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CLIMATE CHANGE LEGISLATION

HEARING

BEFORE THE

COMMITTEE ON ENERGY AND NATURAL RESOURCES UNITED STATES SENATE

ONE HUNDRED TENTH CONGRESS

SECOND SESSION

TO

RECEIVE TESTIMONY ON ENERGY AND RELATED ECONOMIC EFFECTS OF GLOBAL CLIMATE CHANGE LEGISLATION

MAY 20, 2008

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CLIMATE CHANGE LEGISLATION

TUESDAY, MAY 20, 2008

U.S. SENATE,
COMMITTEE ON ENERGY AND NATURAL RESOURCES,
Washington, DC.

The committee met, pursuant to notice, at 10 a.m. in room SD–366, Dirksen Senate Office Building, Hon. Jeff Bingaman, chairman, presiding.

OPENING STATEMENT OF HON. JEFF BINGAMAN, U.S. SENATOR FROM NEW MEXICO

The CHAIRMAN. Why don't we go ahead and get started. Today we'll hear testimony on analyses of global warming legislation to learn about the economic and energy impacts of climate policy and how to understand what the capabilities and restrictions of economic models are. Over the past several years the committee has had a number of hearings and workshops and briefings to understand the economic, environmental impacts of climate legislation, specifically on its impacts to the energy sector.

Last year the Energy Information Administration and others testified before our committee on draft legislation that would become the Bingaman-Specter Climate bill. Since that time many other climate bills have been introduced. Many of them have been modeled and not only by EIA but also by EPA and also by various stakeholders and interest groups.

Debates on climate legislation and energy policy in general have often focused heavily on modeling analyses and predictions. They go from one extreme to another. There are some models that have been used to show that legislation will cause massive disruptions in our economy. There are other models that have been used to show that this legislative proposals can be accomplished with little or no cost.

Given this wide disparity of findings it can be difficult to navigate the space in-between and to understand what the true impacts of legislation will be. We're faced with the question how could reasonable people and institutions analyze the same policy and come to completely different conclusions.

A broader question that the committee needs to focus on is how energy models can be helpful to us in creating a road map to transform our economy toward a low carbon economy. Although EIA and EPA and others have done modeling of various climate change proposals in the last year, the most recent modeling has been of the Lieberman-Warner Climate Security Act which was reported by the Environment Committee in December.

It is my understanding that a substitute for that bill is being developed and that the substitute will be what is considered on the Senate floor in the next several weeks. Obviously, that substitute has not been the subject of modeling as yet. Nevertheless, I believe it's valuable for us to understand first, the extent to which modeling can reliably inform our judgment about what to do.

Second, the assumptions built into the various models about the availability of resources and the need and the speed of technology development in deployment.

Third, the factors that most significantly affect the outcomes from these models.

I very much thank the witnesses for being here to help us understand these complex issues. Let me defer to Senator Domenici before I introduce the witnesses.

[The prepared statements of Senators Salazar and Murkowski follow:]

PREPARED STATEMENT OF HON. KEN SALAZAR, U.S. SENATOR FROM COLORADO

Thank you Chairman Bingaman and Ranking Member Domenici for holding today's hearing on the energy and related economic impacts of global climate change legislation. This Congress has made climate change legislation a priority, and, under your leadership, this Committee has devoted considerable effort to developing a cap-and-trade system to control greenhouse gas emissions. We are all anticipating the upcoming floor debate of the Lieberman-Warner climate change bill.

Many have called the lack of a price on carbon the greatest market failure in history. Placing a price on carbon will likely touch many sectors of the economy. Our design choices can have far-reaching consequences, and we must take care to motivate and reward consumers, farmers, and industrialists to "do the right thing" with regards to embracing a low-carbon footprint.

Above all, a carbon cap-and-trade system has the potential to turbo-charge the nascent clean energy revolution that has already begun in our country. Clean, low-carbon energy can be an economic engine for our nation, and I am hopeful that a cap-and-trade system and the right tax policies will stoke our transformation into the undisputed world-leader in cost-effective solutions to the climate challenge.

Our nation's competitiveness in the global marketplace and the high standard of living we enjoy today are intimately related to our longstanding dedication to promoting and capitalizing on technological innovation. Long the envy of the world, our innovation infrastructure holds the key to solving the climate crisis. A cap-and-trade program has the potential to fully unleash our economy's innovation capacity and fuel incredible economic growth. I am particularly interested to hear from our panelists whether the existing analyses of the Lieberman-Warner bill have captured and incorporated these undeniable forces in our economic system.

In Colorado I have witnessed firsthand the economic muscle of clean energy, where our citizens' commitment to a renewable electricity standard has attracted thousands of new jobs to the state. In the Denver metro region alone, the number of renewable-energy sector jobs tripled between 2004 and 2007.

Our nation holds the technological potential to meet the climate challenge and the economic potential to capitalize on it. Time and again throughout our history American ingenuity has developed the technologies to meet our greatest challenges. Achieving homegrown solutions to the carbon problem will undoubtedly present incredible new economic opportunities to export these technologies to the rest of the world, particularly China and India. Last year Morgan Stanley declared that clean energy industries could reasonably achieve $1 trillion in annual global revenues by 2030. Clean, low-carbon energy will be an economic driver for the 21st century. I look forward to discussing this transformation with this distinguished panel.

Thank you, Mr. Chairman.

PREPARED STATEMENT OF HON. LISA MURKOWSKI, U.S. SENATOR FROM ALASKA

Mr. Chairman, I must admit this is a particularly complex hearing. As the CRS report makes clear, so many of the computer models that purport to look at the effects of Lieberman-Warner and of the alternative Bingaman-Specter cap and trade bills for that matter, seemingly use different assumptions and generate vastly dif-

ferent results. And many of the models themselves produce vastly different results between their reference cases and their "high-tech" alternatives.

While there is some uniformity of opinion that the Lieberman-Warner bill will reduce our gross domestic product, there is a big difference in estimates as to how much. The EPA predicts a drop of between—0.7% to -2.5% by 2020 and from -0.9% to -3.8% by 2030. EIA predicts a drop of from -0.3% to -0.9% by 2020 and from -0.3% to -0.8% by 2030. The Clean Air Task Force model predicts a low of -0.7% by 2030 while the National Association of Manufacturer's ACCF model predict up to a -2.7% reduction by 2030—resulting in a cumulative difference of nearly $4 trillion among the models.

That difference is not unimportant. If you look at all the computer models, the EIA models pegs the cost to the average household at somewhere between $76 and $723 in 2030, quite a spread. But the NAM/ACCF model puts that spread at between $4,000 and $6,750 per household in 2030. The EPA model puts it at between $446 and $608 in 2020, less than half of the $1,340 that the Charles River Associates International model predicts in that same year.

Look at specific utility prices, electricity rates are predicted to rise by a low of 10% in 2030 in the Clean Air Task Force Model, to by 30% in the Nicholas Institute model, to 34% in the Charles River Associates International model, by 44% in the EPA model, to 57% in the MIT model, by between 11 and 64% in the EIA model, and to 101 to 129% in the NAM/ACCF model.

There is not much more uniformity of opinion about the price impacts on coal, natural gas or oil/gasoline costs. Or for that matter how much alternative and renewable energy we are likely to gain by passing the bill. The EIA in its 2008 energy outlook predicted about 4.5 gigawatts of alternatives would be built to 2030 in a business as usual case. MIT predicts in its model about 16 gigawatts will result from the bill. EIA is harder to pin down but I thought the report suggested around 16 gigawatts, which is a 146% increase over their business as usual case. EPA estimates 61 gigawatts, NAM between 108 and 180 gigawatts, the Clean Air Task Force around 100 gigawatts and Charles River Associates 176 gigawatts.

How can we in Congress be on the verge of voting on a measure where there is such a large difference in the forecasts about what the bill will mean to our constituents with little hope of clarifying the estimates before floor action?

From a provincial Alaska perspective, the NAM/ACCF model predicts it will cost the average Alaskan household between $4,548 and $8,294 a year in higher energy costs and will cut jobs in Alaska between 6,410 and 8,530 in 2030. The Heritage Foundation model puts Alaska's job loss at 1,800 by 2025. Meanwhile an analysis by the University of Alaska's Institute of Social and Economic Research implies the cost will be far less, especially in terms of jobs, a recent report indicating the bill might actually hike employment in the State by leading to construction of a natural gas pipeline.

Seldom has Congress been asked to start voting on a bill that will have such a massive impact on our economy and our future with such a large divergence of opinion about what it will mean for the nation and our state's constituents.

Obviously as the CRS report shows, and as other analysis has shown, there are real differences in the assumptions that drive the models and real differences of opinion about what assumptions make the most sense.

Nuclear power may be a rational way to replace carbon emitting power with clean energy. The models, however, have vast differences as to how much nuclear power will be built—that affecting greatly the various cost estimates for how climate legislation will impact people.

As the CRS report notes from 1963 until 1985—22 years—this country built 78 gigawatts of nuclear power in total. But the computer models predict that over the next 22 years we will build somewhere between 117 in the view of the Clean Air Task Force model, which helps to limit the cost of the Lieberman-Warner bill, between 88 and 286 gigawatts in the differing forecasts of EIA, to 62 gigawatts in the EPA model, 40 in the view of Charles River (CRAI), 25 in the view of NAM and just 3.5 gigawatts in the view of the MIT report.

You get almost the same vast spread in predicted outcomes in the amount of carbon capture and storage capable coal-fired plants that will be built. And those differences are vital in how the models determine the predicted cost to Americans of the legislation.

And as the CRS report makes clear there are similar uncertainties in a host of other areas. Look at carbon prices for allowances, a key in determining gasoline, coal, natural gas, and electricity prices that Americans will pay under the measure because of their impacts on carbon emission allowance costs. The estimates are that carbon in 2030 may cost a low of $38 a ton in the report by the Nicholas Institute, which helped design the architecture of the Lieberman-Warner bill. The Clean Air

Task Force places it at $50 a ton. Charles River at $76 a ton, EPA between $61 and $83 a ton, MIT at $86, EIA at between $61 and $156 a ton, depending on which of their forecast scenarios you pick, and NAM at between $227 and $271 a ton.

That variance alone helps to explain why CRAI says that Lieberman-Warner may cost the nation $7.4 trillion in 2007 dollars to 2050, while the Bingaman-Specter alternative cap and trade bill that I am a co-sponsor of is expected to cost just $1.7 trillion till 2050.

And what will Americans get for that cost. As the CRS report makes clear, it depends solely upon whether foreign nations follow America's suit and adopt similar types of carbon emission reductions. If they don't, the world will see a drop in atmospheric levels of carbon of about 23 to 25 parts per million less than would otherwise be seen.

I point out these differences not because I believe nothing should be done to limit carbon emissions. Coming from Alaska, the state already impacted by climate change during the past three decades, and predicted to be the most impacted in America by climate change, I certainly want to do things that work quickly to reduce carbon emissions, if nothing more than an insurance policy against future atmospheric change.'

But I certainly want to make sure that the costs of legislation are the lowest possible on Americans, while maximizing the benefits they will see from any measure that we pass.

I await the testimony and my chance to try to make sense out of the models and the estimates of the impacts of the Lieberman-Warner bill that we are about to hear. Thank you Mr. Chairman.

STATEMENT OF HON. PETE V. DOMENICI, U.S. SENATOR FROM NEW MEXICO

Senator DOMENICI. First, thank you, Mr. Chairman for calling this hearing. I think the more of these kinds of hearings we can hold, gathering expertise from the people like today's witnesses, the better off we are and the better off our country will be. I thank you for coming and lending us your time and your intelligence.

Good morning, everyone. We have five cap and trade bills in the Senate. At least 11 attempts have been made to analyze them. Every single one—11 out of 11—has concluded that these bills will result in higher energy prices, lower economic growth and minimal environmental benefit. That's what every one of the studies says.

There are seven sets of analysis on the Lieberman-Warner Bill alone. They don't agree on much. One study projects 264 gigawatts of new nuclear power plants, while another projects no more than four. But all of them anticipate a negative impact on our Gross Domestic Product. Even those estimated impacts vary, from $444 billion to a high of $4.8 trillion.

Addressing global climate change is one of the great challenges of our time. I have the greatest respect for the goals and efforts of each bill's authors. I also appreciate the hard work that has gone into these studies. But a range of nearly $4.5 trillion is as massive as it is inconclusive. I remain concerned about the dire consequences that the Lieberman-Warner bill could have for our Nation.

We must also remember that projections are just that, projections. The best estimates by our most capable minds often prove inaccurate. Take for instance, EIA's projected oil price for 2010 as it appeared in the Annual Energy Outlook for 2005. I certainly hope that oil prices decline to $25 a barrel over the next 18 months, but right now, we're paying five times that amount. On a projection just 5 years into the future, what a difference the past 3 years have made.

Even the projected environmental impacts of climate change have varied significantly. In 2001 the IPCC predicted that sea levels would rise by 3 feet by the year 2100. In their latest assessment, that number was lowered to between 7 and 23 inches on a projection that sought to look a full century forward, what a difference the past 7 years have made.

Compounding this uncertainty is what appears to be the worst kept secret on Capitol Hill—that what was reported from EPW last December will be replaced by a manager's amendment. Senator Bingaman has alluded to that. Very few will have been able to provide input on this amendment, and even fewer will have had a chance to properly evaluate it.

We're all working on the bill, as it was reported by EPW. But the bill will be irrelevant when it is substituted for by a manager's amendment, which I am certain will have substantial changes at every level and every part. Today, this leaves us to learn about legislation that will never be taken up on the Senate floor.

Given what we lack in future projections, it is critical to look at what other countries have tried to do, including the signatories to what was supposed to have been a binding treaty. It caught my attention last December when President Clinton appeared on the Charlie Rose show, Mr. Chairman, and latented the fate of the Kyoto Protocol. He said 170 countries signed this treaty, only 6 out of the 170 have reduced their greenhouse gases to the 1990 level. He said that only 6 will do so by 2012 deadline.

One hundred sixty-four out of 170 is a staggering rate of failure, and we should give that precedent the attention it deserves. If the Wright Brothers had been among 170 seeking to be the first to fly, I'm certain they would have wanted to know why all but a handful of their fellow aviators came crashing down to earth.

I'm not endorsing the status quo, but our Nation has done reasonably well compared to those who have implemented cap and trade programs. The European Union began operating its system in 2005. According to the Wall Street Journal, their carbon dioxide emissions have continued to rise by about 1 percent a year. During that same period, America's carbon dioxide emissions actually declined by 1 percent.

Any reasonable amount of time spent looking at cap and trade proposals leads to more questions than answers. While that may be acceptable for scientific endeavors it is not a very sound footing from which to embark upon policymaking. One of these questions is particularly troubling. Assume for a moment that Congress passes, and the President signs, the Lieberman-Warner legislation. What then will we have accomplished for the environment?

As it turns out, the answer is next to nothing. This is a global problem. But without further international action, the Lieberman-Warner bill would reduce atmospheric concentrations of greenhouse gases by a mere 1 percent by 2050. To achieve that reduction we may subject our economic prosperity and global competitiveness to irreparable harm.

My concerns are no different than those shared by the full U.S. Senate in 1997, when on a vote of 95 to 0, we passed a resolution indicating that we did not support Kyoto. Our economy grew by 5 percent in the quarter before that vote. In the midst of robust

growth the Senate overwhelmingly rejected the idea of a treaty that did not include developing nations or "could result in serious harm to the United States economy."

With the many factors now limiting our economy, which expanded by just 0.6 of a percent last quarter, today should be no different. Our determination to involve developing nations in these efforts should be stronger than ever, since we now know that China has surpassed us in greenhouse gas emissions decades before they were supposed to. There is a fine line between success and failure in the global economy. We must not let a disproportionate sense of urgency tip the balance away from our economic strength and competitiveness with emerging economies.

