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EMERGING TECHNOLOGIES AND PRACTICES FOR REDUCING GREENHOUSE GAS EMISSIONS

HEARING

BEFORE THE

SUBCOMMITTEE ON PRIVATE SECTOR AND CONSUMER SOLUTIONS TO GLOBAL WARMING AND WILDLIFE PROTECTION

OF THE

COMMITTEE ON
ENVIRONMENT AND PUBLIC WORKS
UNITED STATES SENATE

ONE HUNDRED TENTH CONGRESS

FIRST SESSION

MAY 9, 2007

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EMERGING TECHNOLOGIES AND PRACTICES FOR REDUCING GREENHOUSE GAS EMISSIONS

WEDNESDAY, MAY 9, 2007

U.S. SENATE,
COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS,
SUBCOMMITTEE ON PRIVATE SECTOR AND CONSUMER
SOLUTIONS TO GLOBAL WARMING AND WILDLIFE PROTECTION,
Washington, DC.

The subcommittee met, pursuant to notice, at 10:10 a.m. in room 406, Dirksen Senate Office Building, Hon. Joseph I. Lieberman (chairman of the subcommittee) presiding.

Present: Senators Lieberman, Boxer, Carper, Craig, Inhofe, Voinovich and Warner.

Senator LIEBERMAN. Good morning and welcome to the hearing.

I apologize to the witnesses and my colleagues that I am a bit late this morning. I had to go to a briefing that was unexpected in the Capitol.

I want to welcome everyone here this morning. This is a hearing on Emerging Technologies and Practices for Reducing Greenhouse Gas Emissions.

STATEMENT OF HON. JOSEPH I. LIEBERMAN, U.S. SENATOR FROM THE STATE OF CONNECTICUT

Senator LIEBERMAN. Today, we are going to examine the private sector innovation that can put America on a path to curbing global warming without handicapping our economy, provided—and this is the "provided"—the Federal Government sends a strong new signal to the marketplace.

Last Friday, the Intergovernmental Panel on Climate Change (IPCC), issued a report on mitigating global warming. The report reflects the consensus reached by delegates from 120 countries. It finds that existing technologies—existing technologies—can reduce our greenhouse gas emissions significantly over the next two decades, and that commercializing these technologies would provide the cobenefits of increasing energy security and decreasing air pollution.

The IPCC report also concludes, however, that without strong new Government action, market forces alone will not lead to significant emissions reductions. For example, the IPCC finds that most voluntary agreements between industry and governments have not achieved anything near the emissions reductions required. By contrast, an effective carbon price signal could realize the poten-

tial of existing technologies to cut greenhouse gas emissions in all sectors of our economy.

A portfolio of existing technologies could set us on a safe emissions reduction track if governments like ours establish effective policy drivers for further development, acquisition, deployment and diffusion of those technologies.

So the purpose of today's hearing is in a very sort of on the ground detailed practical way, to examine some of the technologies that could help fill out that winning portfolio that I have described. These innovative solutions, I want to stress again, exist today, but they need new Government action if they are to be commercialized widely enough and quickly enough to avert the climate disaster that we fear.

The specific innovations that today's witnesses will describe also illustrate the cobenefits that the IPCC report mentions. These are technologies and practices that can also enhance America's energy independence and security, and improve public health, actually invigorate our economy, and improve our trading position in the world even as they preserve and enhance our ability to deal with the oncoming threat of global warming.

Fortunately, some of the technologies that our witnesses will describe also demonstrate that we can curb global warming, while continuing to use our most abundant, reliable natural energy source in America, and that is coal, coal reserves, to generate electricity particularly.

I am obviously not suggesting in what I have just said that we can accomplish all that we need to accomplish for nothing, that action will carry no price. What I am suggesting, however, is that all signs point to a very positive net return on any large new investment that we make in accelerating the deployment of these technologies to reduce global warming pollution.

We have an extraordinary group of witnesses here today. Four of the five are executives at significant and respected American corporations: American Electric Power, Babcock and Wilcox, General Electric and Wal–Mart. These companies are really leaders in energy, industrial and commercial sectors within our economy.

One of our witnesses is both a professor at one of the country's most esteemed engineering institutions, MIT. I say that notwithstanding the fact that my long time legislative director, Bill Bonvillian, is now the Washington representative of MIT, so I resent the institution for taking him from me, but nonetheless. This particular witness, beyond being on the MIT faculty, is a principal of a company that is developing cutting edge vehicle technologies for General Motors and other automotive companies.

So we are really privileged to have with us five witnesses that can speak with authority about emerging technologies that have the potential to start this country moving down a safe and productive pathway to greenhouse gas emission reductions.

Senator Warner, who I would not normally call next, has yielded to Senator Inhofe, who has to go on to another meeting. I am proud to recognize him now.

[The prepared statement of Senator Lieberman follows:]

STATEMENT OF HON. JOSEPH I. LIEBERMAN, U.S. SENATOR FROM THE STATE OF CONNECTICUT

Good morning, and welcome to this hearing on emerging technologies and practices for reducing greenhouse gas emissions. Today, we will examine the private sector innovations that can put America on a path to curbing global warming without forcing us to abandon our coal, give up our cars, or handicap our economy, provided the Federal Government sends a strong, new signal to the marketplace.

Last Friday, the Intergovernmental Panel on Climate Change, known as the IPCC, issued a report on mitigating global warming. This report reflects a consensus reached by delegates from 120 governments. It finds that existing technologies can reduce our greenhouse gas emissions significantly over the next two decades, and that commercializing these means of reducing greenhouse gas emissions would provide the cobenefits of increasing energy security and decreasing the air pollution that directly harms human health.

The IPCC report also concludes, however, that without strong new government action, market forces alone will not lead to significant emissions reductions. For example, the IPCC finds that most voluntary agreements between industry and governments have not achieved significant emissions reductions beyond business as usual.

By contrast, an effective carbon-price signal could, according to the IPCC, realize the potential of existing technologies to cut greenhouse gas emissions in all sectors of the economy. A portfolio of existing technologies could set us on a safe emissions track if governments like ours established effective policy drivers for the further development, acquisition, deployment, and diffusion of those technologies.

The purpose of today's hearing is to examine some of the technologies that could help fill out that winning portfolio. These innovative solutions exist today. But they need bold new government action if they are to be commercialized widely enough and quickly enough to preserve our ability to avert climate catastrophe.

The specific innovations that today's witnesses will describe also illustrate the cobenefits that the IPCC discusses. These are technologies and practices that can enhance America's energy security, improve public health, invigorate our economy, and improve our trading position in the world even as they preserve our ability to avoid leaving our children a world wracked by global warming.

Fortunately, some of the technologies that our witnesses will describe also demonstrate that we can curb global warming while continuing to use our abundant, reliable coal reserves to generate electricity.

I do not mean to suggest that we can get something for nothing that action will carry no price. What I am suggesting, rather, is that all signs point to a tremendously positive net return on any large, new investment that we as a Nation make in accelerating the deployment of technology to reduce global warming pollution.

Four of today's five witnesses are executives at large American corporations: American Electric Power, Babcock & Wilcox, General Electric, Wal-Mart. These companies are titans of the energy, industrial, and commercial sectors of our economy. One of our witnesses is both a professor at one of the country's most esteemed engineering institutions, MIT, and a principal of a company that is developing cutting-edge vehicle technology for General Motors and others.

These witnesses can speak with authority about emerging technologies that have the potential to start this country moving down a safe emissions pathway. Gentlemen, I look forward to hearing your testimony.

With that, I will invite my friend and colleague, Senator Warner, to make an opening statement.

STATEMENT OF HON. JAMES M. INHOFE, U.S. SENATOR FROM THE STATE OF OKLAHOMA

Senator INHOFE. Thank you, Mr. Chairman.

I thank Senator Warner for yielding to me.

Thanks for having a hearing focusing on technology. I believe that our Nation's pioneering of technology has been a vital component in America's prosperity, and I am fully committed to expanding new technologies and making our Nation a better place to live.

What technology paths and goals we choose will help determine if further innovation acts as a catalyst or a drag to future economic growth. Mr. Chairman, clearly we disagree on the state of science. Just last year, we discovered for the first time that trees emit

methane, which is a greenhouse gas, which wasn't included in any of the previous models. It seems as if we find out new things on almost a daily basis. New science is coming out all the time.

After Katrina, Senator Gore and some of the others seized the opportunity to claim global warming is causing more hurricanes, but 3 weeks ago, a peer-reviewed study found warming will increase wind shear, which reduces both the severity and the number of hurricane. Just last week, another peer-reviewed study by one of our Government's leading scientists, Dr. Christopher Landsea, found that the annual trend in the number of hurricanes since 1900 has in fact not increased.

My point is this: our policies should reflect a little humility when it comes to whether or not we are omnipotent. That is why I oppose propping up uncompetitive technologies for the sole purpose of trying to avert an over-hyped catastrophe by mandating attacks on carbon, or whether it is a cap and trade system.

Make no mistake, the various proposals currently before the Senate are taxes. The Kyoto Protocol—and we have talked about this many times before—would have imposed a tax increase of approximately $2,700 on each family of four. That came out of the study that is quite old right now, but more recently, I say to Dr. Chiang, MIT has come out with a study of many of the proposals showing that, for example, the Sanders-Boxer bill would impose a tax equivalent of more than $4,500 on a family of four by 2015. Senator Lieberman, the Lieberman–McCain bill is not much better. It would be $3,500 by 2015. That is a tax equivalent, assuming that Government sells the allowances and the amount of money, and then divide that into the families.

Now, if you carry that on out to 2020, the Sanders-Boxer bill would be $392 billion. Anyway, it would be even more substantial than it would be by 2015. I want to submit this report from MIT for the record immediately following my remarks.

Who would bear these costs? According to the Congressional Budget Office study released 2 weeks ago, a carbon cap in trade would result in a massive wealth redistribution from the poor and the working class to wealthier Americans. In short, carbon caps would artificially and needlessly raise the cost of energy the most on people who can least afford it. It astounds me that any Senator could support such a proposal.

I believe we should focus on approaches that unite, rather than divide. That is why I have supported for quite some time the Asia Pacific Partnership, and believe it should be fully funded and expanded. This would promote trade and transfers of technology between our Nation and developing countries, leading to increasing energy supplies and reducing pollution.

Mr. Chairman, it would also help you in your goal of reducing greenhouse gases from countries such as China, which later this year will become the largest emitter of CO_2. I think from my experience—I don't know whether any of the other members of this committee share this experience—the criticism that countries like China, India, Mexico and other countries don't have to share in all these problems and expenses that Americans do is something they find very offensive.

While we may disagree, Mr. Chairman, on the reasons, I share your view that nuclear energy is a vital component of our energy future. I applaud you that you have recognized its importance in the legislative proposals. We need more energy and we need to reduce our reliance on foreign sources. I think nuclear power and hydro—yes, I said "hydro"—should be a part of this equation. They neither pollute nor emit greenhouse gases.

We can't stop there. Our Nation is abundant in coal, and we should pursue coal to liquid technologies for both energy security and military applications. I think you and I are both aware of the fact that they have used this on the B–52 now very successfully. It is something in the future that I am hoping we will be depending upon.

Quite frankly, I see little difference between coal to liquids refineries and IGCC powerplants when it comes to carbon dioxide emissions. Unlike higher ethanol mandates, coal to liquids would increase our reliance on foreign sources.

So that really is the fundamental question: Does our Nation have a vision of increasing domestically supplied energy? Or will we put ourselves on an energy diet and increase our reliance on foreign energy supplies? I hope that my colleagues join me in this vision of hope instead of defeat.

Thank you, Mr. Chairman.

[The prepared statement of Senator Inhofe follows:]

STATEMENT OF HON. JAMES M. INHOFE, U.S. SENATOR FROM THE STATE OF OKLAHOMA

I want to thank the Chairman for having this hearing focusing on technology. I believe that our Nation's pioneering of technology has been a vital component in America's prosperity and I am fully committed to expanding new technologies in making our Nation a better place to live.

What technology paths and goals we choose will help determine if further innovation acts as a catalyst or a drag to future economic growth. Mr. Chairman, clearly we disagree on the state of science. Just last year, we discovered for the first time that trees emit methane, a potent greenhouse gas. This shocking news underscored how little we know about some of the most basic processes of the planet.

And new science is coming out all the time. After Katrina, Gore and some others seized the opportunity to claim global warming is causing more hurricanes. But 3 weeks ago, a peer-reviewed study found warming will increase wind shear, which reduces both the severity and number of hurricanes. And just last week, another peer-reviewed study by one of our government's leading scientists, Dr. Christopher Landsea, found that the annual trend in the number of hurricanes since 1900 has, in fact, not increased.

My point is this—our policies should reflect a little humility when it comes to whether or not we are omnipotent. That is why I oppose propping up uncompetitive technologies for the sole purpose of trying to avert an over-hyped catastrophe by mandating a tax on carbon—whether it is in the form of a direct tax or hidden in the guise of a cap and trade scheme.

And make no mistake, the various proposals currently before the Senate are taxes. The Kyoto Protocol would have imposed a cost of $2,700 per family of four. The global warming bills before Congress today are even worse. A new MIT study of the many proposals shows that the Sanders-Boxer bill would impose a tax-equivalent of $366 billion annually, or more than $4,500 per family of four, by 2015. And the Lieberman-McCain bill is not much better, imposing more than $3,500 on families each year.

I would like to submit the report for the record.

And who would bear these costs? According to a Congressional Budget Office study released 2 weeks ago, a carbon cap and trade would result in a massive wealth redistribution from the poor and working class to wealthier Americans. In short, carbon caps would artificially and needlessly raise the cost of energy the most

on the people least able to afford it. It astounds me that any Senator could support such a proposal.

I believe we should focus on approaches that unite, rather than divide. That is why I support the Asia Pacific Partnership and believe it should be fully funded and expanded. This would promote trade and transfers of technology between our Nation and developing countries, leading to increasing energy supplies and reduced pollution. Mr. Chairman, it would also help you in your goal of reducing greenhouse gases from countries such as China, which later this year will become the biggest emitter of carbon dioxide on the planet.

Mr. Chairman, while we may disagree on the reasons, I share your view that nuclear energy is a vital component of our energy future. And I applaud that you have recognized its importance in legislative proposals. We need more energy and we need to reduce our reliance on foreign sources. I think nuclear power and hydro—yes, I said hydro—should be a part of this equation. They neither pollute nor emit greenhouse gases.

But we cannot stop there. Our Nation is abundant in coal, and we should pursue coal-to-liquid technologies for both energy security and military applications. And, quite frankly, I see little difference between coal-to-liquids refineries and IGCC power plants when it comes to carbon dioxide emissions. And unlike higher ethanol mandates, coal-to-liquids will decrease our reliance on foreign sources.

And that really is the fundamental question: does our Nation have a vision of increasing domestically supplied energy, or will we put ourselves on an energy diet and increase our reliance on foreign energy supplies? I hope my colleagues join me in a vision of hope, not defeat.

Senator LIEBERMAN. Thank you, Senator Inhofe. I do want to say that the MIT report to which you referred will be included in the record without objection.

[The referenced document was not available at time of print.]

Senator LIEBERMAN. I was trained in the conduct of hearings by Senator Warner, whose example inspired me on the Armed Services Committee. Normally, in that committee only the chairman and the ranking member give opening statements. I have continued that in the Homeland Security Committee. This is a much more participatory committee.

So we will invite opening statements from all the Members who are here. I hope they will keep them within the time limit because we have a series of votes later in the morning.

Senator Boxer, who is the chair of the overall committee, thanks for being here.

Senator BOXER. Senator, thank you.

STATEMENT OF HON. BARBARA BOXER, U.S. SENATOR FROM THE STATE OF CALIFORNIA

Senator BOXER. Mr. Chairman and Ranking Member of this distinguished subcommittee, thank you for your leadership on this important issue.

I want to take on the question of cost here, since Senator Inhofe was on the attack on that point. I would recommend those of you who have a chance to go down the hall. A few doors down, there is a hearing now being called by Senators Biden and Lugar. It started about 9:30 a.m. Members of the intelligence community, foreign relations community, and Pentagon have all said that if left unchecked, global warming would be a major cause of war. This is not any other administration but the Bush administration's own people. What is the cost of war?

So although I am sure that it isn't put into many scientists' calculations, we better make sure we understand that our own Pentagon has warned us actually since 2003 that we must take action.

Also, I would put in the record the report of Sir Nicholas Stern, who was the lead economist at the World Bank, who said that spending $1 now save $5 later.

I think the cost question is really debatable. In my former lifetime, I was a stockbroker. I know the difference between an investment that pays dividends and an expenditure. What we invest here makes sense. That is what we are going to learn today, because we are going to hear from the leaders in our society in terms of profits and economic motivation. We are going to learn from them that there is a great opportunity here.

Now, the IPCC report, as Senator Lieberman noted, says that the market for energy technology between now and 2030 will be at least $20 trillion. The report found that addressing global warming is affordable. It will cost one tenth of a percent per year, while increasing business opportunity. As I said before, if we do nothing, the costs can't even be calculated. We need to act now, and the earlier the better. Many businesses, who you have assembled here today, recognize this.

We already had a hearing with some of the members of US CAP, including Duke Energy, DuPont, and BP, who called for action and recommended that we in Congress enact mandatory global warming legislation that reduce greenhouse gas emissions by at least 60 percent, which is Senator Lieberman and Senator McCain's bill, or 80 percent, which is the Sanders-Boxer bill.

Yesterday, and I think this is really important, and Senator Warner in particular I would address this to you, 14 new members joined US CAP, including General Motors, AIG, ConocoPhillips, and Shell. We will be planning a full committee hearing with this second group to hear about their strong commitments to address global warming, because they recognize that caps on greenhouse gas emissions are needed not only to save the planet, but also to give them a clear road map for the future in terms of global economics.

I have been meeting with the leaders of the European Economic Community. They are so far ahead of us. They are reducing greenhouse gas emissions as we speak. Companies that want to do business all over the world understand that they have to adapt. They know what is coming.

So I just want to say, and I again will put the rest of this in the record, we will hear from one of the world's largest companies, GE, developing and selling carbon sequestration technology that is key to the whole coal business. They are also involved in wind turbines, compact fluorescent light bulbs, solar panels, efficient appliances. Another company, American Electric, is helping to lead the way in providing carbon capture and sequestration.

Again, we will hear from Professor Chiang and he will also tell us about the possibilities for electric cars. As a driver of a hybrid vehicle—as a matter of fact, we in our family own three hybrid vehicles—I can tell you that I get between 40 miles a gallon and 55 miles a gallon. That is here now, and they are affordable cars. Saturday night, I was in San Francisco with my husband and we stopped in front of a gas station because we couldn't believe our eyes: gas over $4 a gallon. OK? This is where it is headed. Let's

face facts. Getting 50 miles per gallon is one good temporary solution.

Wal–Mart has reduced its energy consumption through the use of daylight harvesting. I see we have actually opened the curtains. I say to the staff, good thinking. We have to take advantage of outside lighting. These are small points, but it proves that there are things that we can do. Wal–Mart is aggressively monitoring their energy use nationwide.

So clean technologies are creating jobs already, but the signal that we send here is absolutely crucial. We have the ingenuity, we have the spirit to lead the world in this. When you hear, Senators, anybody say, "Oh, China, we can't do anything until China does it." That is ridiculous. We don't sit back and wait for China to do the right thing. We never have. We are the leader. We have to go for it, and then China will buy our green technologies and the world will be better for it.

So to the two Senators leading the subcommittee, I am very grateful to you for your leadership.

[The prepared statement of Senator Boxer follows:]

STATEMENT OF HON. BARBARA BOXER, U.S. SENATOR FROM THE STATE OF CALIFORNIA

Thank you, Chairman Lieberman and Ranking Member Warner for holding this hearing on emerging technologies and practices to reduce greenhouse gas emissions and address global warming.

Increasing energy efficiency and developing new, advanced technologies can help us solve one of the greatest threats to the well being of mankind: global warming. It can also make the United States a world leader in new technologies that we can export to the rest of the world.

There is great economic opportunity in addressing global warming. The most recent IPCC report notes that the market for energy technology between now and 2030 will be at least $20 trillion. The report also found that addressing global warming is affordable and will only cost 0.1 percent per year, while increasing business opportunity.

We need to act now, and the earlier we do so, the lower the costs will be.

Many businesses have begun to recognize this fact. In January, a group of large businesses teamed up with environmental groups to form the U.S. Climate Action Partnership (or US CAP).

The businesses in US CAP, including Duke Energy, DuPont, and BP, issued a "Call for Action" and recommended that Congress enact mandatory global warming legislation and reduce greenhouse gas emissions by 60 percent to 80 percent. Yesterday, US CAP added 14 new members, including GM, AIG, ConocoPhillips, and Shell.

We are now planning a second hearing on US CAP with members we have not yet heard from to learn about their strong commitments to addressing global warming.

These businesses recognize that caps on greenhouse gas emissions are needed to save our planet and they embrace the opportunity to compete in the world market that will result.

They are investing in clean technology and clean energy, because they believe, as I do. that there is an enormous business opportunity at stake and fighting global warming can also make American business more globally competitive.

Today we will hear from a number of companies who are positioning themselves to take advantage of these opportunities.

One of the world's largest companies, GE has an aggressive business strategy to be the world leader in these technologies. GE is developing and selling carbon sequestration technology, wind turbines, compact fluorescent light bulbs, solar panels, efficient appliances, and other energy efficient technologies.

Another company, American Electric Power, is helping to lead the way in proving carbon capture and sequestration technologies. By 2008, AEP will have in place a coal burning power plant in West Virginia that will use a new technology to capture and sequester their carbon dioxide. They are not standing still.

We will also hear from Professor Chiang from MIT who will tell us about the possibilities for electric cars and new advances in battery technologies.

Finally, I am very excited to hear from Wal-Mart, who has taken aggressive action to significantly increase its energy efficiency. They will show us how we can fight global warming and save money at the same time.

Wal-Mart has reduced its energy consumption through the use of "daylight harvesting" that adjusts the lighting in their stores to take advantage of outside lighting. They are using many energy efficient technologies, such as LED lighting and advanced refrigeration units. They aggressively monitor their energy use nationwide through a central location in Bentonville, Arkansas.

Wal-Mart also has a goal to reduce its energy use and greenhouse gas emissions by 20 percent within 7 years.

In 2006, clean energy investment in the United States was over $55 billion. This number is projected to increase in coming years, reaching $226 billion by 2016.

Clean technology will create jobs. 1.4 million new jobs are projected in this area by the year 2025. Clean technology will reduce our dependence on foreign oil. And, of course, it will put the United States in position to stop global warming.

I believe we must fight global warming to protect our economy as well as our planet.

The United States can use its ingenuity and innovative spirit to lead the world in clean technology development. Mandatory greenhouse gas limits will require us to develop a wide range of commercial technologies that we can use at home and export to the rest of the world, including to India and China.

Many have said global warming is not happening, but we now know that it is.

Many have said we could not afford to address this problem, but now we know that is not the case either. There is no excuse for continued inaction.

I look forward to the day when we can look back and tell our children and grandchildren that we were able to solve this problem and also succeed economically.

The businesses before us today will help us get there and I commend them for their leadership.

I look forward to hearing all of the witnesses' testimony.

Senator LIEBERMAN. Thank you, Senator Boxer.

Senator Warner, it is all yours.

STATEMENT OF HON. JOHN W. WARNER, U.S. SENATOR FROM THE COMMONWEALTH OF VIRGINIA

Senator WARNER. Mr. Chairman, I think I will put my statement into the record so we can get to our witnesses here.

I have been here for some many years in this wonderful institution. I am watching this issue in terms of how the Senator meets the challenges of a new frontier. We start off and there is enormous emotion in the hinterland, justifiably so. I think there are strong indications in science, fact finding, to bring to our attention something is going awry in terms of the fluctuations in our temperatures and the consequences that flow from them.

Now, how do we deal with the problem? We come to the threshold issue here today. You have heard the honest opinions of colleagues here, all of whom I respect. They differ strongly. We are going to have to forge a consensus, and do it in such a way that we do not do undue damage to our economy. I draw from Chairman Boxer's comment, that we do not just wait for others to lead.

This is an opportunity for the United States of America to show strong leadership, but do it in a way that reflects a clear understanding that we can't move much faster than technology will permit. We cannot thrust a burden upon our private sector to take steps, steps which scientifically indicate a reduction in the carbon problem, until such time as that technology and its relationship to our economics, is clearly understood and the consequences are understood.

We are in a one-world global market. As we try and get a few hours rest at night, the other half of the world is wide awake trying to figure out how to take the market away from us, and the jobs, and the like. That is the reality in which we live. But I feel that I want to try to join others in seeing what we can do to get a start, a significant start, but not a start that will suddenly deal a blow to our economy, because if we make a false start and fail to harness all the emotion and interest in this country behind that start, and then it just proves to have been wrong, I don't know when we would be able to regain an opportunity like the one that is before us now.

So we are fortunate on this committee to have strong leadership. My good friend, Joe Lieberman, and I, we have served on the military committee together for many, many, many years. We have partnered on quite a few things and taken some fairly bold initiatives, I might add. But I am prepared to try and work with my chairman of this subcommittee and the chairman of the full committee—my friend, Senator Inhofe, he and I have been here in the Senate almost the same length of time now—but do it in such a way that this start can continue to gather momentum and grow, and not halt and stop because of some faulty miscalculations.

So having said that, Mr. Chairman, I yield the floor.

[The prepared statement of Senator Warner follows:]

STATEMENT OF HON. JOHN W. WARNER, U.S. SENATOR FROM THE COMMONWEALTH OF VIRGINIA

I join Chairman Lieberman in welcoming our witnesses today to provide testimony on their views and experiences in developing and deploying new technologies to control carbon dioxide emissions.

I am pleased that the subcommittee will hear from some of our Nation's leading companies in supplying energy, manufacturing, retail and emerging technologies.

As we examine the feasibility of a regulatory program to control carbon dioxide emissions, it is essential that we understand the commercial availability of existing technologies and the prospects for carbon reduction technologies that may be available in the near future.

These technologies are critical to the environmental success of any program, and critical to maintaining a robust economy.

Any future efforts in the Congress to develop a bipartisan consensus on this complex issue will depend on the successful efforts of the private sector, as represented by our witnesses today, to demonstrate the widespread use of existing technologies. While there may be technologies available today to begin the modest control of greenhouse gases, certainly, any significant reductions in carbon dioxide emissions will be achieved only by the development of new technologies.

My general question to all of our witnesses today is what should the Federal Government be doing to further stimulate the marketplace to promote the broad deployment of existing technologies to reduce carbon emissions. I look forward to your testimony.

