C and ΔFlux = 0.9 W m^{-2}, F is –4.5 W m^{-2} /C (= –0.9/0.2).

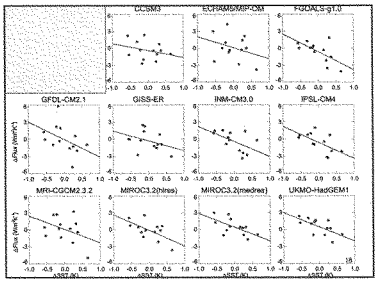
14

The idea now is to take fluxes observed by satellite and produced by models forced by observed sea surface temperatures, and see how these fluxes change with fluctuations in sea surface temperature.

15




ERBE
CCSM3
ECHAM5/MIP-OM
FGOALS-g1.0
GFDL-CM2.1
GISS-ER
INM-CM3.0
IPSL-CM4
MRI-CGCM2.3.2
MIROC3.2(hires)
MIROC3.2(medres)
UKMO-HadGEM1
Here are the records for the shortwave (or visible) radiation.
17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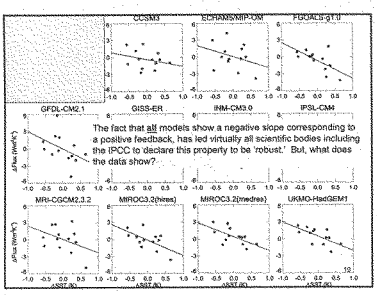
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The fact that all models show a negative slope corresponding to a positive feedback, has led virtually all scientific bodies including the IPCC to declare this property to be 'robust.' But, what does the data show?
MRI-CGCM2.3.2
MIROC3.2(hires)
MIROC3.2(medres)
UKMO-HadGEM1
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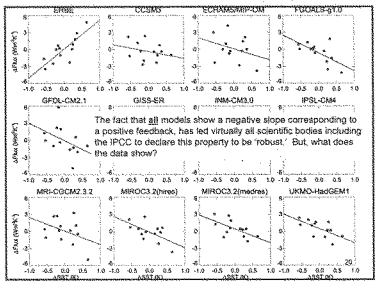
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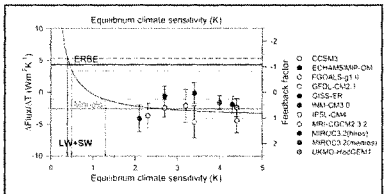
MIROC3.2(hires)
MIROC3.2(medres)
UKMO-HadGEM1
20

Once one has the feedback factor, it is easy to relate this factor to climate sensitivity via the equation

$$\Delta T = \frac{\Delta T_0}{1 - f},$$

21



We see that for the range of sensitivities that characterize the models, the errors in the feedback factors make it impossible to narrow the range of sensitivity, thus explaining why this range has not diminished since 1979. However, for the low sensitivity obtained from the actual climate system, we see that sensitivity is narrowly constrained to about 0.5C, and strongly implies that there is little to be concerned about (due to our emissions). Of course, climate change will always occur and we should be prepared.

22

What we see, then, is that the very foundation of the issue of global warming is wrong.

In a normal field, these results would pretty much wrap things up, but global warming/climate change has developed so much momentum that it has a life of its own – quite removed from science. One can reasonably expect that *opportunism of the weak* will lead to efforts to alter the data (though the results presented here have survived several alterations of the data already). Perhaps most important, these results will of necessity 'offend the sensibilities of the of the educated classes and the entire East and West Coasts,' and who would want to do that.

23

Global Warming:
How to approach the science.

(Climate Models and the Evidence?)

Richard S. Lindzen
Program in Atmospheres, Oceans, and Climate
Massachusetts Institute of Technology

Testimony: House Subcommittee
on Science and Technology hearing on *A Rational Discussion of Climate Change: the Science, the Evidence, the Response*

November 17, 2010

A pdf of these slides is available on request to rlindzen@mit.edu

I wish to thank the House Committee on Science and Technology for the opportunity to present my views on the issue of climate change – or as it was once referred to: global warming. The written testimony is, of course, far more detailed than my oral summary will be. In the summary, I will simply try to clarify what the debate over climate change is really about. It most certainly is not about whether climate is changing: it always is. It is not about whether CO_2 is increasing: it clearly is. It is not about whether the increase in CO_2, by itself, will lead to some warming: it should. The debate is simply over the matter of how much warming the increase in CO_2 can lead to, and the connection of such warming to the innumerable claimed catastrophes The evidence is that the increase in CO_2 will lead to very little warming, and that the connection of this minimal warming (or even significant warming) to the purported catastrophes is also minimal. The arguments on which the catastrophic claims are made are extremely weak – and commonly acknowledged as such.

In my long experience with the issue of global warming, I've come to realize that the vast majority of laymen -- including policymakers – do not actually know what the scientific debate is about. In this testimony, I will try to clarify this. Some of you may, for example, be surprised to hear that the debate is not about whether it is warming or not or even about whether man is contributing some portion of whatever is happening. I'll explain this in this testimony. Unfortunately, some part of the confusion is explicitly due to members of the scientific community whose role as partisans has dominated any other role they may be playing.

Here are two statements that are completely agreed on by the IPCC. It is crucial to be aware of their implications.

1. A doubling of CO_2, by itself, contributes only about 1C to greenhouse warming. All models project more warming, because, within models, there are positive feedbacks from water vapor and clouds, and these feedbacks are considered by the IPCC to be uncertain.

2. If one assumes all warming over the past century is due to anthropogenic greenhouse forcing, then the derived sensitivity of the climate to a doubling of CO_2 is less than 1C. The higher sensitivity of existing models is made consistent with observed warming by invoking unknown additional negative forcings from aerosols and solar variability as arbitrary adjustments.

Given the above, the notion that ***alarming*** warming is 'settled science' should be offensive to any sentient individual, though to be sure, the above is hardly emphasized by the IPCC.

The usual rationale for alarm comes from models. The notion that models are our only tool, even, if it were true, depends on models being objective and not arbitrarily adjusted (unfortunately unwarranted assumptions).

However, models are hardly our only tool, though they are sometimes useful. Models can show why they get the results they get. The reasons involve physical processes that can be independently assessed by both observations and basic theory. This has, in fact, been done, and the results suggest that all models are exaggerating warming.

The details of some such studies will be shown later in this testimony.

Quite apart from the science itself, there are numerous reasons why an intelligent observer should be suspicious of the presentation of alarm.

1. The claim of 'incontrovertibility.'

2. Arguing from 'authority' in lieu of scientific reasoning and data or even elementary logic.

3. Use of term 'global warming' without either definition or quantification.

4. Identification of complex phenomena with multiple causes with global warming and even as 'proof' of global warming.

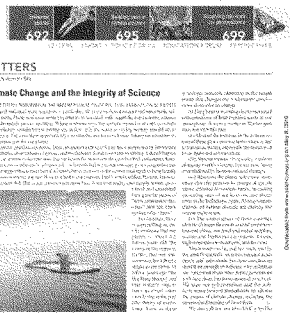
5. Conflation of existence of climate change with anthropogenic climate change.

Some Salient Points:

1. Virtually by definition, nothing in science is 'incontrovertible' – especially in a primitive and complex field as climate. 'Incontrovertibility' belongs to religion where it is referred to as dogma.

2. As noted, the value of 'authority' in a primitive and politicized field like climate is of dubious value – it is essential to deal with the science itself. This may present less challenge to the layman than is commonly supposed. Consider the following example:

This letter appeared last Spring in *Science*. It was signed by 250 members of the National Academy of Science. Most signers had no background whatever in climate sciences. Many were the 'usual suspects.' (ie, Paul Ehrlich, the late Steve Schneider, George Woodwell, Don Kennedy, John Schellnhuber, ...) but a few were indeed active contributors.



LETTERS

Climate Change and the Integrity of Science

Here are two of their assertions:

(iii) Natural causes always play a role in changing Earth's climate, but are now being overwhelmed by human-induced changes.

(iv) Warming the planet will cause many other climatic patterns to change at speeds unprecedented in modern times, including increasing rates of sea-level rise and alterations in the hydrologic cycle.

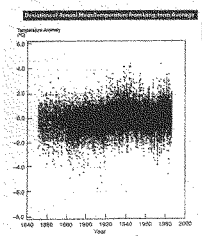
Now, one of the signers was Carl Wunsch. Here is what he says in a recent paper in *Journal of Climate* (Wunsch et al, 2007) (and repeated a couple of weeks ago in a departmental lecture):

It remains possible that the data base is insufficient to compute mean sea level trends with the accuracy necessary to discuss the impact of global warming–as disappointing as this conclusion may be.

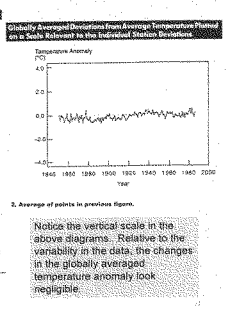
In brief, when we actually go to the scientific literature we see that the 'authoritative' assertions are no more credible than the pathetic picture of the polar bear that accompanied the letter.

3. 'Global Warming' refers to an obscure statistical quantity, globally averaged temperature anomaly, the small residue of far larger and mostly uncorrelated local anomalies. This quantity is highly uncertain, but may be on the order of 0.7C over the past 150 years. This quantity is always varying at this level and there have been periods of both warming and cooling on virtually all time scales. On the time scale of from 1 year to 100 years, there is no need for any externally specified forcing. The climate system is never in equilibrium because, among other things, the ocean transports heat between the surface and the depths. To be sure, however, there are other sources of internal variability as well.

Because the quantity we are speaking of is so small, and the error bars are so large, the quantity is easy to abuse in a variety of ways.

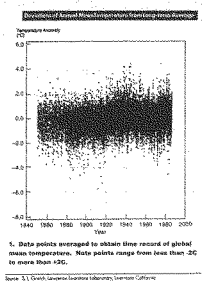


1. Data points averaged to obtain time record of global mean temperature. Note points range from less than -2C to more than +2C.



2. Average of points in previous figure.

Notice the vertical scale in the above diagrams. Relative to the variability in the data, the changes in the globally averaged temperature anomaly look negligible.



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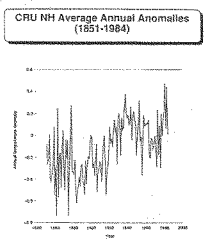
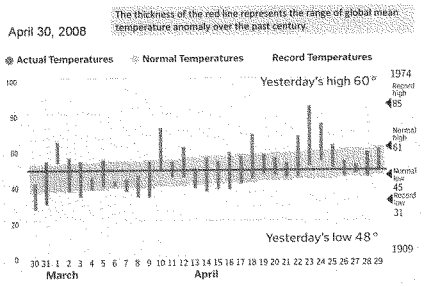


3. Curve in previous figure stretched to fill graph. Note that range is now from about -0.8C to +0.3C.



One month's record of high and low temperatures for Boston.

Two separate but frequently conflated issues are essential for alarm:

1) The magnitude of warming, and

2) The relation of warming of any magnitude to the projected catastrophe.

4. The claims that the earth has been warming, that there is a greenhouse effect, and that man's activities have contributed to warming, are trivially true and essentially meaningless in terms of alarm.

Nonetheless, they are frequently trotted out as evidence for alarm. For example, here is the response of the American Physical Society to Hal Lewis' resignation letter:

On the matter of global climate change, APS notes that virtually all reputable scientists agree with the following observations: Carbon dioxide is increasing in the atmosphere due to human activity; Carbon dioxide is an excellent infrared absorber, and therefore, its increasing presence in the atmosphere contributes to global warming; and The dwell time of carbon dioxide in the atmosphere is hundreds of years. On these matters, APS judges the science to be quite clear.

The last item is actually quite misleading on its own terms. The APS also denies financial involvement despite the fact that POPA's chair is Bob Socolow who is chair of the Carbon Mitigation Initiative, and on the advisory board of Deutsche Bank.

When it comes to unusual climate (which always occurs some place), most claims of evidence for global warming are guilty of the 'prosecutor's fallacy.' For example this confuses the near certainty of the fact that if A shoots B, there will be evidence of gunpowder on A's hand with the assertion that if C has evidence of gunpowder on his hands then C shot B.

However, with global warming the line of argument is even sillier. It generally amounts to something like if A kicked up some dirt, leaving an indentation in the ground into which a rock fell and B tripped on this rock and bumped into C who was carrying a carton of eggs which fell and broke, then if some broken eggs were found it showed that A had kicked up some dirt. These days we go even further, and decide that the best way to prevent broken eggs is to ban dirt kicking.

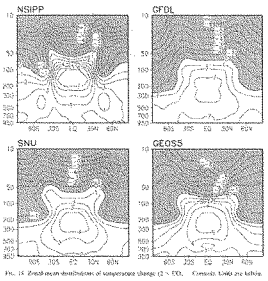
Some current problems with science

1. **Questionable data.** (Climategate and involvement of all three centers tracking global average temperature anomaly.) This is a complicated ethical issue for several reasons. Small temperature changes are not abnormal and even claimed changes are consistent with low climate sensitivity. However, the public has been mislead to believe that whether it is warming or cooling – no matter how little – is of vital importance. Tilting the record slightly is thus of little consequence to the science but of great importance to the public perception.