Addressing climate change is a great challenge, but it is not the only challenge that we face. Between 1990 and 2006, American's reliance on foreign oil increased from 42 percent to 60. As a result, nearly half a trillion dollars will be sent overseas this year for energy that we are capable of producing at home.

Our trade deficit ballooned from $81 billion to $700 billion last year, and our Nation's national debt tripled to over $9 trillion during that same period. These are bipartisan shortcomings that have played out over the course of decades.

During these same years, we did make progress on one front, and it is a front that is central to this debate. Between 1990 and 2007, the greenhouse gas intensity of our economy dropped by nearly 27 percent, even as many other problems became much more serious. We may see an increase in emissions in some years. But over the past 2 decades, our ability to reduce greenhouse gas emissions relative to GDP has been very instructive.

We are already experiencing record prices for gasoline, oil and other commodities. To me, it's more than a little ironic that the free market, which so many of my colleagues have criticized as responsible for those high prices, is the very same mechanism that they ask us to trust for containing the costs associated with a cap and trade regime.

We, as a Congress and as a Nation, must realize that cap and trade is neither our only option nor our best option for addressing climate global climate change. Rather than choosing among cap and trade proposals, we could look at alternate measures promoting nuclear power, advancing clean energy tax incentives, and accelerating the development of clean technologies.

The Energy bills we passed in 2005 and 2007 are the functional equivalent of a clean energy Manhattan Project. There is no question that fully funding these measures, and the additional progress made possible by my Clean Energy Investment Bank that might come into being, will lower emissions even further.

In closing I remind my colleagues of the importance of choosing the right path for our Nation on climate change and the enormity of the consequences if we fail to fully and wisely choose. I look forward to hearing from the witnesses. Many of them I do not know, but I know enough about them to say that they are more than adequate to help us understand what we are about to enter upon.

Thank you, Mr. Chairman.

The CHAIRMAN. Thank you. Let me suggest this way of proceeding. I know there are members here who would like to give opening statements as well.

I think in fairness to our witnesses, I would like to go ahead and hear from the witnesses, and maybe give each member 7 minutes of time for comments or statements and questions on the first round. Any member that has not had a opening statement like I did and like Senator Domenici did, so that we don't get into a major debate here about whether climate change should be addressed through cap and trade or not. Because I do think that these witnesses are really here to talk about the modeling which is the focus of our hearing.

Let me just introduce Senator Corker.

STATEMENT OF HON. BOB CORKER, U.S. SENATOR FROM TENNESSEE

Senator CORKER. Yes, I'll refrain from giving an opening comment. I have to go to a banking meeting at 10:30 that has a mark up and a thin number as it relates to actually having a quorum. I apologize. I do want to thank you for having this hearing.

There are numbers of things that I'd like to say which I guess I will not say at this time out of respect for the chairman, but I thank you for having this hearing. I'll probably enter those into the record. Thank you.

The CHAIRMAN. I would like to give you time to say them, but Senator Domenici has a hearing he has to be at at 11 o'clock. We'll still be giving opening statements by 11 o'clock if we don't go ahead, I'm afraid.

STATEMENT OF HON. MEL MARTINEZ, U.S. SENATOR FROM FLORIDA

Senator MARTINEZ. Mr. Chairman, could I also say that I would have to be going to this banking hearing and mark up as well very shortly, but I'm very interested in this topic. Thank you for calling the hearing.

The CHAIRMAN. Thank you all very much. Our first witness is Brent Yacobucci who is with the Congressional Research Service. I've asked that the CRS provide us with a brief description of how a cap and trade system would work, and he's intending to do that in his statement.

Larry Parker is also with the CRS and will proceed to give us some of the conclusions in a new report that CRS has done seeking to compare the results of various climate change analyses.

Howard Gruenspecht who's a familiar witness to us here is with the Energy Information Administration and Brian McLean who has also been here before with the Environmental Protection Agency. They will talk about the analyses that their respective agencies have done. Brian McLean is accompanied by Francisco de la Chesnaye, thank you for being here to provide technical support.

Peter Orszag is well known to all of us as the Director of the Congressional Budget Office. He'll speak about some of the economic impacts of climate legislation. He recently testified before the Finance Committee on similar issues.

Thank you all for being here. Why don't we start and just go across the table there. If you could take 5 or 6 minutes and make the main points that you think that we need to understand. Then we will have questions.

STATEMENT OF BRENT YACOBUCCI, CONGRESSIONAL RESEARCH SERVICE

Mr. YACOBUCCI. Alright. Good morning, Senators. My name is Brent Yacobucci and I'm joined by Larry Parker.

On behalf of the Congressional Research Service we would like to thank the committee for this invitation to testify here today. I've been asked by the committee to present a short introduction to cap and trade policy including key concepts and terms and relate those to S. 2191, the Lieberman-Warner Climate Security Act of 2008. Attached to my opening statement is a brief glossary of key terms presented in this statement.

A cap and trade system imposes an emissions ceiling or cap on the total annual emissions from entities covered by the system. The level of the cap is equal to the number of emissions permits or allowances allocated each year. At the end of the year covered entities must submit one allowance for each ton of carbon dioxide equivalent emitted.

In general a cap and trade system achieves emission reductions by decreasing the number of allowances allocated in successive years, the steeper the annual reduction in allowances, the more stringent the program. Also for the same cap the wider the coverage, that is, the more economic sectors and entities within those sectors covered by the system, the more stringent the program. S. 2191 as already reported would establish a mandatory cap and trade system reducing overall emissions by 66 percent from 2005 levels by 2020 according to the bill's sponsors.

Allowances may be used to comply with the cap, banked for future use or traded to someone else. This is the trade aspect of a cap and trade program. A key component of trading is the fact that some participants will have lower reduction cost than others.

To the extent that two different firms have different cost it makes the most economic sense for the firm with higher reduction costs to pay the lower firm to further reduce their emissions. In a national program these sorts of trades could occur among entities, sectors and countries within certain limits. A key element in designing a cap and trade system is selecting the point at which emissions are regulated. That is, who should submit allowances under the program.

Greenhouse gases can be controlled downstream at the point where they are emitted into the atmosphere or they could be controlled upstream requiring allowances from firms that produce or supply fuel and other products that will ultimately lead to greenhouse gas emissions. S. 2191 achieves broad coverage through upstream regulation of petroleum, natural gas and fluorinated gas producers and importers and downstream regulation of coal consumers such as electric generators. Now the point of regulation should not be confused with how and to whom allowances are allocated.

Allowances may be given at no cost to cover entities. In contrast allowances could be given to anyone. For example, States who may sell them to covered entities and use the proceeds for various purposes. Also allowances may be auctioned by the government and the proceeds used for purposes related or unrelated to greenhouse gas reduction.

S. 2191 uses a mix of all 3 options allocating roughly 35 percent of allowances in 2012 to covered sectors, another 35 percent to non-covered entities and auctioning the rest. In successive years the percentage of allowances given to covered entities reduces to zero while the share being auctioned increases.

Within a cap and trade system three flexibility mechanisms are key to determining the ultimate cost of the program. The first is banking, which is the ability to retain allowances for future use or sale. A provision included in S. 2191. Banking allows smoother transitions and can promote earlier reductions.

A second flexibility mechanism is the availability of domestic offsets which are emission reductions achieved by non-covered entities. These non-covered entities can sell offsets to covered entities who may use them in lieu of an allowance. Under S. 2191 up to 15 percent of a covered entities requirement can be met using these domestic offsets.

A third flexibility mechanism is the availability of international credits which are reductions achieved in eligible foreign systems that may be used by covered entities to comply with a U.S. program. Under S. 2191 up to 15 percent of a covered entities requirement can be met through the use of international credits.

In addition to these flexibility mechanisms cap and trade approaches may contain techniques to limit costs. These include a safety valve like that in S. 1766 which allows a covered entity to choose to pay a fee in lieu of submitting an allowance. Another way to control costs is S. 2191's carbon market efficiency board with the authority to loosen limits on offsets, international credits and the borrowing of allowances from future years.

To conclude the relative costs of a cap and trade program are largely driven by three factors, as we call them, the three T's: tonnage, time, and techniques or the level of the cap and its coverage, the rate of emissions reductions and the available flexibility and cost control mechanisms.

Thank you for inviting us to appear. We'll be pleased to address any questions you may have.

[The prepared statement of Mr. Yacobucci follows:]

PREPARED STATEMENT OF BRENT YACOBUCCI, CONGRESSIONAL RESEARCH SERVICE

My name is Brent Yacobucci, and I am joined by Larry Parker. On behalf of the Congressional Research Service (CRS), we would like to thank the Committee for its invitation to testify here today. I have been asked by the Committee to present a short introduction of cap-and-trade policy, including key concepts and terms, and relate those to S. 2191, the Lieberman-Warner Climate Security Act of 2008. Attached to my opening statement is a brief glossary of key terms presented in this discussion.

As suggested by its name, a cap-and-trade system imposes an emissions ceiling or cap on the total annual greenhouse gas emissions of entities covered by the system. The level of the cap is equal to the number of emissions permits or allowances distributed each year. The allowances are distributed to entities through an alloca-

tion scheme. At the end of the year, for each ton of carbon dioxide equivalent[1] emitted by a covered entity, that entity must submit one allowance to the agency regulating the program.[2] In general, a cap-and-trade system achieves emissions reductions by decreasing the number of allowances allocated in successive years. For the same cap, the wider the coverage, that is the more economic sectors (and entities within sectors) under the cap, the more stringent the program. Also, the steeper the annual reduction in allowances, the more stringent the program. S. 2191, as ordered reported by the Senate Committee on Environment and Public Works,[3] would establish a mandatory cap-and-trade system, reducing overall emissions by 66% from 2005 levels in 2050, according to the bill's sponsors. S. 2191 would limit emissions from all petroleum refiners and importers, natural gas processors, entities that produce or import fluorinated gases and other greenhouse gases, and facilities that use more than 5,000 tons of coal per year. Sponsors estimate that S. 2191 would cover 87% of the country's greenhouse gas emissions.

Allowances—each of which represents a limited authorization to emit one metric ton of carbon dioxide equivalent—may be used to comply with the cap, banked for use in a future year, or traded to someone else. This is the trade aspect of a cap-and-trade program. A key component of trading is the fact that some participants will have lower reduction costs than others. To the extent that two firms have different costs, it makes the most economic sense for the firm with higher reduction cost to pay the firm with lower costs to further reduce its emissions. An illustrative example of this concept is attached (Appendix).* In a national reduction program, these sorts of trades could occur among entities, sectors, and countries (within certain limitations).

A key element in designing a cap-and-trade system is the point at which emissions are regulated (point of regulation). That is, where are emissions measured, and thus, who must submit allowances to comply with the program. Greenhouse gases can be controlled downstream, at the point where they are emitted into the atmosphere, or they can be controlled upstream, requiring allowances from firms that produce or supply fuel and other products that will ultimately lead to emissions. A key advantage of downstream regulation is that the entity causing emissions has the responsibility for reductions. A key advantage of an upstream system is that it may simplify the regulatory process and help limit the number of covered entities.[4] S. 2191 achieves its broad coverage through an upstream regulation mandate on petroleum, natural gas, and fluorinated gas producers and importers, and a downstream mandate on coal consumers, such as electric generators.

The point of regulation should not be confused with how, and to whom, allowances are allocated. Allowances may be given at no cost to the covered entities. For example, that is how the sulfur dioxide cap-and-trade program of the Clean Air Act allocates allowances. In contrast, allowances could be given to anyone—for example, states—who may sell them to covered entities and use the proceeds for specified or unspecified purposes. Finally, allowances may be auctioned by the federal government and the proceeds used for various purposes related or unrelated to greenhouse gas reduction. For example, those funds could be used to lessen the economic burden of the program on affected workers, industries, and regions, to promote the development of new technology, or to adapt systems to a changing climate. Further, those revenues could be used for non-climate-related purposes such as deficit reduction or tax relief.

S. 2191 uses a mix of all of these options, allocating roughly 35% of allowances in 2012 to covered sectors, roughly 35% to unregulated or non-covered entities, and auctioning the rest. In successive years, the percentage of allowances given to covered entities decreases to zero, while the share of auctioned allowances increases. With respect to revenues, S. 2191 allocates a large share of auction revenue to keep the bill revenue-neutral, to speed deployment of new technology, to provide assistance to energy consumers, and to promote adaptation efforts.

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[1] In general, greenhouse gas reduction bills address emissions of all six greenhouse gases recognized under the United Nations Framework Convention on Climate Change: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), hydrofluorocarbons (HFC), and perfluorocarbons (PFC).

[2] The U.S. Environmental Protection Agency in most proposals.

[3] Available on Senator Lieberman's website: http://lieberman.senate.gov/documents/lwcsa.pdf.

* Figures have been retained in committee files.

[4] A useful example is the automotive sector. While the purpose of the cap-and-trade program would be to have motor vehicle owners make reductions by driving less or purchasing more efficient vehicles, it would be a massive regulatory undertaking to install emissions monitors on the millions of cars and trucks on U.S. roads, and to demand that every driver submit emissions allowances at the end of the year.

Within a cap-and-trade system, three flexibility mechanisms are key to determining the ultimate cost of the program:

- The first is banking. Banking is the ability to retain allowances either received or purchased for future use or sale. (It is a provision included in S. 2191.) This allows smoother transitions and can promote early reductions.
- The second flexibility mechanism is the availability of domestic offsets. Offsets are emissions reductions achieved by non-covered entities, such as the agricultural sector. These non-covered entities can sell offsets to covered entities, who may use them in lieu of an allowance, within certain limits. Effectively, offsets increase the supply of available allowances—under S. 2191, up to 15% of a covered entity's allowance requirement can be met through submission of domestic offsets.
- A third flexibility mechanism is the availability of international credits. International credits are emissions reductions achieved by other countries that may be used by covered entities to comply with a U.S. cap-and-trade program. Under S. 2191, up to 15% of a covered entity's allowance requirement can be met through submission of international allowances from eligible foreign cap-and-trade systems.

In addition to flexibility mechanisms, cap-and-trade approaches may contain other techniques to limit costs. These include a safety valve like that in S. 1766 which allows a covered entity to choose to comply with a cap-and-trade program by paying a safety valve fee instead of submitting allowances. However, this would allow emissions to exceed the cap. Another way to control costs is S. 2191's Carbon Market Efficiency Board, with authority to increase (within certain bounds) the pool of available allowances without increasing overall emissions.

To conclude, the relative costs of a cap-and-trade program are largely driven by three factors, as we call them, the "Three T's": tonnage, time, and techniques.

- Tonnage refers to the stringency of the cap, as well as the breadth of coverage. The more stringent the cap (that is, the fewer the tons allotted), the higher the cost.
- Time refers to the rate of decrease in allowances. The faster the cap decreases, the more expensive the program will be.
- Techniques refers to the flexibility and cost-control mechanisms used. Banking is arguably the most important mechanism to limit volatility in allowance markets. Other techniques that will decrease costs include the availability of domestic offsets and international credits—effectively increasing the supply of allowances.

Thank you for inviting us to appear. We will be pleased to address any questions you may have.

ATTACHMENT.—COMMON TERMS

Allowance.—A limited authorization by the government to emit 1 metric ton of carbon dioxide equivalent. Although used generically, an allowance is technically different from a credit. A credit represents a ton of pollutant that an entity has reduced in excess of its legal requirement. However, the terms tend to be used interchangeably, along with others, such as permits.

Auctions.—Auctions can be used in market-based pollution control schemes to allocate some, or all of the allowances. Auctions may be used to: 1) ensure the liquidity of the credit trading program; and/or 2) raise (potentially considerable) revenues for various related or unrelated purposes.

Banking.—The limited ability to save allowances for the future and shift the reduction requirement across time.

Cap-and-trade program.—An emissions reduction program with two key elements: 1) an absolute limit ("cap") on the emissions allowed by covered entities; and 2) the ability to buy and sell ("trade") those allowances among covered and non-covered entities.