Senator LIEBERMAN. I thank you, my dear friend, for a very thoughtful and important statement. Obviously, I look forward to working with you. I think this subcommittee can play a real leadership role in beginning a process that one recognizes the problem of global warming, the reality that you have stated, and second, achieves a workable consensus that we can take forward to the full committee and hopefully to the Floor. I thank you very much for that statement.

Senator Carper.

STATEMENT OF HON. THOMAS R. CARPER, U.S. SENATOR FROM THE STATE OF DELAWARE

Senator CARPER. Thanks, Mr. Chairman.

I feel a special affinity to this panel, more so than usual. One of them is here representing a university where our oldest son goes to school. It is nice to have you with us today. Another of you represents a company whose sole energy business is headquartered in Newark, DE, near the University of Delaware. Several of you represent companies that are incorporated in the State of Delaware. For that, we are especially grateful.

One of you knows that when——

Senator WARNER. All right. Enough.

[Laughter.]

Senator WARNER. You have so many conflicts of interest that I think you have to stop. Cease and desist.

[Laughter.]

Senator CARPER. I have to get this one in. One of you knows that when a guy from Columbus, OH—I went to Ohio State—says "O H" that the response is——

[Laughter.]

Senator CARPER. I am delighted that you are all here. A lot of times we preface our statements by saying this is an important hearing. Sometimes they are, and sometimes they are not. This is an important hearing. We are just grateful that you all have joined us today to help us address what we all know is a big problem, and one that does not defy solution. I am convinced that by working together that we can whip global warming.

Senator Boxer and I serve together on another committee called the Commerce Committee, and we have been working in the last week or so on legislation that seeks to reduce our dependence on foreign oil, and also improve fuel efficiency in our cars, trucks and vans. About one third of our CO_2 emissions come from the transportation sector, and about 40 percent from the utility sector, and the rest comes from a bunch of different places. But if we can somehow focus on utilities and on transportation on mobile sources, that is about three quarters of the CO_2 emissions that are going up into the air in this country.

We believe that you are going to help us today figure out how to get our arms around that. It is not just enough for our universities and our companies to focus on it, including our science companies. We think the Federal Government has a role here, too, and I always say sort of a three or four part role.

One, we need to provide a clear public policy, a regulatory framework, providing a clear path, what our expectations are. I think we need to pass climate change legislation. My hope is that we will do that, if not this year, then next. I believe a role of the Federal Government is to fund basic R&D. The role of the Federal Government is to help commercialize emerging technologies. An appropriate role of the Federal Government is to provide in certain instances tax credits or tax incentives to encourage people to purchase some of those hybrid vehicles like Senator Boxer drives, or low emission diesel vehicles that are just starting to work their way onto our roads.

I have been working on a couple of pieces of legislation for the utility sector and the transportation sector that seek to fulfill really all of these Federal roles. I recently introduced with some of my colleagues legislation to reduce CO_2 emissions from powerplants, and I am proud to have, among others, Senator Lieberman and a number of our colleagues as cosponsors of that bill.

While I believe in an economy-wide approach on CO_2, we started on the utility sector and we would like to build out from there. If we do an economy-wide bill, my hope is that our utility sector will be part of that economy-wide bill. Our legislation also seeks to accelerate the deployment of new non-emitting powerplants with solar, nuclear, as well as clean coal technology with carbon recapture.

For the transportation sector, just yesterday in the Commerce Committee, we reported out new legislation with much stronger fuel efficiency standards, and reducing CO_2 emissions and reducing our reliance on foreign oil. Much like the power sector bill that I have introduced, the Commerce Committee's CAFE bill not only provides specific targets and time lines, we also include incentives for technology advances. I added an amendment to the bill to increase our investment in new battery technology, lithium batteries, something that we very much need to do. Our friends in Japan are ahead of us. We need to catch up and the Federal Government has an obligation to help us do that.

But those two measures are I think a couple of important steps to get us on the right track to reversing the increase in CO_2 and the threat of global warming.

We are delighted that you are here. We look forward to hearing from you and to asking questions of you.

Thank you.

Senator LIEBERMAN. Thanks very much, Senator Carper. It struck me that the one connection you have with the witnesses that you didn't mention was Mr. Stanway from Wal-Mart. If your family is like most American families, there is an imbalance of payments between you and his company.

[Laughter.]

Senator CARPER. Mr. Stanway and I are from the same part of Arkansas, and when you hear him speak, you will know what I mean.

[Laughter.]

Mr. STANWAY. Yes, the assumption my family is American may well have been a jump there.

[Laughter.]

Senator LIEBERMAN. Welcome.

Senator Voinovich.

STATEMENT OF HON. GEORGE V. VOINOVICH, U.S. SENATOR FROM THE STATE OF OHIO

Senator VOINOVICH. Thank you, Mr. Chairman. I thank you for holding this hearing today on global warming and emerging technologies and practices for reducing greenhouse gas emissions.

As I have often said, this is a difficult and controversial topic. I understand the need to continue to debate this issue and work to-

gether to better utilize advances in technology to reduce greenhouse gases.

I believe solutions to global warming need to be addressed, and I look forward to hearing from the witnesses today. I am particularly happy to see two Ohio-based companies are being represented here today. Mr. Rencheck is the senior vice president of American Electric Power. Dr. John Fees is chairman and CEO of Babcock and Wilcox Companies. We appreciate your being here today.

In the past, the EPW Committee has focused solely on the problem of global warming. I am glad that this subcommittee is now discussing solutions to the problem. Congress passed the Energy Policy Act of 2005 and I am concerned about the lack of funds available to implement the bill. The important research and development programs were authorized, including carbon sequestration, and IGCC technology that many believe will help this country tackle the problem of greenhouse gas emissions.

The Energy Policy Act also authorized a loan guarantee program to encourage private sector investments for those energy projects that avoid, reduce or sequester air pollutants or greenhouse gases. Unfortunately in this fiscal environment, many important programs are not being funded. It is clear that we must get serious about partnerships and strategies that maximize Federal energy funding. It is critical that policymakers work in conjunction with the scientific community to develop policy solutions that are in the best interest of our State and Nation.

For example, one area that requires further research is the development of technology to capture greenhouse gases and sequester carbon dioxide. I am hoping to hear some more about that today. We have to recognize, and I am glad that the Chairman does, that the United States is the Saudi Arabia in terms of coal, with a 250-year coal supply. In my State, 85 percent of the energy is generated by coal.

We also need to follow through on the Energy Policy Act provisions to make sure that they are being adequately implemented. I am afraid that the Administration's implementation of the loan guarantee provision has been slow at best, and left much to be desire. I met recently with Secretary Bodman and OMB's Director Portman to discuss the importance of the 2005 energy bill provisions and getting the Administration to do something about implementing them.

For the past 2 years, I have called for what I refer to as the "second Declaration of Independence," independence from foreign sources of energy for our Nation's competitiveness, and for our national security. I think that we also have to understand that if we are never going to get anywhere in this committee or in Congress, we have to harmonize our energy, our environment, and our economy.

For some reason, we have never been able to. I have been here for 8 years, and we have never been able to get in the room and do that. It just doesn't happen. We do need a Sputnik-like commitment to funding energy technology, particularly technology for carbon capture and sequestration. It is a worldwide problem and we have to realize that we have a role to play, but we also must recognize that others have a role to play. The more we engage them in

this debate, the better off we are going to be and better off the world is going to be.

So I am glad that you have called this hearing. I just want to say, any climate change legislation must take into consideration the state of technology. I am going to ask that an article that appeared in the April 26 issue of Financial Times be inserted in the record. The title of the article is "Industry Caught in Carbon Credit Smokescreen."

[The reference document follows on page 71.]

Senator VOINOVICH. I have to tell you, if what some people are proposing here for cap and trade is anything like they have in Europe, we are in big trouble, because our economy grew more during this period than theirs did, and their emissions increased more than our emissions here in the United States. So I think we have to be very careful in walking down this road that we do it right and make sure that it is in harmony with the technology that these folks are going to tell us about today.

Thank you.

[The prepared statement of Senator Voinovich follows:]

STATEMENT OF HON. GEORGE V. VOINOVICH, U.S. SENATOR FROM THE STATE OF OHIO

Chairman Lieberman and Senator Warner, I thank you for holding this hearing today on global warming and emerging technologies and practices for reducing greenhouse gas emissions. As I have often said, this is a difficult and controversial topic, and I understand the need to continue to debate this issue and work together to better utilize advances in technology to reduce greenhouse gas emissions.

I believe solutions to global warming need to be addressed, and I look forward to hearing from the witnesses here today. I am particularly happy to see that two Ohio based companies are here to testify. I would like to thank Michael Rencheck, Senior Vice President of American Electric Power, and Dr. John Fees, Chairman and CEO of The Babcock and Wilcox Companies for being here to discuss technology options to address global warming. In the past the EPW Committee has focused solely on the problem of global warming, and I am glad this subcommittee is now discussing solutions to the problem.

Congress passed the Energy Policy Act in 2005, but I am concerned about the lack of funds available to implement the bill. Important research and development programs were authorized including carbon sequestration and IGCC technology that many believe will help this country tackle the problem of greenhouse gas emissions. The Energy Policy Act also authorized a loan guarantee program to encourage private sector investments for those energy projects that avoid, reduce, or sequester air pollutants or greenhouse gases. Unfortunately, in this fiscal environment many important programs are not being properly funded.

It is clear that we must get serious about partnerships and strategies that maximize Federal energy funding. It is critical that policymakers work in conjunction with the scientific community to develop policy solutions that are in the best interest of our State and Nation. For instance, one area that requires further research is the development of technology to capture greenhouse gases and sequester carbon dioxide so that we can continue to rely on coal for energy—we are the Saudi Arabia of coal as we have 250 years of supply—my state relies 85 percent on coal for electric generation, that not only protects our environment but public health.

We also need to follow through on the Energy Policy Act provisions to make sure they are being adequately implemented. I am afraid that the Administration's implementation of the loan guarantee provision has been slow at best and much to be desired. I recently met with Secretary Bodman and OMB Director Portman to discuss the importance of the 2005 energy bill provisions, especially the loan guarantee provision, in jump-starting new nuclear and clean coal projects.

For the past 2 years, I have called for a 'Second Declaration of Independence'—independence from foreign sources of energy—and for our Nation to take real action toward stemming our exorbitantly high oil and natural gas prices. Instead of considering them separately, we must harmonize our energy, environment, and economic

needs. This is an absolute must as we consider any additional solutions to address global warming.

Today, we need a national, Sputnik-like commitment to funding energy technology, particularly technology for carbon capture and sequestration. We should also elevate this challenge, in the array of carbon capture and sequestration, to the international level.

This is a worldwide problem. We have to realize that we have a role to play, but we also must recognize that others have a role to play and the more we can engage them in this debate, the better off we are going to be and the better off the world is going to be.

The issue is what do we do from a responsible policy perspective to deal with the problem and offer economically sound solutions? It is something I hope the full EPW Committee can work together on to develop responsible global warming policies that ultimately harmonize our energy, environment, and economic needs—which we have not been able to do for the 8 years I have been a member of this committee. Any climate change legislation must take into consideration the state of technology.

Chairman Lieberman and Senator Warner, I again thank you for holding this hearing today.

Senator LIEBERMAN. Thanks, Senator Voinovich. Without objection, we will include the article from the Financial Times, as well as the full text of the opening statements of Senators Boxer and Warner, and the sections of the Stern Report, to which Senator Boxer referred.

Thanks for your statement, too, Senator Voinovich. I hope that we can use this subcommittee as a forum for beginning to have exactly the kind of discussion about how we go forward together, including folks like this, who can tell us how to do it.

Senator Craig, thanks for being here.

STATEMENT OF HON. LARRY E. CRAIG, U.S. SENATOR FROM THE STATE OF IDAHO

Senator CRAIG. Mr. Chairman, thank you for holding this hearing. I appreciate it. It is an issue that obviously we are all spending a good deal of time on, as we should.

I have struggled over the last decade to bring this issue into perspective. I surprised a lot of conservatives at the tail end of the Clinton administration when I was in Belgium at a climate change conference announcing that, yes, I agree with the science, that our world is warming and we need to understand why it is. But the question is why is it, and we are still struggling with that. Some have already drawn conclusions. I am one of those who has not.

Having said that, I want to share with you an experience I had last weekend that is really quite fascinating. It was in the setting of my home State of Idaho, which just happens to be by EPA standards the cleanest State in the Nation. We have less carbon in the atmosphere per capita. We emit less than any other State in the Nation. So we are very proud of that as a State. It is a marvelous place to live. The stars are very bright at night.

But I was at what is known as Hagerman Fossil Beds. It is an area that I helped protect about a decade ago. It is a unique place. It is a large bend in the Snake River on a bluff that is about 500 feet high from the river's edge up to the top of a plateau. I was with a young anthropologist, and boy, when he was given the opportunity to get the attention of a U.S. Senator, did I get all of the information. I spent several hours with him. He explained to me something that I found fascinating. In another life, I might have

become a geologist. I spent a lot of time studying it at our university.

Here is the story that he told me. He said if you start at the top layer of soil at the top of this bluff—we were standing across the river looking at it—he said that top layer is about 1 million years old. Then he said the 500-foot bluff represented 3.2 million years of time. He said, here, Senator, there are more fossils collected than any other place in the world, to our knowledge. They have found what is now known as the "Hagerman horse," which was a predecessor of the horse. They have found mastodons, and then a myriad of other things.

He said it is like a textbook. It is page after page after page, layer after layer after layer. The world now comes there, and all of the anthropological students of the world come there to study. It is a fascinating place. I am in a warehouse with fossils all around me.

So I said, is there anything we can draw from this? Well, he said it is unique. It is interesting. He said, for example, at this 1-million-year-old layer, this place was about four times wetter than it is now, and much warmer. Then he says, you drop down here, and then it is much colder. These animals and plants could not have lived in that climate. He said in fact it was severely cold here at this time, at this period.

Then you drop down, and further layers were down into the 2 million plus, and then it is all of a sudden warmer again, and the plants and the animals, all of the insects that are captured in this huge time capsule. Then all of a sudden appears a mastodon, and then all of a sudden appears the horse. He said it is like pages in a textbook, Senator. We have never found anything quite like it.

I said, conclusions to be drawn? No. He said it is just reality. It is time. It is the history of the evolution of the world in a 500 foot cliff with all of these pages to be turned and studied—warm, cold, warm, cold, wet, dry, wet, dry. Evolution.

Well, that was the mission I took on a good number of years ago when I went up to Woods Hole to begin to study ocean decimal oscillation. Fascinating idea. A reality we now believe happened in the North Atlantic. It is happening in the Pacific. Some call is El Niño or La Niño. There is a lot about our world we don't know. There is a lot about it we do know.

I have drawn the conclusion that anything we do now and into the future ought to be clean, and all of our technologies ought to be clean. Frankly, George said it well. EPAct set us on that course. Last week, we introduced legislation to set us on another course of clean transportation fuels or cleaner transportation fuels.

I have drawn the conclusion that technology leads us there. Commanding and controlling an economy does not necessarily do that. It could in fact damage us severely. The rest of the world is struggling along behind us. They all complied with or attempted to, they ratified Kyoto, but none could comply, because they found out they had to shut down their economies to comply. Many are even talking about getting off of it by 2012. That doesn't excuse the reality that our globe is getting warmer, and that we ought to push ourselves aggressively toward the new technologies.

But I am not about to turn to our country and our workforce and say, "turn out your lights; that is the way we survive this." We don't even known truly the impact of carbon in the atmosphere. We think we know. But we do know geologic time, and we know this world has gone through phenomenal changes over a long period of time.

I just happened to be at the textbook of geologic time last week at the Hagerman Fossil Beds, and spent a good number of hours there. I thought I would relate that experience to you. It is interesting that all during that timeframe that that 500-foot cliff represents, European man was non-existent, and the emission of greenhouse gases, at least created by man, were nonexistent, and yet the world changed and changed and changed again.

Thank you, Mr. Chairman.

Senator LIEBERMAN. Thanks, Senator Craig.

Now we turn to the witnesses. As you can hear, I think the debate about whether the globe is warming is over. There is still some debate about what is causing it. But obviously, I join with the IPCC in saying that humans are causing it. What we really want to focus on with this extraordinary panel is a description of the emerging technologies and practices that you are individually and corporately involved in, that will have the effect of reducing greenhouse gas emissions, and of course, what significance can the Government play in at least sending you market signals that will encourage the innovative developments that you have been part of.

Dr. Chiang, thanks for being here. We will start with you. Dr. Chiang is the aforementioned Professor of Material Science and Engineering at MIT.

Senator WARNER. Mr. Chairman, would you indulge me for 1 minute?

Senator LIEBERMAN. Certainly.

Senator WARNER. I wonder if our panel would help us sort through the terms "global warming" and "global climate change." We are proud to have some colleagues here from Alaska, and they pound the table, furious when you talk about global warming, because they claim there are parts of Alaska that are experiencing severe cooling compared to previous standards. If you could unite us on one term, it would help us begin to interpret this for the public.

Thank you very much.

Mr. CHIANG. I am not sure that I will in particular be able to do that, but I think that extremes in temperature are part of the phenomenon of global warming. So perhaps one of our other witnesses can address that later.

STATEMENT OF YET–MING CHIANG, PROFESSOR, DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING, MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Mr. CHIANG. Mr. Chairman, Senator Warner, Madam Chairman, Senators, one of the problems I often have following such interesting speakers is I tend to forget what I want to say myself. So I will try not to do that.

There are four basic points I want to make today. One is that there is a revolution going on in the electrification of vehicles. I be-

lieve that the benefits to the environment and to national security from that can no longer be disputed.

The second point is that the battery technology that I will talk about today. I am a technologist. I will talk about battery technology. We all use batteries. We never think they are good enough. But this battery technology I will talk about today is ready and able for a new type of hybrid vehicle called the plug-in vehicle. It is ready today and I hope to convince you of that.

The third is that we believe this is really just the tip of the iceberg. Vehicles and their electrification will do a great deal for the environment and for our dependence on oil. But also, other forms of energy—nuclear energy, solar, and wind—will, over time, benefit from these battery advances as well.

Then the final point has to do with American competitiveness in this area. We are at a position where for the first time in about 20 years, we have the technological lead in advanced batteries. What this committee can do is to help ensure that we maintain that lead and build on it.

So to my first point, the transportation sector accounts for about two thirds of our oil consumption today, and as Senator Carper alluded to earlier, about one third of the CO_2 emitted is from the transportation sector. The number is really quite large. A gas car puts out upwards of 400 grams per mile driven. That is nearly a pound. If this were a pound of byproduct by the roadside, we would be all appalled, but we can't see it and so we have become used to it.

So the hybrid electric vehicles have been a very compelling solution. They are on their way, and by 2010 there will be some 65 or 70 models of hybrid vehicles on the road. I just want to clarify the difference between the conventional hybrid vehicle and the plug-in hybrid that I will speak about. Conventional hybrids use gasoline and are assisted by a battery. A plug-in hybrid uses electricity from the grid. It is one solution on the continuum to all-electric vehicles.

So the hybrid vehicles can give you that 45 to 55 miles per gallon, but what we like to say is that when hybrid vehicles dream, they dream of becoming plug-ins.

[Laughter.]

Mr. CHIANG. A plug-in will give you upwards of 100 miles per gallon. I will tell you more about that in a little bit. If we were to replace each gas-operated car with a plug-in, we would reduce the gas consumption of that car by 80 percent and we would reduce the CO_2 output by 50 percent. Many people ask you if this electricity that we are using to power these plug-ins is coming from electricity generation, in particular coal, aren't we just paying for our pollution in a different way? So it turns out that with the national blend of electrical power sources, we get that 50 percent reduction. If it were solely coal, the reduction is about 30 percent, which is still very significant.

So let me turn to the technology that makes this happen. It is nanotechnology. It is research that we originally did under support from the U.S. Department of Energy at MIT. The fact that it is nanotechnology is scientifically interesting, but the important point today is what is has enabled in terms of battery technology.

In 2002, we started a company called A123Systems. It is named after a force constant. We have been told that the name does not roll off the tongue very well, but nonetheless what this company set out to do was to take this new nanotechnology and to commercialize it. Our first commercial test bed was power tools. Power tools are a nearer term target than vehicles. So today you can buy 36 volt power tools made by DeWalt Power Company—Dewalt is Black and Decker. This puts four horsepower in a two pound package, five times the previous power tool technology. So you can think about what that could really do for vehicles.

So from the very beginning, and currently today we are producing millions of those batteries for the power tool industry. This is truly scaled-up production. But from the beginning, what we were interested in was vehicles. So the most direct way that I can give you an example of what this could do for vehicles, and we are working on both HUVs—HUVs being conventional hybrids—and plug-ins. I refer to a car that I have actually brought with me today. It is parked over there, and I invite all of you to come down and see it and to even drive it. This is a hybrid vehicle which has been supplemented with a battery module, which takes the place of the spare tire. That is as big as it is. You get all your trunk space.

With that, you can get 100 miles per gallon on the highway, and 150 in the city. I have the ideal commute.

Senator CARPER. Is your car for sale?

[Laughter.]

Mr. CHIANG. Yes, it is. We can talk.

I have almost an ideal 40 mile commute, which is the electric range of this vehicle, when I commute to MIT. So I can drive to MIT and park in a special parking spot, one of several that have plugs, and for a 50 cent recharge, I get to go the next 40 miles. Of course, then I get MIT to pay for that 50 cents.

This technology is ready and will be going to fleets this year, and next year our company aims to make it available to the individual consumer.

Senator LIEBERMAN. So it is cost effective now? In other words, you have the costs down to where the market will afford it?

Mr. CHIANG. At this point, the car that I will show you, the add-on that gives you this capability is roughly $10,000 today, but it has already come down very significantly from just a couple of years ago and the costs continue to decrease. One of the things that will spur the adoption of these vehicles, in addition to the kind of legislation we are talking about today, are incentives to make it more affordable to consumers the same why that hybrids were made more affordable to the consumer.

In short, it is still a little expensive, but we expect it to become very affordable.

OK. So now what will happen, we are working with a number of manufacturers. In the plug-in area, for example, we are working with GM, but those cars will take about 5 years to come online. So one of the points I want to make is that in the interim, before the 5 years, we really can do something. What we can do is to start implementing those modules and to help the existing and growing

fleet of hybrid vehicles become upgraded to this 100 miles per gallon.

OK. Now, I will just speak very briefly to the adaptation of this technology to wind and solar.

Senator LIEBERMAN. Speak as quickly as you can, just for the sake of time. I appreciate it.

Mr. CHIANG. OK, very good. I will just say that we are going to get there, and it is going to be applied to wind and solar. We hope it will enable the adoption of those.

My final point really has to do with American competitiveness at this point.

Senator LIEBERMAN. Go right ahead.

Mr. CHIANG. I am sorry?

Senator LIEBERMAN. Please, go ahead and develop that last point.

Mr. CHIANG. OK. So about 15 years ago when lithium batteries first reached the market, Asian companies really got the lead. Now that we have the lead in this new battery technology, the others are not far behind. What we need in order to develop an American-based high quality job profile for the American battery industry is to have incentive legislation that really speeds the adoption of these plug-in hybrids and other vehicles. The reason for that is because the more that we are able to get these into the marketplace and to learn how to continue to innovate, the more we will succeed in the long term.

I have had my nose to the grindstone for 5 years developing the technology, so I am not an expert on cap and trade, but I think I can say that anything that can be done to help this technology get out there, we can accelerate the implementation by several years, and that will reap many benefits in the long term.

Thank you.

[The prepared statement of Mr. Chiang follows:]

STATEMENT OF YET-MING CHIANG, PROFESSOR, DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING AND MASSACHUSETTS INSTITUTE OF TECHNOLOGY

BREAKTHROUGH BATTERY TECHNOLOGY AT THE CENTER OF THE PLUG-IN HYBRID REVOLUTION

Mr. Chairman, Senator Warner and Members of the Subcommittee;

I thank you for the opportunity to appear before you today to explain and answer questions about a recent breakthrough in lithium ion battery technology that we and others believe will help enable this Nation to lead a worldwide plug-in hybrid transportation revolution starting now.

Let me explain.

THE TECHNOLOGY AND ITS CAPABILITIES

Five years ago, research conducted in my group at MIT under U.S. Department of Energy support resulted in new nanomaterials that we believed could enable breakthroughs in lithium ion battery power, safety, and durability. This technology was spun off by forming the company A123Systems, itself initially supported by the DOE with a $100,000 SBIR grant. Today the Company has raised over $100 million, has over 300 employees and operates facilities in Watertown, Massachusetts and Ann Arbor, Michigan. We sell millions of batteries annually to Black and Decker (Dewalt) and others for high powered handheld applications. We are simultaneously developing higher powered solutions for the aerospace and defense industries and have been chosen by GM, and other major American and European automakers, to help develop and power their hybrid and plug-in hybrid sedans, SUVs, trucks, buses and heavy equipment moving vehicles which will be coming on line over the next decade.

This has all been made possible by the development of our unique nanotechnology-enabled based lithium ion battery, which we call Nanophosphate, which has a combination of power, durability and safety in excess of any rechargeable battery that has come before. When I describe our innovation as nanotechnology, what I mean is that we have designed and engineered key active materials in the battery to take advantage of physical and chemical behavior only accessible when the materials are reduced to a few nanometers in dimension. This behavior enables the material to store and release lithium ions with great facility and over a very long service life, all while being much safer than any previous lithium ion battery.

While the fact that our batteries are nanotechnology-enabled is of scientific interest—and indeed the science behind them is fascinating—what the end user and society benefits from are their new performance capabilities. In DeWalt's new 36 volt power tool, our battery technology delivers twice the power of a corded tool with 2–3 times the runtime of conventional cordless tools. In vehicle applications, the advances over previous technology are no less dramatic, as I will now explain.

The automotive industry is in the middle of a critical transition to electric drive because switching from imported oil to a diversifying electric grid is a national security and environmental imperative, now made possible as a result of these battery technology breakthroughs. The evidence for this transformation continues to mount. Fueled by strong consumer demand for greener vehicles and a growing awareness of our greater responsibilities to our planet and our national security, there are now over 65 hybrid vehicle (HEV) launches planned by 2010. A123Systems is working with leading American and European automakers to develop batteries for upcoming hybrids and are working with the DOE and the U.S. Advanced Battery Consortium (USABC) to optimize our technology and provide leading price/performance in this market.