2. More sophisticated data is being analyzed with the aim of supporting rather than testing models (validation rather than testing). That certainly has been my experience during service with both the IPCC and the National Climate Assessment Program. It is also evident in the recent scandal concerning Himalayan glaciers.

(Note that in both cases, we are not dealing with simple measurements, but rather with huge collections of sometimes dubious measurements that are subject to often subjective analysis – sometimes referred to as 'massaging.')

In point of fact, we know that some of the recent temperature data must be wrong!



Here we see the meridional distribution of the temperature response to a doubling of CO_2 from four typical models. The response is characterized by the so-called hot spot (ie, the response in the tropical upper troposphere is from 2-3 times larger than the surface response). We know that the models are correct in this respect since the hot spot is simply a consequence of the fact that tropical temperatures approximately follow what is known as the moist adiobat. This is simply a consequence of the dominant role of moist convection in the tropics.

However, the temperature trends obtained from observations fail to show the hot spot.

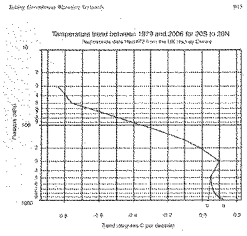


Figure 5: Temperature trend as a function of pressure level for period 1979–2006 in the tropics (20S–20N) based on balloon data analyzed by the Hadley Centre.

The resolution of the discrepancy demands that either the upper troposphere measurements are wrong, the surface measurements are wrong or both. If it is the surface measurements, then the surface trend must be reduced from 'a' to 'b'.

Given how small the trends are, and how large the uncertainties in the analysis, such errors are hardly out of the question.

3. Sensitivity is a crucial issue. This refers to how much warming one expects from a given change in CO_2 (usually a doubling). It cannot be determined by assuming that one knows the cause of change. If the cause is not what one assumes, it yields infinite sensitivity. This problem infects most attempts to infer climate sensitivity from paleoclimate data.

4. Models cannot be tested by comparing models with models. Attribution cannot be based on the ability or lack thereof of faulty models to simulate a small portion of the record. Models are simply not basic physics.

All the above and more are, nonetheless, central to the IPCC reports that supposedly are 'authoritative' and have been endorsed by National Academies and numerous professional societies.

Here is a recent letter signed by the presidents of both the Royal Society and the National Academy of Science

It tells us a great deal about the current state of science, and the exploitation of authority.

FT.com Letters

What's happening to the climate is unprecedented

Martin Rees
President of the Royal Society

Ralph J Cicerone
President of the US National Academy of Sciences

Let us focus on three sentences in this letter

1. *However, as your editorial acknowledges, neither recent controversies, nor the recent cold weather, negate the consensus among scientists, something unprecedented is now happening. The concentration of carbon dioxide in the atmosphere is rising and climate change is occurring, both due to human actions.*

Note that this statement seems to go well beyond the IPCC statement that claimed that only more than half the temperature change over the preceding 50 years could be attributed to man's emissions – with aerosols included in order to cancel much of the excess warming the models produce.

Moreover, the assumptions underlying this claim have been shown to be false (namely that all other possible causes had been adequately accounted for).

Of course, one could carefully parse the sentence. Perhaps they meant that there was increasing CO_2 due to man, and that there was warming due to this though it might only be a small part of the already small observed warming. If this is what they meant, then the statement is trivial and suggests no basis for alarm. However, there is no doubt that this is not what they intended the reader to infer.

2. *Uncertainties in the future rate of this rise, stemming largely from the "feedback" effects on water vapour and clouds, are topics of current research.*

Who would guess from this throw away comment, that feedbacks are the critical issue? Without strong positive feedbacks there would be no cause for alarm, and no need for action. What Rees and Cicerone are actually saying is that we don't know if there is a problem.

3. *Our academies will provide the scientific backdrop for the political and business leaders who must create effective policies to steer the world toward a low-carbon economy.*

Rees and Cicerone are saying that regardless of the evidence the answer is predetermined. If the government wants carbon control, that is the answer that the Academies will provide. Nothing could better epitomize the notion of science in the service of politics – something that, unfortunately, has characterized so-called climate science.

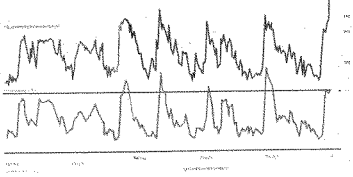
Where do we go from here?

Given that this has become a quasi-religious issue, it is hard to tell. However, my personal hope is that we will return to normative science, and try to understand how the climate actually behaves. Our present approach of dealing with climate as completely specified by a single number, globally averaged surface temperature anomaly, that is forced by another single number, atmospheric CO_2 levels, for example, clearly limits real understanding; so does the replacement of theory by model simulation. In point of fact, there has been progress along these lines and none of it demonstrates a prominent role for CO_2. It has been possible to account for the cycle of ice ages simply with orbital variations (as was thought to be the case before global warming mania); tests of sensitivity independent of the assumption that warming is due to CO_2 (a circular assumption) show sensitivities lower than models show; the resolution of the early faint sun paradox which could not be resolved by greenhouse gases, is readily resolved by clouds acting as negative feedbacks.

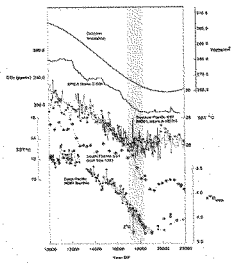
So far we have approached the science in a somewhat peripheral way. In the remainder of this testimony, we will deal with the science more directly.

Here is a graphic made famous by Al Gore. There are lots of problems with this picture. For starters, it confuses correlation with causality. Moreover, it clearly shows that temperature preceded CO_2 by hundreds of years at the last glaciation. It also shows that previous interglacials were warmer than the present.

However, the biggest problem may be that the use of a single number to characterize climate, completely obscures what is really happening. We see this in the next slide.



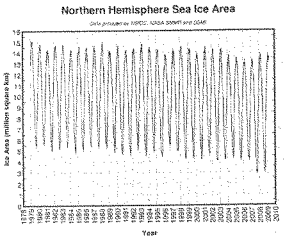
Here is we see why it is often useless to consider merely global mean temperature anomaly and CO_2.



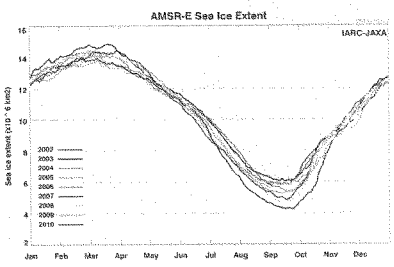
According to Stott et al, warming first occurred in the South Pacific in the region of formation of Upper Circumpolar Deep Water between 19,000BP and 17,000 BP. It was not until about 17,000 BP that the tropical surface water began to warm and the CO_2 concentration also began to rise at this time. It was not until 15,000BP that the Greenland region began to warm. With such a sequence it is apparent that the interglacial warming was initiated in the waters of the Southern Ocean and took nearly 4,000 years to be reflected in Greenland changes; also, the CO_2 variations would seem to be tied to tropical ocean temperature changes.

Here is a simple example of how current approaches inhibit progress.

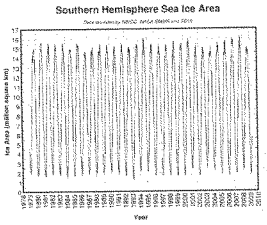
You have all heard about the arctic sea ice disappearing. Here is what is being spoken of.



The latest value : 6,599,688 km² (October 11, 2010)

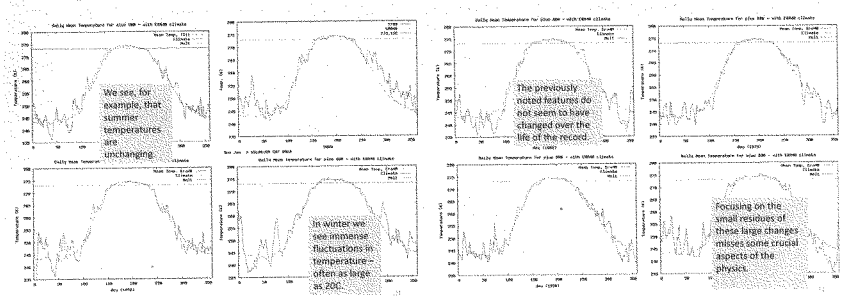


As you may have heard, nothing of the sort has been happening to Antarctic sea ice, although claims of record extent of Antarctic sea ice are also overly dramatic.



Let us now look at the temperature of polar regions in some detail. The following figures show daily arctic temperatures for each day available from reanalyses since 1958. They also show the average temperatures for each day.

If one focuses on variations in annually averaged temperatures, one misses some crucial information, and that information tells us quite a lot.



What the previous slides illustrate is that during summers, when there is sunlight, temperatures are largely determined by local radiative balance and this does not seem to be changing. However, during the winter night, temperatures would be even colder than they are but for the transport of heat from lower latitudes. This transport is by the turbulent eddies or storms. Understanding arctic temperatures must involve understanding why these storms erratically penetrate to the arctic. Judging from the behavior of summer temperatures, CO_2 is not obviously a major player.

Just for the record, summer ice depends mostly on how much is blown out of the arctic basin – something that used to be textbook information.

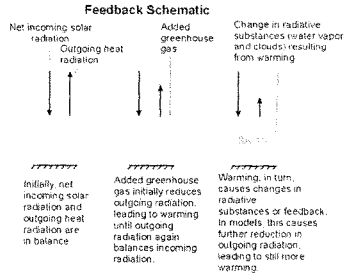
While there really doesn't appear to be that much going on, anecdotal information can be more dramatic.

"THE ARCTIC OCEAN IS WARMING UP. ICEBERGS ARE GROWING SCARCER AND IN SOME PLACES THE SEALS ARE FINDING THE WATER TOO HOT. REPORTS ALL POINT TO A RADICAL CHANGE IN CLIMATE CONDITIONS AND HITHERTO UNHEARD-OF TEMPERATURES IN THE ARCTIC ZONE. EXPEDITIONS REPORT THAT SCARCELY ANY ICE HAS BEEN MET WITH AS FAR NORTH AS 81 DEGREES 29 MINUTES. GREAT MASSES OF ICE HAVE BEEN REPLACED BY MORAINES OF EARTH AND STONES, WHILE AT MANY POINTS WELL KNOWN GLACIERS HAVE ENTIRELY DISAPPEARED."

—US WEATHER BUREAU, 1922

In fact, the arctic is notoriously variable; similar statements are available for 1957, and the Skate surfaced at the N. Pole in 1959. So much for 'unprecedented.'

As already mentioned, it is essential to know climate sensitivity. Model predictions depend on positive feedbacks and not just the modest effect of CO_2. There follows a schematic of what we mean by feedbacks.



One is able to use satellite data from ERBE and CERES (that measures net outgoing radiation in both the visible and infrared portions of the spectrum) to test the preceding situation, and to quantitatively evaluate climate feedback factors. These are related to climate sensitivity by the following equation:

$$\Delta T = \frac{\Delta T_0}{1 - f},$$

ΔT_0 is the zero feedback response to a doubling of CO_2. It is about 1C.

The basis of the approach is to see if the satellite measured outgoing radiation associated with short term fluctuations in Sea Surface Temperature (SST) is larger or smaller than what one gets for zero feedback. Remember that a positive feedback will lead to less outgoing radiation (increased blanket) while a negative feedback will lead to more.

It turns out that the model intercomparison program has the models used by the IPCC, forced by actual SST, calculate outgoing radiation. So one can use the same approach with models, while being sure that the models are subject to the same surface temperature fluctuations that applied to the observations.

Feedbacks as measured by ERBE and CERES
(after corrections described by Trenberth et al, 2009)

Mean+/-standard error of the variables.

	Variables	Value	Comments for likely lag
a	Slope, LW	5.2±1.3	Lag = 1
b	Slope, SW	2.2±3.0	Lag = 3
c	Slope, Total	7.1±2.2	= a+b for the same SST interval
d	f_{LW}	−0.3±0.2	Calculated from a
e	f_{SW}	−0.3±0.4	Calculated from b
f	f_{Total}	−0.6±0.3	Calculated from c

Note that feedbacks are negative.

Lags are used to distinguish fluctuations caused by SST (ie feedbacks) from radiation changes that are not feedbacks (due to volcanic eruptions for example).

For all models, the feedbacks are positive.