Coverage.—Coverage is the breadth of economic sectors covered by a particular greenhouse gas reduction program, as well as the breadth of entities within sectors.

Emissions cap.—A mandated limit on how much pollutant (or greenhouse gases) an affected entity can release to the atmosphere. Caps can be either an absolute cap, where the amount is specified in terms of tons of emissions on an annual basis, or a rate-based cap, where the amount of emissions produced per unit of output (such as electricity) is specified but not the absolute amount released. Caps may be imposed on an entity, sector, or economy-wide basis.

Greenhouse gases.—The six gases recognized under the United Nations Framework Convention on Climate Change are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6) hydrofluorocarbons (HFC), and perfluorocarbons (PFC).

Offsets.—Emission credits achieved by activities not directly related to the emissions of an affected source. Examples of offsets would include forestry and agricultural activities that absorb carbon dioxide, and reductions achieved by entities that are not regulated by a greenhouse gas control program.

Revenue recycling.—How a program distributes revenues from auctions, penalties, and/or taxes. Revenue recycling can have a significant effect on the overall cost of the program to the economy.

Point of Regulation.—Regulatory approaches to limiting emissions can choose different points and participants along the production process to assign compliance responsibility. Upstream allocation schemes establish emission caps at a production, importation, or distribution point of products that will eventually produce greenhouse emissions further down the production process. In contrast, downstream allocation schemes establish emission caps and assign allowances at the point in the process where the emissions are emitted.

Sequestration.—Sequestration is the process of capturing carbon dioxide from emission streams or from the atmosphere and then storing it in such a way as to prevent its release to the atmosphere.

The CHAIRMAN. Thank you very much. I think that was a good summary of the complex issue we're trying to deal with here.

Dr. Parker, why don't you go right ahead?

STATEMENT OF LARRY PARKER, CONGRESSIONAL RESEARCH SERVICE

Mr. PARKER. My name is Larry Parker. On behalf of the Congressional Research Service, Brent Yacobucci and I would like to thank the committee for the invitation to testify here today. S. 2191 would establish a cap and trade program to reduce U.S. greenhouse gas emissions through the year 2050. While CRS takes no position on the bill, CRS has just completed a review and synthesis of six studies that attempt to project the cost of S. 2191 to the year 2030 or 2050.

It is difficult and some would consider it unwise to project cost up to the year 2030 much less beyond. The already tenuous assumption that current regulatory standards would remain constant becomes more unrealistic. Other unforeseen events loom as critical issues which cannot be modeled.

Hence long term cost projections are at best speculative and should be viewed with a tint of skepticism. In the words of the late Dr. Lincoln Moses, the first Administrator of the Energy Information Administration, there are no facts about the future." Models cannot predict the future, but they can indicate the sensitivity of a program's provisions to varying economic, technological and behavioral assumptions that may assist policymakers in designing a greenhouse gas reduction strategy.

The various cases CRS examined do provide some informative insights on the cost and benefits of S. 2191 and its many provisions. We have summarized these insights into seven points.

First, if enacted the ultimate cost of S. 2191 would be determined by the response of the economy to the technological challenges presented by the bill. The bill provides numerous research and development, deployment, regulatory and price incentives for technology and evasion to reduce greenhouse gas emissions. The potential for new technology to reduce the cost of S. 2191 is not fully analyzed by any of the cases examined nor can it be.

The process of technology development and dissemination is not sufficiently understood at the current time for models to replicate it with any long term confidence. In the same vein, it is difficult to determine whether the various incentives provided under S. 2191 are directed in the most optimum manner.

Second, a considerable amount of low carbon, electric generating capacity would have to be built under S. 2191 in order to meet the reduction requirements. The cases presented here do not agree on the amount of new generating capacity necessary under S. 2191 or the mix of fuels and technologies that would be employed. The estimated amount of capacity constructed depends on the cases assumptions about the need for new capacity and the replacement or retirement of existing capacity under S. 2191 along with consumer demand response to the rising prices and incentives contained in the bill.

Third, the cases suggest that the carbon capture and storage bonus allowance allocation provided under S. 2191 would be effective in encouraging deployment of carbon capture and storage technology accelerating development by 5 to 10 years. However, the cases disagree on whether or not the bonus amount provided by the bill is sufficient or needs to be extended additional years.

Fourth, the cases generally indicate that domestic carbon offsets and international carbon credits could be valuable tools for entities covered under S. 2191. Not only to potentially reduce cost, but combined with the bill's provisions permitting the banking of allowances to provide companies more time to develop long term investment and strategic plans and to pursue new technologies. Cost could be lowered further by allowing greater availability to domestic offsets and international credits and with a broader definition of eligible international credits. A more direct path for permitting the use of international credits would also reduce one of the more important cost uncertainties revealed by the cases varying interpretations of S. 2191's international credit eligibility requirements and their projected price.

Fifth, the proposed Carbon Market Efficiency Board could have an important effect on the cost of the program through its powers to increase the availability of domestic offsets and international credits. However, the board is primarily designed to deal with short term volatilities due to episodic events in the allowance market and has only short term powers. Whether it could coordinate a longer terms strategy, if necessary, with its proposed authority is not known.

Sixth, the proposed low carbon fuel standard could greatly—could significantly raise fuel prices and limit supply. The effects would depend on what fuels are included in it, the level of emission reductions achieved by alternatives and the ability of suppliers to reduce those alternatives. If plug-in hybrid vehicles or large amounts of cellulosic biofuel are available early, or if certain fuels such as aviation fuel are excluded from the mandate the cost would be lower.

Seventh, S. 2191's potential climate related and environmental benefit is best considered in a global context and the desire to engage the developing world in the reduction effort. It is in this context that the United States and other developed country agree both

to reduce their own emissions to help stabilize atmospheric concentrations of greenhouse gases and to take the lead in reducing greenhouse gases when they ratify the 1992 framework convention on climate change.

The global scope raises two issues for S. 2191. Whether the bill's greenhouse gas reduction program and other provisions to be considered sufficiently credible by developing countries so that schemes for including them in future international agreements becomes more likely and two, whether the bill's reductions meet U.S. commitments to stabilization under the framework convention and occur in a timely fashion so that global stabilization may occur at an acceptable level.

I thank the chairman. We would be happy to answer any questions the committee may have.

[The prepared statement of Mr. Parker follows:]

PREPARED STATEMENT OF LARRY PARKER, CONGRESSIONAL RESEARCH SERVICE

My name is Larry Parker. On behalf of the Congressional Research Service (CRS), Brent Yacobucci and I would like to thank the Committee for its invitation to testify here today. S. 2191 would establish a cap-and-trade program to reduce U.S. greenhouse gas emissions through the year 2050.[1] While CRS takes no position on the bill, CRS has just completed a review and synthesis of six studies that attempt to project the costs of S. 2191 to the year 2030 or 2050. It is difficult (and some would consider it unwise) to project costs up to the year 2030, much less beyond. The already tenuous assumption that current regulatory standards will remain constant becomes more unrealistic, and other unforeseen events (such as technological breakthroughs) loom as critical issues which cannot be modeled. Hence, long-term cost projections are at best speculative, and should be viewed with attentive skepticism. In the words of the late Dr. Lincoln Moses, the first Administrator of the Energy Information Administration: "There are no facts about the future."[2]

Models cannot predict the future, but they can indicate the sensitivity of a program's provisions to varying economic, technological, and behavioral assumptions that may assist policymakers in designing a greenhouse gas reduction strategy. The various cases CRS examined do provide some important insights on the costs and benefits of S. 2191 and its many provisions. We have summarized these insights into seven points:

First, if enacted, the ultimate cost of S. 2191 would be determined by the response of the economy to the technological challenges presented by the bill. The bill provides numerous research and development, deployment, regulatory, and price incentives for technology innovation to reduce greenhouse gas emissions. The potential for new technology to reduce the costs of S. 2191 is not fully analyzed by any of the cases examined, nor can it be. The process of technology development and dissemination is not sufficiently understood at the current time for models to replicate it with any long-term confidence. In the same vein, it is difficult to determine whether the various incentives provided by S. 2191 are directed in the most optimal manner.

Second, a considerable amount of low-carbon electric generating capacity would have to be built under S. 2191 in order to meet the reduction requirement. The cases presented here do not agree on the amount of new generating capacity necessary under S. 2191 or the mix of fuels and technologies that would be employed. The estimated amount of capacity constructed depends on the cases' assumptions about the need for new capacity, and replacement/retirement of existing capacity under S. 2191, along with consumer demand response to the rising prices and incentives contained in the bill.

Third, the cases suggest that the carbon capture and storage bonus allowance allocation provided under S. 2191 would be effective in encouraging deployment of carbon capture and storage technology, accelerating development by 5-10

[1] CRS Report RL34489, Climate Change: Costs and Benefits of S. 2191, by Larry Parker and Brent Yacobucci. (*Note: CRS report has been retained in committee files.)*

[2] Lincoln E. Moses, Administrator, Energy Information Administration, Annual Report to Congress: 1977, Volume II (1978).

years. However, the cases disagree on whether the bonus amount provided by S. 2191 is sufficient, or needs to be extended additional years.

Fourth, the cases generally indicate that domestic carbon offsets and international carbon credits could be valuable tools for entities covered by S. 2191 not only to potentially reduce costs, but combined with the bill's provisions permitting the banking of allowances, to provide companies more time to develop long-term investment and strategic plans, and to pursue new technologies. Cost could be lowered further by allowing greater availability of domestic offsets and international credits and with a broader definition of eligible international credits. A more direct path for permitting use of international credits would also reduce one of the more important cost uncertainties revealed by the cases' varying interpretations of S. 2191's international credit eligibility requirements and their projected price.

Fifth, the proposed Carbon Market Efficiency Board could have an important effect on the cost of the program through its power to increase the availability of domestic offsets and international credits. The cases generally do not consider the Board in their analyses but, one can infer from the results that the most important power that the Board may have is the ability to increase the availability of domestic offsets and international credits (although the Board would not have the authority to change the eligibility requirements for domestic offsets or international credits). In this sense, the Board's powers could mesh with the previous insight about the importance of offsets and banking to the cost-effectiveness of S. 2191. However, the Board is primarily designed to deal with short-term volatility due to episodic events in the allowance market and has only short-term powers. Whether it could coordinate a longer term strategy, if necessary, with its proposed authority is not known.

Sixth, the proposed Low Carbon Fuel Standard could significantly raise fuel prices and limit supply. The effects would depend on what fuels are included in the LCFS, the level of emissions reductions achieved by alternatives, and the ability of suppliers to produce those alternatives. If plug-in hybrid vehicles or large amounts of cellulosic biofuel are available early, or if certain fuels such as aviation fuel are excluded from the mandate, the costs could be lower.

Seventh, S. 2191's potential climate-related environmental benefit is best considered in a global context and the desire to engage the developing world in the reduction effort. It is in this context that the United States and other developed countries agreed both to reduce their own emissions to help stabilize atmospheric concentrations of greenhouse gases and to take the lead in reducing greenhouse gases when they ratified the 1992 United Nations Framework Convention on Climate Change (UNFCCC). This global scope raises two issues for S. 2191: (1) whether S. 2191's greenhouse gas reduction program and other provisions would be considered sufficiently credible by developing countries so that schemes for including them in future international agreements become more likely, and (2) whether S. 2191's reductions meet U.S. commitments to stabilization under the UNFCCC and occur in a timely fashion so that global stabilization may occur at an acceptable level.

Thank you. We will be glad to answer any questions you may have.

The CHAIRMAN. Thank you very much.
Dr. Gruenspecht, go right ahead.

STATEMENT OF HOWARD GRUENSPECHT, DEPUTY ADMINISTRATOR, ENERGY INFORMATION ADMINISTRATION

Mr. GRUENSPECHT. Mr. Chairman and members of the committee, I appreciate the opportunity to appear before you today to discuss the energy and economic effects of global climate change legislation. EIA is the independent statistical and analytical agency in the Department of Energy. We do not promote, formulate or take positions on policy issues. Our views should not be construed as representing those of the Department or the Administration. Since you already have our written testimony and our recent analysis* that addresses both the reported Lieberman-Warner bill and an updated analysis of S. 1766, the Low Carbon Economy Act of 2007 in-

*Document has been retained in committee files.

troduced by you, Senator Specter and others, my remarks will focus on some key findings and insights.

First, the projected impacts of the Lieberman-Warner proposal on energy prices, energy use and the economy are highly sensitive to assumptions about the cost and availability of no- and low-carbon technologies for power generation and international offsets. Our report on S. 2191 includes five alternative cases that reflect a variety of different assumptions regarding these factors, with the Core case on the one hand and the Limited Alternatives/No International Offsets Case on the other representing, respectively, the most favorable and least favorable situations for ease of compliance with the Lieberman-Warner targets.

Allowance prices and economic impacts through 2030—EIA is not brave enough to go to 2050—are roughly three times larger using the least favorable assumptions than using the most favorable ones. As discussed in our report, both technical barriers and public acceptance barriers to key no- and low-emissions technologies can be influenced by policy design choices.

Second, energy and economic impacts are sensitive to whether the recent steep rise in the cost of major energy infrastructure projects reflects a temporary bubble or a permanent shift. Compliance with very stringent emission targets is expected to result in the need to replace all or the vast majority of the existing fleet of coal-fired power plants. With a large increase in capacity additions needed to replace those units and also meet rising demand, higher costs could result in increased energy and economic impacts.

The baseline, including expectations for future energy prices as noted in Senator Domenici's opening statement, is a third key assumption for analysis. Policy design is another extremely important factor affecting price uncertainty. For example, the technology accelerator payment provision in S. 1766 greatly reduces uncertainty in the cost and energy price impacts of global climate legislation, while adding to uncertainty regarding the amount of emissions reduction in any given year.

Let me now turn briefly to the specific results of our analysis. Figure 1 in my written testimony shows that allowance prices vary widely under the cap and trade program, the Lieberman-Warner version, depending on assumptions regarding the availability and cost of the key electricity technologies and international offsets.

As shown in the top-left-hand panel of figure 2 of my written testimony, the effect of the program on the cost of using coal is particularly significant, with delivered costs between four and eight times higher under the Lieberman-Warner bill than in the reference case. This reflects both the low baseline price of coal relative to other fossil fuels and its relatively high carbon content per unit of energy. The delivered price of natural gas, shown in the lower-left-hand panel of figure 2, is also significantly affected, increasing by between 34 and 107 percent above the reference case projection by 2030. The price of motor gasoline is affected to a lesser extent.

As shown in figure 3 of the written testimony, national average electricity prices in 2030 are 11 percent to 64 percent higher. Electricity price impacts vary by region. Your invitation letter had asked about regional effects. In general, larger price impacts occur

in those regions that are most reliant on coal and have competitive wholesale power markets.

Turning next to energy system impacts as shown in figure 4, electricity-related reductions account for roughly 80 to 90 percent of overall reductions in energy-related emissions. There are several reasons for this result. Over 90 percent of coal, the fuel whose price is most heavily impacted by allowance costs, is used in the electricity sector.

Second, while coal-fired generation is a major source of current and projected reference-case emissions, there are several alternative, no- and low-emissions technologies already demonstrated—wind and nuclear, for example—and others being developed.

Third, changes in electricity generation fuels don't require large changes in distribution infrastructure or electricity—using equipment. Thus, the chicken and egg issues that bedevil major fuel transformations and other areas do not arise.

Finally, recent experience with very high motor fuel prices in other countries over an extended period suggest that major shifts in transportation energy use are not likely to be induced by the impact of the Lieberman-Warner bill on the price of petroleum fuels.

I've already noted the impact on the need for new electric capacity additions—over 2007 to 2030, projected electricity generation additions, other than natural gas, range from 353 to 484 gigawatts across the five Lieberman-Warner cases as compared to 168 gigawatts in the reference case. By comparison, generation capacity additions other than natural gas have totaled only 55 gigawatts since 1990. We haven't been adding a lot of base load recently. Frankly, we haven't needed it. We had a lot of coal, a lot of nuclear. We've raised the utilization rates of those units over the past 18 years. But we're running toward the end of that string.