However, the next generation of technology beyond the conventional hybrid is the plug-in hybrid (PHEV). This game-changing technology will further displace the use of petroleum through shifting a much greater fraction of the vehicle's power to electric drive, using advanced batteries that are recharged from the grid. This technology is one where the U.S. automakers have established technological leadership and which delivers many immediate benefits including 100 MPG or greater fuel economy and reduced emissions, not just measured at the tailpipe but including that due to the additional electricity generated. A123Systems is a leading developer and supplier of battery technology for plug-in hybrids. We are working with General Motors and other leading American and European automobile and heavy equipment manufacturers to validate and introduce this technology into the market. But how long will it take to see the benefits of these new vehicle technologies, which apply to passenger vehicles, large trucks, buses and fleet vehicles, and can change both the emissions and fuel consumption profiles of some of our largest concentrations of polluting commerce?

INTERRELATIONSHIP WITH CAP AND TRADE

Over the years, the Congress has been in the forefront of recognizing the need to nurture these kinds of breakthrough technologies through legislation to kick start consumer demand. For example, putting the CLEAR ACT in place in 2005 was critical to both educating the public and producing the hybrid sale volumes that have lead to ever improving costs and economics. As a result, today's growing demand for hybrid vehicles is a tribute to the public's underestimated desire to do something about the health and national security risks of ever rising petroleum dependency when presented with economic choices.

The overarching question before this committee today is how much more governmental stimulation is needed and how much faster can we go?

Let me suggest that the answer to that question depends on both the availability of new technologies and the practicality of the additional government initiatives which can be deployed.

On the first question of advanced technologies that are waiting and ready to enter the economy based on additional incentives, I can speak with some authority. They are here, ready to go, and await your leadership to make it happen as soon as possible.

Let me be specific. We at A123Systems have spent substantial energy strategizing on how to best move along the continuum from producing millions of our high performance lithium ion batteries for handheld applications today, to adding the manufacturing bandwidth required in 3 to 5 years to supply the major automakers with batteries for their fully designed and tested original equipment plug-in hybrid vehicles. Speed of execution is of the utmost importance to us. To address the power tool market, we developed game-changing battery technology from initial concept to

full-scale manufacturing in just 33 months. Our customers tell us this is the fastest commercialization of a new battery system in history. It is testimony to the speed with which this type of technology can move when the will is there. Clearly, in the emerging and highly competitive plug-in hybrid arena, similar dedication to speed of execution will be critical to American competitiveness.

So we asked ourselves how best to ensure the earliest and ultimate success of the tens of millions of original equipment plug-in hybrids that will need to be rolling off the major manufacturers' production lines through the next decade. Our answer was to develop Battery Range Extender Modules that can be installed in the spare tire well of any existing hybrid.

The result of that effort is parked right outside this building. On its face, it is one of the almost 1 million standard production hybrids now on the road in the United States. Its original equipment nickel metal hydride battery provides enough power to go a few miles on electricity alone. But this car differs from most of its brethren in that it also has a supplemental module small enough to fit into its spare tire well. This module contains our current production battery cells and delivers enough usable energy for the vehicle to achieve as much as 150 MPG in urban driving and 100 MPG in highway driving with a 40 mile electric range. This module is charged overnight from a regular 120 volt extension cord which plugs into the bumper.

Since the average commuter travels under 30 miles per day, off-peak nightly charging of this module both improves a utility's load factor, lowering everyone's electricity bills, while reducing total gasoline consumption and emissions dramatically. In fact, DOE's Argonne National Lab has tested an earlier version of this module providing independent validation of the 150 MPG urban efficiencies that plug-in hybrids provide. Prototypes now being driven around the country, including here in Washington, have been obtaining the same results—mileage that is two to three times the 45 to 55 MPG today's production hybrids achieve. Keeping in mind that this is the first fully-developed version of a new technology, the performance can only improve from here.

Numerous studies have also shown that emissions will drop significantly even after accounting for the generation of additional electricity. With charging occurring predominantly in the off-peak evening hours, a large percentage of this generation is made up of no emission, constantly running nuclear and hydro resources. The remainder comes from coal, which will continue to be baseloaded until cleaned up or replaced, with or without a plug-in revolution. The bottom line is that today's state-of-the-art baseload generating mix is far more efficient in terms of emissions than an individual tailpipe, and the policy choices we are in the process of making to improve the emissions profile of our electric generation grid will only improve that advantage.

Over time as battery costs are reduced, these improvements in battery technology also will benefit renewable energy technologies such as wind and solar, for which storage is a key issue, and will allow them to take on an increasing fraction of the baseload. The durability seen in this new generation of lithium ion batteries suggests that life-cycle costs will be significantly reduced over older technologies, such as lead-acid batteries, that have lower initial costs but a much shorter lifespan and higher maintenance costs. Reduced emissions from the electrification of vehicles starting now will therefore be further accelerated in the future as the same advanced battery technologies are used to help additional renewables come on-line even while continuing to increase the number of plug-in vehicles. These are synergistic effects.

So now let me be clear about where the technology stands: It is possible to achieve over 100 MPG with reduced emissions from a standard production hybrid equipped with a supplemental battery module using our current production lithium ion cells. And yes, it is affordable, reliable and a logical bridge between the even more efficient OEM plug-ins that we aim to enable in mass by the beginning of the next decade, and the ever growing millions of conventional hybrids that will be sold in the interim. A123Systems will be testing our current technology with various fleets in 2007 and intends to market this standardized module nationwide in 2008 in order to accelerate the adoption of plug-ins. It will be certified to meet all applicable new car test standards and can be installed by trained mechanics in less than 2 hours, without any changes to the underlying electronics, mechanics or materially useable space of the production hybrid other than the installation of the plug in the rear bumper.

Our battery modules that can create PHEVs from HEVs will be, for all intents and purposes, ready to go by the end of this year. The faster it is deployed, the cleaner and safer this country will become. So how much more should the government do? I would suggest that the greater the potential for known but not well pub-

licized technologies to make a real difference in emissions and mileage, the more important it is for you to act aggressively.

The applicable market in the United States is already the fastest growing segment of the automobile industry. There will be almost 1 million standard hybrids on the road through the course of this year. With over 60 hybrid models expected by 2009, there will be 5 million standard hybrids on the road by 2010. By 2015 there may be as many as 15 million regular hybrids on American highways. As a matter of additional government action to stimulate deployment, it is clear that if several thousands of dollars in tax credits were needed to start moving consumers from 15 MPG vehicles to initially more expensive 45 MPG hybrid vehicles, one option would be to do at least as much to achieve the 80 percent oil savings and 50 percent emissions reductions that would accumulate if each 45 MPG vehicle is now replaced with a 150 MPG comfortable, high performance plug-in hybrid.

Given the reality of the technology sitting outside of this hearing room for everyone to see and touch and experience, what other measures could help make plug-ins the cutting edge of the transportation revolution not 5 years from now but NEXT YEAR? How do we work into the market's pricing mechanism an accounting for the clear environmental benefits that tax incentives do not address?

Clearly I know a lot more about how to make a battery than I do about how to construct a fair yet complicated regulatory framework. But from where I sit, the sooner PHEVs are deployed, the sooner we drastically cut our oil imports and improve our deteriorating environment. The transportation sector currently provides one third of all our CO_2 emissions. If a fair cap and trade system that increases the cost to emit CO_2 can be put in place and administered so all parties understand the rules and have to play by them, we have no doubt that the rate of deployment of cutting edge facilitators like these modules, and ultimately OEM plug-ins, will be significantly accelerated.

Demand-pull incentives to kick start this promising breakthrough that holds the potential to cut our transportation-based use of oil by 80 percent and emissions by 50 percent has strong precedent with clear success. Increased research dollars to further lower costs and create a level playing field with our Asian competitors in the battery industry, who until now have established superiority as a result of heavy government investment, also has established government precedence in other U.S. business sectors. Today, A123Systems is in the marketplace and in the lead ahead of the Asian governments who are our real competitors. They are investing. If we are to avoid the past mistakes of losing the commercialization race to Asia, we will have to level this playing field with active government involvement in ensuring the development of a new domestic battery industry.

And finding a way to price the environmental benefits of our new American technologies, whether through cap and trade or other regulatory mechanisms, will be the ultimate show of national will and leadership needed to reverse our energy fortunes as quickly as we need.

I urge all of you to come outside and look at the car and battery of the future to see what has already been done on the technology side. With your prompt collective action, over the course of the next year the average American can be in a full, responsive, comfortable sedan that can get over 100 MPG in combined city/highway driving for under $30,000. And as volumes increase, prices also can be expected to eventually fall as in any new breakthrough product. And with a cap and trade system, corporate America will demand more of these vehicles even sooner to stay in the game.

Clearly the original equipment hybrids due out early in the next decade, utilizing even better batteries integrated directly into the vehicle at the factory, will be more efficient and less costly. But there can be as many as 15 million standard hybrids on the road when plug-in volumes skyrocket from 2012 to 2017. Like the initial version of any breakthrough product, our battery technology and the PHEVs it will enable in the immediate future, will be much better than what was there before, and not nearly as good as it is going to get. But it can be an important part of a logical technology and policy continuum as we inevitably move to a dominantly plug-in hybrid national fleet.

In summary, you can count on our technology as one of the presently available breakthrough tools at your disposal which requires creation of a regulatory and business environment that will assure its mass use at the earliest time to begin reducing GHG emissions and our dependence on foreign oil. If we are collectively able to move up by several years the adoption of this particular technological solution, it will:

- Introduce a public hungry for tangible action now to a new American technology that lets them be part of the logical next step of a transportation revolution they

have already started with their unprecedented demand for the standard hybrids available today.

• Gather invaluable experience and data for the next generation of factory produced vehicles through earlier widespread use of this new battery technology in real volumes in the everyday world.

• Stimulate earlier battery cost reductions from the earlier volume sales

• Advance by years the much needed 80 percent reduction in oil consumption and 50 percent emissions savings associated with each plug-in on the road.

• Serve the purpose of potentially speeding up the roll-out of the all important factory produced plug-ins as a result of the growing public awareness and demand.

CONCLUSION

This Nation can turn our current energy vulnerabilities into a new technological renaissance that simultaneously reduces our greenhouse gas emissions, reduces our consumption of foreign oil, and produces an increasing number of good American jobs. We can do it by using a combination of incentives, grants to a more efficient, diversified, balanced and cleaner domestic electric grid, and fair and administrable pricing of the environmental value of new and enabling technologies. With your political will and leadership, and the kind of technological breakthroughs that I have discussed today, we will succeed.

Thank you Mr. Chairman and Members of the committee for this opportunity to explain what we are doing and comment on what you propose. We appreciate your interest and support. We will now be glad to address any questions you may have on this or any other subject.

RESPONSE BY YET-MING CHIANG TO AN ADDITIONAL QUESTION FROM SENATOR LAUTENBERG

Question. Your testimony indicates that you need a regulated environment for greenhouse gases in order for your product to flourish. What must be the cost of carbon dioxide emissions for a company to start utilizing your technology?

Response. The lithium ion battery technology that we have developed enables hybrid and plug-in hybrid automotive, bus, truck, and other transportation technologies which if implemented broadly will have a dramatic impact on US greenhouse gas emissions. Since the users of this technology will range from individual citizens to large corporations, the cost of carbon dioxide emissions that will motivate one to use this technology will vary widely. For example, an individual American citizen will be motivated to use the technology in order to reduce their driving expense, to improve the environment, and to reduce US dependence on imported oil, even in the absence of any charge for CO_2 emission. On the other hand, measures such as cap-and-trade legislation would motivate a company that operates a large fleet of vehicles, as one example, to adopt our clean transportation technology if the cost of the carbon emissions is more than offset by the cost to transition to the new technology, with added benefit also accruing from the reduction in fuel costs. This is one "equation" by which the cost could be calculated, but naturally the specific numbers will depend on the industry involved and the specific scenario. The largest barrier to widespread adoption of our technology is the higher initial cost, but this will be reduced over time as the product matures and manufacturing costs are reduced due to economies of scale.

Senator LIEBERMAN. Thank very much, Dr. Chiang. I find it very exciting. You took me beyond where I understood that the plug-in technology was. The other point to make, very briefly, insofar as we are concerned about energy independence, is that the last time I heard, we only derive 2 percent to 3 percent of electricity from oil, so that, yes, there are problems with coal, but coal at least is American coal, and 20 percent of the rest is gas and 20 percent nuclear, and the rest a mix of alternatives.

So anytime we get somebody to plug-in for a mile of vehicular travel, it is a dramatic reduction in our dependence on foreign sources of oil.

Mr. CHIANG. Just very briefly, much of this recharging I am talking about is a nighttime phenomenon, where the dependence is more on other forms that are nonpolluting than on coal.

Senator LIEBERMAN. Right. I must say the first time I heard about an electric car and a plug-in, I thought it was a big flaky, but then of course over the years, what am I doing and what we are all doing, we are plugging in our cell phones our Blackberrys and the rest at night. There is no reason why we couldn't and shouldn't be plugging in our cars.

Dr. Little, thank you very much for being here. Dr. Mark Little is the director of GE Global Research, unfortunately located in Delaware, but the company overall is headquartered in Connecticut. Thank you for being here.

[Laughter.]

STATEMENT OF MARK M. LITTLE, SENIOR VICE PRESIDENT AND DIRECTOR, GE GLOBAL RESEARCH

Mr. LITTLE. Mr. Chairman and members of the committee, good morning and thank you for the opportunity to address you. My complete comments have been submitted for the record.

I do have the great privilege of leading GE Research, GE's central research and development organization and one of the world's largest and most diversified industrial research labs. I oversee 28,000 technologists across the company and around the world, representing virtually every discipline.

I am here to comment on available technologies that could readily be deployed if the Federal Government issues regulations to address climate change. As you know, GE is a founding member of the U.S. Climate Action Partnership and we launched a worldwide initiative called Ecoimagination, which focuses on getting more green technologies and products into the marketplace.

If the Federal Government were to enact climate change legislation today, the regulated community has many viable technology options. I will focus my remarks on six key technologies that we believe could have the most immediate impact. They are IGCC or cleaner coal; wind energy; solar powered batteries; biofuels; and nuclear power.

I will briefly highlight each technology and discuss how Government can partner with industry to maximize the opportunities each presents.

For IGCC or cleaner coal, GE's energy business has a product on the market today that converts coal and other fossil fuels in to cleaner burning energy systems. Along with dramatically reducing emissions and particulates, this technology provides a more advantageous and economical way to capture carbon dioxide by separating and capturing it before combustion. But to fully realize the environmental benefit of this technology, we will need a clear, consistent policy on carbon emissions set forth by the Government.

Placing a monetary value on carbon and adopting rules governing carbon sequestration would go a long way toward ensuring that the Nation would meet its greenhouse gas objectives and that IGCC technology can be a viable solution in helping us get there.

Wind energy is another available carbon-free technology. With the help of Government incentives like the production tax credit and individual States' efforts to adopt renewable portfolio standards, wind technology today is economically competitive with other sources of energy, but we believe much more can be done. With

more investment in R&D by the industry, Government and academia, we can further improve the economics and accelerate the speed and scale with which wind power can be deployed.

Solar power is another carbon-free technology available today. In States like California and New Jersey, where strong Government incentives are in place, solar is thriving. But to be a truly viable choice for residential and commercial consumers across the country, we need to accelerate the level of investment by Government, industry and academia in solar energy. A great initiative doing just that is the U.S. Department of Energy's new Solar America initiative, in which GE is proud to be a partner. The thrust of this initiative is to accelerate new advancements in solar technology to reduce the cost of solar power to economically competitive levels by the year 2015.

High energy batteries and hybrid systems are other available technologies. GE has made significant progress with its own battery research initiatives. They have been critical to our rail business in its development of a hybrid locomotive, which we will demonstrate for the first time this month at a GE Ecoimagination event in California.

Within 2 to 3 years, batteries could have a real impact on heavy duty vehicle industries, and soon after plug-in hybrids for the automotive industry. GE is now collaborating with the U.S. Government on a variety of projects to advance battery research.

Nuclear power is another carbon-free source of energy available today. Recent permitting, licensing and policy changes have helped to encourage new U.S. plant opportunities, but we believe much more can be done to promote nuclear power. While past incidents raised public concerns over safety and reliability of nuclear power, significant progress has been made since then to address these issues and to make nuclear an even safer and more reliable source of energy.

Finally, although GE does not produce biofuels, we are working on new technologies that will enable our turbine products to burn many more types of fuels. GE Energy has a product today, the Jenbacher engine, which can operate on biofuels from many sources. We will continue to drive new developments in the research lab to make GE's power generation and turbine products even more fuel flexible.

I cannot emphasize enough that the success of each of these technologies is incumbent on having the right policies and committed research and development partner in the Government to help accelerate these advances.

Mr. Chairman, I want to thank you and members of the committee for the opportunity to testify. Addressing the issue of climate change is one of the greatest challenges the United States, and indeed the world, will face this century. The good news is that we have a host of technologies available today that can support swift action by Congress to pass meaningful climate change legislation.

Thank you.

[The prepared statement of Mr. Little follows:]

STATEMENT OF MARK M. LITTLE, SENIOR VICE PRESIDENT AND DIRECTOR, GE GLOBAL RESEARCH

Mr. Chairman, members of the committee. Good morning and thank you for inviting me to address the committee and provide GE's perspective on technologies that could be readily deployed in the event Congress passes climate change legislation.

I am Mark Little, Senior Vice President and Director of GE Global Research, GE's centralized R+D organization. We are one of the world's largest and most diversified industrial research labs, with a proud heritage of innovation spanning the Center's 107-year history.

From developing the first U.S. jet engine to developing many of the technologies that helped build today's modern electrical grid, GE researchers have a proven record of moving the state of technology forward in a meaningful and practical way. Our breakthroughs have had real impact not only in transforming the Nation's infrastructure, but also in improving people's lives.

In my role, I oversee more than 28,000 technologists across the company and around the world representing virtually every scientific discipline. Our mission today is the same as it was at the time of our founding in 1900—to drive innovations that create new or better GE products and meet the needs of our customers and of society.

We gather at a time when concerns about energy security and global climate change are at the top of everyone's list. In May 2005, GE launched ecomagination. Ecomagination represents the company's commitment to develop cleaner, more efficient and environmentally friendly products. As part of this initiative, we have pledged to double our level of R+D investment in green technologies from $700 million to more than $1.5 billion by the year 2010.

Since launching ecomagination, we already have more than doubled the number of green products from the 17 that had originally been identified. GE's customers and consumers now have more and better choices to reduce their emissions and energy consumption. In the years ahead, we will introduce even more products to help address the challenges of global climate change.

In February 2007, GE's Vice Chairman, and President and CEO for GE Infrastructure, John Rice, testified before the Subcommittee on Energy & Power, Energy & Commerce Committee in the U.S. House of Representatives, and called for the enactment of U.S. legislation on climate change at the earliest date possible. He further stated that science has reached a point where such legislation is possible.

Indeed if Congress enacted climate change legislation today, the technology now exists to support viable options for the regulated community. We have technologies available that can help prevent unacceptable greenhouse gas concentrations, such as those suggested by USCAP. I will focus my remarks on six key technologies that we believe could have the most immediate impact. They are: The Integrated Gasification Combined Cycle (IGCC) system, or cleaner coal; wind energy; solar power; batteries; biofuels; and nuclear power.

In discussing each of these technologies, it's important to understand that success in providing readily available solutions is directly tied to government setting a clear, consistent policy direction and continuing its strong commitment with industry and academia to aggressively invest in and accelerate the advancement of clean energy technology. We have already seen how government policies can positively impact the growth and availability of clean energy solutions.

The enactment of the Federal Production Tax Credit (PTC) and new Renewable Portfolio Standards in more than 20 states have helped to fuel a three-fold expansion of the wind industry in the United States over the past few years. In Europe where policies have been more consistently applied, the growth has been more rapid and substantial.

The first technology I would like to discuss is the Integrated Gasification Combined Cycle (IGCC) system, or cleaner coal. GE's Energy business has an IGCC product on the market today that successfully converts coal and other fossil fuels into a cleaner burning energy source. Compared to a traditional pulverized coal plant, an IGCC plant emits less than half of the sulfur oxides, nitrogen oxides, mercury and particulate matter. It also provides a much more advantageous way to capture carbon.

In an IGCC plant, the capability exists to separate and capture carbon before combustion. We believe this presents a much more effective and economical way of removing carbon versus the method that could be used today of removing it from the exhaust at the very end of the combustion process.

We are focused on several advanced gasification technologies to improve our IGCC platform. We're addressing everything from increasing process efficiency to reducing capital costs and emissions.

To fully realize the environmental benefits of IGCC technology, we will need a clear, consistent policy set forth by the government on carbon emissions.

Currently, the increased environmental benefits for IGCC come with increased capital costs. With no value placed on carbon and no regulations governing carbon sequestration or liability associated with it, little incentive exists to adopt this technology. And while we have research programs that are aggressively working to reduce the capital costs of IGCC technology, those solutions will not be available in the short-term.

Placing a monetary value on carbon and adopting rules governing carbon sequestration would go a long way toward ensuring that the Nation meets its greenhouse gas emissions goals, and that IGCC technology can be a viable solution in helping us get there. The fact that nearly 50 percent of the Nation's electricity is derived from coal makes IGCC technology a critical part of the technology solutions needed.

Wind energy is another available, carbon-free technology that already has had a tremendous impact in Europe and is beginning to have real impact here in the United States. With the help of government incentives like the Production Tax Credit (PTC) and individual states' efforts to adopt Renewable Portfolio Standards, wind is economically competitive today with other traditional sources of energy. But for all of wind energy's success, we believe there is much more room for improvement.

Just consider that in the short time since GE got into the wind business in 2002, we have been able to improve the wind capture of our wind turbines by 30 percent. But with more investment in R+D by industry, government and academia, we can do even more to improve the economics and accelerate the speed and scale in which wind assets can be readily deployed.

At GE's research lab, we are exploring new, lighter and more aerodynamic blade designs, lighter composite materials and better electronics and controls to make further improvements to GE's wind turbines and large-scale energy systems. We believe that another 15 percent wind capture can be added with more advanced technology development. By industry partnering with the government, we could greatly accelerate this effort.

Solar power, when coupled with government incentives, is another carbon-free technology that is available today. In states like California and New Jersey where strong government incentives are in place, solar is thriving. But if solar is to be a truly viable choice for residential and commercial consumers across the country, we need to accelerate the level of investment by government, industry and academia in solar energy research. I want to commend the U.S. Department of Energy (DOE) for doing just that with the recent launch of its Solar America initiative.

Solar America, of which GE is proud to be a partner, is exactly the kind of bold initiative that is needed to make solar power economically competitive across the United States. Right now, the price of solar power is around 30 cents per kilowatt-hour. That is much too high. To encourage more widespread availability and use, we need to cut that cost in half. This reduction is the whole thrust of DOE's initiative.

The general view across the solar industry is that the goal of economic viability will not be reached until at least the year 2030. Through Solar America, we believe that aggressively accelerating breakthroughs in less costly and more efficient materials and improvements to the solar module systems could cut that timeline in half to 2015.

The next technology I would like to discuss is high-energy batteries and hybrid systems.

GE has made significant progress with its own battery research initiatives. It has been critical to our Rail business and its development of a hybrid locomotive, which we will be demonstrating for the first time later this month at a planned GE ecomagination event in California.

Within 2 to 3 years, we believe batteries could have a real impact on the heavy-duty vehicle industry and soon after plug-in hybrids for the automotive industry. GE is currently collaborating with the U.S. government on a variety of projects to advance battery technologies.

Although GE is a not a producer of biofuels, we are working on new technologies that will enable our turbine products to burn several types of biofuel. GE Energy already has a product, the Jenbacher engine, which can operate on biofuels such as methane gas from landfills. We will continue to drive new developments in the research lab to make GE's power generation and turbine products more fuel flexible, so that they can accommodate a variety of more environmentally friendly, domestic generated biofuels.

Finally, I would like to discuss a carbon-free technology alternative that is not only available today, it is providing 16 percent of the world's electricity and 20 per-

cent of all electricity produced in the United States—nuclear power. In fact, GE last week announced a contract with Dominion, one of the Nation's largest energy producers, to supply critical project components in the event Dominion decides to build a third nuclear-powered electric generating unit at its North Anna Power Station in Mineral, Virginia.

More recent permitting, licensing and policy changes have helped to encourage new U.S. plant opportunities, but we believe more can be done to promote new opportunities in nuclear power.

In a world that is searching for carbon-free alternatives, nuclear represents one of the most mature and attractive solutions for bringing more carbon-free power online in a significant way. While past incidents raised public concerns over the safety and reliability of nuclear power that persist today, significant progress has been made since then to address these issues and make nuclear a safe, reliable source of energy.

As the U.S. Congress considers climate change legislation, GE believes several technologies can be readily deployed today in the short-term to meet new greenhouse gas emissions goals set forth in such legislation. But the success of these technologies is incumbent upon having the right policies and a committed research and deployment partner in government to help accelerate needed advancements.

Mr. Chairman, I want to thank you and members of the committee for the opportunity to provide testimony. Addressing the issue of climate change is one of greatest challenges the United States and indeed the world will face in the 21st century. The good news is that we have a host of technologies available today that can support swift action by Congress to pass meaningful climate change legislation.

Thank you.

Senator LIEBERMAN. Dr. Little, thank you. Great report. Really good news. Thank you.

Mr. LITTLE. Thank you.

Senator LIEBERMAN. Mr. James Stanway, director of Project Development at Wal-Mart, indicating by your manner of speech either that I am not familiar with all Arkansas dialects, or that Wal-Mart truly has become a global enterprise.

[Laughter.]

STATEMENT OF JAMES W. STANWAY, SENIOR DIRECTOR, GLOBAL SUPPLIER INITIATIVES, WAL–MART STORES, INC.

Mr. STANWAY. Chairman Lieberman, Ranking Member Warner and distinguished members of the committee, no, I am not originally from Arkansas, but I have 3 years ago become a U.S. citizen.

Senator LIEBERMAN. Welcome. Thank you.

Mr. STANWAY. Wal-Mart Stores thanks the subcommittee for its work on this important issue and for holding this hearing today. As the largest retail company in the world, the largest private consumer of electricity in the United States, and the owner of one of the largest private truck fleets in the country, Wal–Mart takes a keen interest in the serious risks and opportunities of climate change.

More than 2 years ago, our CEO Lee Scott, announced that Wal–Mart would make sustainability an organizing principle for the company and he announced three goals: to be supplied 100 percent by renewable energy; to create zero waste; and to sell products that sustain our resources and environment.

Wal–Mart has already taken steps to mitigate its greenhouse gas emissions and we are dedicated to making further significant progress. Among other things, we are committed to reducing greenhouse gas emissions at our existing facilities—that is stores, clubs, and distribution centers—by 20 percent by 2012, and improving our truck fleet efficiency by 25 percent by 2008, and 100 percent by 2015.