		LW				SW				LW+SW			
	N	Slope	R	SE	f_{LW}	Slope	R	SE	f_{SW}	Slope	R	SE	f
CCSM3	19	1.5	0.2	1.8	0.3	-3.1	-0.5	2.3	0.9	-1.6	-0.2	3.5	0.5
ECHAM5/MPI-OM	18	2.8	0.6	1.7	0.1	-1.1	-0.2	3.1	0.2	1.7	0.3	3	0.2
FGOALS-g1.0	18	-0.3	-0.1	1.6	0.5	-2.8	-0.7	1.3	0.8	-3	-0.7	1.6	1
GFDL-CM2.1	18	1.5	0.5	1	0.3	-0.4	-0.1	2.8	0.1	1.1	0.2	2.5	0.3
GISS-ER	23	2.9	0.6	1.4	0.3	-1.3	-0.3	2.3	0.5	-0.5	-0.1	1.8	0.4
INM-CM3.0	24	2.5	0.6	1.5	0.1	-3.1	-0.6	1.7	0.3	-0.3	-0.1	1.9	0.5
IPSL-CM4	22	-0.4	-0.1	2.1	0.6	-2.6	-0.5	3	0.8	-3	-0.5	2.1	0.9
MRI-CGCM2.3.2	22	-1.1	-0.3	2.2	0.7	-3.9	-0.4	3.1	0.6	-5	-0.6	2.6	1.5
MIROC3.2(hires)	23	0.7	0.1	2.2	0.4	-2.1	-0.5	1.6	0.3	-1.4	-0.3	2.3	0.7
MIROC3.2(medres)	22	3.4	0.7	1.8	0.3	-5.3	-0.7	2.3	0.5	-0.9	-0.2	1.9	0.4
UKMO-HadGEM1	19	5.2	0.7	2.2	0.3	-5.9	-0.7	2.1	0.9	-0.8	-0.1	2.5	0.4

Note that much of the 'error' in the regressions arises because radiatively important factors like clouds and aerosols vary due to many factors apart from SST. For observations there is also instrumental error, though relative errors over short time scales are likely to small.

We see that all the models are characterized by positive feedback factors (associated with amplifying the effect of changes in CO_2), while the satellite data implies that the feedback should be negative. Similar results are being obtained by Roy Spencer.

This is not simply a technical matter. Without positive feedbacks, doubling CO_2 only produces 1C warming. Only with positive feedbacks from water vapor and clouds does one get the large warmings that are associated with alarm. What the satellite data seems to show is that these positive feedbacks are model artifacts.

This becomes clearer when we relate feedbacks to climate sensitivity (ie the warming associated with a doubling of CO_2).

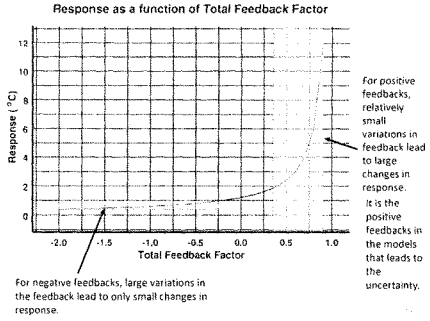
Models

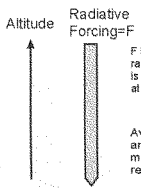
Models	AR4 sensitivity	Sensitivity, mean	Sensitivity, 90%	Sensitivity, 95%
CCSM3	2.7	4.3	1.2 – Infinity	1.0 – Infinity
ECHAM5/MP I-OM	3.4	14	0.7 – 28.9	0.7 – Infinity
FGOALS-g1.0	2.3	22.4	2.4 –Infinity	2.3 – Infinity
GFDL-CM2.1	3.4	16	0.9 –15.4	0.8 –Infinity
GISS-ER	2.7	2.5	1.2 –Infinity	1.1 –Infinity
INM-CM3.0	2.1	2.4	1.2 – Infinity	1.1 –Infinity
IPSL-CM4	4.4	19.5	1.9 – Infinity	1.6 –Infinity
MRI-CGCM2.3.2	3.2	Infinity	2.8 – Infinity	2.2 –Infinity
MIROC3.2(hires)	4.3	3.8	1.2 – Infinity	1.1 –Infinity
MIROC3.2(medres)	4	3.0	1.3 –Infinity	1.2 –Infinity
UKMO-HadGEM1	4.4	2.8	1.2 – Infinity	1.1 –Infinity

Observations

Sensitivity, mean	0.7	Calculated from f
Sensitivity, 90%	0.5-1.1	Twice standard error
Sensitivity, 95%	0.5-1.2	3 times standard error

$$\Delta T = \frac{\Delta T_0}{1-f},$$





F is roughly non-divergent, but while F is radiative at the top of the atmosphere, it is mostly due to latent heat flux (ie evaporation) at the surface.

Averaged over the globe Evaporation=Precipitation and both Precipitation and Evaporation can now be measured from space. This permits one to test one's results for consistency.

From the above, we see that an alternative to observing outgoing radiation from space is to measure evaporation from the surface. This has, in fact, been done. Wentz, F.J. et al (How much more rain will global warming bring. *ScienceExpress*, 31 May 2007) used the above and space based observations to measure how evaporation changed with temperature and compared their results with GCM results.

In GCMs, E (evaporation) increased from 1-3% for each degree increase in temperature. Observationally, E increased 5.7%. Now a 1% change in E corresponds to about 0.8 watts m^{-2}. Climate sensitivity is essentially $\Delta T/\Delta F$.

EC=ΔEvaporation/ΔT (in units of percent change per degree)

CF=Radiative Forcing due to doubling of CO_2=3.6 Watts m^{-2}

FL=Heat Flux associated with EC=0.8 Watts m^{-2} x EC

Climate sensitivity=CF/FL

Source	EC (percent change in E per degree)	Climate Sensitivity (degrees Centigrade)
Model Range	1	4.5
	3	1.5
Observed	5.7	0.8

We may reasonably consider the observed sensitivity to be an overestimate since Wentz et al explicitly rejected observations that were 'too' far from models. The results are, however, very similar to those based on measurements of outgoing radiation.

Discussion of other progress in science can also be discussed if there is any interest. Our recent work on the early faint sun may prove particularly important. 2.5 billion years ago, when the sun was 20% less bright (compared to the 2% change in the radiative budget associated with doubling CO_2), evidence suggests that the oceans were unfrozen and the temperature was not very different from today's. No greenhouse gas solution has worked, but a negative cloud feedback does.

You now have some idea of why I think that there won't be much warming due to CO_2, and without significant global warming, it is impossible to tie catastrophes to such warming. Even with significant warming it would have been extremely difficult to make this connection.

Perhaps we should stop accepting the term, 'skeptic.' Skepticism implies doubts about a plausible proposition. Current global warming alarm hardly represents a plausible proposition. Twenty years of repetition and escalation of claims does not make it more plausible. Quite the contrary, the failure to improve the case over 20 years makes the case even less plausible as does the evidence from climategate and other instances of overt cheating.

In the meantime, while I avoid making forecasts for tenths of a degree change in globally averaged temperature anomaly, I am quite willing to state that unprecedented climate catastrophes are not on the horizon though in several thousand years we may return to an ice age.

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Environmental Policy Outlook

Climate Change: Caps vs. Taxes

By Kenneth P. Green, Steven F. Hayward, and Kevin A. Hassett

As the Kyoto Protocol's 2012 expiration date draws near, a general theme dominates the global conversation: leadership and participation by the United States are critical to the success of whatever climate policy regime succeeds the Kyoto Protocol. Two general policy approaches stand out in the current discussion. The first is national and international greenhouse gas (GHG) emissions trading, often referred to as "cap-and-trade." Cap-and-trade is the most popular idea at present, with several bills circulating in Congress to begin a cap-and-trade program of some kind. The second idea is a program of carbon-centered tax reform—for example, the imposition of an excise tax based on the carbon emissions of energy sources (such as coal, oil, and gasoline), offset by reductions in other taxes. In this paper we will address the strengths and weaknesses of both ideas and the framework by which legislators should evaluate them.

The framing of a global climate regime presents a classic chicken-and-egg problem: the United States does not wish to enter into a regime of economically costly emission caps or taxes that would have the effect of driving industry and jobs to nations such as China and India that do not participate in such caps. China and India, however, are unlikely to enter into a restrictive regime unless the United States goes first, and even then, only so long as the policy regime does not threaten serious constriction of their economies. It is often assumed that if the United States goes first, developing nations will eventually follow, but this is by no means assured. Both China and India have repeatedly declared that they are not prepared to make even a delayed commitment at this time.

Given these policy uncertainties—and other uncertainties about the eventual impacts of climate change in terms of severity, distribution, and timing—there are two guideposts policymakers should keep in mind. The first is that the United States can only effectively impose a national regulatory regime (though such a regime could eventually be harmonized with international efforts). The second is that, given the current uncertainty, policy should conform as much as possible to a "no regrets" principle by which actions undertaken can be justified separately from their GHG emissions effects in the fullness of time, such that nonparticipation by developing nations will disadvantage the United States in the global marketplace as little as possible.

While the United States may wish to join with other nations in setting a post-Kyoto emissions goal, it should be wary of joining an international emissions-trading or other regulatory regime. One of the less-remarked-upon aspects of the Kyoto Protocol, and any prospective successor treaty on that same model, is that it represents an unprecedented kind of treaty obligation for the United States. Most treaties involve direct actions and policies of governments themselves, such as trade treaties that bind nations' tariff levels and affect the private sector of the economy only indirectly. Kyoto and its kin go beyond government policy to affect the private sector directly or require the

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government to control the private sector and the investment decisions of the private sector to an unprecedented degree. It is not governments that emit GHGs, after all. Between the asymmetries of legal and regulatory regimes across nations, the United States should think hard about the dilution of sovereignty that a binding GHG treaty represents, even if the United States agrees with the basic objective of reducing carbon emissions.

Problems with Emissions Trading for GHG

Some economists favor the idea of emissions trading for its elegance in achieving least-cost emissions reductions while avoiding the manifold difficulties of prescriptive "command-and-control" regulation from a centralized bureaucracy. But this is something of a false choice, as such regulation is a deeply troubled policy option. While trading may be superior to command-and-control, it is not necessarily superior to other alternatives, such as carbon-centered tax reform.

While trading may be superior to command-and-control, it is not necessarily superior to other alternatives, such as carbon-centered tax reform.

There are a number of emissions-trading success stories that, upon inspection, suggest significant limitations to the applicability of emissions trading for GHG emissions. Enthusiasts for cap-and-trade point first to our sulfur dioxide (SO_2) trading experience under the 1990 Clean Air Act Amendments. It is claimed that the costs of SO_2 abatement through trading turned out to be dramatically lower than economists had forecast for a prescriptive regime, wherein the Environmental Protection Agency (EPA) would have mandated control technologies on individual coal-fired power plants. But a closer look shows this success to have been uneven. There has been significant volatility in emission permit prices, ranging from a low of $66 per ton in 1997 to $860 per ton in 2006, as the overall emissions cap has been tightened, with the price moving up and down as much as 43 percent in a year.[1] Over the last three years, SO_2 permit prices have risen 80 percent a year, despite the EPA's authority to auction additional permits as a "safety valve" to smooth out this severe price volatility.

Several other aspects of the SO_2-trading program are of doubtful applicability to GHGs. First, SO_2 trading was only applied to a single sector: initially, only 110 coal-fired power plants were included in the system, but it subsequently expanded to 445 plants. While coal-fired power plants account for roughly one third of U.S. carbon dioxide (CO_2) emissions and will therefore be central to a GHG cap-and-trade program, a comprehensive GHG emissions-trading program will have to apply across many sectors beyond electric utilities, vastly complicating a trading system.

Second, SO_2 and CO_2 are not comparable targets for emissions reduction. Reducing SO_2 emissions did not require any constraint on end-use energy production or consumption. Coal-fired power plants had many low-cost options to reduce SO_2 emissions without reducing electricity production. Some switched to low-sulfur coal (abetted in large part by railroad deregulation in the 1980s, which made transport of Western low-sulfur coal more economical than previously). The cost of "scrubbers"—industrial devices which capture SO_2 and sequester it—turned out to be lower than predicted. Other utilities emphasized more use of natural gas. The impact on ratepayers and consumers was modest.

CO_2 is different: it is the product of complete fuel combustion. There is no "low-CO_2 coal," and the equivalent of SO_2 scrubbers does not yet exist in economical form.[2] At the margin there is some opportunity for GHG emissions reductions through substitution—increased use of natural gas (which emits less CO_2 per unit of energy than coal) and possibly nuclear power—but the inescapable fact is that any serious reduction in CO_2 emissions will require a suppression of fuel combustion. This is going to mean lower energy consumption and higher prices, at least in the intermediate term.

Even though confined to a segment of a single sector of energy use, the SO_2 emissions-trading regime was far from simple. There were complicated allocation formulas to distribute the initial emissions permits. Despite the best efforts to create objective criteria, at the end of the day, the allocation of emission permits involves some arbitrary discretion. For political reasons there were special subsidies and extra allowances for the benefit of high-sulfur coal interests. Most trading in the early years took place between power plants within the same company.

Establishing allowances and accounting systems for GHG emissions across industries is going to be vastly more difficult and highly politicized. The forest products industry, for example, will reasonably want credits for creating carbon sinks in the trees it plants and

harvests, but the manufacturing sector that uses these wood products as a raw material will want credit for sequestering carbon. The difference will have to be split in some arbitrary manner that will surely introduce economic distortions in the marketplace. The auto industry will want credits for GHG innovations, while industries and businesses of all kinds will lobby for credits for reducing mobile source emissions from changes to their auto and truck fleets. There are going to be winners and losers in this allocation process. Multiply this problem across sectors and industries and it becomes evident that a GHG emissions-trading system is going to be highly complex and unwieldy, and too susceptible to rent-seeking influence in Washington. The problem of politically adjusting competing interests will be compounded on the international scale. The long-running diplomatic conflicts that can be observed over purported subsidies for aircraft (i.e., Boeing versus Airbus) and the European Union's agricultural subsidies and trade barriers are examples of the kinds of conflicts that will be endemic to any international emissions-trading scheme.