Finally, turning to economic impacts, the left-hand panels of figure 6 compare the reductions in GDP and consumption, 2009 through 2030, across the cases. In the Core case, those accumulative discounted reductions are $444 billion and $558 billion, respectively. They're roughly three times higher in the least optimistic Limited Alternatives/No International Offsets Case. Manufacturing impacts, which are not illustrated in the figure, are significantly higher than GDP impacts and these costs can be framed in many different ways.

Mr. Chairman and members of the committee, that concludes my oral testimony. I'd be happy to answer any questions you might have.

[The prepared statement of Mr. Gruenspecht follows:]

PREPARED STATEMENT OF HOWARD GRUENSPECHT, DEPUTY ADMINISTRATOR, ENERGY INFORMATION ADMINISTRATION

Mr. Chairman, and members of the Committee, I appreciate the opportunity to appear before you today to discuss the Energy Information Administration's (EIA) recent analysis of the energy and economic impacts of global climate change legislation.

EIA is the independent statistical and analytical agency within the Department of Energy. We are charged with providing objective, timely, and relevant data, analyses, and projections for the use of the Congress, the Administration, and the public. Although we do not take positions on policy issues, we do produce data and analyses to help inform energy policy deliberations. Because we have an element of statutory independence with respect to this work, our views are strictly those of EIA and

should not be construed as representing those of the Department of Energy, the Administration, or any other organization. My testimony focuses on EIA's recent analysis of the Lieberman-Warner Climate Security Act of 2007 (S. 2191), which also includes an updated analysis of the Bingaman-Specter Low Carbon Economy Act of 2007 (S. 1766).

The choice of a baseline is one of the most influential assumptions for any analysis of global climate change legislation. Our analysis uses the reference case of the *Annual Energy Outlook 2008 (AE02008)* as its starting point. *AE02008* is based on Federal and State laws and regulations in effect as of the end of 2007, including the Energy Independence and Security Act of 2007, which became law last December. It does not, however, include State-level greenhouse gas limitation initiatives that are in various stages of development in several regions of the country. The projections included in *AE02008* and our analysis, which both extend through 2030, are not meant to be exact predictions of the future but represent plausible energy futures given technological and demographic trends, current laws and regulations, and consumer behavior as derived from available data. EIA recognizes that projections of energy markets over a nearly 25-year period are highly uncertain and subject to many events that cannot be foreseen, such as supply disruptions, policy changes, and technological breakthroughs. In addition to these phenomena, long-term trends in technology development, demographics, economic growth, and energy resources may evolve along a different path than expected in the projections. Generally, differences between cases, which are the focus of our report, are likely to be more robust than the specific projections for any one case.

The Lieberman-Warner bill imposes limits on emissions of energy-related carbon dioxide and other greenhouse gases with a cap-and-trade system that regulates suppliers of oil products and natural gas, owners of plants that burn coal, and suppliers of some industrial gases other than carbon dioxide. EIA's complete report, which includes a full description of the bill, our modeling approach, and our results, as well as a discussion of uncertainties and caveats, has been provided to the Committee and is publicly available on our web site (www.eia.doe.gov).

The projected impacts on energy prices, energy use, and economic activity that are presented in the report and summarized briefly in my testimony suggest several key findings and additional insights. It is important to note that the estimated impacts of the Lieberman-Warner proposal on energy prices, energy use, and the economy are highly sensitive to assumptions about the cost and availability of no- and low-carbon technologies for power generation and international offsets. EIA's report includes five cases that reflect a variety of different assumptions regarding these factors, with the Core Case and Limited Alternatives/No International Offsets Case representing, respectively, the most favorable and least favorable situations for ease of compliance with the Lieberman-Warner targets. We find that allowance prices and economic impacts through 2030 are roughly three times larger using the least favorable assumptions than using the most favorable ones.

It is well-known that key technologies for reducing emissions, such as nuclear power and coal with carbon capture and sequestration (CCS), face a variety of technical challenges and, in some cases, additional questions regarding public acceptance of their widespread deployment arising from concerns unrelated to global climate change. As noted in EIA's report, both technical and public acceptance barriers to key low- and no-emissions technologies can be directly influenced by policy design choices. For example, both the Lieberman-Warner and Bingaman-Specter bills include incentives for early technology deployment. The "technology accelerator" payment in the Bingaman-Specter bill, which implicitly relaxes emissions targets in the event that a predetermined compliance cost threshold is exceeded, can help to promote public acceptance of key technologies by stakeholders who view greenhouse gas emissions limitation as the highest priority, but might be inclined to block deployment of these technologies due to non-climate concerns in the absence of such a mechanism.

Our results also suggest that energy and economic impacts are sensitive to whether the recent steep rise in the cost of major energy infrastructure projects reflects a temporary "bubble" or a permanent shift. EIA's analysis generally reflects only a portion of recent infrastructure project cost increases as a permanent shift, with a much larger permanent component assumed in the High Cost Case. Compliance with the Lieberman-Warner emissions targets is expected to result in the rapid retirement of the existing fleet of coal-fired power plants. With a large increase in capacity additions needed to replace these units and also meet rising demand under any of the technology cases, higher costs translate directly into increased energy and economic impacts.

Your invitation letter, Mr. Chairman, asked about the main factors contributing to price uncertainty in analyses. In addition to uncertainty regarding the cost and

availability of key no- and low-carbon technologies and international offsets, future energy prices also play an important role in determining the cost and energy price impacts of meeting a fixed emissions target. Policy design is another important factor. For example, the technology accelerator payment provision in the Low Carbon Energy Act of 2007 greatly reduces uncertainty in the cost and energy price impacts of global climate legislation, while adding to uncertainty regarding the amount of emissions reduction achieved in any given year.

Let me now turn briefly to the specific results of EIA's recent analysis.

ALLOWANCE AND ENERGY PRICE IMPACTS

Figure 1* shows that allowance prices, which are the key driver of energy price impacts, vary widely under the Lieberman-Warner cap-and-trade program, depending on assumptions regarding the availability and cost of electricity technologies such as nuclear and coal with CCS, as well as the availability of international offsets.

As shown in the top left-hand panel of Figure 2, the effect of the program on the cost of using coal is particularly significant; by 2030, it is between 4 and 8 times higher under Lieberman-Warner than in the reference case. This reflects both the low baseline price of coal on an energy content basis relative to other fossil fuels and its relatively high carbon content per unit of energy. The delivered price of natural gas, shown on the lower left-hand panel of Figure 2, is also significantly affected, increasing by between 34 and 107 percent above the reference case projection by 2030. In cases where the demand for natural gas is increased as a result of the policy proposed in S. 2191, delivered and wellhead prices both move in the same upward direction. As shown in the top right-hand panel, the price of motor gasoline is also affected, but to a much lesser extent than coal or natural gas prices. In fact, the gasoline price changes anticipated to result from this program through 2030 are smaller than the changes experienced over the past several years.

Electricity is generated using a mix of fuels. Currently, about 50 percent of the Nation's electricity is generated using coal, and coal would be a highly competitive source of additional generation to meet demand growth absent any limits on carbon dioxide emissions. The impact of allowance prices on the cost of using fossil fuels to generate power is reflected in higher electricity prices, but the impact is cushioned by changes in the projected electric generation mix that occur in response to S.2191. As shown in Figure 3, national average electricity prices in 2030 are between 1.0 cents to 5.7 cents per kilowatt-hour (11 percent to 64 percent) higher, relative to the reference case. Electricity price impacts vary by region. In general, larger price impacts occur in those regions that are most reliant on coal and have competitive wholesale power markets.

ENERGY SYSTEM IMPACTS

As shown in Figure 4, between 82 percent and 91 percent of reductions in energy-related carbon dioxide emissions in 2030 are achieved through the electricity-related reductions, requiring a rapid expansion of low- and no-carbon generation. There are several reasons for this. First, over 90 percent of coal, the fuel whose price is most heavily impacted by allowance costs, is used in the electricity sector. Second. while coal-fired generation is a major source of current and projected reference case emissions, there are several alternative no- and low-emission technologies already demonstrated, and others are being developed. Third, changes in electricity generation fuels do not require large changes in distribution infrastructure or electricity-using equipment. Thus, the "chicken-and-egg" issues that bedevil major fuel transformations in the transportation sector, where the absence of a robust fuel supply infrastructure—that is precluded by the lack of a sufficient number of dedicated alternative-fueled vehicles to be served—in turn discourages the sale of such vehicles, do not arise. Finally, recent U.S. experience and very high fuel prices over an extended period in Europe and other world regions show that major shifts in transportation energy use are not likely to be induced by the impact of the Lieberman-Warner cap-and-trade program on the price of petroleum fuels.

In addition to changing the projected mix of electricity generation sources, as shown in Figure 5, the Lieberman-Warner program significantly increases the total amount of new electric capacity that must be added between now and 2030. The requirement for capacity additions, which poses significant challenges to siting both generation and transmission facilities, reflects the retirement of many existing coal-fired power plants that would be expected to continue operating beyond 2030 absent the limitations on greenhouse gas emissions required by the Lieberman-Warner bill.

*Figures 1–6 have been retained in committee files.

Over the 2007-to-2030 period, projected electricity generating capacity additions other than natural gas range from 353 to 484 gigawatts (GW) across the five Lieberman-Warner policy cases, as compared to 168 GW in the *AE02008* reference case. By way of comparison, generating capacity additions other than natural gas have totaled only 55 GW since 1990.

ECONOMIC IMPACTS

The left-hand panels of Figure 6 compare the cumulative reductions in gross domestic product (GDP) and consumption over the 2009-through-2030 period across cases. In the Core Case, which has the most optimistic assumptions regarding technology cost and availability and international offsets, the cumulative discounted reductions in GDP and consumption were $444 billion and $558 billion, respectively. In the Limited Alternative/No International Offsets Case, cumulative discounted losses in GDP and consumption are substantially higher, $1.31 trillion and $1.42 trillion, respectively. The reduction in GDP from reference-case levels is between 0.3 percent and 0.9 percent in 2020 and between 0.3 percent and 0.8 percent in 2030. The reduction in real consumption is between 0.4 percent and 1.2 percent in 2020 and between 0.5 percent and 1.1 percent in 2030. Manufacturing impacts, which are not illustrated in the figure, are significantly higher than GDP impacts. Total manufacturing output is 1.5 percent to 5.4 percent lower than in the reference case in 2020 and 3.0 percent to 9.5 percent lower in 2030.

While the greenhouse gas issue is a problem of unprecedented scale in terms of its implications for our energy system, the scale of the economy itself is huge. Therefore, the same estimated economic impacts from any given analysis can be "framed" to sound either large or small. Figure 6, which in its right hand panels presents the same results discussed above in terms of the absolute levels of GDP and consumption in 2020 and 2030, shows how framing matters. At EIA, we strive to present our results as neutrally as possible and leave the framing to others.

Mr. Chairman and members of the Committee, this concludes my testimony. I would he happy to answer any questions you may have.

The CHAIRMAN. Thank you very much.

Dr. McLean, thank you for being here.

STATEMENT OF BRIAN J. MCLEAN, ENVIRONMENTAL PROTECTION AGENCY

Mr. MCLEAN. Thank you, Mr. Chairman and members of the committee. I appreciate the opportunity to testify today before you on the effects of recent climate change legislation. I am Brian McLean, Director of the Office of Atmospheric Programs within EPA's Office of Air and Radiation. With me today is Francisco de la Chesnaye, our chief climate economist to assist me in answering your questions.

To date EPA has analyzed three bills for Congress. S. 280 introduced by Senators Lieberman and McCain. S. 1766 introduced by Senators Bingaman and Specter and S. 2191, introduced by Senators Lieberman and Warner.

In analyzing each bill EPA developed a set of scenarios in consultation with the Senate staff to evaluate the various provisions and to gauge the importance of key assumptions in climate mitigation technologies. The scenarios do not represent an EPA assessment of which scenarios are more likely to occur or any formal position of the EPA or the Administration. EPA's analyses covered all greenhouse gases and key economic sectors, both domestically and internationally and go out to 2050.

To provide a complete picture of possible impacts EPA employed two economy wide models that take slightly different approaches to estimating technological development and macro economic effects as well as a detailed electricity sector model given the significance of the emission reductions from that sector. There is significant un-

certainty about the future course of economic growth and technological advances as has been mentioned several times by people. Our analyses contain several sensitivity analyses, however, that help show the impacts that key assumptions have on future projections.

All of our analyses use the same EIA 2006 reference case for easy comparison and do not reflect the new Energy Independence and Security Act or the most recent EIA Annual Energy Outlook. Both of which tend to lower the estimated costs of these bills. We analyzed an alternative reference scenario with lower referenced emissions as an approximation of the most recent projections.

In my written testimony I respond to each of the eight questions posed in your invitation. This morning I will summarize our major observations.

The overall economy will grow under all the bills. In EPA's alternative reference scenario the size of the U.S. economy is projected to increase an average of 80 percent from 2010 to 2030. Under Lieberman-Warner, the most stringent of the three bills, the economy is estimated to be an average of 2 percent smaller than in the alternative reference scenario in 2030.

We did not calculate the benefits of greenhouse gas reductions. But S. 2191 is expected to have the ancillary benefit of reducing sulfur dioxide and nitrogen oxides from electric generation below current requirements. This will facilitate the achievement of the fine particle and ozone air quality standards.

All of our analyses point out the importance of technology, of offsets and of international action. They illustrate the value of a portfolio of technologies and confirm that there is no silver bullet.

The absence of a single technology such as carbon capture and storage or new nuclear capacity results in some cost increases but the absence of many technologies would significantly increase cost. Most models including ours, do not try to forecast major advances in technology over what we are aware of today. Such advances are likely to reduce costs since market economies not only drive innovation, but generally adopt lower cost solutions over higher cost ones.

The overall price signal plus specific incentives in the bills push deployment of technology earlier. Incentives for carbon capture and storage in particular, help maintain the use of coal as a major source of energy for the next several decades. The offset provisions can also be very important for cost containment.

Although cost can be reduced significantly with larger offset programs, it will be important to ensure environmental integrity and consider implementation issues to ensure that offsets do not lessen the greenhouse gas reductions achieved through the caps. Though significant, legislative action by any country including the U.S. would not be able to reduce greenhouse gas concentrations in the atmosphere enough to fully address the climate challenge. Global participation is clearly needed.

Our analysis shows that if all countries take action we could make significant progress in addressing climate change without risk of emissions leakage because U.S. industry is an effective global competitor. If on the other hand, additional actions are not taken

by other countries, emissions leakage would lessen the impact of our actions by about 11 percent.

In closing we believe that EPA has provided valuable technical input to the U.S. climate policy debate. We look forward to working with you as this process continues. Thank you, Mr. Chairman.

[The prepared statement of Mr. McLean follows:]

PREPARED STATEMENT OF BRIAN J. MCLEAN, DIRECTOR, OFFICE OF ATMOSPHERIC PROGRAMS, OFFICE OF AIR AND RADIATION, ENVIRONMENTAL PROTECTION AGENCY

Mr. Chairman and Members of the Committee, I appreciate the opportunity to come before you today to testify on the energy and economic effects of global climate change legislation as analyzed by EPA. To date, EPA has analyzed the following three bills for this Congress: S. 280, the "Climate Stewardship and Innovation Act" introduced by Senators McCain and Lieberman; S. 1766, the "Low Carbon Economy Act of 2007," introduced by Senators Bingaman and Specter; and S. 2191, the "Lieberman-Warner Climate Security Act of 2007," introduced by Senators Lieberman and Warner. I note that for this last bill, the analysis was based on the bill reported out by the Senate Environment and Public Works Committee this past December; the first two bills were modeled as introduced.