The goals we have adopted for reducing energy consumption in our stores and our vehicle fleets are ambitious. Wal–Mart has installed auxiliary power units, APUs, on our trucks. These APUs alone save 10 million gallons of diesel fuel per year. Our installed lighting load, the daylight harvesting systems that were referred to, these turn out the lights when the curtains are open. It is not just simply opening the curtains. You have to turn off the lights, too. It is 40 percent than the baseline established in the Energy Policy Act of 2005. Our retrofits have resulted in a 15 percent to 20 percent reduction in our energy load and a savings to our company of about $19 million a year.

Within only 15 months, we have developed a prototype store that is 20 percent more energy efficient than our existing stores. These stores will form the model for our future construction. We operate a centralized energy management system from our home office in Bentonville. This allows us to dial down energy usage, for example in the event of a load crisis, such as the one we saw in California several years ago, and indeed at the request of utilities in Connecticut when they ask us to for system stability.

Just this Monday, we announced a major purchase of solar power which, when fully implemented, could be one of the country's, if not the world's, top 10 largest ever solar power initiatives.

While this is only a partial list of our accomplishments, the bottom line is that we are aggressively attacking our greenhouse gas footprint. Our successes within Wal–Mart have led to an aggressive program to work with our suppliers, to wring more efficiency and emissions reductions from our supply chain. Through our Wal–Mart energy program, we have arranged for surveys of selected suppliers' facilities and suggested improvements. As an example, our first partner in this program was a manufacturer of children's clothes and underwear in Georgia called Dana Undies. Wal–Mart engineers went to the 65,000 square foot facility and suggested a number of operational and capital improvements in the areas of lighting and cooling. The result was a 52 percent decrease in electricity costs for that company's operation.

While the payback from many of these technologies are short, small businesses and consumers are often turned off by the up front cost and complexity. I would like to mention two ways we are addressing this. Wal–Mart has launched a nationwide campaign to sell 100 million compact fluorescent, or CFL, light bulbs. We are making the CFL more affordable to consumers, as well as helping educate them on the benefits of this technology. We have already seen sales go from less than 5 percent to 15 percent of our total light bulb sales, and we hope that trend continues.

Last month, our Sam's Clubs in Phoenix, AZ test marketed a lighting retrofit program specifically designed for small business owners. Selling through a market channel such as Sam's, direct buying the technology, and adopting a community-based marketing approach, we hope to deliver prices that will enable small businesses to make investments in energy efficiency, reduce their operating expenses, and thus reduce their greenhouse gas emissions. In other words, achieve the same efficiency that Wal-Mart and other large companies are already harvesting.

We believe we have shown that energy savings and emissions reductions can be achieved in ways that will benefit companies and consumers of all shapes, sizes and incomes. Clearly, however, a properly designed regulatory framework could help considerably. A properly designed system will enable the market where real carbon reductions have a value, and where this could be passed back to those customers by using the product's carbon value to rollback the technology price.

A market-based approach under a cap and trade system that allows downstream actors to monetize carbon value offers opportunities like Wal–Mart and others to innovate and deliver more value to customers. We urge Congress to recognize the type of progress we have already begun to make by including the mechanisms such as a carbon credit set-aside program that would allow more players to harvest the value of energy efficiency in the economy. The result would be more emissions reductions, more energy efficiency, and more savings to all.

Thank you for your time in allowing me to speak on behalf of Wal–Mart on this very important topic. We look forward to working with you.

[The prepared statement of Mr. Stanway follows:]

STATEMENT OF JAMES W. STANWAY, SENIOR DIRECTOR, GLOBAL SUPPLIER INITIATIVES, WAL-MART STORES, INC.

Chairman Lieberman, Ranking Member Warner, and distinguished Members of the committee:

Wal-Mart Stores, Inc., thanks the subcommittee for its work on this important issue and for holding this hearing today. Wal-Mart appreciates the opportunity to participate in this critical discussion.

BACKGROUND

Wal-Mart is based In Bentonville, Arkansas. Our company employs approximately 1.3 million Associates from all 50 states and approximately 1.8 million Associates worldwide. Each week over 176 million customers worldwide choose to shop at Wal-Mart, which we feel reflects the success of our dedication to providing Every Day Low Prices to our customers. Wal-Mart does not just operate stores, clubs, and distribution centers in communities; we take a proactive stance in community involvement on a number of Issues.

PURPOSE OF HEARING AND WAL-MART'S ROLE

As we understand it, the purpose of today's hearing is to discuss emerging technologies and practices for reducing greenhouse gas emissions. As the largest retail company in the world, the largest private consumer of electricity in the United States, and the owner of one of the largest private heavy-duty truck fleets in the country, Wal-Mart takes a keen interest in the serious risks—and opportunities—of global climate change. More than 2 years ago our CEO Lee Scott announced that Wal-Mart would make "sustainability" an organizing principle for the company. In recognizing that climate change is among the greatest issues confronting our business, our customers, and our communities, he announced three goals for our company: to be supplied 100 percent by renewable energy; to create zero waste; and to sell products that sustain our resources and the environment. Since that time we have acted rapidly to become a cleaner, greener and more sustainable company.

A crucial part of reaching the company's environmental goals is reducing our impact on the world's climate. Wal-Mart already has taken steps to mitigate its greenhouse gas emissions and we are dedicated to making significant further prowess. Among other things, we are committed to investing approximately $500 million annually in sustainable technologies and innovations; reducing greenhouse gas emissions at our existing stores, Sam's Clubs and distribution centers by 20 percent over the next 5 years; designing and opening a viable prototype that is 25–30 percent more efficient and wilt use 30 percent less energy; and improving our vehicle fleet's efficiency by 25 percent in 3 years and 100 percent in 10 years. Just this Monday,

we announced a major purchase of solar power from three solar power providers for 22 combined Wal-Mart stores, Sam's Clubs and a distribution center in California and Hawaii. When fully implemented, the aggregate purchase could be one of the country's, if not the world's, top-10 largest ever solar power initiatives.

This past January we announced our support of the effort by the companies and organizations of the U.S. Climate Action Partnership (US–CAP), and endorsed the group's call for strong mandatory national policies and market-based programs for greenhouse gas reductions. Wal-Mart looks forward to working with Congress and the White House to enact meaningful legislation to slow, stop and reverse the growth of greenhouse gas emissions. To be clear, we take this position because we believe it is in the best interest of our customers, our employees, our stockholders and our Nation to tackle this challenge. But we also believe that with the right policies, businesses large and small—from Wal-Mart, to our suppliers, to small businesses across the country—can save. We believe this because of what we are seeing every day as we undertake our aggressive sustainability agenda.

In this testimony, we will address four subjects today: (1) how Wal-Mart has succeeded in mitigating its own carbon footprint and how that has added savings to our customers; (2) the successes we have had working with our suppliers to increase efficiency and reduce emissions; (3) how we are helping small businesses and consumers save money by reducing their own carbon footprint; and (4) the elements of any Federal climate legislation that we think are needed to achieve the greatest greenhouse gas reductions for the lowest cost while ensuring benefits for customers.

OUR OWN EFFORTS

The goats we have adopted far reducing energy consumption in our stores and our vehicle fleet are ambitious. However, with the remarkable innovation and dedication of our associates and our partners, we have found these changes to be not only achievable, but cost effective, and we are ahead of our own aggressive schedule.

• With regard to our goal of a 25 percent improvement in our vehicle fleet efficiency, we are ahead of schedule. Wal-Mart has installed auxiliary power units (APUs) on its trucks as part of our fuel conservation policy. For individual trucks, we have achieved 28 percent improvement over our base 2005 truck/trailer (that improvement consists of fuel additives, aerodynamic improvements to the truck/trailer, weight reduction, fuel efficient tire application, and APUs). We have over half of that improvement installed on all 7,200 trucks (8 percent from APU, 2 percent from additives, 6 percent from tires). The use of the Mills alone saves 10 million gallons of diesel fuel and prevents 100,000 metric tons of CO_2 from entering the atmosphere,

• We have developed over the last decade what might be the most efficient lighting system in the world. We have implemented daylight harvesting, computer controlled continuous dimming, T8 lighting and other efficiency technologies in 1,000 stores. We vary light output on our sales floor from 100 percent to 0 percent (completely off on bright sunny days) and reduce late night light levels (35 percent). In fact, our installed lighting load is more than 40 percent less than the baseline established in the Energy Policy Act of 2005 and our retrofits have resulted in a 15–20 percent reduction in our energy load and a savings to the Company of about $90 million per year.

• Within only 15 months, we have developed and opened two new prototype stores that are mare than 20 percent more efficient than our existing stores. These stores will farm the model for future construction.

• The EER rating of our High Efficiency HVAC units ranges between 10.8 and 13.2, versus the industry standard of 9.0. Units are 4–17 percent more efficient than California's Title 24 standard requirements.

• We now utilize LED Lighting in all of our internally illuminated building signage far new construction (except Sam's Clubs) and are replacing existing signs with LEDs. These changes represent a 70 percent increase in efficiency.

• We recently opened a new facility in Savannah, Georgia, which included what was at the time the first low temperature CO_2 secondary (pop refrigeration system in the United States. On the day of the grand opening we conducted tours of the facility, including detailed descriptions of the systems, to representatives from our competitors Target, Food Lion, Publix, and Costco.

• In 2006 we committed to examine the packaging of every product we sell, and have encouraged our suppliers to reduce packaging and to use reusable or recyclable materials. February 1, 2007 we made our "packaging scorecard" available to all 60,000 suppliers. We will improve that scorecard between now and February 1, 2008, when it will become a factor in merchandise buying decisions.

• Wal-Mart has adopted its Plastic Sandwich Bale™ program in over 3,000 stores, a process that greatly increases the recycling of packaging plastics. In 2005, the company recycled over 5,734 tons of plastic significantly saving energy and reducing greenhouse gases.

• In 2005 Sam's Club partnered with NatureWorks to introduce use of PIA fresh cut produce packaging to replace conventional packaging, saving the equivalent of 800,000 gallons of gasoline and reducing more than 11 million lbs. of greenhouse gases.

• Centralized Energy Management—All U.S. stores are monitored and controlled from our home office in Bentonville. This allows us to dial down energy usage, for example, in the event of a load crisis such as the one we saw in California several years ago.

• Wal-Mart Supercenters and Neighborhood Markets (over 2,000) capture waste heat from refrigeration equipment to heat water for the kitchen prep areas of the stores, saving 165 million BTUs per year.

WORKING WITH OUR SUPPLIERS

The bottom line is that we are dramatically improving our greenhouse as footprint. These savings help us to fulfill our commitment to our customers to provide them with low prices. And our successes within Wal-Mart have led to an aggressive program to work with our suppliers to wring more efficiency and emissions reductions from the supply chain. Through "Wal-Mart Energy", we offer an energy efficiency program that can significantly lower our suppliers' energy costs. We arrange for a survey of our suppliers' facilities and suggest improvements based an technologies Wal-Mart is already using. We then use our existing supplier relationships and bid management expertise to arrange the lowest-cost services for the supplier. Wal-Marts supply chain is dispersed across all 50 states; small companies and large are already seeing great success.

As an example, our first partner in this program was a manufacturer of children's clothes and underwear in Georgia called Dana Undies. Like many U.S. companies, Dana Undies was facing challenges competing on price with competitors and pointed to energy costs for much of the problem. Wal-Mart engineers went to the 65,000 square foot Dana facility in Georgia and suggested a number of operational and capital improvements in the areas of lighting and cooling. The result was a 52 percent decrease in energy costs. As Dana Undies CEO Steve Varon has said, the technology to achieve significant energy reductions exist today, "All you need is the will and a great partner like Wal-Mart."

WORKING WITH SMALL BUSINESSES AND HELPING CUSTOMERS SAVE ENERGY

Because of our buying power and size, we are able to invest in energy efficiency in a cost effective manner. For small businesses and consumers, there are often challenges to taking advantage of these opportunities and we are working to address those. In our energy related business efforts, we are looking to address two key challenges: the upfront costs of dean energy technologies and inadequate channels to market.

While the payback for many of these technologies is short, small businesses and consumers often are turned off by the upfront costs and complexity. Below are two examples of how we are addressing this.

• 18 Seconds. Wal-Mart has launched a nationwide campaign to sell 100 million compact fluorescent light bulbs (CFLs). Our partner GE sells CFLs to Wal-Mart in large numbers and we offer them to consumers. Here is where we are doing what we do best—offering products at everyday low prices—and we are making the CFL more affordable to consumers, as well as helping educate them on the benefits of this available technology. We are dedicating prime display space for CFLs, adding educational displays, educating our sates associates and creating friendly competition among stores based on CFL sales. We have already seen sales go from less than 5 percent to 15 percent.

• Energy Efficiency for Small Businesses. Last month, our Sam's Clubs in Phoenix, Arizona test marketed a lighting retrofit program designed for small business owners. Selling through a market channel such as Sam's, direct buying the technology and adopting a community based marketing approach, we hope to deliver prices that enable small businesses to make investments in energy efficiency, reduce their operating expenses and reduce greenhouse gas emissions. Hughes Performance, a small manufacturer of transmissions for dragsters and race cars in Phoenix was our first customer. After working with our program CEO Jim Hughes said, "The program was great because as a small business owner you get so caught up in the daily activities of running a company that this kind of improvement doesn't

even cross your mind. I didn't realize how much small efficiencies could add up and improve my bottom line. Now I expect to save on my electric bill each month, and as a small business owner, every bit helps."

Our small business program is also meant to overcome the challenge of getting efficiency technologies to market. Many traditional Energy Service Companies focus on Large corporations, since the transaction costs of pursuing smaller entities prohibit downstream sales. Utilities have also undertaken to market energy efficiency but sometimes operate in a regulated environment that discourages such efforts and they often have a limited relationship or brand with their customer base. Non-traditional energy efficiency providers can greatly reduce these marketing and sales costs. We are proving this model.

DESIGNING A REGULATORY PROGRAM TO HELP CONSUMERS AND SMALL BUSINESSES

We believe we have shown that energy savings and emissions reductions can be achieved in ways that will benefit companies and consumers of all shapes, sizes and incomes. Clearly, however, a properly designed regulatory framework could help considerably.

In a greenhouse gas regulators/regime, the value of energy savings will include both the savings in the cost of energy and the value of the greenhouse gas emissions avoided. A properly designed system will enable a market where real carbon reductions have a value and this value could be monetized and passed back to those customers by using the products' "carbon value" to rollback the technology price. Companies like Wal-Mart are in an excellent position to add that value into the product delivery and value chain and use the competitive pressures of the market to pass that value an to consumers in the form of reduced costs. We believe that making that carbon value available downstream will increase efficiency and speed to market. As with any business sector, the more economic opportunity, the more market entrants, the more innovation and an acceleration of products to market occurs. A regulatory regime that creates a robust carbon market can drive innovation—both in technological and marketing fields—which U.S. companies could excel at in both domestic and global markets.

A market-based approach under a cap and trade system that allows downstream actors to monetize carbon value offers opportunities for businesses like Wal-Mart to innovate and deliver more value to customers. The utility sector will require many years to decarbonize its electricity production, but that does not mean other sectors of the economy—such as the end user—cannot economically reduce consumption and effectively "buy time" for the new low or no carbon electricity sources to be built. We urge the Congress to recognize the type of progress that we have already begun to make by including a mechanism—such as a carbon credit set-aside program—that would allow more players to "mine" the value of energy efficiency. The result will be more emissions reductions, more energy efficiency and more savings to all.

CONCLUSION

At Wal-Mart, we are known for saving our customers money, and we have been successful because we innovate our way to savings. We believe that the challenge of global warming presents just another opportunity for innovation and the creation of value. We support Congress' efforts to craft climate legislation because we believe—and we have shown—that reducing emissions and saving energy will be profitable and that the benefits can be shared by all.

Thank you for your time in allowing me to speak on behalf of Wal-Mart on this very important topic. We look forward to working with you to effectively and constructively address these issues.

RESPONSES BY JAMES W. STANWAY TO ADDITIONAL QUESTIONS FROM SENATOR LAUTENBERG

Question 1. Last year, CEO Lee Scott stated a goal of reducing Wal-Mart's greenhouse emissions by 20 percent and reducing energy costs by 30 percent in 7 years. How confident are you that you can meet that goal, and which "green building" technologies have yielded the highest emissions reduction and cost savings?

Response. We have begun to implement technologies to achieve our goal and have seen great progress. Because we are truly attempting unprecedented energy and emission-saving changes, we do not yet know if all the technologies we have planned to develop and deploy will work. Nevertheless, we fully intend to meet our stretch goals. The best results so far have been in the area of lighting technologies. Simply upgrading to the latest fluorescent technologies and adding new controls, for exam-

ple, has proved very successful. These controls range from motion sensors to daylight harvesting systems which turn lights off on sunny days when integrated with skylights/windows. LED lighting is evolving quickly and we are adopting this technology for use in our refrigerated food cases. We expect further LED product evolution to enable this technology to be applied more widely. Variable speed drives applied to our refrigeration systems and white roofs are also delivering good results.

Question 2. The work that you are starting to undertake in improving energy efficiency in your supply chain is very important. You have reportedly helped one of your suppliers reduce electricity bills by 60 percent by using simple efficient lighting technology. When your suppliers make these improvements, does Wal-Mart keep the energy savings or does the supplier? Does Wal-Mart re-negotiate the price of the goods based on these savings to the supplier?

Response. The supplier retains the energy savings and Wal-Mart does not re-negotiate the price of goods based on these initiatives.

Question 3. If there was a cap-and-trade system in place for carbon dioxide, would you require your supply chain to provide your company with the credit for the emissions reductions? Is Wal-Mart considering doing this?

Response. We would only negotiate for the 'GHG credits' if we invested or were otherwise involved in creating the efficiency gain. We do intend to do this by selling technology to our supply chain at prices they could not achieve on their own—in other words bulk buying and deployment of energy efficient technology within the Wal-Mart supply chain. If the GHG value was assigned to Wal-Mart then the cost of the technology could be lowered—it simply becomes another source of economic value. Some suppliers may wish to retain the GHG value but many would not have the scale of operations to effectively harvest the financial value of these credits under any foreseeable regulatory regime. Just as we would bulk buy technology for the supply chain—we would bulk sell the GHG credits if such a mechanism existed. We believe that by adopting a supply chain approach to energy technology we can overcome a profound market failure currently existing, i.e., the inability of energy efficient technologies to be sold and deployed without significant transaction costs.

Senator LIEBERMAN. Thanks, Mr. Stanway. Again, and I know we are going to hear it from our last two witnesses, but you have told a story of good business practices, innovation to make the business more efficient and profitable, but also tremendous what I call corporate citizenship to deal with the problem. I thank you for it.

Mr. STANWAY. Thank you.

Senator LIEBERMAN. Michael Rencheck is next, senior vice president for Engineering, Projects and Field Services, American Electric Power. He apparently has something to do with the State of Ohio.

Mr. RENCHECK. That is correct.

STATEMENT OF MICHAEL W. RENCHECK, SENIOR VICE PRESIDENT FOR ENGINEERING, PROJECTS AND FIELD SERVICES, AMERICAN ELECTRIC POWER

Mr. RENCHECK. Good morning, Mr. Chairman and members of the committee. Thank you for inviting me to participate in today's hearing.

American Electric Power is one of the Nation's largest electric utilities with more than 5 million retail customers in 11 States. We are also one of the Nation's largest power producers, with over 38,000 megawatts of generating capacity with a very diverse mix of generating assets. But of particular note today, AEP is one of the largest coal-fired electric generators in the United States and we have implemented a portfolio of voluntary reductions to avoid and offset greenhouse gases during the past decade.

Coal generates over 50 percent of the electricity used in the United States, and is extensively used worldwide. As the demand for electricity increases significantly, coal will increase as well. In

the future, coal-fired electric generation must be zero emission or close to it.

This will be achieved through new technologies that are being developed today, but are not yet proven or commercially available. Like most companies in our sector, AEP needs new generation. We are investing in new clean coal technology that will enable AEP and our industry to meet the challenge of reducing greenhouse gas emissions for the long term. This includes plans to build two new integrated gasification combined cycle plants, IGCCs, and two state of the art ultrasupercritical coal plants. These will be the first new generation of ultrasupercritical coal plants in the United States.

AEP has also taken the lead in commercialization of carbon capture technology for use on new generation, and more importantly, for retrofit on existing generation. We signed a memorandum of understanding with Alstom for post-combustion capture technology, using Alstom's chilled ammonia system. Starting with the commercial performance verification project in mid to late 2008 in West Virginia, a project that will also include storage in deep geological sequestration in a saline aquifer, we will move to the first commercial size project at one of our 450 megawatt coal-fired units, our Northeastern Plant, in Oklahoma by late 2011. This will capture about 1.5 million metric tons of CO_2 a year, which will be primarily used for enhanced oil recovery.

We are also working with Babcock and Wilcox to take its oxy-coal combustion technology from the drawing board to commercial scale activity in the next decade.

AEP is very comfortable leading technology. We have a long and impressive list of technological firsts that we have achieved during our first 100 years. But we have identified one very important caveat during our century of technological achievement and engineering excellence. Proving technology to be commercially viable and proving it out for wide scale commercial use are two different things. It takes time to develop off the shelf commercial technology offerings.

AEP is not calling for indefinite delay in the enactment of mandatory climate change legislation until the advanced technology such as carbon capture and storage is developed. However, as the requirements become more stringent during the next 10 years to 20 years, and we move beyond the ability of current technology to deliver those reductions, it is essential that the requirements for deeper reductions allow sufficient time for the demonstration and commercialization of advanced technologies.

How can you help? It is also important to establish public funding, as well as incentives for private funding, for the development of commercially viable technology solutions, as well as providing the legal and the regulatory structures to facilitate their development. AEP believes that IGCC, advanced coal and carbon capture technologies, need to be advanced. But the building of an IGCC and the timely commercial development of carbon capture and sequestration technologies will require additional public funding.

AEP and others in our sector have already invested heavily in the research and the early deployment of technologies that may be commercially viable at some point in the future to address greenhouse gas emissions. For this reason, separate investment tax cred-

its are needed to facilitate both the construction of IGCC, advanced coal technologies, and carbon capture and sequestration technologies.

Of significance here, the final decider on the type of power generation that can be built in many States is the public utility commission of that State. The commission determines how or if a utility can recover the costs of new generation or retrofits of existing generation. How do you reconcile a Federal mandate for expensive greenhouse gas mitigation, with States that desire to cap energy costs? The utilities and their shareholders remain caught in the middle and need your help to research, develop and build this type of generation.

American industry has long been staffed by excellent problem solvers. I am confident we will be able to develop technologies to address emissions of greenhouse gases in a more efficient manner. We have the brain power. We need the time, funding assistance, and legal and regulatory support.

Thank you very much for allowing me to participate today.

[The prepared statement of Mr. Rencheck follows:]

STATEMENT OF MICHAEL W. RENCHECK, SENIOR VICE PRESIDENT FOR ENGINEERING, PROJECTS AND FIELD SERVICES, AMERICAN ELECTRIC POWER

Good morning Mr. Chairman and distinguished members of the Senate Committee on Environment and Public Works Subcommittee on Private Sector and Consumer Solutions to Global Warming.

Thank you for inviting me here today. Thank you for this opportunity to offer the views of American Electric Power (AEP) and for soliciting the views of our industry and others on climate change technologies.

My name is Mike Rencheck, Senior Vice President-Engineering Projects & Field Services of American Electric Power (AEP). Headquartered in Columbus, Ohio, we are one of the Nation's largest electricity generators—with over 36,000 megawatts of generating capacity—and serve more than five million retail consumers in 11 states in the Midwest and south central regions of our Nation. AEP's generating fleet employs diverse sources of fuel—including coal, nuclear, hydroelectric, natural gas, and oil and wind power. But of particular importance for the committee members here today, AEP uses more coal than any other electricity generator in the Western hemisphere.

AEP'S TECHNOLOGY DEVELOPMENT

Over the last 100 years, AEP has been an industry leader in developing and deploying new technologies beginning with the first high voltage transmission lines at 345 kilovolt (kV) and 765kV to new and more efficient coal power plants starting with the large central station power plant progressing to supercritical and ultrasupercritical power plants. We are continuing that today. We implemented over 11 selective catalytic reactors (SCRs), 9 Flue Gas Desulphurication units with others currently under construction, and we are a leader in developing and deploying mercury capture and monitoring technology. In addition, we continue to invest in new clean coal technology plants and R&D that will enable AEP and our industry to meet the challenge of significantly reducing GHG emissions in future years. For example, AEP is working to build two new generating plants using Integrated Gasification Combined Cycle (IGCC) technology in Ohio and West Virginia, as well as two highly efficient new generating plants using the most advanced (e.g. ultrasupercrifical) pulverized coal combustion technology in Arkansas and Oklahoma. We are also supporting a leading role in the FutureGen project, which once completed, will be the world's first near-zero CO_2 emitting commercial scale coal-fueled power plant. We are also working to progress specific carbon capture and storage technology.

AEP'S MAJOR NEW INITIATIVE TO REDUCE GHG EMISSIONS

Just this past month, AEP announced several major new initiatives to reduce AEP's GHG emissions and to advance the commercial application of carbon capture and storage technology and Oxy-coal combustion. Our company has been advancing

technology for the electric utility industry for more than 100 years. AEP's recent announcement continues to build upon this heritage. Technology development needs are often cited as an excuse for inaction. We see these needs as opportunities for action.

AEP has signed a memorandum of understanding (MOU) with Alstom, a worldwide leader in equipment and services for power generation, for post-combustion carbon capture technology using Alstom's chilled ammonia system. It will be installed at our 1300-megawatt Mountaineer Plant in New Haven, W.Va., as a "30-megawatt (thermal) commercial performance verification" project in mid- to late-2008 and it will capture go to 100,000 metric tons of carbon dioxide (CO_2) per year—Once the CO_2 is captured, we will store it. The Mountaineer site has an existing deep saline aquifer injection well previously developed in conjunction with DOE and Battelle. Working with Battelle and with continued DOE support, we will use this well (and develop others) to store and further study CO_2 injection into deep geological formations.

Following the completion of commercial verification at Mountaineer, AEP plans to install Alstom's system on one of the 450-megawatt coal-fired units at its Northeastern Plant in Oologah, Oklahoma, as a first-of-a-kind commercial demonstration. The system is expected to be operational at Northeastern Plant in late 2011, capturing about 1.5 million metric tons of CO_2 a year. The CO_2 captured at Northeastern Plant will also be used for enhanced oil recovery.