The favored solution to these problems is to over-allocate the number of initial permits both to ease the cost and to encourage the rapid start-up of a market for trades. This was the course the European Union took with its Emissions Trading System (ETS), and it has very nearly led to the collapse of the system. Because emissions permits were over-allocated, the price of emissions permits plummeted, and little—if any—emissions reductions have taken place because of the ETS. The over-allocation of initial permits merely postpones both emissions cuts and the economic pain involved. Economist Robert J. Shapiro notes:

> As a result of all of these factors and deficiencies, the ETS is failing to reduce European CO_2 emissions. . . . [T]he European Environmental Agency has projected that the EU is likely to achieve no more than one-quarter of its Kyoto-targeted reductions by 2012, and much of those "reductions" will simply reflect credits purchased from Russia or non-Annex-I countries [developing countries], with no net environmental benefits.[3]

As economist William Nordhaus observes:

> We have preliminary indications that European trading prices for CO_2 are highly volatile, fluctuating in a band and [changing] +/- 50 percent over the last year. More extensive evidence comes from the history of the U.S. sulfur-emissions trading program. SO_2 trading prices have varied from a low of $70 per ton in 1996 to $1500 per ton in late 2005. SO_2 allowances have a monthly volatility of 10 percent and an annual volatility of 43 percent over the last decade.[4]

Nordhaus points out the ramifications of such volatility, observing that "[s]uch rapid fluctuations would be extremely undesirable, particularly for an input (carbon) whose aggregate costs might be as great as petroleum in the coming decades," and that "experience suggests that a regime of strict quantity limits might become extremely unpopular with market participants and economic policymakers if carbon price variability caused significant changes in inflation rates, energy prices, and import and export values."[5]

Nordhaus is not alone in this concern about price volatility. Shapiro similarly observes:

> Under a cap-and-trade program strict enough to affect climate change, this increased volatility in all energy prices will affect business investment and consumption, especially in major CO_2 producing economies such as the United States, Germany, Britain, China and other major developing countries.[6]

Additional pitfalls and dilemmas of emissions trading can be seen through a review of the spectacular trading failure of the RECLAIM (Regional Clean Air Incentives Market) emissions-trading program in Southern California. Launched in 1994 after three years of development, RECLAIM set in motion an emissions-trading program targeting SO_2 and nitrogen oxides (NO_x) emissions, and eventually hoped to expand to include volatile organic compound (VOC) emissions. All three types of emissions are important precursors to ozone formation in the greater Los Angeles air basin. RECLAIM, for the first time, offered swaps between stationary and mobile sources: stationary sources such as oil refineries could help reach their emissions reduction targets by purchasing old, high-polluting automobiles and trucks and taking them off the road—a cost-effective measure in a voluntary demonstration program. The South Coast Air Quality Management District (SCAQMD) estimated that SO_2 and NO_x would be reduced by fourteen and eighty tons per day, respectively, by the

year 2003, at half the cost of the usual prescriptive method of regulation.[7] There was great public support and enthusiasm for the program at the outset.

RECLAIM never came close to operating as predicted, and was substantially abandoned in 2001. Between 1994 and 1999, NO_x levels fell only 3 percent, compared to a 13 percent reduction in the five-year period before RECLAIM. There was extreme price volatility aggravated by California's electricity crisis of 2000. NO_x permit prices ranged from $1,000 to $4,000 per ton between 1994 and 1999, but soared to an average price of $45,000 per ton in 2000, with some individual trades over $100,000 per ton. Such high prices were not sustainable, and SCAQMD removed electric utilities from RECLAIM in 2001. SCAQMD also dropped its plan to expand RECLAIM to VOCs. Despite the hope that RECLAIM would be simple and transparent, there were serious allegations of fraud and market manipulation, followed by the inevitable lawsuits and criminal investigations.

One particular problem with RECLAIM that is likely to plague any international GHG emissions-trading regime is the lack of definite property rights to the emissions allowances the program creates. A cliché of the moment is that industry would like some clarity and certainty about any prospective GHG regulatory regime. A cap-and-trade program, however, cannot provide certainty precisely because emissions allowances are not accorded real property rights by law.[8] The government can change the rules at any time, making emissions allowances worthless. This is exactly what happened to electric utilities in Los Angeles: their allowances were terminated, and the utilities were subsequently required to install specified emissions-control technologies and to pay fines for excess emissions. In effect, some Los Angeles firms had to pay three times over for emissions reductions.

A GHG emissions-trading scheme on an international level will be even more vulnerable to these kinds of unpredictable outcomes. To the extent that a GHG emissions-trading program results in international cross-subsidization of the economies of trading partners, it is going to be politically unsustainable in the long run. An international emissions-trading program is also unlikely to survive noncompliance by some of its members.

There are two final, overriding reasons to be doubtful about global emissions trading. It is possible that the defects of previous emissions-trading programs could be overcome with more careful design and extended to an international level, though this would require an extraordinary feat of diplomacy and substantial refinements of international law. Even if such improvement could be accomplished, it would not provide assurance against the prospect that the cost of such a system might erode the competitiveness of the U.S. economy against developing nations that do not join the system.

If warming is either less pronounced than some current forecasts predict or if emissions reductions have limited effect in moderating future temperature rise . . . a severe global emissions-reduction policy through emissions trading could turn out to be the costliest public policy mistake in human history, with the costs vastly exceeding the benefits.

The second reason for skepticism about global emissions trading is that it fails the "no regrets" test. It is considered bad form nowadays to express doubt or skepticism about the scientific case for rapid and dangerous global warming in the twenty-first century. If warming is either less pronounced than some current forecasts predict or if emissions reductions have limited effect in moderating future temperature rise, however, a severe global emissions-reduction policy through emissions trading (on the order of a minimum 50 percent cut by 2050) could turn out to be the costliest public policy mistake in human history, with the costs vastly exceeding the benefits.

Could instituting a tax on the carbon emissions released by fuel use, as part of a revenue-neutral tax reform package, pass these two tests? We believe it could.

Advantages of a Revenue-Neutral, Carbon-Centered Tax Reform

Most economists believe a carbon tax (a tax on the quantity of CO_2 emitted when using energy) would be a superior policy alternative to an emissions-trading regime. In fact, the irony is that there is a broad consensus in favor of a carbon tax everywhere except on Capitol Hill, where the "T word" is anathema. Former vice president Al Gore supports the concept, as does James Connaughton, head of the White House Council on

Environmental Quality during the George W. Bush administration. Lester Brown of the Earth Policy Institute supports such an initiative, but so does Paul Anderson, the CEO of Duke Energy. Crossing the two disciplines most relevant to the discussion of climate policy—science and economics—both NASA scientist James Hansen and Harvard University economist N. Gregory Mankiw give the thumbs up to a carbon tax swap.[9]

There are many reasons for preferring a revenue-neutral carbon tax regime (in which taxes are placed on the carbon emissions of fuel use, with revenues used to reduce other taxes) to emissions trading. Among them are:

- **Effectiveness and Efficiency.** A revenue-neutral carbon tax shift is almost certain to reduce GHG emissions efficiently. As economist William Pizer observes, "Specifically, a carbon tax equal to the damage per ton of CO_2 will lead to exactly the right balance between the cost of reducing emissions and the resulting benefits of less global warming."[10] Despite the popular assumption that a cap-and-trade regime is more certain because it is a quantity control rather than a price control, such a scheme only works in very limited circumstances that do not apply to GHG control. The great potential for fraud attendant on such a system creates significant doubt about its effectiveness, as experience has shown in both theory and practice in the gyrations of the European ETS.

  The likelihood of effectiveness also cannot be said for regulations such as increased vehicle fuel economy standards. In fact, such regulations can have perverse effects that actually lead to increased emissions. By making vehicles more efficient, one reduces the cost of a unit of fuel, which would actually stimulate more driving, and, combined with increasing traffic congestion, could lead to an increase in GHG emissions rather than a decrease.

  As Harvard researchers Louis Kaplow and Steven Shavell point out, "The traditional view of economists has been that corrective taxes are superior to direct regulation of harmful externalities when the state's information about control costs is incomplete," which, in the case of carbon emissions reductions, it most definitely is.[11] And when it comes to quantity controls (as a cap-and-trade system would impose), Pizer found that

  > My own analysis of the two approaches [carbon taxes vs. emission trading] indicates that price-based greenhouse gas (GHG) controls are much more desirable than quantity targets, taking into account both the potential long-term damages of climate change, and the costs of GHG control. This can be argued on the basis of both theory and numerical simulations.

  Pizer found, in fact, that a carbon-pricing mechanism would produce expected net gains five times higher than even the best-designed quantity control (i.e., cap-and-trade) regime.[12]

- **Incentive Creation.** Putting a price on the carbon emissions attendant on fuel use would create numerous incentives to reduce the use of carbon-intensive energy. The increased costs of energy would flow through the economy, ultimately giving consumers incentives to reduce their use of electricity, transportation fuels, home heating oil, and so forth. Consumers, motivated by the tax, would have incentives to buy more efficient appliances, to buy and drive more efficient cars, and to better insulate their homes or construct them with more attention to energy conservation. A carbon tax would also create incentives for consumers to demand lower-carbon power sources from their local utilities. A carbon tax, as its cost flowed down the chains of production into consumer products, would lead manufacturers to become more efficient and consumers to economize in consumption. At all levels in the economy, a carbon tax would create a profit niche for environmental entrepreneurs to find ways to deliver lower-carbon energy at competitive prices. Finally, a carbon tax would also serve to level (somewhat) the playing field among solar power, wind power, nuclear power, and carbon-based fuels by internalizing the cost of carbon emission into the price of the various forms of energy.

- **Less Corruption.** Unlike carbon cap-and-trade initiatives, a carbon tax would create little incentive or opportunity for rent-seeking or cheating. As William Nordhaus explains:

  > A price approach gives less room for corruption because it does not create artificial scarcities, monopolies, or rents. There are no permits transferred to countries or leaders of countries, so they cannot be sold abroad for

> wine or guns. . . . In fact, a carbon tax would add absolutely nothing to the instruments that countries have today.[13]

Without the profit potential of amassing tradable carbon permits, industry groups would have less incentive to try to get credits for their favored but non-competitive energy sources. That is not to say that tax-based approaches are immune from corruption, for they certainly are not. If set too far down the chain of production or set unevenly among energy sources, carbon taxes could well lead to rent-seeking, political favoritism, economic distortions, and so on. Foreign governments might have an incentive to undermine a trading scheme by offering incentives to allow their manufacturers to avoid the cost of carbon trading. A tax on fuels proportionate to their carbon content, levied at the point of first sale, should be less susceptible to corruption, and by delivering revenue to the government rather than to private entities, should create incentives more aligned with the government's objective.

A carbon tax, as its cost flowed down the chains of production into consumer products, would lead manufacturers to become more efficient and consumers to economize in consumption.

- **Elimination of Superfluous Regulations.** Because a carbon tax would cause carbon emissions to be reduced efficiently across the entire market, other measures that are less efficient—and sometimes even perverse in their impacts—could be eliminated. With the proper federal carbon tax in place, there would be no need for corporate average fuel economy standards, for example. California's emissions-trading scheme, likewise, would be superfluous, and its retention only harmful to the Golden State. As regulations impose significant costs and distort markets, the potential to displace a fairly broad swath of environmental regulations with a carbon tax offers benefits beyond GHG reductions.

- **Price-Stabilization.** As the experiences of the European ETS and California's RECLAIM show us, pollution-trading schemes can be easily gamed, resulting in significant price volatility for permits. Imagine one's energy bill jumping around as permits become more or less available due to small changes in economic conditions. A carbon tax would be predictable, and by raising the overall price of energy to include the tax, the portion of energy cost per unit that stems from fluctuation in market rates for fossil fuels shrinks as a percentage of the whole. That shrinkage makes the price of a given form of energy less susceptible to volatility every time there is a movement in the underlying production costs.

- **Adjustability and Certainty.** A carbon tax, if found to be too stringent, could be relaxed relatively easily over a timeframe, allowing for markets to react with certainty. If found too low to produce results, a carbon tax could easily be increased. In either event, such changes could be phased in over time, creating predictability and allowing an ongoing reassessment of effectiveness via observations about changes in the consumption of various forms of energy. A cap-and-trade system, by contrast, is more difficult to adjust because permits, whether one is the seller or the buyer, reflect significant monetary value. Permit traders would demand—and rightly so—compensation if what they purchased in good faith has been devalued by a governmental deflation of the new "carbon currency." In addition, sudden changes in economic conditions could lead to significant price volatility in a cap-and-trade program that would be less likely under a carbon-tax regime.

- **Preexisting Collection Mechanisms.** Whether at local, state, or federal levels, carbon taxes could be levied and collected through existing institutions with extensive experience in enforcing compliance, and through ready-made statutes to back up their actions. The same cannot be said for emissions-trading schemes that require the creation of new trading markets, complete with new regulations and institutions to define and enforce the value of credits.