In all three bill analyses, EPA developed a set of scenarios in consultation with Senate staff to evaluate various provisions in the bills as well as gauge the importance of key enabling climate mitigation technologies. EPA's scenarios describe a wide range of possibilities but do not represent an EPA assessment of which scenarios are more likely to occur. The analyses do not attempt to estimate the benefits of reducing greenhouse gas emissions (GHGs) nor do they represent any formal position or opinion of the EPA or the Administration.

EPA's analyses covered all GHGs and key economic sectors, both domestically and internationally, and go out to 2050. For the broader impacts on the U.S. economy, EPA employed two economy-wide models to estimate a range of economic impacts and GHG reductions. Combined, these two models provide a more complete picture of possible impacts than can be provided from any single model. These models take different approaches to estimating technological development and macroeconomic effects. Since the electricity sector plays a key role in GHG mitigation, and the near-term response in the electricity sector is of particular interest, EPA also used a detailed electricity sector model to shed further light on the near-term impact of the bills and complement the broader picture presented by the economy-wide models.

It is worth noting that in projecting significant policies such as global climate change legislation, there is significant amount of uncertainty about what that future will look like (e.g. uncertainty with regards to economic growth and technological advances). Our analysis contains a number of sensitivity analyses that help show the impact that key assumptions have on future projections. This uncertainty increases the further into the future one is making projections. It is also worth noting that EPA did not separately assess or judge the "workability" of the legislation from an implementation standpoint. For example, the Agency did not assess whether various provisions would be able to be implemented or enforced.

The following responses to the questions posed by the Committee in its letter of invitation to this hearing are based on EPA's analyses of the bills indicated above.

Question 1. What do the analyses show about impacts of global climate legislation on GDP and the overall economy?

Answer. The economic impacts of the bills EPA analyzed depended on the level of greenhouse gas reductions sought and percentage of U.S. GHG emissions that are from sources that are covered and would thus be required to hold allowances under the cap. The following estimates are from the main bill scenarios in EPA's analyses of the three bills that incorporate the assumptions agreed upon with Senate staff. All of these scenarios assume that there is a widely available portfolio of enabling mitigation technologies. However, it does not assume major breakthroughs in technology over the next 40 years. Additionally, the analyses assume that there are no significant regulatory or litigation obstacles to the infrastructure needed to support a massive scale-up of low carbon energy, such as new interstate transmission lines, new pipelines and liability concerns surrounding CCS, access to natural gas (domestic production or new LNG terminals), and adequate long term storage for spent nuclear fuel. In EPA's Reference Scenario, the size of the U.S. economy is projected to increase an average of 97% from 2007 ($13.4 trillion) to 2030 ($26.3 trillion) and by an average 215% by 2050 ($42 trillion).

- For the Lieberman-McCain bill which would cover about 73% of U.S. GHG emissions (based on the 2005 GHG inventory), GHG emissions in 2030 were projected to be approximately 25% below what they are projected to be in the reference scenario without a climate policy in 2030. The estimated reduction in GDP is between 0.6% and 1.6% (between $146 and $419 billion) in that same year. GHG emissions in 2050 were projected to be approximately 44% below what they are projected to be in the reference scenario without a climate policy in 2050. The estimated reduction in GDP is between 1.1% and 3.2% (between $457 and $1,332 billion) in that same year.
- For the Bingaman-Specter bill which would cover about 83% of U.S. GHG emissions, GHGs also were projected to be approximately 23% below reference emissions in 2030. The estimated reduction in GDP was slightly lower estimated at between 0.5% and 1.4% (between $124 and $370 billion) in 2030. GHG emissions in 2050 were projected to be approximately 40% below what they are projected to be in the reference scenario without a climate policy in 2050. The estimated reduction in GDP is between 0.9% and 2.9% (between $401 and $1,199 billion) in that same year. The small difference in GDP impacts between the two bills was due to the broader coverage in the Bingaman-Specter bill and the slightly higher allowance prices under the Lieberman-McCain bill.
- For the more recent Lieberman-Warner bill which would cover about 87% of U.S. GHG emissions, GHGs were projected to be approximately 40% below reference emissions in 2030 with an estimated impact on GDP of between 0.9% and 3.8% (between $238 and $983 billion) in 2030. GHG emissions in 2050 were projected to be approximately 56% below what they are projected to be in the reference scenario without a climate policy in 2050. The estimated reduction in GDP is between 2.4% and 6.9% (between $1,012 and $2,856 billion) in that same year. The coverage of GHGs is slightly more than the Bingaman-Specter bill, and the level of GHG reductions is greater than the other two bills.

Please see Figures 1 and 2* from our Lieberman-Warner analysis for a comparison of the bills projected GHG emission reductions.

Question 2. How does the impact on energy prices vary from region to region under these analyses?

Answer. Our detailed power sector analysis provides insight into regional electricity price changes. Retail electricity price impacts vary by region, depending on a host of factors. The most important factors determining electricity price impacts are the types of existing power generating technologies and the electricity market structure for each region. Generally, the Central and Midwestern portions of the country, which are more dependent upon coal-fired generation for electricity production, will see higher price impacts than the Western and Northeastern portions of the country, which rely less on coal. In the South, prices increase somewhat less than in the Midwest even though the South is reliant on coal-fired generation. This is largely due to the fact that much of the South is a regulated market, and the value of allowances allocated directly to utilities at no cost must be passed along to customers, which will dampen price increases.

Question 3. Why do the analyses contain such a broad range of projected economic impacts?

Answer. The response to question #1 explains some of the key differences in the results of EPA's analyses. When considering the range of results from various analyses of a given bill, there are a number of factors that lead to such a broad range of estimated economic impacts.

- The projected reference case economic growth rate will affect both the level of GDP and projected levels of U.S. GHG emissions. In general, a higher projected level of reference GHG emissions will make it more costly to meet GHG reduction targets. This is highlighted in EPA's analysis using an alternative reference scenario which is more consistent with recent projections of GHGs related to lower projected economic growth and also emission reductions attributed to the Energy Independence and Security Act of 2007 (EISA). For example, in the Lieberman-Warner bill the estimated reduction in GDP would be smaller, estimated at between 0.6% and 3.6% in 2030 ($158 and $947 billion). Allowance prices also would be 15% lower on average ($60/t$CO_2$ vs. $72/t$CO_2$).
- Assumptions about the development and deployment of key enabling technologies such as nuclear power, advanced coal-fired power with carbon capture and storage, and more efficient renewable power have a significant effect on projected economic impacts. The greater the extent of the development and de-

*Figures have been retained in committee files.

ployment of key enabling technologies, the lower the costs of achieving GHG emission reductions. (To the extent the development and deployment of key enabling technologies do not occur in the timeframe assumed by the analysis, the costs of achieving GHG emissions reductions will undergo a corresponding increase.)

- The use and amount of allowable offsets, that is, reductions made outside of the covered sectors as specified in the bills, will influence the estimated economic impacts. In general, greater use of offsets, both domestic and international, can reduce costs, while providing commensurate environmental benefits. However, the costs and benefits need to be considered in the context of issues related to the implementation of an offset program. The models assumed that an offsets program could be managed efficiently and generate additional reductions in emissions and increases in carbon sequestration with no discounting and minimal transaction costs. If offsets are not truly additional they will lessen the expected reductions in GHGs achieved through a cap. If international offsets are fully utilized, the total payments for international credits are approximately $12 billion in 2030 and $22 billion in 2050.

Question 4. What are the 5 most influential assumptions made in these analyses?
Answer. Five of the more influential assumptions in our analyses were:

- On modeling: In all the policy scenarios, we assume that there is a well functioning market for the trading of emission allowances, that once technologies are commercially available they are deployed, and that the agents in the models know the future prices of allowances hence there is no market volatility.
- Nuclear Power: The main bill scenarios assume a substantial growth in nuclear power reflecting possible future policies to promote this technology in the bills and elsewhere. Our assumption is that nuclear power generation increases by 150% from 2005 to 2050. This would require the construction of approximately 60 new or expanded nuclear plants by 2030 and 150 new or expanded nuclear plants by 2050. These assumptions are based on a study conducted by the U.S. Climate Science Program on long-term scenarios.
- CCS: The main bill scenarios assume advanced coal-fired power with carbon capture and storage is deployable as soon as it is projected to be commercially available. Where bonus allowances for CCS are available, this helps advance the deployment of this technology from 5 to 10 years in our analysis. The assumption of widespread deployment of CCS is critical to the continued use of coal in the U.S. for electric power generation under any of the three bills analyzed. In our analyses, we constrain the rate at which CCS technology can be deployed considering historic capital turnover rates given the existing capital investments and infrastructure of the electricity sector. It is also worth noting, however, that in absence of a carbon price, there are zero coal fired power plants with CCS in operation today and that there are only a handful of applications for commercial scale coal fired power plants with CCS to be built in the next 10 years. In addition, deployment of CCS will be contingent upon the ability to site new pipelines as well as addressing the liability concerns surrounding underground storage of CO_2. Please see Figure 3 from our Lieberman-Warner analysis.
- International action: In the main bill scenarios, we assume the following: High-income countries in the Kyoto Protocol fully comply with the treaty. After 2012, Kyoto countries, with the exception of Russia, follow an emissions path that falls gradually from simulated Kyoto levels in 2012 to 50% below 1990 levels in 2050. Low-income countries adopt a policy in 2025 that returns emissions and holds them at 2015 levels through 2034 and returns emissions to and maintains them at 2000 levels from 2035 to 2050.
- Offsets: In the main bill scenarios we assume that both domestic and international offsets are available up to the amounts allowed in the bills and that there are systems in place to ensure the environmental integrity of those offsets, that do not result in the benefits being heavily discounted or high transaction costs.

Question 5. What are the most significant factors contributing to price uncertainty in the analyses?

Answer. In our analyses, the two most significant factors affecting the projected allowance prices are the availability of enabling technologies and the use of offsets. For example, in our analysis of the Lieberman-Warner bill for the scenarios that limit the availability of enabling technologies, the projected allowance prices increase by over 80% (from $61/tCO_2$ to $112/tCO_2$ in 2030). We did not run scenarios that assumed significant advances over current technologies. In scenarios that do

not allow use of domestic offsets and international credits, costs increase by over 90%.

Question 6. What are the consequences if either new nuclear power plants or new coal-fired power plants that capture and sequester carbon dioxide, which are both assumed in many analyses, are not available at such significant levels?

Answer. EPA evaluated additional scenarios for the impact on GDP given the availability of these two key enabling technologies. In our analysis of the Lieberman-Warner bill under the scenario where nuclear power and biomass power do not exceed reference case growth and carbon capture and sequestration technology does not become commercially available until 2030, the impact on GDP is slightly more than double the impact estimated under the main bill scenario ($603 versus $238 billion). In sensitivity cases conducted as part of the analysis of the McCain-Lieberman bill where carbon capture and sequestration technology was not allowed and nuclear power growth was cut in half, there was a greater impact on GDP. The lower nuclear power case only slightly increased costs, as long as there is compensating increases in CCS generation to reduce the economic impact of the lower nuclear capacity. In the case where CCS is not available, this results in almost a doubling of the impacts on GDP versus the main bill scenario.

Question 7. What conclusions are reached on American competitiveness in the global economy?

Answer. EPA did evaluate the potential impact on the trade of U.S. energy-intensive manufactured goods in the recent analysis of the Lieberman-Warner bill. The general conclusion is that in the case where developing countries also take on mandatory reductions of GHGs, the terms of trade for the U. S. are better than in the case where those countries do not take action.

In the main bill scenarios where the U.S. and all other countries are assumed to take action, imports of energy-intensive manufacturing goods from high-income countries to the U.S. fall as that group of countries also takes on emission targets.

In the same scenario, there is an increase of U.S. exports of energy-intensive manufacturing goods to developing countries, particularly after 2030 as that group of countries is assumed to take on mandatory reductions in GHGs starting in 2025. This is due to the greater energy-efficiency in the production of U.S. manufactured goods relative to those goods being manufactured in lower income countries.

In the case where developing countries do not adopt any additional policies or measures to reduce GHGs, the terms of trade for the U.S. are substantially worse. In 2030 there is a 6.3% decrease of U.S. exports of energy-intensive manufacturing goods to developing countries, and a 1.5% increase of U.S. imports of energy-intensive manufacturing goods from developing countries. However, the use of an International Reserve Allowance Requirement limits imports from those countries.

Question 8. What impact does domestic climate change legislation have on global concentrations of greenhouse gases?

Answer. In EPA's analysis of the Lieberman-Warner bill, there is a reference scenario for global CO_2 concentrations that increases from today's levels of about 380 parts per million (ppm) to about 720 ppm by the end of the century. If the US adopts the Lieberman-Warner bill the concentration is reduced by between 7—10 ppm in 2050 and by 25—28 ppm in 2095. In the scenario where the U.S. adopts the Lieberman-Warner bill and the international community takes on mandatory GHGs reductions as described above, global CO_2 concentrations would be reduced by about 50 ppm in 2050 and 230 ppm in 2095 with US action under Lieberman-Warner accounting for about 10 ppm in 2050 and 25 ppm in 2095, leading to global CO_2 concentrations of 458 ppm in 2050 and about 490 ppm at the end of the century. It is important to note that while CO_2 concentrations would be significantly reduced in this scenario with international action; they are not on a stabilization trajectory since this scenario assumes that emissions are held constant after 2050 which results in continued increases in CO_2 concentrations.

In summary, based on the analyses of the three bills, I would like to make the following points:

- The analyses illustrate the value of a portfolio of technologies and confirm that there is no silver bullet. Although the absence of certain technologies, or availability of offsets would significantly increase cost.
- If we assume that CCS technology will be successfully developed at the commercial scale, the overall price signal plus specific incentives in the bills push deployment of technology earlier, and incentives for CCS, in particular, help maintain the use of coal as a source of energy for the next several decades.
- The offset provisions are also very important for cost containment. Although costs are reduced with larger offset programs, it will be important to ensure

that offsets do not lessen the GHGs reductions achieved through the cap and that the offsets program is efficient and the benefits are fully recognized.
- There will be economic costs associated with the bills. However, in all cases the U.S. economy grows over time. In EPA's Reference Scenario, the size of the U.S. economy is projected to increase approximately 97% from 2007 to 2030 and 215% higher by 2050. Under the Lieberman-Warner bill, that growth is projected to decrease by between 0.9% and 3.8% in 2030 and 2.4% and 6.9% in 2050.
- The ability of models to forecast major changes in technology or the invention of new responses to the climate challenge which may significantly reduce costs is limited and are therefore not a part of this analysis.
- Our analyses indicate that there will be ancillary benefits under the Lieberman-Warner bill in the form of greater SO_2 and NO_X emissions reductions from the power sector under current regulations. This will facilitate the achievement of the fine particle and ozone air quality standards.

The impact of any of these bills, as would action by any one country alone, on the concentration of GHGs in the atmosphere is not enough to address the global climate challenge, but this is not surprising. Clearly, global participation is needed.

In closing, we believe that EPA has provided valuable technical input to the U.S. climate policy debate. We look forward to working closely with members of Congress as this process continues.

Thank you, Mr. Chairman, and Members of the Committee for this opportunity. This concludes my prepared statement. I would be pleased to answer any questions that you may have.

The CHAIRMAN. Thank you very much.

Dr. Orszag, go right ahead.

STATEMENT OF PETER R. ORSZAG, DIRECTOR, CONGRESSIONAL BUDGET OFFICE

Mr. ORSZAG. Thank you very much, Chairman Bingaman, Senator Domenici, members of the committee. Let me make four basic points.

First. Global climate change does pose a significant long term risk to the economy and to our Nation. Addressing that by reducing greenhouse gas emission, however, will involve short term economic costs. A cap and trade program reduces the economic costs involved by providing flexibility to firms to in terms of where and how they undertake the emission reductions as has already been referred to.

But what I want to focus on today is the very important timing issue involved in a cap and trade program. In particular under an inflexible cap there is a level of emissions specified each year. The problem arises because costs for achieving that cap can vary substantially from year to year depending on the state of economic activity, environmental conditions, the weather, technology, etc.