AEP has also signed an MOU with Babcock and Wilcox to pursue the development of Oxy-coal combustion that uses oxygen in lieu of air for combustion, which forms a concentrated CO_2 post combustion gas that can be stored without additional post combustion capture processes. AEP will work with B&W on a "30-megawatt (thermal) pilot project in mid-2007 then use the results to study the feasibility of a scale 100–200MW demonstration. The CO_2 from the demonstration project would be captured and stored in a deep saline or enhanced oil recovery application.

In March, AEP voluntarily committed to achieve an additional five million tons of GHG reductions annually beginning in 2011. We will accomplish these reductions through a new AEP initiative that will add another 1000 Mw of purchased wind power into our system, substantially increase our forestry investments (in addition to the 62 million trees we have planted to date), as well as invest in domestic offsets, such as methane capture from agriculture, mines and landfills.

AEP PERSPECTIVES ON A FEDERAL GHG REDUCTION PROGRAM

While AEP has done much, and will do much more, to mitigate GHG emissions from its existing sources, we also support the adoption of an economy-wide cap-and-trade type GHG reduction program that is well thought-out, achievable, and reasonable. Although today I intend to focus on the need for the development and deployment of commercially viable technologies to address climate change and not on the specific policies issues that must be addressed, AEP believes that legislation can be crafted that does not impede AEP's ability to provide reliable, reasonably priced electricity to support the economic well-being of our customers, and includes mechanisms that foster international participation and avoid creating inequities and competitive issues that would harm the U.S. economy. AEP supports reasonable legislation, and is not calling for an indefinite delay until advanced technology such as carbon capture and storage (CCS) is developed. However, as the requirements become more stringent during the next 10 to 20 years, and we move beyond the ability of current technology to deliver those reductions, it is essential that requirements for deeper inductions coincide with the commercialization of advanced technologies.

PHASED-IN TIMING AND GRADUALLY INCREASING LEVEL OF REDUCTIONS CONSISTENT WITH TECHNOLOGY DEVELOPMENT THAT IS FACILITATED BY PUBLIC FUNDING

As a practical matter, implementing climate legislation is a complex undertaking that will require procedures for measuring, verifying and accounting for GHG emissions, as well as for designing efficient administration and enforcement procedures applicable to all sectors of our economy. Only a pragmatic approach with achievable targets, supported by commercial technology, and reasonable timetables—that does not require too many reductions within too short a time period—will succeed. Past experience with the Clean Air Act Amendments of 1990 (which involved a vastly simpler SO_2 allowance trading system for just the electric power sector), strongly suggests that a minimum of 5 years will be necessary to have the administrative mechanisms in place for full implementation of the initial GHG emission targets.

AEP also believes that the level of emissions reductions and timing of those reductions under a Federal mandate must keep pace with developing technologies for reducing GHG emissions from new and existing sources. The technologies for effective

carbon capture and storage from coal-fired facilities are developing, but are not commercially engineered to meet production needs, and cannot be artificially accelerated through unrealistic reduction mandates.

While AEP and other companies have successfully lowered their average emissions and emission rates during this decade, further substantial reductions will require the wide-scale commercial availability of new clean coal technologies. AEP believes that the electric power industry can potentially manage much of the expected economic (and CO_2 emissions) growth over the course of the next decade (2010–2020) through aggressively deploying renewable energy, further gains in supply and demand-side energy efficiency, and new emission offset projects. As stated above, AEP supports reasonable legislation, and is riot calling for an indefinite delay of GHG reduction obligations until advanced clean coal technology is developed. However, as the reduction requirements become more stringent, and move beyond the ability of current technologies to deliver those reductions, it is important that those stringent requirements coincide with the commercialization of advanced technology. This includes the next generation of low- and zero-emitting technologies. In the case of coal, this means demonstration and full-scale deployment of new IGCC units with carbon capture, new ultrasupercritical or oxy-coal plants with carbon capture and storage, as well as broad deployment of retrofit technologies for carbon capture and storage at existing coal plants. The next generation of nuclear technology will also play an important role in meeting significant reduction targets.

However, today's costs of new clean coal technologies with carbon capture and storage are much more expensive than current coal-fired technologies. For example, carbon capture and storage using current inhibited monoethanolamine (MEA) technology is expected to increase the cost of electricity from a new coal fired power plant by about 60–70 percent and even the newer chilled ammonia carbon capture technology we plan to deploy on a commercial-sized scale by 2012 at one of our existing coal-fired units will result in significantly higher costs. It is only through the steady and judicious advancement of these applications during the course of the next decade that we can start to bring these costs down, in order to avoid substantial electricity rate shocks and undue harm to the U.S. economy.

Simply put, our Nation cannot wait a decade or longer to begin the development and commercialization of IGCC and carbon capture and sequestration technologies. The need for new electric generating capacity is upon us now. The need is real and it is pressing. Unfortunately, the deployment of advanced coal electric generation technology, such as IGCC, is expensive now and will only become more so if development is postponed.

AEP believes that IGCC is the best commercially ready technology for the future inclusion of CCS but that the timely development of commercially viable CCS technologies will require additional public funding. Our IGCC plants will incorporate the space and layout for the addition of component to capture CO_2 for sequestration, but AEP does not plan to incorporate CCS equipment until after the plants are operating and the technology is demonstrated and proven.

Our IGCC plans will be among the earliest, if not the first, deployments of large-scale IGCC technology. The cost of constructing these plants will be high, resulting in a cost of generated electricity that would be at least twenty percent greater than that from conventional pulverized goal (PC) combustion technology. As more plants are built, the costs of construction are expected to come into line with the cost of PC plants.

To help bridge the cost gap and move IGCC technology down the cost curve, there is a need for continuation and expansion of the advanced coal project tax credits that were introduced by the Energy Policy Act of 2005. All of the available tax credits for IGCC projects using bituminous coal were allocated to only two projects during the initial allocation round in 2006. More IGCC plants are needed to facilitate this technology. AEP believes an additional $1 billion of section 48A (of the Internal Revenue Code) tax credits are needed, with the bulk of that dedicated to IGCC projects without regard to coal type.

Along with an increase in the amount of the credits, changes are needed in the manner in which the credits are allocated. Advanced coal project credits should be allocated based on net generating capacity and not based upon the estimated gross nameplate generating capacity of projects. Allocation based upon gross, rather than net, generating capacity potentially rewards less efficient projects, which is antithetical to the purpose of advanced coal project tax incentives. AEP also believes that the Secretary of Energy should be delegated a significant role in the selection of IGCC projects that will receive tax credits.

On a critical note, the inclusion of carbon capture and sequestration equipment must not be a prerequisite for the allocation of these additional tax credits due to the urgent need for new electric generating capacity in the U.S. AEP also believes

that this requirement is premature and self-defeating, since the technology to capture and sequester a significant portion of an IGCC project's CO_2 does not currently exist. The addition of yet-to-be-developed carbon caption and sequestration technology to an IGCC project would cause the projected cost of a project to increase significantly, making it that much more difficult for a public utility commission to approve.

AEP also believes that additional tax incentives are needed to spur the development and deployment of greenhouse gas capture and sequestration equipment for all types of coal fired generation. We suggest that additional tax credits be established to offset a significant portion of the incremental cost of capturing and sequestering CO_2. These incentives could be structured partly as an investment tax credit, similar to that in section 48A (of the Internal Revenue Code), to cover the upfront capital cost, and partly as a production tax credit to cover the associated operating costs.

In summary, AEP recommends a pragmatic approach for phasing in GHG reductions through a cap-and-trade program coincident with developing technologies to support these reductions. The emissions cap should be reasonable and achievable in the early years of the program, the cap should be set at levels that slow the increase in GHG emissions. Allowing for moderate emissions increases over the first decade is critical due to limitations on currently available GHG control options and technologies. The stringency of the cap would increase over time-first stabilizing emissions and then requiring a gradual, long-term decline in emissions levels. The cap levels should be set to reflect projected advances in new carbon-saving technologies, which advances AEP believes can be facilitated by Federal incentives. In the case of the electric power sector, additional time is necessary to allow for the deployment of new nuclear plants as well as the demonstration and deployment of commercial-scale gasification and advanced combustion facilities fully integrated with technologies for CO_2 capture and storage. Substantial GHG reductions should not be required until after the 2020 timeframe.

Requiring much deeper reductions sooner would very likely harm the U.S. economy. For AEP and the electric sector, the only currently available strategy to achieve substantial absolute CO_2 reductions prior to 2020 without the full-scale deployment of new technologies will inevitably require much greater use of natural gas, in lieu of coal-fueled electricity, with the undesirable effects of higher natural gas prices and even tighter supplies.

TECHNOLOGY IS THE ANSWER TO CLIMATE CHANGE

The primary human-induced cause of global warming is the emission of CO_2 arising from the burning of fossil fuels. Put simply, our primary contribution to climate change is also what drives the global economic engine.

Changing consumer behavior by buying efficient appliances and cars, by driving less, and by similar steps, is helping to reduce the growth of GHG emissions. However, these steps will never be nearly enough to significantly reduce CO_2 emissions from the burning of coal, oil and natural gas. Such incremental steps, while important, will never be sufficient to stabilize greenhouse gases concentrations in the atmosphere at a level that is believed to be capable of preventing dangerous human-induced interference with the climate system, as called for in the U.S.-approved U.N. Framework Convention on Climate Change (Rio agreement).

For that, we need major technological advances to effectively capture and store CO_2. The Congress and indeed all Americans must come to recognize the gigantic undertaking and significant sacrifices that this enterprise is likely to require. It is unrealistic to assume, and wrong to argue, that the market will magically respond simply by the imposition of severe caps on CO_2 emissions. The result will not be a positive response by the market, but rather a severe impact on the economy. Not when what we are talking about, on a large scale, is the capture and geologic storage of billions and billions of tons of CO_2 with technologies that have not yet been proven anywhere in the world.

CCS should not be mandated until and unless it has been demonstrated to be effective and the costs have significantly dropped so that it becomes commercially engineered and available on a widespread basis. Until that threshold is met, it would be technologically unrealistic and economically unacceptable to require the widespread installation of carbon capture equipment. The use of deep saline geologic formations as the primary long-term geologic formations for CO_2 storage has not yet been sufficiently demonstrated. There are no national standards for permitting such storage reservoirs; there are no widely accepted monitoring protocols; and the standards for liability are unknown (and whether Federal or state laws would apply), as well as who owns the rights to these deep geologic reservoirs remains a question.

Underscoring these realities, industrial insurance companies point to a lack of scientific data on CO_2 storage as one reason they are disinclined to insure early projects. In a nutshell, the institutional infrastructure to support CO_2 storage does not yet exist and will require years to develop. In addition, application of today's CO_2 capture technology would significantly increase the cost of an IGCC or a new efficient pulverized coal plant, calling into serious question regulatory approval for the costs of such a plant by state regulators. Further, recent studies sponsored by the Electric Power Research Institute (EPRI) suggest that application of today's CO_2 capture technology would increase the cost of electricity from an IGCC plant by up to 50 percent, and boost the cost of electricity from a conventional pulverized coal plant by up to 60–70 percent, which would again jeopardize state regulatory approval for the costs of such plants.

Despite these uncertainties, I believe that we must aggressively explore the viability of this technology in several first-of-a-kind commercial projects. AEP is committed to help lead the way, and to show how this can be done. For example, as described earlier in this testimony, AEP will install carbon capture controls on two existing coal-fired power plants, the first commercial use of this technology, as part of our comprehensive strategy to reduce, avoid or offset GHG emissions.

AEP is also building two state-of-the-art advanced ultrasupercritical power plants in Oklahoma and Arkansas. These will be the first of the new generation of ultrasupercritical plants in the United States.

AEP is also advancing the development of IGCC technology. IGCC represents a major breakthrough in our work to improve the environmental performance of coal-based electric power generation. AEP is in the process of permitting and designing two of the earliest commercial scale IGCC plants in the Nation. Construction of the IGCC plants will start once traditional rate recovery is approved.

IGCC technology integrates two proven processes—coal gasification and combined cycle power generation—to convert coal into electricity more efficiently and cleanly than any existing uncontrolled power plants can. Not only is it cleaner and more efficient than today's installed power plants, but IGCC has the potential to be retrofitted in the future for carbon capture at a lower capital cost and with less of an energy penalty than traditional power plant technologies, but only after the technology has been developed and proven.

AEP is also a founding member of FutureGen, a groundbreaking public-private collaboration that aims squarely at making near-zero-emissions coal-based energy a reality. FutureGen is a $1.5 billion, 10-year research and demonstration project. It is on track to create the world's first coal-fueled, near-zero emission electricity and hydrogen plant with the capability to capture and sequester at least 90 percent of its carbon dioxide emissions.

As an R&D plant, FutureGen will stretch—and indeed create—the technology envelope. Within the context of our fight to combat global climate change, FutureGen has a truly profound mission—to validate the cost and performance baselines of a fully integrated, near zero-emission coal-fueled power plant.

The design of the FutureGen plant is already underway, and we are making great progress. The plant will be on-line early in the next decade. By the latter part of that decade, following on the advancements demonstrated by AEP, FutureGen and other projects, CCS technology should become a commercial reality.

It is when these technologies are commercially demonstrated, and only then, that commercial orders will be placed on a widespread basis to implement CCS at coal-fueled power plants. That is, roughly around 2020. Widespread deployment assumes that a host of other important issues have been resolved, and there is governmental and public acceptance of CCS as the proven and safe technology that we now believe it to be. AEP supports rapid action on climate change including the enactment of well thought-out and achievable legislation so that our Nation can get started on dealing with climate change. However, the complete transformation of the U.S. electricity system will take time, and we can't put policy ahead of the availability of cost-effective technology. The development of technology must coincide with any increase in the stringency of the program.

What will happen if the Congress does the opposite, and mandates deep reductions in the absence of a proven, viable technology? It is the proverbial road of good intentions, and only dangerous consequences can follow. The most immediate would be a dramatic—and very likely costly—increase in the use and price of natural gas by the utility sector, since there would be no other identifiable alternative. This would have significant adverse impacts on consumers and workers by driving up the cost of gas for home heating and cooking, and would further increase costs to any industry dependent upon natural gas as a feedstock, such as chemicals and agriculture with a further exporting of jobs overseas.

A huge challenge that our society faces over the remainder of this century is how we will reduce the release of GHG emissions from fossil fuels. This will require nothing less than the complete reengineering of the entire global energy system over the next century. The magnitude of this task is comparable to the industrial revolution, but for this revolution to be successful, it must stimulate new technologies and new behaviors in all major sectors of the economy. The benefits of projects like FutureGen and the ones AEP is pursuing will apply to all countries blessed with an abundance of coal, not only the United States but also Nations like China and India.

In the end, the only sure path to stabilizing GHG concentrations over the long term is through the development and utilization of advanced technologies. And we must do more than simply call for it. Our Nation must prepare, inspire, guide, and support our citizens and the very best and the brightest of our engineers and scientists; private industry must step up and start to construct the first commercial plants; and our country must devote adequate financial and technological resources to this enormous challenge. AEP is committed to being a part of this important process, and to helping you achieve the best outcome at the most reasonable cost and timelines possible. Thank you again for this opportunity to share these views with you.

AMERICAN ELECTRIC POWER

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FOR IMMEDIATE RELEASE

AEP TO INSTALL CARBON CAPTURE ON TWO EXISTING POWER PLANTS; COMPANY WILL BE FIRST TO MOVE TECHNOLOGY TO COMMERCIAL SCALE

As climate policy advances, 'it's time to advance technology for commercial use,' CEO says

COLUMBUS, Ohio, March 15, 2007 – American Electric Power (NYSE:AEP) will install carbon capture on two coal-fired power plants, the first commercial use of technologies to significantly reduce carbon dioxide emissions from existing plants.

The first project is expected to complete its product validation phase in 2008 and begin commercial operation in 2011.

"AEP has been the company advancing technology for the electric utility industry for more than 100 years," said Michael G. Morris, AEP chairman, president and chief executive officer. "This long heritage, the backbone of our company's success, makes us very comfortable taking action on carbon emissions and accelerating advancement of the technology. Technology development needs are often cited as an excuse for inaction. We see these needs as an opportunity for action.

"With Congress expected to take action on greenhouse gas issues in climate legislation, it's time to advance this technology for commercial use," Morris said. "And we will continue working with Congress as it crafts climate policy. It is important that the U.S. climate policy be well thought out, establish reasonable targets and timetables, and include mechanisms to prevent trade imbalances that would damage the U.S. economy."

Morris will discuss AEP's plans for carbon capture during a presentation today at the Morgan Stanley Global Electricity & Energy Conference in New York. A live webcast of the presentation to an audience of investors will begin at 12:10 p.m. EDT and can be accessed through the Internet at

http://www.aep.com/go/webcast. The webcast will also be available after the event. Visuals used in the presentation will be available at http://www.aep.com/investors/present.

AEP has signed a memorandum of understanding (MOU) with Alstom, a worldwide leader in equipment and services for power generation and clean coal, for post-combustion carbon capture technology using Alstom's Chilled Ammonia Process. This technology, which is being piloted this summer by Alstom on a 5-megawatt (thermal) slipstream from a plant in Wisconsin, will first be installed on AEP's 1300-megawatt Mountaineer Plant in New Haven, W.Va., as a 30-megawatt (thermal) product validation in mid-2008 where up to 100,000 metric tons of carbon dioxide (CO_2) will be captured per year. The captured CO2 will be designated for geological storage in deep saline aquifers at the site. Battelle Memorial Institute will serve as consultants for AEP on geological storage.

Following the completion of product validation at Mountaineer, AEP will install Alstom's system on one of the 450-megawatt (electric) coal-fired units at its Northeastern Station in Oologah, Okla. Plans are for the commercial-scale system to be operational at Northeastern Station in late 2011. It is expected to capture about 1.5 million metric tons of CO_2 a year. The CO_2 captured at Northeastern Station will be used for enhanced oil recovery.

Alstom's system captures CO_2 by isolating the gas from the power plant's other flue gases and can significantly increase the efficiency of the CO_2 capture process. The system chills the flue gas, recovering large quantities of water for recycle, and then utilizes a CO_2 absorber in a similar way to absorbers used in systems that reduce sulfur dioxide emissions. The remaining low concentration of ammonia in the clean flue gas is captured by cold-water wash and returned to the absorber. The CO_2 is compressed to be sent to enhanced oil recovery or storage.

In laboratory testing sponsored by Alstom, EPRI and others, the process has demonstrated the potential to capture more than 90 percent of CO_2 at a cost that is far less expensive than other carbon capture technologies. It is applicable for use on new power plants as well as for the retrofit of existing coal-fired power plants.

AEP has signed an MOU with The Babcock & Wilcox Company (B&W), a world leader in steam generation and pollution control equipment design, supply and service since 1867, for a feasibility study of oxy-coal combustion technology. B&W, a subsidiary of McDermott International, Inc. (NYSE:MDR), will complete a pilot demonstration of the technology this summer at its 30-megawatt (thermal) Clean Environment Development Facility in Alliance, Ohio.

Following this demonstration, AEP and B&W will conduct a retrofit feasibility study that will include selection of an existing AEP plant site for commercial-scale installation of the technology and cost estimates to complete that work. Once the retrofit feasibility study is completed, detailed design

engineering and construction estimates to retrofit an existing AEP plant for commercial-scale CO_2 capture will begin. At the commercial scale, the captured CO_2 will likely be stored in deep geologic formations. The plant, with oxy-coal combustion technology, is expected to be in service in the 2012-2015 time frame.

B&W, in collaboration with American Air Liquide Inc., has been developing oxy-coal combustion, a technology that utilizes pure oxygen for the combustion of coal. Current generation technologies use air, which contains nitrogen that is not utilized in the combustion process and is emitted with the flue gas. By using pure oxygen, oxy-coal combustion excludes nitrogen and leaves a flue gas that is a relatively pure stream of carbon dioxide that is ready for capture and storage. B&W's and Air Liquide's collaborative work on oxy-coal combustion began in the late 1990s and included pilot-scale development at B&W's facilities with encouraging results, burning both bituminous and sub-bituminous coals.

The oxy-coal combustion process, as envisioned, uses a standard, cryogenic air separation unit to provide relatively pure oxygen to the combustion process. This oxygen is mixed with recycled flue gas in a proprietary mixing device to replicate air, which may then be used to operate a boiler designed for regular air firing. The exhaust gas, consisting primarily of carbon dioxide, is first cleaned of traditional pollutants, then compressed and purified before storage. B&W, working with Air Liquide, can supply the equipment, technology and control systems to construct this new value chain, either as a new application or as a retrofit to an existing unit.

The Alstom technology provides a post-combustion carbon capture system that is suitable for use in new plants as well as for retrofitting to existing plants. It requires significantly less energy to capture CO_2 than other technologies currently being tested.

The B&W technology provides a pre-combustion boiler conversion option for existing plants that promotes the creation of a pure CO_2 stream in the flue gas.

Both pre- and post-combustion technologies will be important for companies facing decisions on carbon reduction from the wide variety of coal-fired boiler designs currently in use.

AEP anticipates seeking funding from the U.S. Department of Energy to help offset some of the costs of advancing these technologies for commercial use. The company will also work with utility commissions, environmental regulators and other key constituencies in states that have jurisdiction over the plants selected for retrofit to determine appropriate cost recovery and the impact on customers.

"We recognize that these projects represent a significant commitment of resources for AEP, but they are projects that will pay important dividends in the future for our customers and shareholders," Morris said. "Coal is the fuel used to generate half of the nation's electricity; it fuels

about 75 percent of AEP's generating fleet. By advancing carbon capture technologies into commercial use, we are taking an important step to ensure the continued and long-term viability of our existing generation, just as we did when we were the first to begin a comprehensive, system-wide retrofit program for sulfur dioxide and nitrogen oxide emissions controls. We have completed the sulfur dioxide and nitrogen oxide retrofits on more than two-thirds of the capacity included in the program and we are on schedule to complete all retrofits by shortly after the end of the decade.

"By being the first to advance carbon capture technology, we will be well-positioned to quickly and efficiently retrofit additional plants in our fleet with carbon capture systems while avoiding a potentially significant learning curve."

AEP has led the U.S. electric utility industry in taking action to reduce its greenhouse gas emissions. AEP was the first and largest U.S. utility to join the Chicago Climate Exchange (CCX), the world's first and North America's only voluntary, legally binding greenhouse gas emissions reduction and trading program. As a member of CCX, AEP committed to gradually reduce, avoid or offset its greenhouse gas emissions to 6 percent below the average of its 1998 to 2001 emission levels by 2010. Through this commitment, AEP will reduce or offset approximately 46 million metric tons of greenhouse gas emissions by the end of the decade.

AEP is achieving its greenhouse gas reductions through a broad portfolio of actions, including power plant efficiency improvements, renewable generation such as wind and biomass co-firing, off-system greenhouse gas reduction projects, reforestation projects and the potential purchase of emission credits through CCX.

American Electric Power is one of the largest electric utilities in the United States, delivering electricity to more than 5 million customers in 11 states. AEP ranks among the nation's largest generators of electricity, owning nearly 36,000 megawatts of generating capacity in the U.S. AEP also owns the nation's largest electricity transmission system, a nearly 39,000-mile network that includes more 765 kilovolt extra-high voltage transmission lines than all other U.S. transmission systems combined. AEP's utility units operate as AEP Ohio, AEP Texas, Appalachian Power (in Virginia and West Virginia), AEP Appalachian Power (in Tennessee), Indiana Michigan Power, Kentucky Power, Public Service Company of Oklahoma, and Southwestern Electric Power Company (in Arkansas, Louisiana and east Texas). AEP's headquarters are in Columbus, Ohio.

This report made by AEP and its Registrant Subsidiaries contains forward-looking statements within the meaning of Section 21E of the Securities Exchange Act of 1934. Although AEP and each of its Registrant Subsidiaries believe that their expectations are based on reasonable assumptions, any such statements may be influenced by factors that could cause actual outcomes and results to be materially different from those projected. Among the factors that could cause actual results to differ materially from those in the forward-looking statements are: electric load and customer growth; weather conditions, including storms; available sources and costs of, and transportation for, fuels and the creditworthiness of fuel suppliers and transporters; availability of generating capacity and the performance of AEP's generating plants; AEP's ability

to recover regulatory assets and stranded costs in connection with deregulation; AEP's ability to recover increases in fuel and other energy costs through regulated or competitive electric rates; AEP's ability to build or acquire generating capacity when needed at acceptable prices and terms and to recover those costs through applicable rate cases or competitive rates; new legislation, litigation and government regulation including requirements for reduced emissions of sulfur, nitrogen, mercury, carbon, soot or particulate matter and other substances; timing and resolution of pending and future rate cases, negotiations and other regulatory decisions (including rate or other recovery for new investments, transmission service and environmental compliance); resolution of litigation (including pending Clean Air Act enforcement actions and disputes arising from the bankruptcy of Enron Corp. and related matters); AEP's ability to constrain operation and maintenance costs; the economic climate and growth in AEP's service territory and changes in market demand and demographic patterns; inflationary and interest rate trends; AEP's ability to develop and execute a strategy based on a view regarding prices of electricity, natural gas and other energy-related commodities; changes in the creditworthiness of the counterparties with whom AEP has contractual arrangements, including participants in the energy trading market; actions of rating agencies, including changes in the ratings of debt; volatility and changes in markets for electricity, natural gas and other energy-related commodities; changes in utility regulation, including the potential for new legislation or regulation in Ohio and/or Virginia and membership in and integration into regional transmission organizations; accounting pronouncements periodically issued by accounting standard-setting bodies; the performance of AEP's pension and other postretirement benefit plans; prices for power that AEP generates and sell at wholesale; changes in technology, particularly with respect to new, developing or alternative sources of generation; other risks and unforeseen events, including wars, the effects of terrorism (including increased security costs), embargoes and other catastrophic events.

BACKGROUND: AMERICAN ELECTRIC POWER'S ACTIONS TO ADDRESS CLIMATE CHANGE

GHG REDUCTION COMMITMENT

American Electric Power (AEP) was the first and largest U.S. utility to join the Chicago Climate Exchange (cop and make a legally binding commitment to gradually reduce or offset its greenhouse gas emissions to 6 percent below the average of 1998–2001 emission levels by 2010.

As a founding member of CCX, AEP committed in 2003 to reduce or offset its emissions gradually to 4 percent below the average of 1998–2001 emission levels by 2006 (1 percent reduction in 2003, 2 percent in 2004, 3 percent in 2005 and 4 percent in 2006). In August 2005, AEP expanded and extended its commitment to a 6 percent reduction below the same baseline by 2010 (4.25 percent in 2007, 4.5 percent in 2008, 5 percent in 2009 and 6 percent in 2010). Through this commitment, AEP expects to reduce or offset approximately 46 million metric tons of greenhouse gas emissions.