- **Keeping Revenue In-Country.** Unlike an international cap-and-trade regime, carbon taxes—whether done domestically or as an internationally agreed-upon value—have the advantage of keeping tax payments within individual countries. This could strongly reduce the opposition to international action that has, until this point, had a strong

implication of wealth redistribution overlaid on the policy discussion.

This dynamic leads to a second reason why a carbon tax is a better fit for U.S. climate policy: it offers an international analogue to our federalist approach to public policy innovation within the United States. As we have seen, there is reason to doubt the long-run effectiveness and sustainability of the EU's emissions-trading program. If the United States adopts a carbon tax approach, we will be able to compare the effectiveness of tax versus emissions trading in short order.

- **Mitigation of General Economic Damages.** As energy is one of the three most important variable inputs to economic production (along with labor and capital), raising the cost of energy would undoubtedly result in significant economic harm. Using the revenues generated from a carbon tax to reduce other taxes on productivity (taxes on labor or capital) could mitigate the economic damage that would be produced by raising energy prices. The most likely candidates for a carbon tax tradeoff would be the corporate income tax (the U.S. rate is currently among the highest in the industrialized world) and payroll taxes, the latter of which would lower the cost of employment and help offset the possibly regressive effects of higher energy prices on lower-income households. But across-the-board income tax rate cuts and further cuts in the capital gains tax could also be considered.

  Few other approaches offer this potential. Regulatory approaches such as increasing vehicle efficiency standards do not because they mandate more expensive technologies and allow the costs to be passed on to consumers without offsets (unless they are subsidized), in which case it is the general taxpayer whose wallet shrinks. Emissions-trading would allow for this if one auctioned all initial permits and used the revenue to offset other taxes. The vast majority of trading systems, however, begin with the governing entity distributing free emission credits to companies based on historical emission patterns rather than having an open auction for permits that would produce such revenue streams. Without an auction, the revenues in a trading scheme accrue only to private companies that trade in carbon permits, while the companies buying permits would pass the cost on to consumers. International emissions-trading approaches such as Kyoto's clean development mechanism are worse still: the beneficiaries of the scheme are likely to be foreign governments or private entities that can reduce (or pretend to reduce) carbon emissions more efficiently, leaving Americans with higher energy prices and no revenue stream to offset the negative impacts on productivity.

Exploring the Parameters of Carbon-Centered Tax Reform

Published estimates of an initial optimal carbon tax on fuels are in the range of $10 to $20 per ton of CO_2 emitted (in 2005 dollars). Nordhaus, for example, estimates the optimal rate for a tax implemented in 2010 to be $16 per ton of carbon and rapidly rising over time.[14] We will focus primarily on a tax rate of $15 per ton of CO_2, while also providing enough information to allow a reader to consider the likely impact of a range of possible taxes.

- **Background on Emissions.** According to the U.S. Energy Information Administration, emissions of CO_2 in the United States in 2005 equaled 6,009 million metric tons (MMT) of CO_2, an increase of twenty MMT over 2004.[15] Emissions have grown at an annual rate of 1.2 percent between 1990 and 2005. Recently, the rate has slowed, with the average annual rate between 2000 and 2005 equaling 0.5 percent.

- **Price Impacts.** Table 1, on the following page, shows the price impacts of a $15 per ton CO_2 tax under the assumption that the tax is fully passed forward. The price shown for gasoline is not in addition to that on crude oil (i.e., it is not a double-tax). It is included to show how the price levied on crude oil would change the price of the refined product.[16] This provides a rough guide to the excise tax equivalent price impacts of a tax on CO_2. We can scale the tax rates to evaluate different carbon taxes. For example, a $10 per ton tax on CO_2 would raise the price of coal by $28.55 x 0.66 = $18.84.

  A $15 CO_2 tax would raise the price of gasoline by 14¢ per gallon. A similar calculation can be made for coal-fired electricity. Using the most recent data from EPA's Emissions & Generation Resource Integrated Database (eGRID), we calculate that the average emission rate for coal-fired power plants is 2,395 pounds of CO_2 per megawatt-hour (MWh) of electricity. A $15 per ton CO_2 tax would raise the price of coal-fired electricity by 1.63¢ per kilowatt-hour (kWh), or 20 percent at an average electricity price of 8.3¢ per kWh.

Table 2 shows the impact of a $15 per ton carbon tax on the price of major fuels used in electricity generation. Fuel prices are prices at which the carbon tax would likely be applied.[17] Not surprisingly, coal is most heavily impacted by a carbon tax, with coal's price rising by more than three-quarters with a tax of this magnitude.

- **Behavioral Responses and Revenue.** The higher energy prices in table 2 should bring about a reduction in the demand for carbon-intensive fuels. A full analysis of equilibrium changes in carbon emissions requires a Computational General Equilibrium (CGE) model, an exercise that is beyond the scope of this paper. We can, however, make a rough calculation using previously published results from CGE models. Here, we extrapolate results from the analysis of Bovenberg and Goulder of a $25 per ton tax on carbon.[18] Table 3 presents the price and output changes for fossil fuels following the imposition of the carbon tax in Bovenberg and Goulder's study. We compute the arc elasticity as the ratio of the percentage output change to price change.

These response elasticities are not price elasticities in the usual sense, since they are the outcome of the entire general equilibrium response to the tax. These responses, for example, include a shift in electricity production away from coal toward natural gas and oil.[19] They are also relatively short-run responses, on the order of three to five years following the phased-in introduction (over three years) of the carbon tax.

The elasticities from table 3 combined with the price increases in table 2 imply the reductions in fuel use and carbon emissions seen in table 4.

TABLE 1
PRICE IMPACTS OF A $15 CO_2 TAX

	Coal	Crude Oil	Natural Gas	Gasoline
Energy Unit	**Short Ton**	**Barrel**	**mcf**	**Gallon**
MT C/Quad Btu	25,980,000	20,300,000	14,470,000	19,340,000
Mt CO_2/Quad Btu	95,260,000	74,433,333	53,056,667	70,913,333
Btu/Energy Unit	19,980,000	5,800,000	1,027,000	124,167
Mt CO_2/Energy Unit	1.903	0.432	0.054	0.009
Tax/Energy Unit	$28.55	$6.48	$0.81	$0.14

SOURCES: Carbon content of fuels from www.eia.doe.gov/environment.html; energy content of fuels from U.S. Department of Energy (DOE), Energy Information Administration (EIA), *Annual Energy Review 2005*, DOE/EIA-0384(2005), Washington, DC: EIA, 2006.

TABLE 2
SHORT-RUN PRICE EFFECTS OF A $15 CO_2 TAX

Energy Source	Unit	Price Per Unit ($)	Tax Per unit of Energy	Price Change (%)
Coal	short ton	$34.29	28.55	83.3
Crude Oil	barrel	$60.23	6.48	10.8
Natural Gas	thousand cubic feet	$8.53	0.82	9.6

SOURCE: Prices are 2006 averages as reported by Energy Information Administration (EIA). Coal statistics from EIA, "Receipts, Average Cost and Quality of Fossil Fuels," available at www.eia.doe.gov/cneaf/electricity/epm/table4_2.html; crude oil statistics from EIA, "Refiner Acquisition Cost of Crude Oil," available at http://tonto.eia.doe.gov/dnav/pet/pet_pri_rac2_dcu_nus_a.htm; and natural gas statistics from EIA, "Natural Gas Prices," available at http://tonto.eia.doe.gov/dnav/ng/ng_pri_sum_dcu_nus_m.htm. Unit taxes computed from table 1.

NOTE: Tax is assumed to be fully passed forward.

TABLE 3
IMPLIED OUTPUT ELASTICITIES

	Price Change (%)	Output Change (%)	Output Elasticity
Coal Mining	54.50	-19.10	-0.350
Oil	13.20	-2.10	-0.159
Natural Gas	13.20	-2.10	-0.159

SOURCE: A. Lans Bovenberg and Lawrence Goulder, "Neutralizing the Adverse Industry Impacts of CO_2 Abatement Policies: What Does It Cost?" in *Distributional and Behavioral Effects of Environmental Policy*, eds. Carlo Carraro and Gilbert E. Metcalf (Chicago: University of Chicago Press, 2000), table 2.2.

NOTE: Output elasticity is the ratio of the percent change in quantity demanded divided by the percent change in price, multiplied by negative one.

As table 4 shows, CO_2 emissions are reduced by 663 million metric tons, a decline of 11 percent. Most of the reduction in emissions comes from reduced coal use. A static estimate of CO_2 tax revenue (ignoring the behavioral response) suggests that a $15 tax would raise $90.1 billion per year in the near term.[20] Allowing for the emissions reductions calculated in table 4, the tax would raise $80.2 billion per year. Clearly, the tax would raise less money in future years as greater reductions in carbon emissions occurred through improvements in efficiency, fuel switching, or new technologies like carbon capture and sequestration.[21] The revenue estimate, however, does not factor in growth in demand for electricity nor the baseline growth in carbon emissions that would result in the absence of any carbon policy.

Applying this approach to different carbon tax rates gives the results for emissions reductions and tax revenues seen in table 5.

While these results are useful for providing a ballpark estimate of the impact of a carbon tax, more detailed modeling will be required to refine them further. Our estimates are broadly consistent with results from more detailed CGE modeling of U.S. carbon policies.[22]

TABLE 4
EMISSIONS REDUCTIONS FOR A $15 TAX

Energy Source	Output Change (%)	CO_2 Emissions (MMT)	Reduction in CO_2 Emissions (MMT)
Coal	–29.2	2,046	597.1
Crude Oil	–1.7	2,832	48.4
Natural Gas	–1.5	1,130	17.2
Total	N/A	6,009	662.8

SOURCE: Authors' calculations.

TABLE 5
VARYING THE TAX RATE

Tax Rate Per Ton ($)	Emissions Reductions (%)	Tax Revenue ($ billions, annual rate)
10	7.40	55.7
15	11.0	80.2
20	14.7	102.5
25	18.4	122.6

SOURCE: Authors' calculations.

TABLE 6
CARBON TAXES AS A SHARE OF OTHER TAXES

Tax Rate Per Ton ($)	Tax Revenue ($ billions)	Personal Income Tax (%)	Corporate IncomeTax (%)	Payroll Taxes (%)
10	55.7	6.0	20.0	7.0
15	80.2	8.6	28.8	10.1
20	102.5	11.1	36.8	12.9
25	122.6	13.2	44.1	15.4

SOURCE: Authors' calculations.

- **Potential Uses of Revenue.** Carbon tax revenues could be used for a number of purposes, such as lowering payroll and corporate income taxes, funding tax relief to low-income earners most affected by increased energy prices, or a combination of these. Table 6 reports the carbon tax revenue from table 5 as a percentage of various tax collections in 2005, as reported in the most recent administration budget submission.

A $15 per ton CO_2 tax raises enough revenue to reduce the corporate income tax by over one-quarter and income or payroll taxes by roughly 10 percent. In a policy brief for the Brookings Institution and the World Resources Institute, economist Gilbert Metcalf estimated that a rebate of the employer and employee payroll tax contribution on the first $3,660 of earnings per worker in 2003 would be sufficient to make the carbon tax both revenue- and distributionally neutral.[23]

Distributional neutrality may well impact the desirability and political feasibility of a carbon tax, but there are efficiency considerations as well. There is substantial literature on the "double dividend" that examines the economic conditions under which a

carbon tax can be paired with a reduction in other taxes in a manner that improves the overall efficiency of the economy. Where such a double dividend is available, a carbon tax swap would be desirable, even if the environmental benefit of reduced carbon emissions failed to be realized.

The concept of the double dividend stems from the observation that a tax on an environmental externality not only helps curb the externality (dividend 1), but also provides revenue with which other distorting taxes can be reduced, thereby providing efficiency gains (dividend 2).[24]

The double dividend comes in different levels.[25] The "weak" double dividend states that if one has an economically distorting tax, using environmental tax proceeds to lower it provides *greater efficiency gains* than returning the proceeds lump sum to those who pay the environmental tax. An intermediate form of the double dividend hypothesis is that there exists a distortionary tax, such that using environmental tax proceeds to lower this tax will *improve welfare*, setting aside environmental benefits.[26] A strong form claims that a welfare gain will occur when environmental proceeds replace those of the typical distorting tax.

A tax swap would create economy-wide incentives for energy efficiency and lower-carbon energy, and by raising the price of energy, would also reduce energy use.

The weak double dividend is uncontroversial,[27] while the strong double dividend is somewhat more controversial.[28] Criticisms notwithstanding, logic suggests that the pursuit of a strong double dividend is desirable as a matter of public policy. To that end, it would seem much more desirable in terms of efficiency to pursue capital tax reduction as a revenue feedback than other choices, as the current treatment of capital in the tax code is quite far from the optimal tax of zero, and the efficiency gains from a reduction in a payroll tax would likely be minimal if labor is, as is generally accepted, supplied relatively inelastically.

It should be noted that cap-and-trade systems and carbon-tax systems can be designed so they are quite similar. If, for example, emissions are capped and permits are auctioned off, then one could, after observing the auction price, set a carbon tax that leads to a similar emissions and revenue outcome. Cap-and-trade systems, however, generally have been pursued as an alternative to revenue-raising taxes, and often allocate the permits according to some formula rather than through an auction. For the purposes of exposition, we compared a carbon tax to this latter form of the cap-and-trade system. One should remember that cap-and-trade proposals can be adjusted to raise revenues, and the revenues could then be used to pursue the double dividend. In that case, the relative merits of a carbon tax would be diminished.