From an environmental prospective, however, it does not matter to a first approximation whether you reduce a ton of carbon emissions this year or next year. The costs, however, can vary substantially. An inflexible cap does not provide that kind of timing flexibility which can have a very substantial impact on costs.

Let me try to illustrate that point with the following chart. What you see on the left hand part on the top is what happens in 2018 if costs are at or equal to what's projected currently. That's a simple cap in the light blue.

The white area and then the dark blue area present different approaches in which there is either a price ceiling or a price floor. That's ways of trying to limit the fluctuation from year to year and provides a timing flexibility in when emission reductions occur. So

if things turn out as you expect, those price ceilings and price floors don't matter. You hit what you expected to occur.

But now let's consider a case in which costs are significantly higher than projected. In that case having a price ceiling or a safety valve in place will mean that there's not as much emission reductions occurring. You can see reflected in the white bar being lower than the light blue bar. But also that costs are significantly below what was projected because you're not undertaking as much emission reductions in that year. The existence of a price floor which is shown in the dark blue area doesn't matter when costs are higher than you projected.

Now let's take a case in which costs are lower than were expected. In that case the price ceiling doesn't matter. But the existence of a price floor where you're not allowing the price of carbon permits to fall below some level means that you're actually undertaking more emission reductions in that low cost year than you would without either the price ceiling or the price floor.

But costs are higher with the price floor in this case. You can see that by the fact that the dark blue bar is higher than the other two. Costs are also somewhat higher because you're undertaking more emission reductions in that year.

Now the kicker is that if we go to the next slide combine a high cost and a low cost year. Then focus on, in particular, the first bar and the last bar. You can see that under an inflexible cap and under a combined price ceiling and price floor, you wind up with the same cumulative emission reductions.

From an environmental perspective, that is the key. It doesn't matter when you undertake the emission reductions. It matters how much you undertake ultimately.

From a cost perspective, however, there is a very significant difference. The combination of a price ceiling and a price floor means cumulative costs that are roughly 20 percent lower than under an inflexible cap and trade system. Twenty percent is the significant amount of money given the cost involved in many of these efforts.

So I think the key point that I wanted to make here is providing the timing flexibility to allow emission reductions when they're cheapest to do. That's what generating this difference here. You're getting more of the emission reductions in the cheap year rather than in the expensive year, can have a very significant effect on cost.

Another very substantial influence on cost is shown in the next chart—what one does with the value created from the allowance permits where the value of the allowances created. There's a very substantial amount of money at stake here, often in the hundreds of billions of dollars a year.

If you auction those allowance permits and then you provide an equal lump sum rebate to households—so you just give the money back to households on an equal basis for each household—you wind up with a macro economic efficiency cost of about half a percent of GDP according to at least one estimate.

We can sort of scale these. But they also produce a progressive net result. The reason is that the fact that each household is getting the same amount per dollar back from the government more

than offsets the price increases on electricity and gasoline and other things for low income households.

Alternatively you could auction the revenue and then use that to reduce corporate income taxes. That's the second bar. There you have a regressive of outcome because high income households will benefit more.

Low income households wind up worse off. But you significantly reduce the macro economic efficiency costs, cut it basically in half. That's what you see on the top bar.

If you give the permits away you wind up with the worst of both worlds. You wind up with the full macro economic cost and all the regressivity of the first set of results, or the second set of results. I'm sorry.

Giving the permits away is effectively equivalent to auctioning the permits and then giving the money that you raise back to the producers. That foregoes both the opportunity to reduce the macro economic cost and the opportunity to offset the regressivity of the ultimate price increases.

So just in summary, two key factors of a cap and trade system.

One whether you provide timing flexibility which could be done through a combined price ceiling and price floor.

Second, what you do with the revenue will have a very substantial effect on the economic cost involved.

Thank you very much.

[The prepared statement of Mr. Orszag follows:]

PREPARED STATEMENT OF PETER R. ORSZAG, DIRECTOR, CONGRESSIONAL BUDGET OFFICE

Chairman Bingaman, Senator Domenici, and Members of the Committee, thank you for the invitation to discuss the implications of cap-and-trade programs that are designed to reduce U.S. emissions of greenhouse gases, most prominently carbon dioxide (CO_2). Under a cap-and-trade program, policymakers would set a limit on emissions and allow entities to buy and sell permits (or allowances) to emit CO_2 and other greenhouse gases.

Global climate change is one of the nation's most significant long-term policy challenges. Human activities are producing increasingly large quantities of greenhouse gases, particularly CO_2. The accumulation of those gases in the atmosphere is expected to have potentially serious and costly effects on regional climates throughout the world. Although the magnitude of such damage remains highly uncertain, there is growing recognition of the risk that the damage could prove extensive and perhaps even catastrophic. The risk of potentially catastrophic damage associated with climate change can justify actions to reduce that possible harm in much the same way that the hazards we all face as individuals motivate us to buy insurance.

Reducing greenhouse-gas emissions would provide benefits to society by helping to limit the damage associated with climate change, especially the risk of significant damage. However, decreasing those emissions would also impose costs on the economy—in the case of CO_2, because much economic activity is based on fossil fuels, which release carbon when they are burned.

Most analyses suggest that an appropriately designed program to begin lowering CO_2 emissions would produce greater benefits than costs. Market-oriented approaches to reducing carbon emissions, such as a cap-and-trade program or a carbon tax, would reduce emissions more cheaply than would command-and-control approaches, such as regulations requiring across-the-board reductions by all firms. Those market-oriented approaches are relatively efficient because they create incentives and flexibility for emission reductions to occur where and how they are least expensive to accomplish.

I will focus today on two key design elements of a cap-and-trade system that could help to improve its efficiency further in terms of reducing the cost of emission reductions: (1) structural features to allow the timing of reducing emissions to respond to year-to-year differences in conditions that affect the cost of doing so and (2) the use of the allowances' value created by a cap-and-trade system to reduce its cost.

The Congress is currently considering a bill, S. 2191, which would reduce emissions by establishing a cap-and-trade program.[1] S. 2191 would also establish a Carbon Market Efficiency Board, which would be authorized to transfer emission allowances across years to help minimize the cost of meeting a long-term target for reducing emissions. Other approaches—such as imposing limits on the price of allowances—could also be used to contain the costs that a cap might impose on the economy.

My testimony makes the following key points:

- The cost of meeting an emission target with a cap-and-trade program could be reduced, potentially quite substantially, by providing firms flexibility in the timing of their efforts to reduce emissions. In particular, the most cost-effective cap-andtrade design would encourage firms to make greater reductions when the cost of doing so was low and would allow them leeway to lessen their efforts when the cost was high. Providing firms with such flexibility could also prevent large fluctuations in the price of allowances that could be disruptive to the economy. The reduction in economic burden need not come at the cost of additional environmental risk: The flexibility to shift emission reductions across years could be designed to achieve any given cumulative reduction in emissions over the medium or long term.
- One option for allowing firms flexibility in determining when to reduce emissions while also achieving compliance with a cumulative target would be through setting both a ceiling—typically referred to as a safety valve—and a floor on the allowance prices each year. The price ceiling would allow firms to exceed the annual target when the cost of cutting emissions was high, while the price floor would induce firms to cut emissions more than the annual target in low-cost years. The price ceiling and floor could be adjusted periodically to ensure that emission reductions were on track for achieving the long-run target; such a dynamic price system could substantially reduce the cost of a cumulative target for emissions.
- Another option would be to authorize firms to "borrow" future allowances for use in the current year or to "bank" allowances for use in future years. Firms would have an incentive to borrow allowances, though, only if they expected the price in the future to be sufficiently lower than the current price to make borrowing cost-effective. Similarly, firms would have an incentive to bank allowances only if they expected the price in the future to be sufficiently higher than the current price. Most proposals for borrowing and banking would impose limits on the degree to which they could be undertaken, and partially as a result of those limits, this approach is likely to be less effective at reducing cumulative costs for any given cumulative target for reducing emissions than a dynamic price system would be.
- Under the Carbon Market Efficiency Board described in S. 2191, which would be authorized to transfer emission allowances across time periods, regulators would attempt to shift allowances in a manner that led to more reductions when costs were relatively low and less reductions when costs were high. An alternative approach, which may be easier for regulators to implement efficiently, would be to have the board set a ceiling and floor for allowance prices and be responsible for adjusting those price limits periodically as needed to achieve a long-term target for reducing emissions.
- Policymakers' choices about whether to distribute the allowances without charge or to auction them—and if they are auctioned, how to use the proceeds—could also have a significant effect on the overall economic cost of capping emissions. Evidence suggests that the cost to the economy of a 15 percent cut in U.S. emissions (not counting any benefits from mitigating climate change) might be half as large if policymakers sold the allowances and used the revenue to lower current taxes on capital that discourage economic activity, rather than giving the allowances away to energy suppliers and energy-intensive firms or using the auction proceeds to reduce the costs that the policy could impose on low-income households. Using the allowances' value to lower the total economic cost could, however, exacerbate the regressivity of the cap-and-trade program.

[1] The Congressional Budget Office (CBO) reviewed S. 2191 as the bill was ordered reported by the Senate Committee on Environment and Public Works on December 5, 2007. As discussed later, on April 10, 2008, CBO provided a cost estimate for the bill as it was ordered reported and a cost estimate for it with a proposed amendment transmitted to the agency on April 9, 2008.

CONTAINING COSTS BY PROVIDING FLEXIBILITY IN THE TIMING OF EMISSION REDUCTIONS

A cap-and-trade program, which creates financial incentives for firms and households to cut their greenhouse-gas emissions, is a lower-cost approach to reducing emissions than more restrictive command-and-control approaches, which mandate how much those entities can emit or what emission-reduction technologies they should use. The lower cost of a cap-and-trade program stems from the flexibility it provides as to where and how emission reductions are to be achieved.

Under a cap-and-trade program for CO_2, policymakers would set a limit on total emissions during some period and would require regulated entities to hold allowances for the emissions permitted under that cap. (Each allowance would entitle companies to emit one ton of CO_2 or to have one ton of carbon in the fuel that they sold.) After the allowances for a given period were distributed, entities would be free to buy and sell them. The trading aspect of the program could lead to substantial cost savings relative to command-and-control approaches: Firms that were able to reduce emissions most cheaply could profit from selling allowances to firms that had relatively high abatement costs. The cost-effectiveness of a cap-and-trade program could be further improved by providing firms with flexibility in determining when to reduce their emissions.

THE IMPORTANCE OF FLEXIBILITY IN THE TIMING OF EMISSION REDUCTIONS

In its most inflexible form, a cap-and-trade program would require that a specified cap on emissions was met each year. That lack of flexibility would increase the cost of achieving any long-term goal because it would prevent firms from responding to year-to-year differences in conditions that affected costs for reducing emissions, such as fluctuations in economic activity, energy markets, and the weather (for example, an exceptionally cold winter would increase the demand for energy and make meeting a cap more expensive), and the technologies available for reducing emissions.

In contrast, because of the long-term nature of climate change, the key issue from an environmental perspective involves emissions over the long term and concentration paths of greenhouse gases, not the year-to-year fluctuations in emissions. In other words, limiting global climate change will entail substantially reducing the amount of greenhouse gases that accumulate in the atmosphere over the next several decades, but the benefits of doing so are largely independent of the annual pattern of those reductions.[2] Consequently, a cap-and-trade program could achieve roughly the same level of benefits at a significantly lower cost if it provided firms with an incentive to make greater reductions in emissions at times when the cost of doing so was low and allowed them leeway to lessen their efforts when the cost was high.

Including features in a cap-and-trade program that enabled to firms to reduce emissions less when costs were high and more when costs were low could also reduce the volatility of allowance prices. Experience with cap-and-trade programs has shown that price volatility can be a major concern when a program's design does not include provisions to adjust for unexpectedly high costs and to prevent price spikes. For example, one researcher found that the price of sulfur dioxide allowances under the U.S. Acid Rain Program was significantly more volatile than stock prices between 1995 and 2006 (see Figure 1).*[3]

Price volatility could be particularly problematic with CO_2 allowances because fossil fuels play such an important role in the U.S. economy. In 2006, fossil fuels accounted for 85 percent of the energy consumed in the United States. CO_2 allowance prices could affect energy prices, inflation rates, and the value of imports and exports. If those prices were volatile, they could have disruptive effects on markets

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[2] Although costs and benefits are difficult to measure, the long-term cumulative nature of climate change implies that the benefit of emitting fewer less ton of CO_2 in a given year—referred to as the marginal benefit—is roughly constant. In other words, the benefit in terms of averted climate damage from each additional ton of emissions reduced is roughly the same as the benefit from the previous ton of emissions reduced, and shifting the reductions from one year to another does not materially affect the ultimate impact on the climate. In contrast, the cost of emitting one fewer ton of CO_2 in a given year—the marginal cost—tends to increase with successive emission reductions. The reason is that the least expensive reductions are made first and progressively more-expensive cuts would then have to be made to meet increasingly ambitious targets for emission reductions.

* Figures 1–4 have been retained in committee files.

[3] See William D. Nordhaus, "To Tax or Not to Tax: Alternative Approaches to Slowing Global Warming," Review of Environmental Economics and Policy, vol. 1, no. 1 (Winter 2007), pp. 37-39.

for energy and energy-intensive goods and services and could make investment planning difficult.

DESIGN FEATURES PROVIDING FLEXIBILITY IN THE TIMING OF EMISSION REDUCTIONS

Recent proposals for cap-and-trade proposals include a variety of design features that would provide firms or regulators with flexibility in the timing of emission reductions, thereby reducing the economic costs of the effort to limit greenhouse gas emissions.

A PRICE CEILING AND A PRICE FLOOR

The combination of a price ceiling and a price floor offers one method of allowing timing flexibility and thereby reducing the economic burden of achieving any desired cumulative target for reducing emissions:

- Setting a ceiling, or safety valve, for the price of allowances could prevent the cost of reducing emissions from exceeding either the best available estimate of the environmental benefits or the cost that policymakers considered acceptable. The government could maintain a price ceiling by selling companies as many allowances as they would like to buy at the safety-valve price.
- Similarly, policymakers could prevent the price of allowances from falling too low by setting a price floor. If the government chose to auction a significant share of the allowances, it could specify a so-called reserve price and withhold allowances from the auction as needed to maintain that price. The efficiency advantage of a price floor would stem from the fact that it could prevent the cost of emission reductions from falling below the expected benefits or below the level of effort that policymakers intended.

A cap-and-trade program that included both a ceiling and a floor for allowance prices could achieve a long-term target for emissions while minimizing both the overall cost of achieving the target and price volatility. Under such a program, policymakers would specify annual emission targets as well as a ceiling and a floor for the price of allowances for each year. Regulators could adjust the levels of the price ceiling and floor periodically (for example, every five years) to ensure that emission reductions were on track for achieving the long-term target. For example, the rate at which the price floor or ceiling rose over time could be increased if regulators determined that the reductions in the previous five-year period were significantly lower than the amount needed to achieve the long-term target. Alternatively, policymakers could include provisions in a cap-and-trade program that would automatically trigger adjustments in the price ceiling and floor. For example, the rate at which the price ceiling and floor rose could be based on the percentage gap between anticipated and actual emissions in the previous five-year period.

Figures 2 and 3 illustrate the effects of price ceilings and floors. The figures present a simple example of an inflexible cap each year relative to a system involving price ceilings and floors. In Figure 2, the results illustrate what happens in 2018 if the costs of reducing emissions by roughly 15 percent are twice as high or 50 percent lower than expected. Under an inflexible cap, the emission reductions are unaffected. Under a price ceiling, fewer emission reductions are undertaken when costs are high; the result is lower economic costs that year but also less of a reduction in emissions. Under a price floor, more emission reductions are undertaken when costs are low.