OPERATIONAL IMPROVEMENTS

AEP has been able to reduce its carbon dioxide (CO_2) emission by improving plant efficiency for its fossil-fueled plants through routine maintenance and investments like turbine blade enhancements (installing new turbine blades) and steam path replacements that improve the overall heat rate of a plant and, in turn, reduce CO_2 emissions. A one-percent improvement in AEP's overall fleet efficiency can reduce the company's greenhouse gas emissions by 2 million metric tons per year.

AEP has also reduced its CO_2 emissions by improving the performance and availability of its nuclear generation. AEP's D.C. Cook Nuclear Plant in Michigan set plant records for generation and capacity factor in 2005. The plant had a capacity factor (energy generated as compared to the maximum possible) of 96.8 percent in 2005 and generated 17,471 gigawatt-hours (GWH) of electricity. Additionally, AEP will invest $45 million to replace turbine motors in one unit at D.C. Cook in 2006, which will increase that unit's output by 41 megawatts.

As a member of the U.S. EPA's Sulfur Hexafluoride (SF6) Emission Reduction Partnership for Electric Power Systems, AEP has significantly reduced emissions of SF6, an extremely potent greenhouse gas, from 1999 levels of 19,778 pounds (a leakage rate of 10 percent) to 2004 emissions of 1,962 pounds (a leakage rate of 0.5 percent).

MANAGING FORESTS AND AGRICULTURAL LANDS FOR CARBON SEQUESTRATION

To reduce carbon dioxide (CO_2) concentrations in the global atmosphere, AEP has invested more than $27 million in terrestrial sequestration projects designed to conserve and reforest sensitive areas and offset more than 20 million metric tons of CO_2 over the next 40 years. These projects include protecting nearly 4 million acres of threatened rainforest in Bolivia, restoring and protecting 20,000 acres of degraded or deforested tropical Atlantic rainforest in Brazil, reforesting nearly 10,000 acres of the Mississippi River Valley in Louisiana with bottomland hardwoods, restoring and protecting forest areas in the Sierra Madres of Guatemala, and planting trees on 23,000 acres of company-owned land.

DEPLOYING TECHNOLOGY FOR CLEAN-COAL GENERATION

AEP is focused on developing and deploying new techeology that will reduce the emissions, including greenhouse gas emissions, of future coal-based power generation. AEP announced in August 2004 its plans to build a commercial-scale Integrated Gasification Combined Cycle (IGCC) plants to demonstrate the viability of this technology for future use of coal in generating electricity. AEP has filed for regulatory approval in Ohio and West Virginia to build a 629-megawatt IGCC plant in each of these states. The plants are scheduled to be operational in the 2010 to 2011 timeframe and will be designed to accommodate retrofit of technology to capture and sequester CO_2 emissions.

DEVELOPING TECHNOLOGY FOR CO_2 CAPTURE AND STORAGE

AEP's Mountaineer Plant in New Haven, W.Va., is the site of a $4.2 million carbon sequestration research project funded by the U.S. Department of Energy, the Ohio Coal Development Office, and a consortium of public and private sector participants. Scientists from Battelle Memorial Institute lead this climate change mitigation research project, which is designed to obtain data required to better understand

and test the capability of deep saline aquifers for storage of carbon dioxide emissions from power plants.

AEP is a member of the FutureGen Alliance, who, along with the Department of Energy, will build "FutureGen," a $1 billion, near-zero emission plant to produce electricity and hydrogen from coal while capturing and disposing of carbon dioxide in geologic formations.

Additionally. AEP funds research coordinated by the Massachusetts Institute of Technology Energy Laboratory and the Electric Power Research Institute that is evaluating the environmental impacts, technological approaches, and economic issues associated with carbon sequestration. The MIT research specifically focuses on efforts to better understand and reduce the cost of carbon separation and sequestration.

RENEWABLE ENERGY AND CLEAN POWER

AEP strongly supports increased renewable energy sources to help meet our Nation's energy needs. AEP is one of the larger generators and distributors of wind energy in the United States, operating 311 megawatts (MW) of wind generation in Texas. The company also purchases and distributes an additional 373.5 megawatts of wind generation from wind facilities in Oklahoma and Texas. Additionally, AEP operates 2,285 megawatts of nuclear generation and 884 megawatts of hydro and pumped storage generation.

More than 125 schools participate in AEP's "Learning From Light" and "Watts on Schools" programs. Through these programs, ALE partners with learning institutions to install 1 kW solar photovoltaic systems, and uses these systems to track energy use and demonstrate how solar energy is a part of the total energy mix. Similarly, AEP's "Learning From Wind" program installs small-scale wind turbines to provide wind power education and renewable energy research at educational institutions.

BIOMASS ENERGY

Until the company sold the plants in 2004, AEP co-fired biomass in 4,000 MW of coal-based power generation in the United Kingdom (Fiddler's Ferry and Ferry Bridge). AEP has been evaluating and testing biomass co-firing for its smaller coal-fired power plants in the United States to evaluate potential reductions in CO_2 emission levels.

ENERGY CONSERVATION AND ENERGY EFFICIENCY

AEP is implementing "Energy Efficiency Plans" to offset 10 percent of the anneal energy demand growth in its Texas service territory. In 2003 alone, AEP invested more than $8 million to achieve over 47 million kilowatt-hours (kWH) of reductions from installation of energy efficiency measures in customers' homes and businesses. Total investments for the 4-year program will exceed $43 million, achieving more than 247 million kWh of energy efficiency gains.

2005 EPA CLIMATE PROTECTION AWARD

In May 2005, the EPA selected AEP to receive a 2005 Climate Protection Award for demonstrating ingenuity, leadership and public purpose in its efforts to reduce greenhouse gases. EPA began the Climate Protection Awards program in 1998 to recognize outstanding efforts to project the earth's climate.

SUMMARY

American Electric Power (AEP) is one of the Nation's largest electricity generators with over 5 million retail consumers in 11 states. AEP has a diverse generating fleet—coal, nuclear, hydroelectric, gas, oil and wind. But of particular note, AEP is one of the largest coal-fired electricity generators in the United States.

Over the last 100 years, AEP has led the Industry in developing and deploying new technologies beginning with the first high voltage transmission lines at 345 kilovolt (kV) and 765 kV to new and more efficient coal power plants starting with the large central station power plant progressing to supercritical and ultra critical power plants. During the past decade, American Electric Power has implemented a portfolio of voluntary actions to reduce, avoid or offset greenhouse gases (GHG). During 2003–05, AEP reduced its GHG emissions by 31 million metric tons of CO_2 by planting trees, adding wind power, increasing power plant generating efficiency, and retiring less-efficient units among other measures.

We also continue to invest in new clean coal technology that will enable AEP and our industry to meet the challenge of reducing GHG emissions for the long term. This includes plans to build two new integrated gasification combined cycle (IGCC) plants and two-state-of-the-art, ultrasupercritical plants. These will be the first of the new generation of ultrasupercritical plants in the U.S. AEP plans to take the lead role in commercializing carbon capture technology. We signed a memorandum of understanding (MOU) with Alstom for post-combustion carbon capture technology using its chilled ammonia system. Starting with a "commercial performance verification" project in mid- to late-2008 in West Virginia, we would move to the first commercial-sized project at one of our 450-megawatt coal-fired units at Northeastern Plant in Oklahoma by late 2011. This would capture about 1.5 million metric tons of CO_2 a year, which will be used to enhance oil recovery.

Over all, AEP supports the adoption of an economy-wide cap-and-trade type GHG reduction program that is well thought-out, achievable, and reasonable. We believe legislation can be crafted that does not impede AEP's ability to provide reliable, reasonably priced electricity to support the economic well-being of our customers, and includes mechanisms that foster international participation and avoids harming the U.S, economy. A pragmatic approach for phasing in GHG reductions through a cap-and-trade program coincident with developing technologies to support these reductions will be critical to crafting achievable and reasonable legislation.

The development of these technologies will be facilitated by and are dependent on public funding through tax credits and similar incentives. AEP is doing its part as we aggressively explore the viability of this technology in several first-of-a-kind commercial projects. We are advancing the development of IGCC and other necessary technologies as we seek to build two IGCC plants and two state-of-the-art ultrasupercritical power plants. In addition, we are a founding member of FutureGen, a groundbreaking public-private collaboration that aims squarely at making near-zero-emissions coal-based energy a reality. Simply put, however, commercially engineered and available technology to capture and store CO_2 does not exist today and we strongly recommend that any legislation you adopt reflect this fact.

RESPONSE BY MICHAEL RENCHECK TO AN ADDITIONAL QUESTION FROM SENATOR INHOFE

Question. What would the cost be to your company if a federally mandated climate policy were instituted that created a price of $85 a ton for CO_2 emissions?

Response. It is very difficult to answer this question precisely because of the large uncertainties involved. We believe that any Federal mandated climate policy that creates a price of $85 per ton would either require a very large amount of reductions that would result in an $85 price or be a tax set at $85 per ton. If it was a carbon tax then the costs would on the order of $10–12 billion per year costs for AEP (and its customers) with the majority of the costs being carbon taxes paid. A cap and trade program that results in a price of $85 would cost AEP significantly less than a tax to the extent allowances are allocated at no cost rather than auctioned. We would not support legislation that would result in a carbon price of $85 per ton.

Senator LIEBERMAN. Thanks, Mr. Rencheck. Again, a great statement, accepting the future goal of zero emissions, accepting the challenge of greenhouse gas emissions. AEP I know has supported an economy-wide cap and trade system, but quite reasonably saying to us not that we ought to wait to set the goals, but we have to acknowledge that all the technologies you need to meet the goals are not there now. I think asking for some reasonable help from Government will help get you there. Thank you for a really good statement.

The next witness on the panel is Dr. John Fees. We are honored to have you here as chairman and chief executive officer of the Babcock and Wilcox Companies. Good morning.

STATEMENT OF JOHN A. FEES, CHIEF EXECUTIVE OFFICER, THE BABCOCK AND WILCOX COMPANIES

Mr. FEES. Good morning, Mr. Chairman. Thank you, Senator Warner. It is great to be here with you. My name is John Fees. As the Senator has indicated, I am the chief executive officer of The Babcock and Wilcox Companies. We employ about 20,000 people worldwide that work on advanced energy solutions.

I am here today to testify to you on a technology that will limit carbon dioxide emissions from coal combustion generation plants, those that provide essentially all of our coal-based electric power. Constructive actions by Government will make is possible for this and other near-commercial technologies to be ready for wide-scale use in the next decade.

I ask Congress to ensure that any draft legislation on carbon capture set standards that will encourage the emergence of improved technologies. During the development of climate policy, it will be extremely important for Congress to avoid pre-selecting technology winners through legislation or regulatory provisions that would be biased towards or against specific technologies. Our country's interests will be best served if Congress promotes marketplace competition among a variety of viable technology solutions.

B&W has a long history of providing technology solutions for efficient baseload electrical generation throughout the United States, North America and around the globe. The first utility plant in the United States had a B&W boiler designed and supplied by B&W. B&W has literally written the book on steam, which is difficult to lift, but here it is, and its use for power generation. It is the longest continuously public engineering textbook of its kind in the world, first published in 1875, and recently updated in 2005.

In addition to our coal interests, we are the only United States manufacturer of heavy nuclear components for the emergence of the nuclear renaissance that is upon us. Coal combustion and nuclear plants provide over two thirds of the domestic-generated electricity, and they are the foundation of our economic competitiveness, our energy security, and the basis of our standard of living.

With coal, B&W has been an environmental technology leader at the forefront of the development of technology solutions for things like mercury, SOx and NOx emissions, and particulates. In power generation, B&W has been awarded a number of new, highly efficient, supercritical coal-fired plants in the United States, including, as Mike indicated, the first next generation ultrasupercritical coal-fired plant. The plant is about 20 percent more efficient than the average of the installed based on coal-fired technology in the United States. Therefore, it is 20 percent less coal-intensive and 20 percent less CO_2-intensive, using advanced technology.

These plants, with their higher efficiencies, are able to produce electricity at these lower carbon intensities and ongoing efforts will be able to deliver higher efficiencies in the future.

B&W understands that now we must provide realistic solutions and timely solutions to climate challenge. B&W is doing just that. We are among the leading developers of technology in carbon dioxide at the powerplant for subsequent storage. Most notably, we are working to commercialize oxy-coal combustion. This technology inherently produces a stream of undiluted carbon dioxide, with a

powerplant configuration very close to that of a conventional plant. The process captures essentially all of the carbon dioxide produced by burning the coal fuel. The carbon dioxide stream is amenable to geological storage or for such commercial beneficial uses such as enhanced oil recovery.

We have been working on oxy-coal combustion technology for 7 years, and we are ready to move forward with the first full-scale demonstrations. I am particularly pleased to be on this panel with Michael Rencheck, whose company, AEP, is evaluating the array of potentially viable solutions for this challenge, as he indicated. We are partnered with AEP in the feasibility study of oxy-coal combustion, with a goal of retrofitting the technology to capture carbon dioxide from the existing plants, not new plants, but existing plants.

We are in a parallel effort with Saskatchewan Power, the major utility in Saskatchewan, Canada. That plant envisions building a new oxy-coal combustion powerplant that will provide 300 megawatts of additional electricity for the grid, while simultaneously supplying 8,000 metric tons per day of carbon dioxide for advanced oil recovery.

Presuming that both of these projects are successful, we will have demonstrated the applicability of oxy-coal combustion for capturing nearly all the carbon dioxide produced at both a new and an existing powerplant. AEP and Saskatchewan Power, along with seven other organizations, are members of our Oxy-coal Advisory Group. They will witness the operation this summer of our large pilot-scale oxy-combustion facility in Alliance, OH. We will conduct oxy-combustion test operations on three different coals: eastern bituminous, western sub-bituminous, and a lignite. This will be the largest full-scale demonstration associated with this type of technology that ever existed. It is funded 100 percent by our company.

The first deployment of near-zero emission coal plants, including carbon capture and storage, could start operations around 2012, which is not very far away. Given appropriate Government action, we anticipate that a suite of technology alternatives will be available for the commercial use and storage of carbon in the next decade.

While publicized technology such as oxy-coal combustion are a path toward commercialization, other carbon friendly concepts can be expected to emerge from B&W and some of our competitors. At B&W, we are working on a portfolio of solutions that is being nurtured by about a 300 percent increase in our R&D. We will spend this year on R&D nearly $48 million of our own money trying to develop these technologies for a currently unregulated emission. At B&W, we envision advanced technology concepts that will enable reductions in CO_2 emissions and the associated costs. We envision small-scale demonstrations of new advanced concepts beginning in the 2010 timeframe, with scale-up demonstrations around 2015.

Finally, disposition of captured carbon dioxide is a critical dimension toward solving climate change. We and other technology developers may be able to provide the technical capability for carbon capture to be able to get our hands on the carbon well before the resolution of the issues with the storage in place. We are encouraged by the increased technical and public policy attention towards the storage of captured carbon. We strongly advocate for a large-

scale demonstration of captured carbon projects in the neighborhood of 1 million tons stored of carbon per year.

Thank you for inviting me to testify before the committee.

[The prepared statement of Mr. Fees follows:]

STATEMENT OF JOHN A. FEES, CHIEF EXECUTIVE OFFICER, THE BABCOCK & WILCOX COMPANIES

Chairman Lieberman, Senator Warner and Members of the subcommittee: My name is John Fees and I am the Chief Executive Officer of The Babcock & Wilcox Companies.

It is my privilege to present this testimony on the combustion-based technology alternatives available on the near horizon, which are designed to capture carbon dioxide emissions from electric power plants.

The Babcock & Wilcox Company has a rich legacy of providing reliable engineered technology solutions for efficient, base load electric generation throughout the United States, North America and across the globe. We have sustained our business by developing and commercializing realistic solutions. For over a century, we have successfully met the challenges of power generation and provided the technologies and equipment to resolve the associated environmental control issues. We provide commercially viable solutions to meet emissions control requirements of regulated pollutants. We will provide practical technologies to resolve the challenges of greenhouse gas emissions as well. B&W is a premier, comprehensive provider of clean energy.

B&W was formed in 1867. The first utility power plant in the United States had a boiler designed and supplied by B&W. Steam remains the most economic means to transfer the heat energy released by burning fuel to the turbine/generator, to produce electricity. B&W has literally written the book on steam. "Steam, Its Generation and Use" a text book produced by B&W, is the longest continuously published engineering textbook of its kind in the world, first published in 1875 and last updated in 2005.

Our manufacturing capabilities have also powered national security since the start of the last century. Teddy Roosevelt's Great White Fleet was primarily powered by B&W boilers. At the end of World War II, at the surrender of Japan, 395 of the 400 U.S. Navy ships in Tokyo Bay were powered by B&W boilers. In the 1950s, B&W became a major U.S. manufacturer and supplier of components for the U.S. Navy's fleet of nuclear powered ships and submarines which are now built in Groton, Connecticut and Newport News, Virginia.

Beyond defense, nuclear power is a route to carbon-free electricity generation for civilian purposes. We are the only U.S. manufacturer of the heavy nuclear components that will be required for the emerging civilian nuclear power plant build-up. As such we anticipate playing a critical role in the coming nuclear renaissance to provide clean, safe nuclear power. I could easily write a substantial amount on nuclear power and its potential to help reduce carbon emissions, but the principal focus of this testimony is coal fired generation and carbon capture.

Coal-fired and nuclear power plants provide the vast majority of the reliable and lowest cost electricity generation in this country. Coal-fired and nuclear power plants combined comprise 41 percent of the Nation's electric generation capacity. However, due to their cost effectiveness, these plants are highly dispatched, and actually produce 69 percent of all the electricity in the country. These technologies are the foundation of our economic competitiveness, energy security, and increasing standard of living.

B&W's position as a premier developer and manufacturer of coal technologies and facilities is widely recognized. Thirty-eight percent of U.S. coal-fired boilers have been designed and manufactured by B&W. We supply around one-third of all environmental control technologies and equipment to the U.S. coal power marketplace. We have been selected to provide many of the emission control technology solutions used by electric power generators to meet the strictest requirements under the Clean Air Act, the Clean Air Interstate Rule (CAIR) rule and various stringent air permitting requirements in the states. B&W has also been awarded a number of the new, highly efficient supercritical coal fired power plant projects, including the first, next-generation, high efficiency Ultra Supercritical Power plant in the U.S.

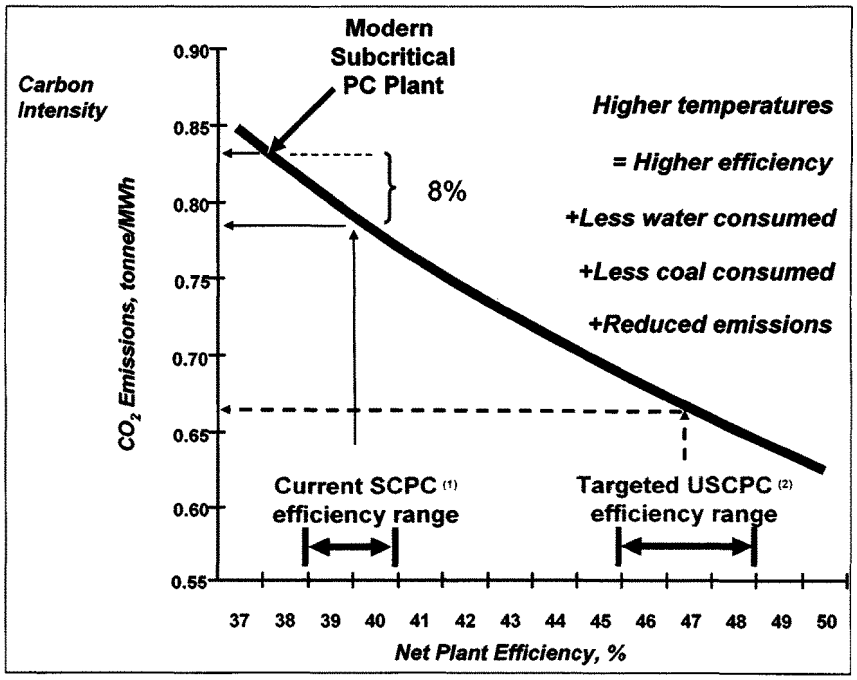
ADVANCED COAL POWER TECHNOLOGIES

Efficiencies

Efficiency at a power plant is measured by the ratio of the electricity generated compared to the energy in the fuel used. Increasing steam temperatures and pres-

sures provides more energy to the steam turbine, enabling higher efficiency and allowing the same amount of electricity to be generated by burning less coal. This results in less production of CO_2 and pollutants derived by coal combustion, reduced fuel costs and smaller and less costly power plants for the same power generated.

Many existing U.S. coal-fired plants operate with relatively low steam temperatures and pressures (subcritical steam conditions). These old plants are generally used during high electricity demand periods because of the low generation efficiency, typically in the 30–35 percent range. When steam conditions exceed the combination of both 760F and 3200psi, the steam (or working fluid) is said to reach supercritical conditions. Efficiencies of these plants exceed 37 percent. Replacement of a relatively common 37 percent efficient subcritical unit with a 40 percent supercritical unit of same generating capacity would reduce CO_2 emissions by about 8 percent. Supercritical plants with efficiencies around 40 percent are already commercially available and being increasingly deployed. R&D projects with advanced materials and manufacturing methods are underway to permit increases of working fluid temperatures to 1200F, and then to around 1400F. When this happens efficiencies will rise above 43 percent toward 48 percent. Carbon intensity will be reduced by a further 20 percent versus current modern plants.



It is important to note when evaluating coal plant performance, that efficiency numbers, taken at face value, can be misleading. The U.S. convention for calculating efficiency, called "higher heating value (HHV)," is different from that used in Europe, "lower heating value (LHV)." One of the factors responsible for the difference is the way moisture in coal is treated in the efficiency calculation. There are other factors that enter into the calculation as well. The result is that, for virtually identical plant performance (coal fuel in vs. power out), the U.S. efficiency (HHV basis) would be reported as being up to 5 percent lower than European efficiency (LHV basis).

Pollutants

The emissions from pulverized coal-fired power plants have been reduced tremendously over the past three decades, with this achievement due in part to market based regulatory structures pulling technology forward for deployment. Great strides have been made in SO_2 and NOx reduction through scrubbing and selective

catalytic reduction technologies. Fabric filters and improvements in electrostatic precipitators have reduced particulate emissions and more recently, technologies such as wet electrostatic precipitators and sorbent injection are capable of further reductions including fine particulates ($PM_{2.5}$).

With technologies available to address regulated pollutants and major programs to retrofit the existing fleet in progress, public and industry attention turned to mercury. As a result, commercially available mercury control, for both eastern and western coals are being deployed. Now, concerns about climate change have intensified leading to the pressing need for the development of ways to address carbon dioxide emissions.

Carbon Dioxide Capture

There are several promising technologies to address capture of CO_2 from the use of fossil fuels and all are dependent upon development of a safe means of permanent storage. Assuming storage technologies can be commercialized and enabled, the challenge for coal combustion processes becomes one of extracting the CO_2 from the combustion process. A modern power plant using sub-bituminous coal will produce about 1,800 lbs. of CO_2 per MWh. In an uncontrolled state, the CO_2 is diluted in the exhaust gas to about 15 percent of its volume; this creates a challenge to produce a concentrated CO_2 stream for storage.

Three approaches are presently seen as plausible carbon capture techniques: (1) Oxy-Coal Combustion for new and existing plants that burn coal, (2) amine or other solvent scrubbing for new or existing plants that burn coal, and (3) pre-combustion, or integrated gasification combined cycle, if the IGCC system is designed and fitted with facilities to accommodate CO_2 capture. Oxygen combustion produces a concentrated stream of CO_2 in the combustion process by supplying pure oxygen instead of air for combustion eliminating nitrogen which dilutes the CO_2 concentration. Pre-combustion and amine or other solvent scrubbing processes extract the CO_2 from the gas stream using a regenerable solvent such as monoethanolamine (MEA). Some current studies now show oxygen combustion as the least costly while other studies lean toward pre-combustion or advanced amines, indicating that technology development is underway and competition is strong. None of the technologies has been demonstrated at significant size in an integrated full-scale system for electricity generation.

Oxy-Coal Combustion

The Oxy-Coal combustion process is based upon equipment and systems that are already commercially available at the required scale. However, there are integration requirements, operating parameters and final designs that require verification at larger scale. Oxygen combustion and the major operational processes have been demonstrated at pilot scale. B&W has been actively engaged in oxy-coal combustion R&D since the late 1990s. We will complete a large pilot demonstration this summer with a variety of coal types at our 30 MW_{th} combustion test facility.

A new 300 MWe commercial plant using this technology is being developed by B&W for the SaskPower Corporation to be located at Estevan, Saskatchewan. At this facility the captured CO_2 will be used for enhanced oil recovery.

In addition, American Electric Power, one of the largest utilities in the U.S., has announced it is undertaking a feasibility study with B&W with the proposed objective of retrofitting one of its existing coal fired power plants with B&W's Oxy-Coal combustion technology for carbon capture and storage (CCS).

In spite of the additional cost to concentrate a CO_2 stream for storage, recent studies show oxygen combustion to be competitive with the other capture technologies. Since this technology utilizes conventional equipment, it is likely to have a considerably lower deployment and operational risk, and has potential for retrofit to some of the existing fleet of conventional plants.

Oxygen combustion provides a means of replacing the nitrogen in air with CO_2 gas exiting the combustion chamber. By recirculating a portion of the combustion stream the oxy-coal combustion plant effectively replaces the nitrogen in a conventional system with CO_2 thereby inherently creating a concentrated CO_2 stream for permanent storage. The net effect is that the system looks and acts like a conventional power plant with which power plant operators are comfortable, but which is capable of near zero emissions given carbon storage. Additionally, by excluding air conveyed nitrogen from the combustion chamber there is a sharp reduction in nitrogen oxide emissions from this technology, which is likely to obviate the need for selective catalytic reduction facilities.

Although the properties of the flue gas differ from those with air firing due to the lack of nitrogen, it has been found that with the proper recycle ratio, an existing boiler can be converted to oxy-coal combustion without changing heat transfer sur-

faces and only experiencing a small impact on fuel efficiency in the boiler island. For new units, optimized arrangements are being studied that offer some reduction in equipment size and improved performance.

The first generation of full-scale units is intended to require minimal change to the conventional power plant as reasonable to permit retrofit application and minimize risk. Advanced air separation technologies and optimization of the product gas specification and the cleanup/compression process are also expected to improve both performance and cost.