Achieving a More Efficient System

A cap-and-trade approach to controlling GHG emissions would be highly problematic. A lack of international binding authority would render enforcement nearly impossible, while the incentives for cheating would be extremely high. The upfront costs of creating institutions to administer trading are significant and likely to produce entrenched bureaucracies that clamor for ever-tighter controls on carbon emissions. Permit holders will see value in further tightening of caps, but will resist efforts outside the cap-and-trade system that might devalue their new carbon currency. Higher energy costs resulting from trading would lead to economic slowdown, but as revenues would flow into for-profit coffers (domestically or internationally), revenues would be unavailable for offsetting either the economic slowdown or the impacts of higher energy prices on low-income earners.

A program of carbon-centered tax reform, by contrast, lacks most of the negative attributes of cap-and-trade, and could convey significant benefits unrelated to GHG reductions or avoidance of potential climate harms, making this a no-regrets policy. A tax swap would create economy-wide incentives for energy efficiency and lower-carbon energy, and by raising the price of energy would also reduce energy use. At the same time, revenues generated would allow the mitigation of the economic impact of higher energy prices, both on the general economy and on the lower-income earners who might be disproportionately affected by such a change. Carbon taxes would be more difficult to avoid, and existing institutions quite adept at tax collection could step up immediately. Revenues would remain in-country, removing international incentives for cheating or insincere participation in carbon-reduction programs. Most of these effects would remain beneficial even if science should

determine that reducing GHG emissions has only a negligible effect on mitigating global warming.

A modest carbon tax of $15 per ton of CO_2 emitted would result in an 11 percent decline in CO_2 emissions, while raising non–coal-based energy forms modestly. Coal-based energy prices would be affected more strongly, which is to be expected in any plan genuinely intended to reduce GHG emissions. A number of possible mechanisms are available to refund the revenues raised by this tax. On net, these tools could significantly reduce the economic costs of the tax and quite possibly provide economic benefits.

For these reasons, we conclude that if aggressive actions are to be taken to control GHG emissions, carbon-centered tax reform—not GHG emission trading—is the superior policy option.

AEI editorial associate Nicole Passan worked with Messrs. Green, Hayward, and Hassett to edit and produce this Environmental Policy Outlook.

Notes

1. United States Environmental Protection Agency (EPA), "Progress Reports," available at www.epa.gov/airmarkets/progress/progress-reports.html.

2. Sequestration projects currently appear to be not only very expensive, but they also reduce net power generation by as much as 20 percent, further aggravating the cost that will be passed along to consumers and rate payers.

3. Robert J. Shapiro, "Addressing the Risks of Climate Change: The Environmental Effectiveness and Economic Efficiency of Emissions Caps and Tradable Permits, Compared to Carbon Taxes," February 2007, 22, available at www.theamericanconsumer.org/Shapiro.pdf.

4. William Nordhaus, "Life after Kyoto: Alternative Approaches to Global Warming Policies" (NBER working paper no. W11889, December 2005), 15.

5. Ibid., 22.

6. Robert J. Shapiro, "Addressing the Risks of Climate Change: The Environmental Effectiveness and Economic Efficiency of Emissions Caps and Tradable Permits, Compared to Carbon Taxes."

7. RECLAIM covered 390 stationary sources of NOx and fourteen stationary sources of SO_2, which represented only 17 percent of total basin-wide NO_x emissions and 31 percent of basin-side SO_2 emissions.

8. The Clean Air Act forbids it, in fact. SCAQMD's RECLAIM regulations read: "An RTC [RECLAIM Trading Credit] shall not constitute a security or other form of property." Section 4 of the RECLAIM regulations reiterated this point: "Nothing in District rules shall be construed to limit the District's authority to condition, limit, suspend, or terminate any RTCs or the authorization to emit which is represented by a Facility Permit." (Cited in James L. Johnston, "Pollution Trading in La-La Land," *Regulation* [Fall 1991], available at www.cato.org/pubs/regulation/reg17n3-johnston.html.)

9. Carbon Tax Center, "Who Supports," available at http://carbontax.wrkng.net/who-supports/.

10. William Pizer, "Choosing Price or Quantity Controls for Greenhouse Gases," *Resources for the Future Climate Issues Brief* 17 (July 1999).

11. Louis Kaplow and Steven Shavell, "On the Superiority of Corrective Taxes to Quantity Regulation," *American Law and Economics Review* 4, no. 1 (2002).

12. William Pizer, "Choosing Price or Quantity Controls for Greenhouse Gases."

13. William Nordhaus, "Life after Kyoto: Alternative Approaches to Global Warming Policies," 15.

14. Ibid.

15. U.S. Department of Energy (DOE), Energy Information Administration (EIA), *Emissions of Greenhouse Gases in the United States 2005*, DOE/EIA-0573(2005), Washington, DC: DOE, 2006. Total GHG emissions equaled 7,147 million metric tons CO_2 equivalent using hundred-year global warming potentials. Note that a simple conversion of other GHGs (i.e., methane, nitrous oxides, HFCs, and PFCs) does not exist. The global warming potential depends on the time horizon. We focus on CO_2 only in this study, though, ideally, a carbon tax would also tax these non-CO_2 emissions.

16. This is a standard assumption borne out by CGE modeling. See, for example, A. Lans Bovenberg and Lawrence Goulder, "Neutralizing the Adverse Industry Impacts of CO_2 Abatement Policies: What Does It Cost?" in *Distributional and Behavioral Effects of Environmental Policy*, eds. Carlo Carraro and Gilbert. E. Metcalf (Chicago: University of Chicago Press, 2000), 45–85.

17. We assume the tax on coal would be applied for electric utilities and major industrial coal users. Note that 91 percent of domestic and imported coal is consumed by electric utilities. (DOE, EIA, *Emissions of Greenhouse Gases in the United States 2005*.) The tax on crude oil is levied at refineries, and the tax on natural gas at the city gate.

18. A. Lans Bovenberg and Lawrence Goulder, "Neutralizing the Adverse Industry Impacts of CO_2 Abatement Policies: What Does It Cost?"

19. Increased coal prices could also lead to increased demand for imported oil, an important policy consideration outside the scope of this paper.

20. Carbon taxes can be reported in either units of carbon or CO_2. To convert a tax rate per unit of carbon dioxide to a rate per unit of carbon, multiply the CO_2 rate by 44/12 (the mass difference between carbon and CO_2). Thus, a tax of $10 per ton of CO_2 is equivalent to a tax of $36.67 per ton of carbon.

21. The recent coal study by researchers at the Massachusetts Institute of Technology suggests that carbon capture and sequestration is cost competitive at a carbon price of $30 per ton of CO_2. See John Deutch and Ernest Moniz, *The Future of Coal* (Massachusetts Institute of Technology, 2007), available at http://web.mit.edu/coal/.

22. Sergey Paltsev et al., *Assessment of U.S. Cap-and-Trade Proposals*, report 146 (Cambridge, MA: MIT Joint Program on the Science and Policy of Global Change, 2007), available through http://mit.edu/globalchange/www/abstracts.html#top.

23. Gilbert Metcalf, *A Green Employment Tax Swap: Using a Carbon Tax to Finance Payroll Tax Relief* (Washington, DC: Brookings Institution–World Resources Institution, 2007).

24. Don Fullerton and Gilbert E. Metcalf, "Environmental Taxes and the Double Dividend Hypothesis: Did You Really Expect Something for Nothing?" *Chicago-Kent Law Review* 73, no. 1 (1998): 221–56.

25. See Lawrence H. Goulder, "Environmental Taxation and the 'Double Dividend': A Reader's Guide," *International Tax and Public Finance* 2 (1995): 157–83, for a thorough taxonomy of the various double dividends. Also see A. Lans Bovenberg and Lawrence Goulder, "Neutralizing the Adverse Industry Impacts of CO_2 Abatement Policies: What Does It Cost?"

26. The terminology of intermediate and strong double dividends is due to Goulder, "Environmental Taxation and the 'Double Dividend': A Reader's Guide."

27. Mustafa Babiker, Gilbert E. Metcalf, and John Reilly, "Tax Distortions and Global Climate Policy," *Journal of Environmental Economics and Management* 46 (2003): 269–87. Babiker et al. show that it is possible, however, to find taxes such that lump-sum replacement dominates, lowering a distortionary tax.

28. A. Lans Bovenberg and Ruud de Mooij, "Environmental Levies and Distortionary Taxation," *American Economic Review* 84, no. 4 (1994): 1085–89. See also Lawrence H. Goulder, "Environmental Taxation and the 'Double Dividend': A Reader's Guide."

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Climate Change: The Resilience Option

By Kenneth P. Green

> "The willow which bends to the tempest, often escapes better than the oak which resists it; and so in great calamities, it sometimes happens that light and frivolous spirits recover their elasticity and presence of mind sooner than those of a loftier character."
>
> —Albert Schweitzer

The Earth's climate is prone to sharp changes over fairly short periods of time. Plans that focus simply on stopping climate change are unlikely to succeed; fluctuations in the Earth's climate predate humanity. Rather than try to make the climate static, policymakers should focus on implementing resilience strategies to enable adaptation to a dynamic, changing climate. Resilience strategies can be successful if we eliminate current risk subsidies and privatize infrastructure.

Recent climate research tells us that our climate is not the placid, slow-changing system people assume it to be. Instead, it is prone to sharp changes over fairly short periods of time. Whether those changes are natural or caused by human actions, we now know that we live in a world of greater climatic risks. Previous generations did not think about, plan for, or factor in these risks when they sited their cities and decided how to build and manage them. While planning was done for weather in what was considered a largely predictable system, little thought was given to making cities resilient to climate variability. As efforts to reduce greenhouse gas (GHG) emissions fail, we need to consider alternative plans and actions to reduce the risks we face.

The United Nations Intergovernmental Panel on Climate Change (IPCC) has always discussed the idea of adaptation to climate change as a second- or third-best response—something to be done only after every possible effort has been made to reduce GHG emissions. Both governmental and environmental groups have generally been hostile to adaptation-based responses to climate change, as they view such approaches as surrender—an acceptance of the idea that GHG emissions will continue, that the climate will change, and that people will come to believe they can adapt. They fear that a focus on adapting to climate change would detract from a focus on mitigating emissions.

There will be arguments about mitigating GHG emissions for many years (and perhaps decades) to come, but our new understanding of how variable our climate can be suggests we should broaden our climate policy focus by

Key points in this *Outlook*:

- Climate change is almost impossible to stop.
- While working on that problem, we need to shift policymaking to resilience building and adaptation.
- This can be successful if we eliminate current risk subsidies and privatize infrastructure.

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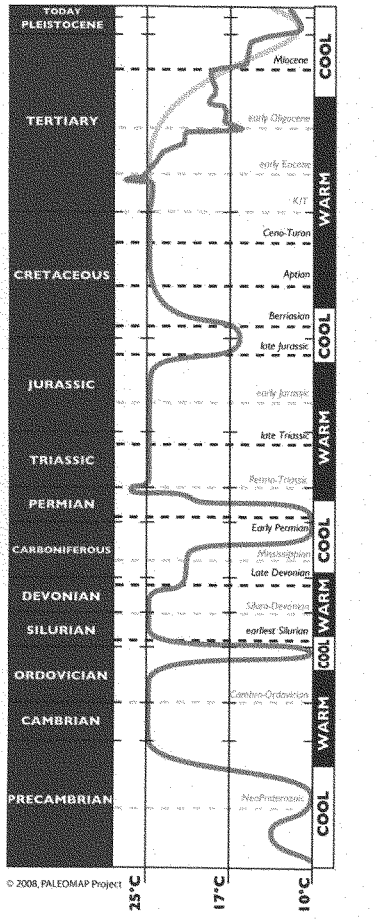
strengthening our efforts to facilitate adaptation. We should focus on building resilience as an approach to protecting ourselves from the risks of climate change as superior to a static approach that singles out only one possible climate influencer (the GHGs) and largely ignores natural climate variability.

This *Outlook* discusses our variable climate and outlines an agenda for building climate resilience that can be implemented immediately and that could offer significant protection for future generations from climate variability.

FIGURE 1
EARTH'S LONG-TERM CLIMATE HISTORY



SOURCE: Christopher R. Scotese, "The Paleomap Project" (Paleomap website, 2002), available at www.scotese.com/climate.htm.