Figure 3 shows the results after one high-cost year and one low-cost year. Cumulative reductions of emissions are the same under the inflexible cap and the combined price ceiling-and-floor system, but costs are more than 20 percent lower under the latter approach. The reason, again, is that more of the emission reductions are undertaken in the low-cost year under that approach.

BORROWING AND BANKING ALLOWANCES

An alternative but generally somewhat less effective approach to reducing economic costs involves allowing companies to borrow future allowances in high-cost years, thereby deferring emission reductions to later years. Borrowing allowances from future years would tend to reduce allowance prices in the current year but then raise prices in the future (because borrowing would allow smaller reductions now but require greater reductions later). Firms would want to borrow allowances only if they expected the price of allowances in the future to be sufficiently below the current price as to make deferring reductions profitable. Most proposals would impose limits on borrowing, furthermore, in part because of concerns about enforcement and questions about who would be liable if the firm that borrowed future allowances was unable to pay them back (if it declared bankruptcy, for example).

Similarly, policymakers could help keep the price of allowances from falling too low by allowing companies to exceed their required emission reductions in low-cost years in order to bank allowances for use in future high-cost years. The additional emission reductions motivated by banking in low-cost years would put upward pressure on the price of allowances in those years.

S. 2191 AND THE CARBON MARKET EFFICIENCY BOARD

S. 2191 would address sustained high prices for allowances by allowing an administrative board, the Carbon Market Efficiency Board, to transfer future allowances to the current year. That action could be viewed as a form of forced borrowing—that is, it would require firms to trade lower reductions today for higher reductions in the future, even if they would not have found it profitable to do so voluntarily. Such transfers could ultimately raise or lower the overall cost of meeting a long-run target depending on how the price of allowances changed over time. For example, if a low-cost, low-carbon energy technology became available in the future, transferring future allowances to the current period would have successfully shifted emission reductions to a time when the cost of achieving them was lower. Alternatively, if policymakers borrowed future allowances with the expectation that such a technology would become available, but it did not, then the transfer could cause even more reductions to be made at a relatively high-cost time. (An alternative approach to the one embodied in S. 2191, which may be easier for regulators to implement efficiently, would be to have the board be the entity responsible for setting a ceiling and a floor for allowance prices and for adjusting those price limits periodically as needed to achieve a long-term target for reducing emissions.)

USING THE VALUE OF ALLOWANCES TO REDUCE ECONOMIC COSTS

In establishing a cap-and-trade program, policymakers would create a new commodity: the right to emit CO_2. The emission allowances would have substantial value. For example, on April 10, 2008, CBO estimated that the value of the allowances created under S. 2191 (as order reported) would be roughly $145 billion (in 2006 dollars) once the proposed program took effect in 2012; in subsequent years, the aggregate value of the allowances would be even greater. (See Box 1 for a short description of CBO's cost estimate for S. 2191.)

BOX 1.—CBO'S COST ESTIMATE FOR S. 2191

On April 10, 2008, the Congressional Budget Office (CBO) issued a cost estimate for S. 2191, the America's Climate Security Act of 2007, as ordered reported by the Senate Committee on Environment and Public Works in December 2007. CBO also issued a cost estimate for a slightly amended version of the legislation that was transmitted by the committee on April 9.

The legislation would create a cap-and-trade system for carbon dioxide and other greenhouse gases. (The bill actually calls for two separate cap-and-trade programs—a bigger one covering most types of greenhouse gases and a smaller one covering hydrofluorocarbons.) Some of the emission allowances would be auctioned—through a new entity, the Climate Change Credit Corporation; the remaining allowances would be distributed at no charge to states and other recipients. Over the roughly 40 years that the proposed capand-trade programs would be in effect, the number of allowances—and thus the emissions of relevant gases—would be reduced each year.

On the basis of an analysis of the results of several economic models, CBO estimates that if the legislation was enacted, the auction price of emission allowances for those gases would rise from about $23 per metric ton of carbon-dioxide-equivalent (mt CO_2e) emissions in 2009 to about $44 per mt CO_2e in 2018.[1] (In 2006 dollars, the auction price per metric ton of CO_2e would rise from about $21 in 2009 to $35 in 2018.) Measured relative to base-case emissions (that is, those that would occur under current law), emissions of the main greenhouse gases covered by the programs would decline by 7 percent in 2012 and by 17 percent in 2018; over the 2012-2050 period, emissions would decline by a total of 42 percent relative to the base case.

Enacting S. 2191 as it was ordered reported would increase revenues by about $1.19 trillion over the 2009-2018 period, CBO estimates. Direct spending from distributing those proceeds would total about $1.21 trillion over the period. The net effect of the original legislation (as ordered reported) would be to increase the deficit

[1] A carbon dioxide equivalent is defined for each greenhouse gas as the quantity of that gas that makes the same contribution to global warming as one metric ton of carbon dioxide, as determined by the Environmental Protection Agency.

(excluding any effects on future discretionary spending) by an estimated $15 billion over the next 10 years. The effect of the amended version, in contrast, would be to reduce the deficit (again excluding any effects on future discretionary spending) by roughly $80 billion over the same period. In addition, if policymakers appropriated the amounts necessary to implement S. 2191, discretionary spending would increase over the 2009-2018 period, CBO estimates, by about $4 billion under the original legislation and by about $80 billion under the amended version.

The cost estimates for the two versions of the bill differ because the amendment would increase the proportion of allowances that were auctioned, deposit some of the auction proceeds in a Climate Change Deficit Reduction Fund, and make spending from that fund subject to appropriation.

OPTIONS FOR DISTRIBUTING EMISSION ALLOWANCES

Policymakers would need to decide how to allocate the allowances that corresponded to each year's CO_2 cap. One option would be to have the government capture their value by selling the allowances, as it does with licenses to use the electromagnetic spectrum. Another possibility would be to give the allowances to energy producers or some energy users at no charge. The European Union has used that second approach in its two-year-old cap-and-trade program for CO_2 emissions, and in the United States, the federal government has distributed nearly all of the allowances issued under the 13-year-old U.S. cap-and-trade program for sulfur dioxide emissions (which contribute to acid rain) that way.

Selling the allowances would provide lawmakers with an opportunity to reduce the overall economic impact of a CO_2 cap. For instance, the government could use the revenue from auctioning allowances to reduce existing taxes that tend to dampen economic activity—primarily, taxes on labor, capital, or personal income. As research indicates, a CO_2 cap would exacerbate the economic effects of such taxes: The higher prices caused by the cap would lower real (inflation-adjusted) wages and real returns on capital, which would be equivalent to raising marginal tax rates on those sources of income. Using the value of the allowances to reduce such taxes could help mitigate that adverse effect of the cap. Alternatively, policymakers could choose to use the revenue from auctioning allowances to reduce the federal deficit. If doing so lessened the need for future tax increases, the end result could be similar to dedicating the revenue to cuts in existing taxes.

The decision about whether or not to sell the allowances and how to use the proceeds could have a significant impact on the overall cost. For example, researchers have estimated that the efficiency cost of a 15 percent cut in emissions could be reduced by more than half if the government sold allowances and used the revenue to lower corporate income taxes, rather than devoting the revenue to providing lump-sum rebates to households or giving the allowances away (see the top panel of Figure 4).[4]

THE DISTRIBUTIONAL CONSEQUENCES OF DIFFERENT APPROACHES

The ways in which lawmakers allocated the revenue from selling emission allowances would affect not only the total economic cost of a cap-and-trade policy but also its distributional consequences. The ultimate distributional impact of a cap-and-trade program would be the net effect of two distinct components: the distribution of the costs of the program (including the cost of paying for the allowances) and the distribution of the allowances' value. (Because someone would pay for them, someone would benefit from their value.) Market forces would determine who bore the costs of a cap-and-trade program, but policymakers would determine who received the value of the allowances. The ultimate effect could be either progressive or regressive, imposing disproportionately large burdens on high-income or low-income households, respectively.

MARKET FORCES WOULD DETERMINE WHO BORE THE COSTS OF A CAP

Obtaining allowances—or taking steps to cut emissions to avoid the need for such allowances—would become a cost of doing business for firms that were subject to the CO_2 cap. However, those firms would not ultimately bear most of the cost of the allowances. Instead, they would pass the cost along to their customers (and their customers' customers) in the form of higher prices. By attaching a cost to CO_2 emis-

[4] The efficiency cost of a policy reflects the economic losses that occur because prices are distorted so that they do not reflect the nonenvironmental resources used in their production. That cost includes decreases in the productive use of labor and capital as well as costs (both monetary and nonmonetary) associated with reducing emissions. To provide perspective on the magnitude of such efficiency costs, they are depicted as a share of gross domestic product.

sions, a cap-and-trade program would thus lead to price increases for energy and energy-intensive goods and services. Such price increases would stem from the restriction on emissions and would occur regardless of whether the government sold emission allowances or gave them away. Indeed, the price increases would be essential to the success of a cap-and-trade program because they would be the most important mechanism through which businesses and households were encouraged to make investments and change their behavior to reduce CO_2 emissions. (In regulated electricity industries, distributing the permits at no cost might mitigate or prevent price increases in those markets but only at the cost of requiring even larger price increases in other markets. Ultimately, consumers will, in one way or another, bear costs roughly equal to the value of the permits.)

The rise in prices for energy and energy-intensive goods and services would impose a larger burden, relative to income, on low-income households than on high-income households. For example, without incorporating any benefits to households from lessening climate change, CBO estimated that the price increases resulting from a 15 percent cut in CO_2 emissions would cost the average household in the lowest one-fifth (quintile) of all households arrayed by income slightly more than 3 percent of its income; such increases would cost the average household in the top quintile just under 2 percent of its income (see Table 1).*[5]

The higher prices that resulted from a cap on CO_2 emissions would reduce demand for energy and energy-intensive goods and services and thus create losses for some current investors and workers in the sectors of the economy supplying such products. Investors might see the value of their stock decline, and workers could face the risk of unemployment as jobs in those sectors were cut. Stock losses would tend to be widely dispersed among investors, because shareholders typically diversify their portfolios. In contrast, the costs borne by workers would probably be concentrated among relatively few households and, by extension, communities.

POLICYMAKERS WOULD DETERMINE WHO RECEIVED THE VALUE OF THE ALLOWANCES

Although the price increases triggered by a cap-and-trade program for CO_2 emissions would be regressive, the program's ultimate distributional effects would depend on policy-makers' decisions about how to allocate the allowances. As noted above, those allowances would be worth tens or hundreds of billions of dollars per year. Who received that value would depend on how the allowances were distributed.

Lawmakers could more than offset the price increases experienced by low-income households or the costs imposed on workers in particular industrial sectors by providing for the sale of some or all of the allowances and using the revenue to pay compensation. For example, when CBO examined the ultimate distributional effects of a capand-trade program that would reduce CO_2 emissions in the United States by 15 percent, it concluded that lower-income households could be better off (even without any benefits from reducing climate change considered) as a result of the policy if the government chose to sell the allowances and use the revenue to pay an equal lump-sum rebate to every household in the United States. In that case, the size of the rebate would be larger than the average increase in low-income households' spending on energy and energy-intensive goods.[6] Such a strategy would, on net, increase average income for households in the lowest income quintile by about 2 percent (see the bottom panel of Figure 4). At the same time, the net average income for households in the top quintile would fall by less than 1 percent, CBO estimated.

In contrast, if lawmakers chose to use the allowances to decrease corporate income taxes, the overall cost to the economy would fall but the distributional effects would be significantly more regressive than the initial price increases. Because low-income households pay relatively little in corporate taxes, the cut in corporate tax rates would not offset their increased spending on energy and energy-intensive goods. Households in the top income quintile, however, would experience an increase in after-tax income as a result of the policy. Should policymakers decide to use the revenue from selling allowances to decrease payroll taxes, the effects (not shown in

*Table 1 has been retained in committee files.

[5] Those numbers are based on an analysis that CBO conducted using 1998 data; see Congressional Budget Office, Who Gains and Who Pays Under Carbon -Allowance Trading? The Distributional Effects of Alternative Policy Designs (June 2000). CBO is in the process of updating those figures, using recent data on households' expenditures and income.

[6] One researcher has suggested that an environmental tax credit based on earnings could offer another means of reducing the regressive effects of the price increases that would result from a tax or cap on CO_2 emissions. See Gilbert E. Metcalf, A Proposal for a U.S. Carbon Tax Swap (Washington, D.C.: Brookings Institution, October 2007).

the figure) would be regressive as well, although less so than for a cut in corporate taxes.[7]

Giving all or most of the allowances to energy producers to offset the potential losses of investors in those industries—as was done in the cap-and-trade program for sulfur dioxide emissions—would also exacerbate the regressivity of the price increases. On average, the value of the CO_2 allowances that producers received would more than compensate them for any decline in profits caused by a drop in demand for energy and energy-intensive goods and services. As a result, the companies that received allowances could experience windfall profits.

For example, in 2000, CBO estimated that if emissions were reduced by 15 percent, as in the scenario discussed above, and all of the allowances were distributed free of charge to producers in the oil, natural gas, and coal sectors, the value of the allowances would be 10 times as large as the producers' combined profits in 1998. Profits for those industries have climbed substantially since then, yet the value of the allowances associated with the policy that CBO analyzed would still be large relative to those producers' profits.[8] Because the additional profits from the allowances' value would not depend on how much a company produced, such profits would be unlikely to prevent the declines in production and resulting job losses that the price increases (and resulting drop in demand) would engender.

In addition, those profits would accrue to shareholders, who typically are from higher-income households, and would more than offset those households' increased spending on energy and energy-intensive goods and services. Low-income households, by contrast, would benefit little if allowances were given to energy producers for free, and they would still bear a disproportionate burden from the price increases that would nonetheless occur. Thus, giving away allowances would be significantly regressive, making higher-income households better off as a result of the cap-and-trade policy while making lower-income households worse off. Further, giving away the allowances would preclude the government from dedicating the value of the allowances to reducing the overall economic impact of the policy.

The CHAIRMAN. Thank you very much. I'll start and just ask 5 minutes of questions and then defer to Senator Domenici. Then, as I said earlier, members that have not had a chance to make an opening statement will each have 7 minutes so they can make whatever statement they want, if they would prefer rather than ask some questions.

Let me start with a question to you, Dr. Gruenspecht. I looked at this CRS report. They did an analysis of the various studies.

The ACCF NAM study, National Association of Manufacturers Study, high cost scenario stands out. It has, it proposes or contemplates allowance prices roughly 75 percent higher than the highest cost scenario that you have come up with at EIA. But the Gross Domestic Product impact in 2030 is three times higher than what you estimate in 2030.

Could you explain that? Just how that would be the case or what your understanding of that is? I just wasn't able to understand why the 75 percent increase in allowance prices would translate into a three time increase in impact on the Gross Domestic Product.

Mr. GRUENSPECHT. Thank you, Mr. Chairman. It's always difficult to talk about somebody else's work, but I think I can try a little bit here. Amen corner. Now I'm on my own, I guess.

First of all, the allowance price differences reflected some of the assumptions, like the absence of banking in their analysis which they were very clear about. There are some similarities in that

[7] For those results, see Congressional Budget Office, Trade-Offs in Allocating Allowances for CO_2 Emissions (April 25, 2007).

[8] Specifically, CBO estimated that the value in 1998 of the allowances stemming from the 15 percent reduction in U.S. emissions would total $155 billion (in 2006 dollars). By comparison, profits for U.S. producers of oil, natural gas, and coal totaled $13.5 billion in 1998 (in 2006 dollars). Those companies' total profits have grown substantially—for example, in 2006, they totaled $174 billion.

when we make similar technology cost and availability assumptions as they do, we get fairly close in allowance prices for that high case.

However, based on our own previous work we were surprised, as I guess you are, by the size of the macro-economic losses reported in the study done for NAM, we had concerns about their consistency with the identified energy market impacts.