Development of Other Innovations

While we see oxy-coal technology as one of the potential carbon management solutions for the relatively near future, B&W is also developing a portfolio of potential solutions—including some that are radically different from any that are currently approaching readiness for full scale testing. We have increased our R&D budget by 300 percent in the last 5 years, with the great majority of this increase directed toward advanced technology. With similar amounts planned on an ongoing basis, we envision development of new advanced techniques for the capture of CO_2 (in addition to oxy-coal combustion); and materials developments that will both greatly increase the efficiency of new coal plants and synergistically enable reductions in carbon capture cost impacts. We envision small scale demonstrations of new advanced concepts beginning in the 2010 timeframe, with scale-up demonstrations anticipated around 2015.

Carbon Storage

Disposition of captured CO_2 is a critical dimension to solving climate challenges. Providing technologies to effectively capture CO_2 will accomplish little if storage is not simultaneously enabled. We, and other technology developers, may be able to provide the technical capability for carbon capture well before resolution of the issues associated with large scale storage. We are encouraged that issues pertaining to actual storage of captured CO_2 are drawing increasing technical and policy attention. Legislation must support the acceleration of technical efforts promoting large scale carbon injections associated with advanced coal technology and storage. In addition there is a need for clear policies regarding legal ownership of and liability for the injected CO_2, and concise communications to overcome local concerns with large annual injections at storage sites. We believe that unless the regulatory and technical obstacles to the long-term storage of carbon dioxide from electric power plants are resolved, these will become the limiting factors in reducing carbon emissions.

Closing Comments

B&W believes that from a technology standpoint that CO_2 storage from power plants could commence wide scale around 2020. The first wave of near-zero emission coal plants are expected to start operation around 2012–2013. As industry learns from these early commercial deployments, we will make adjustments to improve efficiency, competitiveness and performance. After this, around 2015, commercial availability of CCS technologies should be available for new plants and retrofit of some existing plants. These will take 4–5 years to build before the plants come online and begin storing CO_2 in the 2020 timeframe.

Technology development, economic and market incentives are essential to accelerate the timeframe for implementing widespread carbon capture deployments on a commercial scale. This will only be successful if legislation does not favor one technology over another.

We are confident that our Oxy-Coal Combustion technology can provide the most cost-effective solution for some power plants, while other technologies are better suited for others.

We are encouraged by indications that a consensus is building toward a market-based system for carbon management. A market-based system should encourage an efficient allocation of resources for reductions of carbon emissions both at new plants and, where tenable, at some existing plants. It is important to recognize that to significantly reduce our Nation's CO_2 emissions, capture of CO_2 will have to occur at a number of existing fossil-fired plants.

B&W is in general agreement with many of the perceptions and recommendations cited in the MIT report, "The Future of Coal":

- The U.S. Government should promote a suite of technology approaches to CCS, and avoid picking winners. Biasing RD&D funds towards one technology and/or biasing commercial deployment incentives will only discourage investment in technologies that have significant potential for marketplace acceptance, improved performance and reduced cost.

• An array of large scale CCS projects should be implemented in the near to mid-term, with the ~ 1 million ton of captured carbon dioxide per plant annually stored at a variety of CO_2 storage sites across the country.

To facilitate the attainment of commercial readiness of CCS technologies, the government will need to provide funding levels well in excess of those traditionally available through DOE's Fossil Energy programs.

Thank you for the privilege to testify before the subcommittee on these critically important matters.

MAJOR POINTS

• Society will be best served if an array of competitive technologies is available to meet the climate challenge. The promise of marketplace competition will stimulate investment in technology development. Therefore, while considering carbon management legislation, Congress should reject provisions in bills that would explicitly or implicitly provide preferential advantage or disadvantage to any potentially viable technology. The regulatory system must be based on a "level playing field".

• Many ways will emerge to capture the CO_2 that would be otherwise be emitted from coal power plants. The three major approaches with the potential to be commercially available in the near to mid term may be categorized as oxygen combustion, post-combustion scrubbing using sorbents such as amines and other chemicals, and pre-combustion IGCC, if configured to capture CO_2. Of these, studies by B&W and others lead us to believe that oxycombustion shows great promise in terms of cost effectiveness and nearness to commercialization.

• B&W continues to make significant technical progress in oxycombustion. We are on track to deploy the first commercial scale near zero emissions coal power plant with carbon capture and storage in North America using oxycombustion technology. B&W also has a Memorandum of Understanding to undertake a feasibility study to retrofit an existing U.S. coal-fired power plant for CO_2 capture and storage utilizing Oxy-Coal Combustion technology.

• It will be necessary to have clear policies regarding legal ownership of and liability for the injected CO_2; concise communications to overcome local concerns with large annual injections at storage sites; and, accelerated demonstrations of several large scale CO_2 injection projects each on the order of ~ 1 million tons annually.

• We anticipate that the first wave of commercial carbon capture plants will begin operation around 2012. Through lessons learned at these plants and with additional innovations/modifications, improvements in efficiency and cost will be attained with subsequent installations. We believe commercial storage of CO_2 can commence on a large scale in approximately 2020.

• Deployment of coal combustion units with higher steam (working fluid) conditions, such as those in modern supercritical steam plants, will result in higher efficiency. Increasing the efficiency reduces the intensity of CO_2 emissions, as less coal fuel is required to generate a unit of electric power. Efficiency increases also cause proportionately lower generation of traditional pollutants. Very low levels of pollutant emissions can be attained with modern environmental control facilities.

Senator LIEBERMAN. Mr. Fees, thanks very much.

Because a vote may go off sometime in the next half hour, I am going to limit us each to five minutes of questioning so each of us can get a chance to ask a question.

The totality of your testimony to me is both impressive and encouraging, because you said, in very many ways, that there are technologies now available that if implemented or acquired and dispersed throughout the economy, can begin to reduce greenhouse gases, and also have a great effect on our energy security and on air pollution.

I go back to what you said, Mr. Rencheck, I think it is important that even where the technologies are not exactly where we will need them eventually to be, that should not be an excuse for not setting out in law a series of goals, because everybody knows we are not going to hit the goals overnight, alongside support for the increasingly advanced technologies that will enable us to do that.

The other thing that strikes me, and may I will just ask a few of you to comment on it, is that some of the pioneering work that you are doing is done on the presumption that global warming is real and that at some point before long, the Government is going to require people to do something about it. Let me ask Dr. Little and Mr. Fees is you would comment on that.

Mr. LITTLE. Senator, I have the great privilege of traveling the world over, and I talk to politicians and Government officials of all parties in all places. What I see everywhere I go is a tremendous interest in this subject, and recognition that somehow and some way there will be strong Government action to deal with the issue. The forms and opinions may differ about what it would take, but around the world there is a strong view that there will be something put in place.

So our company is very well recognizing that we need to be a global leader in this technology and is pushing ahead very aggressively in developing technologies even ahead of the missions requirements.

Senator LIEBERMAN. Thanks.

Mr. Fees.

Mr. FEES. We as a company are a technology provider. The thing that I need to be able to do is when Mr. Rencheck needs a solution, I have to have it.

Senator LIEBERMAN. Right.

Mr. FEES. We believe that based upon where the discussion is going, the dialogue that we are having in the country, that there is going to be some type of limits and regulation associated with carbon and we want to be there to be able to serve our clients and to be able to get it done. That is why we are spending basically $49 million of our own money on an unregulated substance at this point.

Senator LIEBERMAN. I am not asking you to endorse any particular program, although if you would like to endorse the Lieberman–McCain bill, I wouldn't object, but I take it that from a purely business point of view, the sooner the Government sends a signal that this is happening, this is going to happen as a matter of law, the better it is for the work that you are doing. Correct?

Mr. LITTLE. More than anything, we need clarity of purpose to have a long-term view of where the country, where the globe, and where our company is going. So clarity of purpose and definition of goals is critical to developing technologies for success.

Senator LIEBERMAN. Mr. Rencheck.

Mr. RENCHECK. Regulatory certainty is absolutely important in our business. The assets that we build last 40, 60, 80 years. Without that framework and an understanding of what the regulatory framework will entail, then it certainly creates great distress in making incremental decisions about asset additions. In our business, we have an obligation to our customers to keep our rates as low as reasonably achievable, and at the same time we have an obligation to protect the environment. So we have to keep all of this in balance.

Senator LIEBERMAN. Dr. Chiang, did you want to answer that?

Mr. CHIANG. Yes. From the point of view of a small company like ours, and we are relatively small at this point, the most important

thing is giving us the opportunity to practice our technology. Technology development is a contact sport. Our competitors are very able and, as I said earlier, they are not too far behind us. They have the benefit of Government action over a couple of decades.

So any form of legislation that allows us to get the technology out to where we can practice it and learn from it and develop the best practices in the long term is of great benefit.

Senator LIEBERMAN. Mr. Fees, do you want to add something?

Mr. FEES. Yes. I think there are two things. One is that I think industry and our clients need some level of certainty. I think this dialogue is creating a level of uncertainty.

Senator LIEBERMAN. Right.

Mr. FEES. So I think the sooner we can get to that point, the more we can sustain our investments and know where we are going as a company.

The other thing that I think is important, the second point, is that the amount of carbon that we are talking about sequestering is very large. If you take just coal-fired generation today that exists, and if you want to sequester half of it, you need an infrastructure that is anywhere, depending on whose calculations you believe, to do half of it, one to three times the infrastructure for dealing with oil in the United States today. So this is a big deal.

I believe that we will be there as a technology supplier for technologies that will put the carbon in your hand, but will we be prepared to be able to put it somewhere is the real question. The investment is going to be huge. It took us 100 years as a country to establish that infrastructure that we are enjoying today. I think we have to get our minds wrapped around the limit that the size of that challenge presents.

Senator LIEBERMAN. That is a very important point. We don't, at this point. I will just say, because my time is up, that in addition to giving you as soon as possible a legal and regulatory certainty about what is happening, the other thing your testimony says is that we have a parallel responsibility to continue to invest public funds either directly or through investment tax credits in stimulating as rapidly as possible the existence of these technologies that we don't fully have yet at competitive prices. I am very proud that Senator McCain and I have included such a section in our bill.

Senator Warner.

Senator WARNER. Thank you, Mr. Chairman. I want to commend you and others for bringing this distinguished panel. This has really been a fascinating session for me. I put myself in the category of one who is in the learning process, even though I have been on this committee now two decades. We really haven't come to grips with this, although we had pioneers like Mr. Carper—he is not listening to what I am saying—but he has been out here with bills. How many bills have you introduced in the last 5 years?

Senator CARPER. Five.

Senator WARNER. Five. He has given them all to me and I have looked at them and filed them.

[Laughter.]

Senator WARNER. We really have to get down to work on this thing.

To what extent can you as an industry, without getting into antitrust troubles and competitive troubles, try and put some benchmarks of what you really want to see in a Federal regulatory program together. Then we will have to do the final analysis, but it seems to me it would help us if we could get some common starting place.

Do you want that program to not only have a regulatory aspect like we have been successful with the sulfur one? Or do you want a grant program out here, direct Federal grant subsidies? Do you want some tax relief for the heavy investment, Mr. Fees, that your company has made and others?

Where are we in this thing? Have you got any consensus on that? Why don't we just start off, Mr. Little?

Mr. LITTLE. Senator, if I may, GE, of course, is a member of the U.S. Climate Action Partnership, where we have collected our resources with a number of nongovernment organizations and other very large companies, including, as Senator Boxer mentioned, several others including GM, which has just joined. That group has put forward some ideas of a policy framework to be used as a starting point for discussion about what Government might want to consider.

In there, we talk about a cap and trade regime to enable the Government to move forward. As you well know, we have had a 15-year-old sulfur dioxide cap and trade regime that has worked, we think, quite well. That is a policy framework.

Senator WARNER. So we use that as sort of a blueprint and build on that?

Mr. LITTLE. That is what we think, Senator. Yes.

Senator WARNER. Now, what about grants and tax?

Mr. LITTLE. Well, as you well know also, we have the production tax credit, which is supporting wind power today. Stability in that regime has had a huge impact. You may know that it has been an on again-off again sort of a program, and you can see the industry flip on when it is on, and flip off when it is off. We have had stability for the last 2 years, and that has ignited a tremendous run toward wind power in the United States so we think it is a very successful thing. So that model also works.

Senator WARNER. I am still a little bit of a skeptic on whether the wind power is returning enough net gain into the whole energy system, but we really did do some heavy lifting for the wind power. They were very clever. Their lobbyist got in here and got these provisions. I am quite concerned about you are trying to do down in Babcock and Wilcox.

Mr. FEES. Yes, I think a very strong R&D tax credit for work that is going on that is directed towards carbon capture technologies would be very beneficial for the industry. We are spending a lot of money without a broader-based benefit there already, but it would be very, very helpful to encourage industry.

Senator WARNER. That is not to be drawn tight enough so as to not let it leak out and give tax relief elsewhere and concentrate on carbon capture?

Mr. FEES. I think if we dilute it, it will become a problem.

Senator WARNER. Yes.

Mr. FEES. The other thing is that there is a lot of talk about capturing carbon and sticking it in the ground. That is really the available thing that we can see in front of us. If you go into the decade that goes beyond 2020, into the 2020 timeframe, we are working on some technologies that would make very safe forms of carbon, like bicarbonate, which is an inert substance that could be disposed of in regular waste repositories at no harm to the environment, so anything we can do to encourage that technology to move forward.

We are working hard to look at how we can do that. Can we avoid all this infrastructure that we have to build to stick this billions or trillions of tons into the earth by coming up with another form and another technology to be able to make that happen? We think the technology road map for that is into the 2020-plus timeframe, and whatever we can do to move that forward would save trillions of dollars in capital investment in the United States to put holes into the earth and pump it into the ground.

So I think a good strong R&D tax credit and taking a look at those advanced technologies in the future and how could we bring those forward would be very helpful.

Senator WARNER. Yes?

Mr. RENCHECK. We are members of the Edison Electric Institute. We have taken a look that a cap should be applied to all the economy in all sectors on all greenhouse gases. It should be an unfettered cap and trade framework that takes a look at levels and gradually implements them over time, allowing a timeframe for technology to take hold and take root.

We also think we should be able to use the unrestricted use of real and verifiable domestic and international offsets. Also as part of a cap and trade system, we ought to be able to take a look at historic caps, and then provide those cap and trade allowances to companies who need the technology to advance the technology.

Also from that perspective, companies should be given credit for the voluntary actions they have already taken over the past several decades. We are going to need long-term public and private funding for the development of technology. It is not going to happen overnight. With increased funding and with the increased resources, it can move faster.

We have also the need for regulatory pre-approval for utility cost recovery for energy efficiency and demand side management to help stimulate those programs and get them off the ground and running.

Senator WARNER. My time is up, and we have to stick to it. Edison, I have worked with them for years. They have an established record. Could they bring forth, for instance, some assessment? All of the colleagues to my left here have bills in. I have not yet put anything in. But you have been a pioneer, the Senator from Delaware, for years on this issue. I need some help in evaluating the merits of their different pieces of legislation as we reach towards trying to get a consensus on this committee.

I tell you, I want to join to move this ball forward, but there are some very distinguished colleagues to my right here who are not quite as enthusiastic as I am. This is going to be a hard fought legislative battle. So the more help we can get, and the more concept

of we are going to take carefully a step at a time, and not take an enormous leap, and then end up failing and then losing all the benefit of the momentum and the interest you have now.

I thank the Chair.

Senator LIEBERMAN. Thanks, Senator Warner. I think you and I should talk, but I would like to see us sometime soon work towards some just working sessions with some of these folks and other stakeholders in this discussion, which is important. It remains controversial in some quarters, but I appreciate very much your commitment to try to move the ball forward.

Senator Carper, you are much appreciated on this end of the panel for your leadership here over the years.

Senator CARPER. I am happy to yield to the Chairman of the full committee, if she would like.

Senator BOXER. No. Go ahead.

Senator CARPER. Thanks for sharing. This has been fascinating and most helpful. We are grateful for your participation and your counsel.

Several of you have said words like "clarity of purpose," and "regulatory certainty." Several of you have talked about Federal support for basic R&D. A couple of you talked about the need for the Federal Government to help commercialize technologies, whether it is using our purchasing power on the defense side or the civilian side, or both. Some of you have alluded to tax policy, which would incentivize the production of or the purchase of certain kinds of technology.

I am going to be just real frank with you. Going back to what Senator Warner said, we kind of fall apart as a body, and with the Administration, when we get to the point of putting mandatory caps on carbon emissions. There is a concern, and I won't say his name but he is sitting right over there, and used to be a Governor of a State, but he has a huge concern. He has watched the economic meltdown of his State over the last decade or so. He has a huge concern that we not do anything that will further that economic disadvantage for his State or for our country to put us in an uncompetitive position with somebody like China, which may not have any intention of doing anything about CO_2 for some time.

In my heart, I believe it is possible to forge these new technologies, to address CO_2 emissions, and frankly to reduce SOx, NOx and mercury from our utility plants, and to do it in a way that fosters economic growth, that leads to technologies that will lead to new products that we can sell not just in this country, but around the world.

I would welcome any comments. We will just start with you, Dr. Chiang, to just respond to that potential.

Mr. CHIANG. Yes. With respect to what Government can do, I think that we can think about it, or at least I think about it, in terms of how far off is the opportunity and therefore how it is addressed. So for things that are essentially ready today, a tax incentive of course would work very well, but if it is technology that needs to be developed, you might need to find a different route.

So for this plug-in technology that I have been talking about, we believe it is here and ready today so a tax incentive is a very appropriate way to accelerate that.

But looking forward, clearly there is going to need to be more R&D. We are at the beginning of a new wave in battery technology to compete and to grow. For instance, we hear regularly about overseas efforts, new national projects in Japan. There is a pan-European effort that is attempting to unite 50 research labs and industry to develop better batteries. That is what we are competing against. So near-term, we need to compete with that.

But in the area of vehicles, the main thing that we want to do is to enable the American auto companies to leapfrog their competitors. They are our customers, and by doing that, you create a lot of jobs in the United States and that is very significant.

Senator CARPER. Dr. Little.

Mr. LITTLE. Senator, I argued earlier that we see a trend around the world of trying to do something to go toward greener technologies, as I will call them. I believe the United States should be a leader in that. I believe our industry should be strong and in every phase of it in a portfolio of technologies leading the way. I would rather see our country lead than follow in nuclear, lead than follow in solar, lead than follow in wind.

Wind is a very interesting example for me. The European manufacturers were long the leaders in wind technology, and they were importing things into the United States. GE took a hold of the wind business from Enron's bankruptcy and that business today is a $5 billion business for us. Many U.S. jobs are associated with that. That business is as big today as our commercial aviation business, as our conventional fossil fuel gas turbine and steam turbine business, and is a very, very strong business with very high technology and investment.

I have seen in our gas turbine business us take emissions of NOx 15 years ago at 200 parts per million. Today, we can make in the same turbines three parts per million of NOx, a tremendous technology advance. At the same time, efficiency has improved and costs have gone down. That was all driven by a societal thrust to drive emissions down, and our company has benefitted from that and is able thus to develop high technology products that we export all over the world. I think that is a great thing for America's economy.

Senator CARPER. Thank you.

Mr. Stanway, go ahead.

Mr. STANWAY. Another point that I would just like to make is there are technologies around today which are perfectly economic. You look at them, and a small business can invest in them and make a 2-year simple payback. One of the issues here is not only do we need to do R&D on new technologies, is we need to focus on how do we sell the ones which exist on the market today transactionally efficiently.

Some of these technologies are seriously struggling to make inroads not just in the United States, but across a lot of industrialized economies. So how do we move that more efficiently? I think that is another area that we need to look at because it is another area, potentially, of great U.S. competitiveness.

The American economy is good not only both at innovation and R&D, but also in the ability to sell.

Senator CARPER. One of the things that my colleague, Senator Boxer, has been focusing on is how can the Government set a good example with respect to reducing our own levels of emissions. For example, I was looking at the light bulbs in the ceiling of my office yesterday. They are all incandescent light bulbs.

I don't know what these are. They feel pretty warm. There is so much that we can do in terms of helping to commercialize these technologies, not just the basic R&D. It is not just using the U.S. Government's purchasing power to commercialize these technologies, but it is the tax policy as well.

Mr. Rencheck, my time has expired, and more than expired. The Chair has been very generous. Let me halt for now, and I will come back. I have to slip out, but I will be right back.

Thank you.

Senator LIEBERMAN. Thanks, Senator Carper.

Senator Voinovich.

Senator VOINOVICH. Thank you, Mr. Chairman.

The question that I would like to have answered is, and I was at a meeting a couple of weeks ago, and your folks were there from Babcock—we've got it; we capture carbon; we can do sequestration. Another gentleman came into my office that wants to do coal to liquid, and, we are going to capture carbon; and we are going to sequester it.

When is this going to be "commercially viable" in terms of your best guess? Because if we are going to deal with this whole program, and we go to something like cap and trade, it should be reflective of reality. I ran into Carol Browner a couple of weeks ago and she said, cap and trade; that is the thing to do. We will cap and trade, and by golly, everybody will go out there and they will spend the money to get the technology that we need to capture carbon and sequester it.

I said, hold on a minute. I said, do you really understand where the technology is and how many years it is going to take to develop so it is commercially viable, for example, to put capturing carbon on the back end of a retrofit of a coal-fired facility we have today?

So I would like to ask all of you, what is realistic in terms of when this would come on to the point where it is commercially viable? That is No. 1. No. 2, the issue of how to pay for it. Can the private sector do it? Or is the Federal Government going to have to pitch in? Or should we look more internationally and say this whole issue of capturing carbon and sequestration is something important to the world in terms of doing something about greenhouse gases? So No. 1, how long is it going to take realistically to do it? Who is going to pay for it?

The last one would be new source review, which I understand is just a tough one for everybody out there because they don't know if they do certain things whether it is subject to new source review or not because this thing is in limbo right now.

Thank you.

Mr. Rencheck.

Mr. RENCHECK. Yes, to address that, we are moving forward with carbon capture and sequestration projects. The first will be a product validation in roughly the 10 megawatt electric scale for a back-end retrofit. We are also working with B&W on an oxy-coal process.

So that will pan out whether or not it can be scaled, and the scale that we would be looking is in the 2011 to 2012 timeframe for the first time.

We are also working with General Electric on IGCC plants for installing those from an efficiency perspective.

Senator VOINOVICH. The IGCC does a good job on NOx, SOx, carbon and mercury, and the potential to do something about carbon, and become more efficient, so you are going to emit less gases.

Mr. RENCHECK. That is correct.

Senator VOINOVICH. But the issue still is, even when you are building these plants, you are still going to have the carbon problem.

Mr. RENCHECK. That would work on the capture piece, so we would see the first type of demonstration projects that capture in that 2011 timeframe. At our Mountaineer facility, we are also working on a sequestration project. For the past several years, we have worked with the DOE and Battelle and others in drilling a 9,200 foot hole into the earth and studying the geology. We now understand the geology. We understanding the saline aquifers. We are moving to the next step with the carbon capture process now to begin the injection of CO_2 into those aquifers and begin to study its behavior.

We hope start doing that with approximately 100,000 tons a year at the end of 2008, and are working that in parallel with the back-end capture.

Senator VOINOVICH. What we need to make good decisions here is what is the reality of this in terms of, and I don't mean dragging feet, but trying to move forward? When does it become viable so that if we put something in place that the company says, I am going to natural gas or someplace else because I can't afford to do what they are making us do.

Mr. RENCHECK. In the next decade, we need tax incentives to support that. Then to address your question on NSR, NSR impedes the efficiency improvements on some of these plants, so we could effectively make the existing fleet produce less CO_2 by making them more efficient with the regulation corrected.

Senator VOINOVICH. Mr. Fees.

Mr. FEES. Senator, I think it is important when we talk about this to think about it from a framework of when would a technology provider like ourselves or GE or others be willing to enter into a fixed price contract to deliver to American Electric Power some of the utility technology. So when I talk about these frameworks, I think about it in that realm.

Right now today, sitting here today I don't think oxy-coal, IGCC, or any of those things are quite at that level. These are in early stage development, so we are going to be in a position, however, thinking about this at three different tranches.

First tranche, having plants capable of being sold and delivered that can provide captured carbon ready for sequestration early next decade. Several technologies are available. The more advanced technologies, where you may not have to put it in the ground and do things along those lines, is probably early in the following decade, in the 2020 timeframe, in terms of when we would go off to

a utility and be ready to sign a contract to be able to do those kind of things.

So those are about the road maps. I still think that the long pole in the tent is what are we going to do with all the carbon; where is the infrastructure for it; and also legislatively, who owns it. I think there is going to be a big debate about when the carbon goes in the ground, who is responsible for the carbon? That is a solution that needs to be worked on very, very heavily.

Senator VOINOVICH. Mr. Chairman, I have spent some time with Sam Bodman. I said, sequestration of carbon is a lay-up shot. That is easy. So wait a second, we are not sure about that, is the question about the geology that you need, and then once you put it in the ground, whether or not that is going to matriculate out of that, and then cause other problems. It is not that easy as you think it is.

Senator LIEBERMAN. I hear you. Part of our challenge here, assuming we want to do something, which I believe a majority of us do, is to kind of calibrate how we create statutory and regulatory certainty that drives the technology. But also, obviously we don't want to demand so much that it is unrealistic, and actually has an adverse effect. I think that is the sweet spot, if I can put it that way, that we are looking for here.

The vote has gone off, but we have a good 10 minutes before we have to go over there.

Senator Boxer.

Senator BOXER. Thanks, Mr. Chairman. I will take just 5 minutes, and again thank you for a fantastic hearing. You have had a series of wonderful hearings. The reason we divided the global warming task between two subcommittees is because there is so much work to be done.

I think Senator Voinovich has certainly put his finger on an issue, which is we have to deal with clean coal. My belief is that we need to have a Manhattan Project for clean coal. We need to give both incentives and we need to make investments, and we need to deal with the issue of the sequestration and the responsibility after you have stored the carbon and the rest.