Our Variable Climate

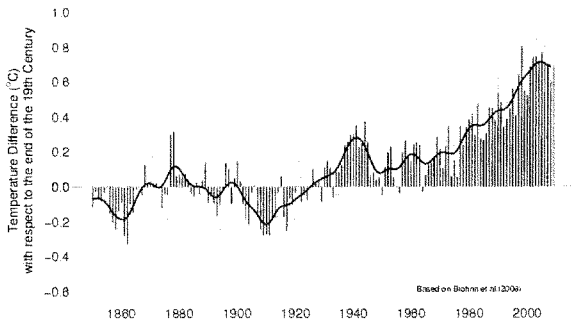
Whether viewed in long- or short-term periods, the Earth's climate history is one of variability, not stasis. Our planet has moved into and out of ice ages and warm periods for as long as we have evidence of historic climate. Figure 1 shows the longest-term picture of climate variability scientists have developed, which uses measured and proxy data. Proxy data consist of estimated temperatures (or other climate variables such as atmospheric moisture) developed by studying what are, in essence, climate fossils: tree rings, ice cores, fossil diatoms, boreholes, fossilized plant leaves, and so on. While proxy data should be considered less reliable than empirical data (meaning that the farther back we look, the more hazy the picture becomes), the scientific paleotemperature reconstructions clearly show the huge variability of the Earth's climate.[1]

The causes of global climate change are a combination of astronomical, geological, oceanographic, geographical, and biological "forcings." Forcings are things that can change the Earth's balance of incoming and outgoing radiation, making the climate warmer or cooler. On the astronomic side of the equation are changes in solar output and cosmic wind, as well as the angle and inclination of the Earth with respect to the sun. On the geological side are variations in volcanic activity or oceanic GHG flux and the response of atmospheric water vapor to climate change. On the biological side of the equation are changes in GHG emissions caused by animals (termites, ruminants, humans) and the production and sequestration of atmospheric carbon by plants and other photosynthetic organisms (such as phytoplankton). On the geographical side, changes in reflectivity of the land through changes in land use and the emission of different amounts of reflective and absorptive particulate pollution can also affect the local climate.

For more recent time periods, scientists have data of slightly better reliability (though there are still problems with data quality). The land temperature record shows that the climate has indeed been changing in

the last century. As figure 2 shows, according to the surface temperature record, there have been five stages of change since 1850, when measurements began. From 1910 to 1940, the Earth experienced a period of warming; from 1940 through 1970, a pronounced cooling; from 1970 to 2000 a pronounced warming; from 2000 to the present, the rate of warming has flattened out and begun to decline.

FIGURE 2
GLOBAL AVERAGE NEAR-SURFACE TEMPERATURES, 1850–JUNE 2009



SOURCE: UK Met Office, "Annual Global and Hemispheric Surface Temperatures," HadCrut3 data set, www.metoffice.gov.uk/climatechange/science/monitoring/temperatures.html.
NOTE: The solid bars show the global annual average near-surface temperature anomalies from 1850 to June 2009. The error bars show the 95 percent uncertainty range on the annual averages. The thick line shows the annual values after smoothing with a twenty-one-point binomial filter.

The last published report of the United Nations IPCC says that "[m]ost of the observed increase in global average temperatures since the mid-twentieth century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations."[2] Others dispute this assertion, arguing that climate models are attributing too much influence to GHGs in the atmosphere.[3]

This *Outlook* does not focus on the question of climate change causality (there are plenty of studies that do), but it is fair to say that scientific understanding of which factors contribute to changes in the Earth's climate is still in a very early stage. Even the experts at the IPCC acknowledge this to be the case. Figure 3, from the Fourth Assessment Report of the IPCC, shows how limited scientific understanding of climate forcing really is. Scientific understanding of potential anthropogenic forcings is often medium-low to low. The same applies to scientific understanding of the nonbiological factors in climate change: articles disputing the role of solar output, cosmic ray flux, ecological GHG contributions, and responses are published on an ongoing basis.[4] From a policy perspective, the important policy question is less about the *cause* of climate variability than about the best response to climate variability, whether manmade or natural.

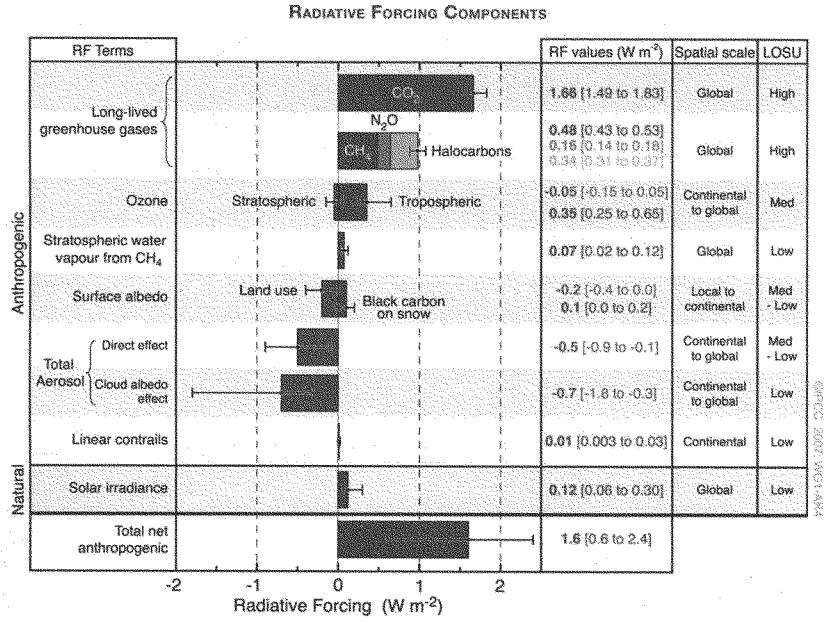
What Is Better, Climate Resilience or Climate Stasis?

In general, the mainstream response to the issue of climate change has been reactive, pessimistic, authoritarian, and resistant to change. Those alarmed about a changing climate would stand athwart the stream of climate history and cry "stop, enough!" Rather than working to cease human influence on climate, they want to find a way to make the climate stand still. This focus on creating climate stasis has led to policy proposals that would have been laughed at or dismissed as wacky conspiracy theories in the 1980s. But mainstream anti–climate change activists are proposing nothing less than the establishment of global weather control through energy rationing, regulations, and taxes, all managed by a global bureaucracy with a goal of leading humanity into a future that will become smaller, more costly, and less dynamic over time. Environmental groups, along with organizations like the United Nations IPCC, are calling for nothing less than imposing climate stasis on a chaotic system.

Consider the climate bill now before Congress: the Waxman-Markey *American Climate and Energy Security Act*. Waxman-Markey sets the ambitious target of reducing total U.S. GHG emissions by 83 percent below 2005 levels by the year 2050 (with intermediate benchmarks at 2020 and 2030). Thus, the cap and the allowances sold pursuant to it will be lowered from a peak of 5.4 billion tons in 2016 to just a little over 1 billion tons in 2050. As my colleague Steven F. Hayward and I have pointed out elsewhere, these targets are absurd.[5] From Department of Energy historical statistics

FIGURE 3

GLOBAL MEAN RADIATIVE FORCINGS, WITH LEVELS OF SCIENTIFIC UNDERSTANDING



SOURCE: IPCC, "2007: Summary for Policymakers," *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (New York and Cambridge: Cambridge University Press, 2007), 4, available at www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-spm.pdf (accessed September 28, 2009).

NOTE: Global average radiative forcing estimates and ranges in 2005 for anthropogenic carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and other important agents and mechanisms, together with the typical geographical extent (spatial scale) of the forcing and the assessed level of scientific understanding (LOSU). The net anthropogenic radiative forcing and its range are also shown. These require summing asymmetric uncertainty estimates from the component terms and cannot be obtained by simple addition. Additional forcing factors not included here are considered to have a very low LOSU. Volcanic aerosols contribute an additional natural forcing but are not included in this figure due to their episodic nature. The range for linear contrails does not include other possible effects of aviation on cloudiness.

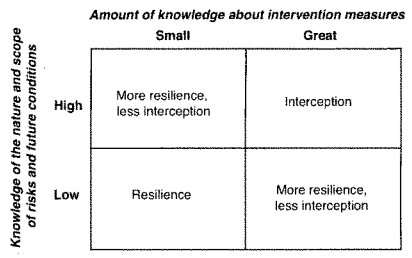
on energy consumption, it is possible to estimate that the United States last emitted 1 billion tons in the year 1910, when the nation's population was only 92 million people, per-capita income (in 2008 dollars) was only $6,196, and total GDP (also in 2008 dollars) was about $572 billion—about one-twenty-fifth the size of the U.S. economy today. By the year 2050, however, the United States is expected to have a population of 420 million, according to Census Bureau projections—more than four times the population of 1910. In order to reach the 83 percent reduction target, per-capita carbon dioxide (CO_2) emissions will have to be no more than 2.4 tons per person—only one-quarter the level of per-capita emissions in 1910.

When did the United States last experience per-capita CO_2 emissions of only 2.4 tons? From the limited historical data available, it appears that this was about 1875. In 1875, the nation's GDP (in 2008 dollars) was $147 billion, per-capita income (in 2008 dollars) was $3,300, and the population was only 45 million.[6]

My colleague Kevin A. Hassett, Hayward, and I have also written elsewhere about the problems with cap-and-trade and suggested that a revenue-neutral carbon tax would be preferable,[7] but that, too, represents an effort to impose stasis on a dynamic system simply using more efficient means. A carbon tax is, to be sure, vastly superior to a cap-and-trade system, but there are doubts that it is politically possible to enact one in a way that is actually revenue-neutral and is not abused by politicians who will look to tax those they dislike and rebate the taxes to groups they favor, namely, those that are most inclined to vote for their party.

A more forward-looking, optimistic, and free-market approach to the risks of climate variability accepts that the climate has been, is, and will be variable; focuses on the risks of variability; and looks for ways to build resilience in the face of that change, regardless of cause.

FIGURE 4
APPROPRIATE STRATEGIES FOR DIFFERENT STATES OF KNOWLEDGE



SOURCE: Adapted from Aaron Wildavsky, *Searching for Safety* (New Brunswick, NJ: Transaction Publishers, 1988), 122.

Aaron Wildavsky's Resilience Paradigm

Aaron Wildavsky, one of the great policy analysts of the late twentieth century, wrote extensively about the benefits of resilient social institutions. Wildavsky observed that possible risk-reduction interventions lie along a spectrum from resilient to interceptive. Resilient approaches maximize our ability to cope with risk by maintaining a dynamic, market-based, knowledge-building strategy. Interceptive interventions emphasize specific risk-reduction efforts that require certain specific actions and prohibit or restrict others.[8] But how do we decide, for a given risk such as climate change, whether an interceptive approach is more likely to provide greater safety than a resilient approach?

Wildavsky demonstrated that uncertainties about the likelihood or extent of any given risk and about the effectiveness of any intervention constrain risk-reduction decisions.[9] Figure 4 shows how uncertainties about the nature and scope of a risk and uncertainties about intervention measures and their effects constrain strategy selection, favoring certain approaches over others.

Employing both theory and empirical observation, Wildavsky observed that a strategy of interception is likely to be successful only in situations of truly excellent information. So, for example, for a power plant owner who knows that a particular part is going to burn out every 150 days, an interception strategy of replacing the part every 149 days to prevent the risk is likely cost-effective. But where less information exists, more resilient strategies are likely to succeed because interception will be either infeasible or expensive in such situations. If a power plant had eight thousand critical pieces of equipment that would create a fire upon failure, but the plant owner did not know the failure rates of each piece, trying to intercept the risk by replacing pieces before they failed would be enormously costly. Further, trying to have backup systems on all eight thousand pieces would be technologically difficult and probably not financially feasible. Instead, a strategy of resilience, such as implementing a sophisticated fire-response system, is more likely to be a feasible and efficient way of dealing with this risk.

In the case of climate change, our knowledge of the nature and scope of risks and future conditions is low, and our knowledge about how to intervene to head off specific risks is small. This suggests that contrary to current policy approaches that focus on mitigating GHG emissions largely to the exclusion of everything else, resilience should be considered the default climate strategy. As Wildavsky observed:

- Resilient systems build knowledge through research and build safety through efficient use of resources, enhancing the ability to respond to and reduce risks over time.

- Resilient approaches optimize use of local knowledge of specific and particular circumstances. Since resources are retained by individuals and firms in the social and economic system, people will instinctively reduce risks as they perceive them.

- Resilient approaches create spillover knowledge by building knowledge at local levels that can then be brought into play in other areas. Research is a natural part of resilient systems.[10]

Wildavsky illustrates these characteristics, drawing from the work of systems ecologists Kenneth E. F. Watt and Paul Craig. In one example, Wildavsky explains why a market-based system is more stable and, therefore, safer: the complexity and intricate nature of negative and positive feedback as conveyed through a market is a powerful stabilizing force whether that market is financial or involves the way energy is distributed through an ecosystem. Natural systems exhibit this complexity and rich feedback milieu, but so do economic systems:

> Systems of great complexity, with stability maintained by a lot of fast acting negative feedback loops are complex economies, with prices responding freely to trends in supply and demand. In such circumstances, we see very rapid introduction of new products, or replacement of old by new products.[11]

In yet another example, Wildavsky points out that ecological studies present cautionary findings with regard to poor specific risk-reduction investments:

> We are specifically concerned with stability of the entire system in contradistinction to stability of each component of the system. That is, we understand that in biological, economic, or any other kind of systems, the former can be maintained at the expense of the latter. Putting this differently, if the goal adopted is to preserve stability of particular system components, the ultimate consequence can be decreased stability in the entire system.[12]

To a large extent, the resilience option is the complete opposite of the climate-stasis approach; it focuses on decentralization, deregulation, and freeing markets to maximize resilience.