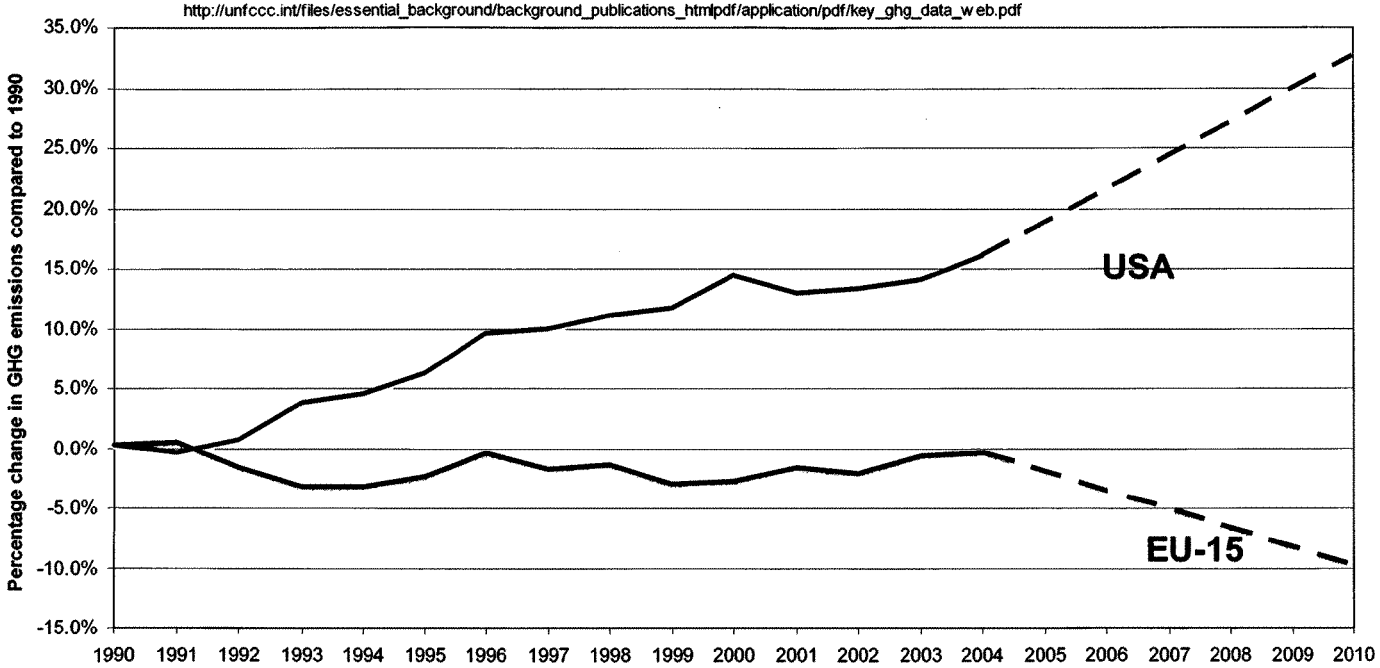
I am very optimistic on this matter because I approach this whole thing with hope. I do want to put a couple of things in the record. One is, because Senator Voinovich raised the issue of the European Union versus the United States, I have a chart that shows just the opposite of what he said, so for what it is worth, I am going to place it in.

Senator LIEBERMAN. Without objection.

[The referenced document follows:]

Total actual and projected emissions 1990-2010
(without land-use, land-use change and forestry (LULUCF))

http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/3734.php
http://unfccc.int/files/essential_background/background_publications_htmlpdf/application/pdf/key_ghg_data_web.pdf



Note:
1)Projections for the EU-15 are "with additional measures"
2)Projections for the USA are "with measures"
3)2010 simply represents the mid-point for the 2008-2012 period
4)Dotted lines represent the projections and straight lines actual emissions

Senator BOXER. Also showing the increase in just U.S. emissions over the past few years. It is dramatic. If you take it out, it is just a straight line up. So we don't have a lot of time to waste.

What has encouraged me so much about this hearing is not only the can-do attitude from America's business and scientists and researchers, but also Senator Warner's comments about looking for what he basically calls the benchmarks of what we ought to look at with legislation, Mr. Chairman. If I could kind of summarize what I think I heard this panel discuss, and I would like you to correct me if I leave something out or if I misstate what I heard you say, just from this panel.

A carbon credit set-aside I think is a really important point. There are people out there now doing the right thing. They are doing the right thing. They may be motivated by all the good reasons. They may be motivated by business reasons. They may be motivated by the global marketplace. It doesn't matter to me. What matters to me is there are people out there doing the right thing who ought to get a reward for doing the right thing, and ought to get a carbon credit set-aside.

So I think that ought to be part of whatever we do because as we do move toward a cap and trade, which I think inevitably we will do, and I want to point out that there are now four candidates for President on the Democratic side who have gone onto the Sanders–Boxer bill, and you have Senator McCain who is working with Senator Lieberman on cap and trade, and we have other Republicans out there who seem very inclined to do something.

When we started talking about this, I said I had two goals. One was to make this a bipartisan issue, move forward legislation, and also make this part of the presidential debate. So looking forward, given the Supreme Court's decision, Mr. Chairman, saying that in fact the EPA can just move forward on its own.

So just reading the tea leaves here, whatever reason you are doing the right thing, I want to say thank you. I want, too, as a legislator and Chair of this great committee, to say there ought to be a way to reward those who are doing the right thing now. So I thank you, Mr. Stanway, for that point of talking about a carbon credit set-aside.

Then, I think you also are talking about tax credits, whether it is to get these batteries moving faster, or to stimulate your R&D investments. I hear you talking about, and you didn't say a Manhattan Project, but you talked about some help from the Federal Government, which makes a lot of sense. We are dealing with a situation where, and I want to say this very clearly, 40 percent of the species that God created could be gone if we do nothing. We are talking about a crisis that could come where, just listen to what happened down the hall today in Foreign Relations, our intelligence officials and defense officials are saying this could be the cause of major wars in the future.

So we need to move forward. I think what has happened here today, Mr. Chairman, if I might thank you, is that we are coming up with these ideas. Cap and trade is already out there. I think we have had pretty much an endorsement of that. So credit for work done, Manhattan Project, I think we have some concepts here which could really work.

The very last point I want to make is, Senator Craig is struggling with why the world is warming. He has really plunged into this issue. I respect him for it. But I want to say that over the history of America, we have in fact embraced science. The IPCC includes hundreds of the leading scientists in the world from over 100 governments, including our own Government is part of the IPCC. They are unanimous in saying global warming is 100 percent certainty and 90 percent certainty that mankind is causing it.

Now, we could have walked away from the scientists when they told us to vaccinate after the polio epidemic. We could have walked away from scientists when they said the Cuyahoga River is on fire because of toxic pollution there. We could have walked away when scientists said, you know, the reason you can see the air is it is filthy and dirty and you have to clean it up. We could have walked away on AIDS. We could have walked away on the Safe Drinking Water Act when the scientists told us what we had to do. We could have walked away on brownfields, the Endangered Species Act and all the rest. We didn't and we are better for it.

So thank you, Mr. Chairman, for doing this. You are such a can-do legislator and it gives me great confidence that we are going to really move forward with your leadership in the subcommittee. Thank you very much.

Of course, with Senator Warner's as well.

Senator LIEBERMAN. Thanks very much, Senator Boxer. Look, you are the Chair of the overall committee. You are driving this vehicle fuel efficiently, I am sure.

Senator BOXER. Yes.

[Laughter.]

Senator LIEBERMAN. Meaning we are at zero greenhouse gas emissions on this committee.

I want to thank you.

Senator BOXER. A lot of hot air, but no greenhouse gas.

[Laughter.]

Senator LIEBERMAN. The can-do spirit that comes out of this panel, and actually will-do, is so classically America at its best, which is its combination of innovation and entrepreneurship for the general benefit. This country, and you look at some of those surveys of public opinion, we need to show each other that we can tackle a big problem and solve it. I can't think of a better one than this one, because if we do this, we also tackle the energy dependence problem, which is so serious to us in so many different ways.

You have been a wonderful panel. I thank you not only for great, inspiring testimony, frankly, but for what you are doing in your work every day to help us deal with this problem.

We are going to leave the record of the hearing open for another 10 days if you would like to add anything, an afterthought, or we have questions that we want to add to you.

I do want to restate to everyone here, to you and to Senator Boxer, that we are going to work very hard on this subcommittee to see if we can find a consensus that hopefully everybody on the subcommittee, but at least a good bipartisan majority, can support and send to the full committee a bill that will really begin to take the steps America needs to take to confront this great challenge.

But here is the final word. The testimony today says this is a solvable problem. That is the most exciting thing that I have learned again today.

Thank you very much. The hearing is adjourned.

[Whereupon, at 12 p.m. the subcommittee was adjourned.]

[Additional material submitted for the record follows.]

Financial Times (London, England)

April 26, 2007 Thursday
London Edition 1

Industry caught in 'carbon credit' smokescreen

BYLINE: By REBECCA BREAM, STEPHEN FIDLER and FIONA HARVEY

SECTION: FRONT PAGE - FIRST SECTION; Pg. 1

LENGTH: 587 words

Companies and individuals rushing to go green have been spending millions on "carbon credit" projects that yield few if any environmental benefits.

A Financial Times investigation has uncovered widespread failings in the new markets for greenhouse gases, suggesting some organisations are paying for emissions reductions that do not take place.

Others are meanwhile making big profits from carbon trading for very small expenditure and in some cases for clean-ups that they would have made anyway.

The growing political salience of environmental politics has sparked a "green gold rush", which has seen a dramatic expansion in the number of businesses offering both companies and individuals the chance to go "carbon neutral", offsetting their own energy use by buying carbon credits that cancel out their contribution to global warming.

The burgeoning regulated market for carbon credits is expected to more than double in size to about Dollars 68.2bn (Pounds 34bn) by 2010, with the unregulated voluntary sector rising to Dollars 4bn.

The FT investigation found:

* Instances of people and organisations buying worthless credits that do not yield any reductions in carbon emissions.

* Industrial companies profiting from doing very little - or from gaining carbon credits on the basis of efficiency gains from which they have already benefited substantially.

* Brokers providing services of questionable or no value.

* A shortage of verification, making it difficult for buyers to assess the credits' true value.

* Companies and individuals being charged over the odds for the private purchase of European Union carbon permits that have plummeted in value because they do not result in emissions cuts.

Francis Sullivan, environment adviser at HSBC, the UK's biggest bank that went carbon-neutral in 2005, said he found "serious credibility

concerns" in the offsetting market after evaluating it for several months.

"The police, the fraud squad and trading standards need to be looking into this. Otherwise people will lose faith in it," he said.

These concerns led the bank to ignore the market and fund its own carbon reduction projects.

Some companies are benefiting by asking "green" consumers to pay them for cleaning up their own pollution. For instance, DuPont, the chemicals company, invites consumers to pay Dollars 4 to eliminate a tonne of carbon dioxide from its plant in Kentucky that produces a potent greenhouse gas called HFC-23. But the equipment required to reduce such gases is relatively cheap.

DuPont said: "The issue of credit for early action is a principle that we believe should be followed in general."

The FT has also found examples of companies setting up as carbon offsetters without appearing to have a clear idea of how the markets operate. In response to FT inquiries about its sourcing of carbon credits, one company, carbonvoucher.com, said it had not taken payments for offsets.

Blue Source, a US offsetting company, invites consumers to offset carbon emissions by investing in enhanced oil recovery, which pumps carbon dioxide into depleted oil wells to bring up the remaining oil. However, Blue Source said that because of the high price of oil, this process was often profitable in itself, meaning operators were making extra revenues from selling "carbon credits" for burying the carbon.

There is nothing illegal in these practices. However, some companies that are offsetting their emissions have avoided such projects because customers may find them controversial.

Additional reporting by Rebecca Bream

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DELEGATION OF THE EUROPEAN COMMISSION

Head of Delegation

FEB 22 2007
D/272

The Honorable Barbara Boxer
Chairman, Committee on Environment and Public Works
United States Senate
Washington, D.C. 20510

Dear Madame Chairman,

In recent publications in the media and in statements by U.S. Administration officials as well as at the Hearing on the U.S. Climate Action Partnership report, which you organized in the Senate Committee on Environment and Public Works on February 13, 2007, incorrect or incomplete information has been presented about the European Union (EU) climate policy. In particular, this concerns the EU's achievements to date by comparison to achievements in the U.S., and whether the EU will meet its obligation under the Kyoto Protocol, which is to reduce its emissions by 8% by 2012.

This letter is intended to put the facts before you[1].

To start, I would like to address one major misunderstanding in the discussions in the U.S.: we hear statements such as those from Senator Inhofe that only a few EU countries are on target to meet their Kyoto obligations and that other EU members will fail to do so, thus implying that the EU will not meet its Kyoto obligations. That is not correct. The EU is on track to meet its Kyoto commitment.

Of course, the performances of individual EU member states vary, but under the Kyoto Protocol, it is the 15 countries that were EU Member States when the Kyoto Protocol was signed in 1997 (EU-15) that have a joint commitment to reduce emissions by 8% by 2012[2]. Individual EU-15 Member States do also have individual targets but these are EU internal targets in the framework of our joint commitment. This joint commitment allows some EU countries to increase their emissions, while others reduce theirs significantly. The contributions of each Member State to achieving the 8% reduction are set down in EU law and are legally binding. It is thus inappropriate to assess the EU's overall performance on the basis of the performance of a few individual Member States. If the U.S. ratified the Kyoto Protocol with its foreseen 7% reduction target, I doubt if the U.S. would agree that its overall performance should be assessed by focusing on a few individual states rather than the overall U.S. performance.

[1] See also the 2006 Progress Report COM(2006)658 at http://ec.europa.eu/environment/climat/pdf/kyotoreport_en.pdf

[2] Since 2004, 12 new countries have become members of the EU, most recently Bulgaria and Romania in January 2007. Ten of these twelve have Kyoto targets ranging between -6 and -8% reductions on 1990 levels. Cyprus and Malta do no have targets.

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In the year 2000, the 15 EU Member States had stabilized greenhouse gas emissions at 1990 level and by 2004 they had reduced their emissions by 0.8% compared to 1990.

In the U.S., emissions grew by 15.8% between 1990 and 2004. The U.S. still lags far behind the EU which has seen its economy grow with a far lesser effect in terms of emissions.

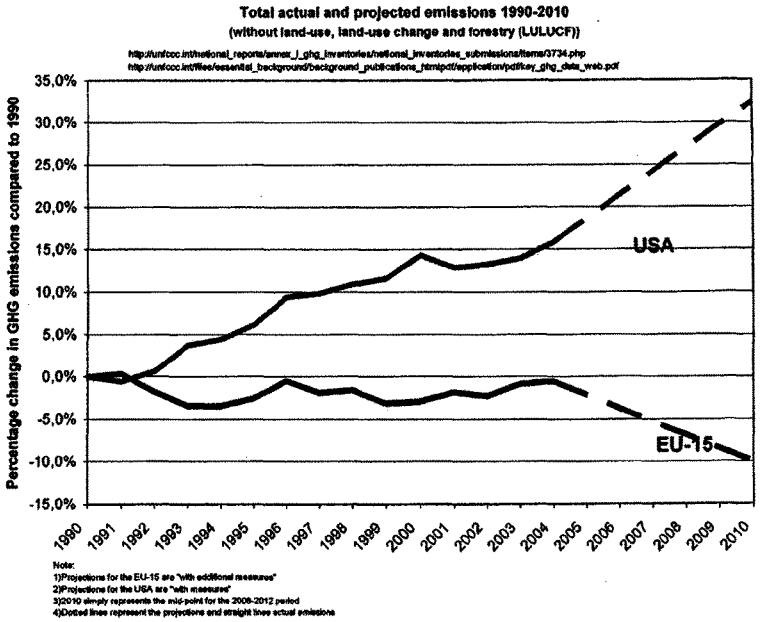
Between 1990 and 2002, greenhouse gas (GHG) emissions per unit of GDP decreased proportionately more in the EU than they did in the U.S., although they were at similar levels back in 1990. It seems that despite its improvement in recent years, the U.S. is not fully exploiting its potential for emission reductions.

When examining other important indicators such as energy use per capita or GHG emissions per capita which take into account the significant population increase in the U.S. in recent years the energy use and GHG emission figures for the U.S. have remained almost double of what they are for the EU. Increasing energy efficiency would decrease GHG emissions whilst reducing fuel imports.

The 2000-2004 time period

During the period 2000-2004, recently chosen as a reference period by the U.S. Administration, emissions in the U.S. grew more slowly than in the EU. However, in absolute terms the U.S. increase in GHG over that period was still more than in any other country in the world or than the EU as a whole (US: 29 million tonnes of CO_2, EU-27: just under 21 million tonnes of CO_2).

The selection of the limited 2000-2004 period for comparison of progress in reducing GHG emissions is far from representative. It is the longer term that is relevant in terms of successfully addressing climate change. The chart below, based on official UNFCCC data, shows how US and EU emissions have evolved and are projected to evolve between 1990 and 2010.



Furthermore, despite the developments in relative GHG emissions trends in the U.S. over the last couple of years, the future is not promising. By 2010, emissions in the U.S. are projected to be 32.4% above 1990 levels.

In contrast, the action taken at the EU level and currently under implementation at the national Member State level, is projected to result in an absolute reduction in emissions of 10.8 % from the base year 1990 by 2010 across the 25 Member States and by 8% for the EU-15 when existing (0.6%) and additional measures (4%) as well as the use of Kyoto mechanisms (2.6%) and carbon sinks (0.8%) are taken into account.

Amongst other measures such as a wide range of energy efficiency, renewable energy targets, vehicle emission and fuel standards to reduce greenhouse gas emissions, the EU has introduced a EU-wide cap and trade system which provides industry with the necessary (financial) incentives to take action and innovate in the most cost effective way.

The EU Emission Trading System (ETS) started January 1, 2005 for a three year pilot phase. Currently, it involves more than 10,000 companies, covering around 2 billion tonnes of CO_2 emissions (half of EU's total CO_2 emissions) with transactions valued at $ 19 billion in 2006. Emissions trading has two main advantages: it introduces climate change considerations in industry's financial bottom line and through the linking directive it opens up markets to Clean Development Mechanism projects in developing countries. Currently, credits from emission-

reducing projects in 169 countries representing more than 90% of the global population can be used by companies to meet part of their reduction objectives.

In addition to industry, the EU member states are also making use of the Kyoto mechanisms. The projected use of Kyoto mechanisms by 10 Member States is expected to amount to 110.6 million tonnes of CO_2eq. per year of the commitment period. This amount corresponds to over 30% of the total required emission reduction for the EU-15 of about 342 million tonnes CO_2 equivalents per year during the first commitment period. The total budget already allocated by member states amounts to about 3 billion EURO.

The EU ETS pilot phase has shown that there is room for improvement in the initial allocation, which is being addressed. An over-allocation of emissions permits in some Member States and in small and medium sized sectors for this initial period, resulting from the use of projected emissions and from a lack of data on actual emissions when the system was launched, has led to a relative drop in permit prices for the 2005-7 period. On the other hand, these price movements alongside high trading volumes are an indication that the market mechanism itself is functioning as it should. Thanks to reporting required under the EU ETS, we have the data to improve allocations for the second trading period which runs from 2008 and 2012. This is already reflected in the forward price for second phase permits. EU ETS is a very important tool for the future. We are currently working on streamlining its design for trading from 2013 onwards and expanding it to more sectors and other GHGs.

For your information, I attach some annexes with an overview of EU policies and measures, and a recent table on the EU performance under Kyoto.

The way forward

The EU is pleased to see that the climate debate is gaining momentum in Congress, in many states and with other stakeholders, and that the U.S. as a whole has started to make progress in reducing the growth of its emissions. The EU is certainly keen to exchange experiences with all interested parties in the U.S. regarding new and existing policies and measures, research programs and other initiatives and assess what is the best way forward in tackling the pressing and long term challenge of climate change. The EU has gained a lot of experience of using market-based measures such as emissions trading, and is keen to share this experience and avoid any need for the US to "reinvent the wheel" when it comes to the building blocks of emissions trading such as monitoring requirements and electronic registries.

On the basis of the scientific assessment of man-made climate change impacts, the EU's objective is to limit the average increase in global temperature to a maximum of 2 degrees Celsius (3.6 Fahrenheit) above pre-industrial levels. If the world stays within this threshold, we will still see some serious impacts, but we would have a reasonable chance of avoiding catastrophic consequences. A 3.6 degree Fahrenheit target would translate into making sure that global GHG emissions peak by 2020 and then fall drastically – by around 50% over 1990 levels to ensure that atmospheric concentrations stabilize at around 450 ppm. The EU's own calculations show that these concentrations could be achieved if developed countries as a group were to reduce their emissions by 30% by 2020 and by 60% - 80% by 2050, and if developing countries with some support limit their growth in emissions before 2020 and to reduce them in absolute terms thereafter.

The EU is looking for a shared vision amongst major GHG emitters of what needs to be done to tackle climate change. We propose these objectives and reduction paths as a framework to guide action. To underline its commitment to action, the EU has agreed an independent reduction target of at least 20% by 2020, if there is no outcome of the negotiations on a global binding post-2012 agreement.

The EU is open to discussing the details of this framework and of the actions needed with other countries and with the US in particular. One thing is nonetheless certain: time is running short and decisions need to be made as soon as possible.

Yours sincerely,

John Bruton

Ambassador

Annex I:

European Climate Change Programme (ECCP)

Status of implementation of important ECCP I identified policies and measures

Measure	Reduction potential EU-15, 2010 (Mt. CO_2)	Entry into force	Starting to deliver
EU emission trading scheme	~ NAP2	2003	2005
Link Joint Implementation (JI)/ Clean Development Mechanism (CDM) projects to emission trading	~ NAP2	2004	2005/2008
F-Gases Regulation and Directive on Mobile Air Conditioning	23	2006	2008
Dir. on the promotion of electricity from renewable energy sources	100-125	2001	2003
Directive on the promotion of Cogeneration of Heat and Power (CHP)	65	2004	2006
Directive on energy performance of buildings	35-45	2003	2006
Directive on the promotion of transport bio-fuels	35-40	2003	2005
Directive on the promotion of energy efficiency and energy services	40-55	2003	2006
ACEA voluntary agreement	75-80	1998	1999
Energy labeling directives	20	1992	1993
Total	**393-453**		

Note: The emission reduction potential for the various ECCP measures are (ex-ante) estimates. The 'ex ante' ECCP evaluation of the potential of a certain measure does not necessarily coincide with the actual realisation in the field, as not all of the detailed provisions of the proposals or adopted measures have been taken into account in the pre-evaluation. Another reason is that the estimated potential is sometimes based on reaching certain (indicative) targets, which will need to be proven in practice (eg., CHP and biofuels proposals).

Annex II: the EU's Kyoto performance

Greenhouse gas emissions trends and Kyoto Protocol targets for 2008-2012

(source: European Environment Agency, 2006)

MEMBER STATE	Base year[1] (million tonnes)	2004 (million tonnes)	Change base year–2004 (%)	Change 2003–2004 (million tonnes)	Change 2003–2004 (%)	Targets 2008–12 under Kyoto Protocol and "EU burden sharing" (%)	Distance to target indicator (index points) in brackets, excluding Kyoto mechanisms and sinks (%)
Austria	78.9	91.3	+15.7 %	-1.2	-1.3 %	-13.0 %	+17.9 (+24.8)
Belgium	146.9	147.9	+0.7 %	0.3	+0.2 %	-7.5 %	+1.8 (+5.9)
Cyprus [2]	6.0	8.9	+48.2 %	-0.3	-3.0 %	no target	no target
Czech Republic	196.3	147.1	-25.1 %	-0.5	-0.3 %	-8.0 %	-19.9 (-19.5)
Denmark	69.3	68.1	-1.8 %	-6.0	-8.1 %	-21.0 %	+7.9 (+12.9)
Estonia	42.6	21.3	-50.0 %	0.1	+0.7 %	-8.0 %	-44.4
Finland	71.1	81.4	+14.5 %	-4.2	-4.9 %	0.0 %	+13.1 (+14.5)
France	567.1	562.6	-0.8 %	1.5	+0.3 %	0.0 %	-1.2 (-0.8)
Germany	1230.0	1015.3	-17.5 %	-9.1	-0.9 %	-21.0 %	-2.8
Greece	111.1	137.6	+23.9 %	0.3	+0.3 %	+25.0 %	+6.4
Hungary	122.2	83.1	-32.0 %	-0.2	-0.2 %	-6.0 %	-27.8
Ireland	55.8	68.5	+22.7 %	0.1	+0.1 %	+13.0 %	+6.5 (+13.6)
Italy	519.6	582.5	+12.1 %	5.1	+0.9 %	-6.5 %	+9.9 (+16.7)
Latvia	25.9	10.7	-58.5 %	0.0	+0.4 %	-8.0 %	-52.9
Lithuania	50.9	20.3	-60.1 %	3.1	+17.9 %	-8.0 %	-54.5
Luxembourg	12.7	12.7	+0.3 %	1.3	+11.3 %	-28.0 %	+3.3 (+19.9)
Malta [2]	2.2	3.2	+45.9 %	0.1	+4.2 %	no target	no target
The Netherlands	214.3	217.8	+1.6 %	2.5	+1.1 %	-6.0 %	-0.7 (+5.8)
Poland	565.3	386.4	-31.6 %	3.7	+1.0 %	-6.0 %	-27.4
Portugal	60.0	84.5	+41.0 %	0.9	+1.0 %	+27.0 %	+14.6 (+22.1)
Slovakia	73.2	51.0	-30.3 %	-0.1	-0.1 %	-8.0 %	-24.7
Slovenia	20.2	20.1	-0.8 %	0.4	+2.0 %	-8.0 %	-1.0 (+4.8)
Spain	289.4	427.9	+47.9 %	19.7	+4.8 %	+15.0 %	+31.2 (+37.4)
Sweden	72.5	69.9	-3.6 %	-1.1	-1.5 %	+4.0 %	-8.4 (-6.4)
The United Kingdom	767.9	659.3	-14.1 %	1.3	+0.2 %	-12.5 %	-5.8 (-5.4)
EU-15	4266.4	4227.4	-0.9 %	11.5	+0.3 %	-8.0 %	+2.3 (+4.7)
EU-10	1104.9	752.2	-31.9 %	6.5	+0.9%	no common target	no common target
EU-25	5371.3	4979.6	-7.3 %	18.1	+0.4 %	no common target	no common target

([1]) For EU-15 the base year for CO_2, CH_4 and N_2O is 1990; for the fluorinated gases 13 Member States have indicated to select 1995 as the base year, whereas Austria and France have chosen 1990. As the EC inventory is the sum of Member States' inventories, the EC base year estimates for fluorinated gas emissions are the sum of 1995 emissions for 13 Member States and 1990 emissions for Austria and France.

([2]) Cyprus and Malta did not provide GHG emission estimates for 2004, therefore the data provided in this table is based on gap filling.

The base-year emissions reported in this table are the latest data available from national greenhouse gas inventories (6 June 2006). Final data will be available in the report on the EU's assigned amount (pursuant to Article 3, Paragraphs 7 and 8 of the Kyoto Protocol) under the UNFCCC, due end of 2006.

Note: Malta and Cyprus do not have Kyoto targets.