Managing Risks with Resilience-Building Policies

A vast range of risks has been discussed in the context of climate change, from flood to drought, threatened food supplies, more deadly insect-borne diseases, higher heat-related deaths, rising sea levels, and so forth. The risks discussed in this *Outlook* are not future probabilities based on empirical evidence and extrapolation. Rather, they derive from computer models of potential future change and are, therefore, not to be taken as known threats but rather as hypothesized threats made using relatively primitive modeling technology subject to the garbage-in, garbage-out problem typical of the breed. The risks are discussed here with that limitation in mind, as potential risks, without any measure of probability attached. Several approaches economists and policy analysts have identified could help increase social resilience to such risks.

Contrary to current policy approaches that focus on mitigating GHG emissions largely to the exclusion of everything else, resilience should be considered the default climate strategy.

Eliminate Risk Subsidies. Predicted damages associated with sea levels and storms are high because of the popularity of such locales for high-density business and upscale residential development. As a result, damages from extreme coastal weather events have been hugely expensive. The damages from Hurricane Katrina, for example, reached over $150 billion.[13] The question, however, is why was there so much value that was so badly protected against completely predictable events? Levees and sea walls were underdesigned. Many houses and businesses were not insured against flood damage. As Charles Perrow observes in *Our Next Catastrophe*, "Even in areas known to be hazardous, only about 20 percent of homeowners purchase flood insurance, and less than 50 percent of businesses purchase flood and earthquake insurance in risky areas."[14]

The answer to that question lies, at least in part, in the presumed role of state and federal governments as the insurer of last resort. People know that in the event of a disaster, even if uninsured, the Federal Emergency Management Agency will give grants to let people recover from natural disasters such as hurricanes, floods, and storm surges. Without such assurances, we can assume that many people would be unwilling to face the

risk of living in coastal areas that could be flooded by rising sea levels and would relocate to higher ground. Capital needed for businesses would also avoid areas of high risk due to sea-level rise, preventing further siting of high-value structures in vulnerable areas.

As researchers at the Wharton Risk Center observe:

> Highly subsidized premiums or premiums artificially compressed by regulations, without clear communication on the actual risk facing individuals and businesses, encourage development of hazard-prone areas in ways that are costly to both the individuals who locate there (when the disaster strikes) as well as others who are likely to incur some of the costs of bailing out victims following the next disaster (either at a state level through ex post [facto] residual market assessments or through federal taxes in the case of federal relief or tax breaks).[15]

Similarly, the CATO Institute points out:

> Government-provided programs for crop insurance and flood insurance, as well as other interventions in private disaster insurance markets, often are justified as necessary to overcome the failure of private markets to offer adequate and affordable disaster insurance. Defenders of government insurance programs claim that they reduce dependence on "free" disaster assistance and promote efficient risk management by property owners and farmers.
>
> But government policies are the cause of, not the cure for, the limited supply and narrow scope of private-sector disaster insurance. Demand for private coverage is low in part because of the availability of disaster assistance, which substitutes for both public and private insurance. Moreover, a government that cannot say no to generous disaster assistance is unlikely to implement an insurance program with strong incentives for risk management.
>
> The subsidized rates and limited underwriting and risk classification of federal government insurance programs aggravate adverse selection, discourage efficient risk management, and crowd out market-based alternatives.
>
> Federal tax policy reduces supply by substantially increasing insurers' costs of holding capital to cover very large but infrequent losses. State governments also intrude on insurance markets by capping rates, mandating supply of particular types of insurance, and creating state pools to provide catastrophe insurance or reinsurance coverage at subsidized rates. By reducing both the supply and demand sides of private insurance protection, government intervention leads to greater reliance on politically controlled disaster assistance and higher costs for taxpayers.[16]

Perrow makes the case that this is no better at the state level:

> State-mandated pools have been established to serve as a market of last resort for those unable to get insurance, but the premiums are low and thus these have the perverse effect of subsidizing those who choose to live in risky areas and imposing excess costs on people living elsewhere. In addition, the private insurers are liable for the net losses of these pools, on a market-share basis. The more insurance they sell, the larger their liability for the uninsured. Naturally, they are inclined to stop writing policies where there may be catastrophic losses (hurricanes in Florida and earthquakes in California). The Florida and California coastlines are very desirable places to live and their populations have grown rapidly, but these handsome lifestyles are subsidized by residents living in the less desirable inland areas in the state, and, to some limited extent, by everyone in the nation.[17]

If risk subsidies cannot be abolished entirely, at the very least, insurance companies should charge risk-based premiums. As Wharton researchers explain:

> Insurance premiums (whether public or private coverage) should, to the extent possible, reflect the underlying risk associated with the events against which coverage is bought in order to provide a clear signal to individuals and businesses of the dangers they face when locating in hazard-prone areas and [to] encourage them to engage in cost-effective mitigation measures to reduce their vulnerability to disasters.[18]

Privatize Infrastructure. Climate change could also pose a challenge for coastal or low-lying roadways, water-treatment facilities facing increased rainfall intensity, energy utilities facing increased summertime electricity demand, and so on. Governments are quite good at building infrastructure. After all, what politician does

not enjoy a ribbon cutting ceremony for some new element of name-bearing infrastructure? But governments are dismal at maintaining infrastructure, as they generally fail to establish a revenue stream to maintain a system that provides feedback about whether a particular road should be raised or a water-treatment facility expanded or a power capability increased. A solution to these problems, as well as a potential source of revenue for cash-strapped state and municipal governments, is the privatization of infrastructure. While a few poorly executed privatization efforts have tarnished the name, the baby should not be thrown out with the bath water; privatization offers a host of benefits. A great deal of research on privatization in developing and developed countries demonstrates that, on the whole, privatization shows considerably more benefit than risk.

It has long been known that certain types of risk are not suited to attempted prevention but instead must be met with the resilience needed to live with the risk. Climate change is one such risk that is virtually impossible to prevent.

In "An Assessment of Privatization," Sunita Kikeri and John Nellis conclude that "[i]n infrastructure sectors, privatization improves welfare, a broader and crucial objective when it is accompanied by proper policy and regulatory frameworks." Further, they observe that "ownership change in productive firms, as well as private investment in less than full ownership capacity, usually improves the financial situation of the firm and the fiscal position of selling government, increases returns to shareholders, and in the right policy circumstances, generates significant welfare benefits as well."[19] Private owners of infrastructure have a lot of investment tied up in getting a long-run stream of revenue from the infrastructure. Ensuring that future changes in climate do not disrupt that long-run cash flow is critical to their current financial performance.

Roadways. If roads are privately owned and tolled, road operators have a revenue stream to tap in order to raise, resurface, or recontour roadways to adapt to climate changes. If costs of such adaptation are high, tolls will rise, and at some point, an economic decision will occur about whether a road should be maintained or whether some alternate route should be developed. In some cases, people may indeed find their transportation options so limited that they must move away to a place with a less fragile climate. One can imagine something like this for some coastal roadways where there are no easy alternate routes, but it would probably be a fairly rare outcome. Still, if such situations did develop, this is a desirable outcome, as it is both economically efficient and reduces the likely cost of climate-related damages to structures.

Electricity Supply. As long as governments distort the prices consumers pay for energy with subsidies, fuel mandates, renewable power mandates, and the like, electricity markets cannot effectively adapt to changing climatic conditions. If electricity markets were fully deregulated, and if full costs were passed onto consumers, price signals would be created for the electricity provider in terms of expanding or decreasing capacity and for the consumer in terms of the real cost of living in an environment subject to energy-consuming heat waves (or cold snaps). Privatization would create incentives for electricity conservation and for the acquisition of energy-efficient appliances and devices without any need for specific governmental efficiency standards. Further, electric companies would be driven to connect with one another to ensure reliability to their customers rather than doing the minimum possible to satisfy regulators.

Water Supply. Full pricing of water and full privatization of the water supply, drinking water plants, and wastewater treatment plants would ameliorate many climatic risks incrementally over time, including flooding, seawater intrusion, and coastal and river pollution from storm runoff. Charging the full price for water, from supply to disposal, would create a price signal for consumers regarding the real risks they face living in hydrologically sensitive areas and create incentives for conservation while producing a revenue stream to allow for expanded capability or the securing of alternative supplies. At some point, again, high prices could simply lead people to move away from areas that are hydrologically costly, such as cities dependent on a single winter snow pack that shrinks or a single major river that suffers reduced flow.

Flooding. What is not achieved by removing insurance subsidies in flood-prone areas can be managed through the creation of privately administered hydrologic utilities, which would be financed by flood-protection fees charged to residents of flood-prone areas. Again, such a system creates a price signal that can show when it is and when it is not efficient to raise the height of a levee, for example, or to expand permeable surfacing requirements in development. The cost of paying for such activities would send the consumer a signal about the true cost of living in flood-prone areas and would ultimately lead those who could not afford to fully finance their level of risk to relocate to safer areas.

Trust in Resilience, but Tie Up Your Camel

In the event that climate change does tend toward higher estimates put forward by the United Nations and other groups, it is reasonable to consider insurance options that might help deal with such climate changes. Such options might include government investment in geoengineering research, investment in research and development to advance technologies allowing the removal of GHGs from the atmosphere, and possibly the creation of a climate adaptation fund to be used when state and local governments find themselves unable to cope with a given climate change, or even to compensate others should it ultimately be shown that U.S. emissions of GHGs have caused harm to other countries or the property of other individuals.

It has long been known that certain types of risk are not suited to attempted prevention but instead must be met with the resilience needed to live with the risk. Climate change is one such risk that is, as the world is increasingly observing, virtually impossible to prevent, whether it is manmade or natural.

As efforts to mitigate GHGs fail around the world, it is long past time to broaden the tools available to us in order to make our society resilient to climate risk. Rather than remain largely focused on the quixotic effort to reduce GHG emissions or to stand athwart the stream of climate and shout "stop, enough!" we should shift the majority of our policymaking attention to an agenda of resilience building and adaptation, two areas with which governments particularly struggle. Plan B for climate resilience should consist of an aggressive program of resilience building through the elimination of risk subsidies and the privatization of infrastructure. Other subsidies and regulations that make the overall economy more brittle in the face of climate change would also be ripe targets for removal, such as those which permeate energy and water markets.

The author would like to acknowledge the assistance of Dharana Rijal in producing this Outlook.

Notes

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4. Nir J. Shaviv and Ján Veizer, "Celestial Driver of Phanerozoic Climate?" GSA *Today* (July 2003), available at www.gsajournals.org/archive/1052-5173/13/7/pdf/i1052-5173-13-7-4.pdf (accessed September 24, 2009). See also Judith L. Lean and David H. Rind, "How Will Earth's Temperature Change in Future Decades?" *Geophysical Research Letters* 36 (August 2009), available at http://pubs.giss.nasa.gov/docs/2009/2009_Lean_Rind.pdf (accessed September 24, 2009).

5. Steven F. Hayward and Kenneth P. Green, "Waxman-Markey: An Exercise in Unreality," AEI *Energy and Environment Outlook*, no. 3 (July 2009), available at www.aei.org/outlook/100057.

6. It is possible that per-capita CO_2 emissions were never this low even before the advent of widespread use of fossil fuels: wood burning by Americans in the nineteenth century may have produced more than 2.4 tons of CO_2 per capita. Much depends on the emissions coefficient for wood burning and how, since wood is biomass rather than a fossil fuel, reforestation is credited in carbon accounting. In 1875, burning wood generated twice as much energy as fossil fuels.

7. Kenneth P. Green, Steven F. Hayward, and Kevin A. Hassett, "Climate Change: Caps vs. Taxes," AEI *Environment and Energy Outlook*, no. 2 (June 2007), available at www.aei.org/outlook/26286.

8. Aaron Wildavsky, *Searching for Safety* (New Brunswick, NJ: Transaction Publishers, 1988). Wildavsky used the terms "resilience" and "anticipation" rather than "resilience" and "interception." In adapting Wildavsky's framework to more recent risk-related issues, I have chosen to use "interception" because it corresponds better to common perceptions of how risk regulations work.

9. Ibid., 122.

10. Ibid.

11. Ibid., 114.

12. Ibid., 112.

13. Mark L. Burton and Michael J. Hicks, *Hurricane Katrina, Preliminary Estimates of Commercial and Public Sector Damages* (Huntington, WV: Marshall University Center for Business and Economic Research, September 2005), available at www.marshall.edu/cber/research/katrina/Katrina-Estimates.pdf (accessed September 24, 2009).

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15. Erwann O. Michel-Kerjan, "Disasters and Public Policy: Can Market Lessons Help Address Government Failures?" *The National Tax Journal* (January 2007), available at http://opim.wharton.upenn.edu/risk/library/07-04.pdf (accessed September 24, 2009).

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17. Charles Perrow, *The Next Catastrophe: Reducing Our Vulnerabilities to Natural, Industrial, and Terrorist Disasters*, 38–39.

18. Erwann O. Michel-Kerjan, "Disasters and Public Policy: Can Market Lessons Help Address Government Failures?"

19. Sunita Kikeri and John Nellis, "An Assessment of Privatization," *The World Bank Research Observer* 19, no. 1 (Spring 2004).