In order to better understand their work we asked to look at some of their modeling results and met with their contractor, and we did identify an issue we think contributes to the size of the economic impacts in the study performed for NAM and the ACCF. They apparently arose from problems in implementing the modification of the Annual Energy Outlook 2007 baseline to pick up the Energy Independence and Security Act and the lower baseline economic growth.

For example, they used EIA's high price oil scenario in their policy case. But then they compared the results to a baseline with much lower oil prices. So really the macro impacts that are shown in their report reflect both the S. 2191 policy and the effects of higher oil prices, not just the effects of the S. 2191 policy.

So, we think that there are some abnormal results in the report. We've shared our concern and other comments with both the contractor and the report sponsors, and look forward to their resolution.

We certainly recognize and welcome the use of our modeling tools by diverse users for climate policy studies. There was also one by the Clean Air Task Force that used NAM. So again, I think there may be a mix of—maybe what is attributed to the cap and trade bill may also be picking up the high oil price scenario that they used.

The CHAIRMAN. I guess I understand that you're saying basically there's some type of double counting going on in the model. Is that what I'm understanding?

Mr. GRUENSPECHT. I don't know if it's double counting. I think it's more mixing the impact of two things, the effect of S. 2191 and moving from lower oil prices to higher oil prices that is not because of S. 2191. Senator Domenici had talked about the difficulty in projecting or looking at scenarios of oil prices.

We have a high oil price case that's much higher than the reference case. They use the high oil price case, which is actually closer to current prices, for looking at the S. 2191 policy. Then our understanding is they compared that to a scenario with the reference oil prices in the baseline. So it was mixing the effects of S. 2191 and a less favorable oil price situation which is not good, obviously, for the U.S. economy either.

The CHAIRMAN. Let me ask, Dr. Orszag. As I understand one of the points you made, is that you think the best result of getting emission reductions at minimal cost is accomplished by a structure that would have both a price ceiling and also a price floor on allowances. Did I understand that correctly?

Mr. ORSZAG. That is correct. I don't want to use the word, best. But if you wanted to create an efficient system that from the perspective of achieving the emission reductions at the lowest possible economic cost, providing timing flexibility which could be done by

both a price ceiling and a price floor where both of those prices could be adjusted over time to hit any cumulative emission reductions target you wanted is an effective way of achieving that objective.

The CHAIRMAN. Thank you very much. My time is up.

Senator Barrasso.

Senator BARRASSO. Thank you very much, Mr. Chairman. I very much appreciate you holding these hearings. This is very important for all of us to get a clear understanding. I do have real concerns as do all the members. I have a lengthy statement. With your permission I'd like to have that inserted into the record?

[The prepared statement of Senator Barrasso follows:]

PREPARED STATEMENT OF HON. JOHN BARRASSO, U.S. SENATOR FROM WYOMING

In dealing with climate change, there are certain principles that I apply in assessing any approach to this issue.

One, is that fossil fuels, such as coal, maybe ironically to many in the Senate, is vital to achieving our goals of having a cleaner energy future.

We can not get there without them.

Two, a strong American economy—that creates jobs and new technologies—is critical to developing the tools we need that capture and sequester carbon.

China and India will not act to address carbon emissions until such technologies are developed.

And third, we cannot afford to hurt the very regions, industries, and workers, who will provide that technology through hard work and innovation.

In terms of economic impact, I have serious concerns with the Lieberman-Warner approach as currently written.

According to a recent study done by the National Association of Manufacturers, the impact to my home State of Wyoming is dire.

I will note these numbers could change because we do not know what the final bill that will be on the floor will look like.

The study projects Wyoming would lose roughly 2,000 to 3,000 jobs by 2020, and 6,000 to 8,000 jobs by 2030.

Gasoline prices and energy prices for Wyoming families would double.

How would that impact Wyoming families?

Wyoming family budgets are predicted to lose 900 to 3,000 dollars a year in income by 2020, and 4,000 to 7,000 dollars a year by 2030.

Sadly, the impacts of the bill results in class warfare, hitting lower income families the hardest. Low income families in Wyoming would have to dedicate 1 dollar out of 5 from their family budget for energy costs under the Lieberman-Warner bill.

The statistics go on and on.

Higher costs for Wyoming schools, universities, and hospitals.

According to the study, Wyoming coal would face a serve decline.

That would result in lost jobs, broken family budgets, and displacement.

As I have said, fossil fuels, including coal, are vital to our energy security. We need to make them cleaner so that they can be a basis for America's energy mix.

But clean coal technology is a work in progress. It will take time to perfect.

The men and women of Wyoming, who are the backbone of the coal industry, are essential to providing clean coal technology to America.

The capital and infrastructure that make coal happen in Wyoming are also essential to providing clean coal technology to America.

America can simply not tolerate the lost jobs and high energy prices that will come from dramatic decreases in coal production under Lieberman-Warner.

As I stated in the beginning, we need to have a strong economy, we need an economy that creates jobs and fosters innovation to provide the clean energy technologies we need.

We can ill afford to hurt the very regions, industries, and workers, who will provide that technology through hard work and innovation.

On both points, at least according to this report, the Lieberman-Warner bill appears to fail.

It doesn't have to be this way. I truly believe we can address climate change. There are betters ways, more economically friendly approaches, that can make a real difference.

I do not simply offer platitudes on this issue.

Earlier this year, I introduced legislation to address climate change.

I believe overlooked in the debate are green house gasses, currently in the atmosphere. Those are the gasses contributing to the warming of the planet.

The best science tells us it is a factor.

To what extent, we are not sure.

It would seem to me a worthy approach, to find a way to remove existing green houses gases from the atmosphere and permanently sequester them. This is the other end of the problem.

To accomplish this, we certainly are going to need to invest the money to develop the technology.

The approach my legislation takes to address this is through a series of financial prizes where we set technological goals, and outcomes.

The first to meet each criteria would receive federal funds and international acclaim.

The prizes would be determined by a federal commission under the Department of Energy.

The commission would be comprised of climate scientists, physicists, chemists, engineers, business managers and economists.

They would be appointed by the President, with the advice and consent of the Senate.

The awards would go to those, both public or private, who would achieve milestones in developing and applying technology.

Technology that could significantly help to slow or reverse the accumulation of greenhouse gases in the atmosphere.

The greenhouse gasses would have to be permanently sequestered. Sequestered in a manner that would be without significant harmful effects.

I believe this approach is just one example of how we can tackle the problem of climate change in an economically friendly way without sacrificing real progress.

I would hope, as we begin debate on this issue, that more members of this body embrace approaches that address climate change while protecting jobs, family budgets, and the industries we must count on.

The CHAIRMAN. We'll be glad to include anyone's statement in the record.

Senator BARRASSO. Dr. Gruenspecht, if I may. You state in your testimony both written and oral that the larger price impacts occur in those regions that are most reliant on coal and being from Wyoming, the No. 1 coal producer in the United States, that is clearly a concern. So I know we're in the category.

But you say different regions of the country will be affected. What specific regions are you talking about?

Mr. GRUENSPECHT. We looked at electricity prices. We looked at 13 regions of the country. They each use different amounts of coal for power generation. They each have different regulatory structures. We generally find, I'm just doing this by memory, but we find places like the Pacific Northwest, which have a lot of hydropower and don't have competitive markets, places like California, are less affected. Places that are more heavily reliant on coal and are competitive have larger impacts. In the testimony we tried to illustrate the effect on the 13 regions.

Senator BARRASSO. So it looks like we're talking about having significant impact on the Midwest, the Rocky Mountains, the South. They're going to suffer the most. When I look at these studies it looks like in the State of Wyoming and many of those other Rocky Mountain States that about one dollar out of five dollars in the income of an average family in my State will have to be spent on energy costs under Lieberman-Warner.

Does it appear to you that the impacts of the bills are really hitting the lower income families the hardest? Would you agree with that assessment?

Mr. GRUENSPECHT. We have not really looked at income distribution, and we haven't really looked at the individual State levels. All we did regionally, in response to the chairman, is look at the electricity price impacts on a broad regional basis.

Senator BARRASSO. You stated that the price of motor fuel gasoline would be affected maybe to a lesser extent than coal or natural gases. There's a study that's reported in today's copy of The Hill: Warner-Lieberman bill could raise gas prices.

They talked about some large numbers there. This would be on top of the gas prices that people are already enduring across the country. How do you explain this increase in the cost of gasoline prices under Lieberman-Warner?

Mr. GRUENSPECHT. We do not see the Lieberman-Warner proposal significantly affecting the world oil price. But we do see the cost of the allowances that are needed under the cap and trade program as being reflected in the price of motor fuels. So the real question is how high those allowance prices are.

In our analysis, that really depends on how successfully the electric power sector can reduce its carbon emissions. The electric power sector accounts for 40 percent, roughly, of energy-related emissions and energy-related emissions account for a little bit more than 80 percent of total emissions. So energy-related emissions are very important.

The range we get for gasoline price impacts is about 40 cents a gallon to about a dollar a gallon. That almost completely reflects the value of these allowances under a cap and trade program.

Senator BARRASSO. Which is significant in terms of the amount of prices already that people are enduring at the pump—another 40 cents to a dollar.

Mr. GRUENSPECHT. I don't think anyone likes the first number that they're seeing when they drive up to the pump. I guess this analysis would affect either the second digit or potentially in the case where it's a dollar, you know it would be a dollar. But again, that's what we find.

Senator BARRASSO. As Congress is being asked to address some of these pieces of legislation I want to make sure the American people realize what the impacts are going to be on their own pocketbook as we try to address an issue and as this comes to the floor next month.

Dr. Yacobucci and Dr. Parker, you talk a bit about the uncertainty of the estimates in terms of the costs to the economy, the cost to American jobs. The uncertainty as I read this, really reflects the magnitude rather than the direction in terms of it seems is it a question of how many jobs will be lost. How big the drag will be on the economy. You know, how much we will shackle our economy. I think Dr. Parker, you used the word, challenges to the economy.

Would including a so called safety valve help things if in part of the legislation?

Mr. PARKER. Yes, I always forget that. A safety valve which for people who don't know, that's basically putting an upper limit on a price so that if the volatility and the allowance market exceeds a certain level, you can pay a fee as opposed to having to submit

an allowance. It is basically a very effective method of controlling the upper level prices that you would entail.

A question of course, is where do you set that price. So the, yes, it would be very effective at doing so. In fact it would guarantee the price of the program could not exceed that level because any rational entity would decide to pay the fee rather than pay more for an allowance.

Senator BARRASSO. It does seem, well, that no matter how you do this there's going to be impacts on higher heating bills, higher electrical cost for cooling, higher prices at the pump, lower wages and lower returns for people in their long term retirement plans. No matter what you do. No matter which way you go, all of those things are going to be impacted by all of the assessments.

Mr. PARKER. Prices will go up. Whether or not individual bills go up depend on how people respond to the prices. A couple of the models attempted to look at what the various incentives that the bill has it in for conservation and other abilities.

They concluded that while, yes, electric for example, electric prices or natural gas prices might go—the prices would go up. The monthly bills might go down if people sufficiently conserved. So in the end it's how the economy and ourselves respond to what's occurring as to how much it ultimately hits our pocketbook. But yes, no one is predicting that prices were going down.

Senator BARRASSO. Dr. Gruenspecht, if I could ask about the issue of nuclear energy. I think there's been some criticism regarding some of the assumptions in the model in terms of construction of 264 gigawatts of electricity from nuclear power by the year 2030. Could you explain what that means in terms of the number of plants, the construction timelines, locations, to see if this is actually a realistic assessment of where this Nation can be with nuclear power in 23 years?

Mr. GRUENSPECHT. My view would be that it is very unlikely that much nuclear would actually be built. But this is a Core case result. It results from running the reference case distribution version of the EIA model which does not reflect constraints that would likely hold the maximum number of nuclear builds to a lower level.

The implications of more modest nuclear builds are reflected in our High Cost and Limited Alternatives cases which are also included in the report. I'd like to give you some context. Until recently the primary issues surrounding nuclear power, as members of this committee know, was whether any nuclear plants would be built. EIA was often excoriated by coming up here and suggesting that our long term outlooks projected that no nuclear would be built through 2030. In this setting, modeling attention really focused on the issue of what it would take to build any and not on a concern that too many might be built. As a result there was not much focus on characterizing constraints that would limit builds.

Without such constraints, nuclear's status is as a demonstrated base load technology with no carbon dioxide emissions that's already close to being economically attractive, even without a carbon constraint. That leaves the model to choose large amounts of nuclear when a strict carbon cap applies. That's a little bit of the history.

Indeed, the reason this study was built the way it was, and this came up in the questions asked by the chairman, was to show what matters. These technology assumptions really matter a lot. There's no implied or intended preference for the Core case as representing the most likely or preferred view.

As I said, technology is important. Public acceptance is also really important. Nuclear is an example of a technology that exists today in large part, but there are issues surrounding public acceptance. So I think it's important we frame this issue. We not only discuss it in terms of if we did R and D, which is very important, but we also have to worry about whether the market will take it.

I'd also point out that 250 gigawatts of nuclear power or something very close to the level we talked about in that Core case was actually ordered in the 1960s at various points in time. One hundred and fifty gigawatts of it ended up being canceled. One hundred ended up being built.

That was a time when U.S. electricity demand was growing at a very rapid rate. This was not just planned plants, it was actually ordering the steam supply systems for 250 gigawatts of nuclear power. So we were able to order literally 250 gigawatts of nuclear in the 1960s. Clearly we're not ordering much if any yet. But it's a very important question.

Senator BARRASSO. Thank you, Mr. Chairman.

The CHAIRMAN. Thank you.

Senator Sanders.

Senator SANDERS. Thank you, Mr. Chairman for holding this important hearing. I thank our guests for all the work that they have done. I just want to say a few words.

I didn't hear much discussion this morning. Maybe that wasn't your assignment. About what happens in fact if the United States and the world do not act aggressively to address the crisis of global warming.

There are studies out there which suggest that in terms of the growth of drought, of flooding, wars, disease, severe environmental disturbances and weather patterns that if we do not act sufficiently we're going to end up in an economic situation worse than the Great Depression with massive job loss and economic dislocation. So I want in a moment, I would to ask some of you to address that issue.

The other issue that concerns me very much, Mr. Chairman, is I think we're into old think here. I do not think that we are looking at the extraordinary potential of energy efficiency to substantially reduce greenhouse gas emissions at a reasonable cost. I think there is not significant attention paid to the tremendous potential in sustainable energy on top of energy efficiency.

I find it hard to be talking about the cost of moving away from greenhouse gas emissions without looking at the reality that we're driving cars today that get 15 miles per gallon. That we have homes and appliances which are grossly inefficient. That we have a transportation system in terms of rail which lags far behind Europe and Japan and in some cases even China. That we have not explored the potential of electric cars. That photovoltaics are just beginning to take off.

So I would say, Mr. Chairman, that there is huge potential out there. We have seen it in California. We have seen it in the State of Vermont in terms of energy efficiency. The day will come and certainly should come that our people will be driving cars that get 50, 75 miles per gallon. There will be millions of electric cars out there.

Just one example in terms of concentrating solar power, as some of you may know there is a plant that is going to be built by Pacific Gas and Electric in the Mohave Desert which should be online within a couple of years. Over 500 megawatts of electricity at a competitive price. There are those people who think that we can build dozens of those plants in the Southwest of the United States that could provide a very substantial amount of the electricity that we consume as a people at a competitive price. No greenhouse gas emissions.

What I fear very much is that our old friends in the coal industry, in the fossil fuel industry, in the automobile industry, simply continue to want us to go the old way and are not looking at a bold, new future. I think if we look at a bold, new future what we can be talking about is the creation of significant numbers of good paying jobs as we transform our economy away from fossil fuels and dependence on foreign oil. Alright.

So my first question and anyone can jump right up there. What happens if you don't act? How much is it going to cost us, the American people, the people around the world in increased costs and in human suffering? Who wants to tell us that?

Mr. ORSZAG. I guess I'll step up. As I tried to indicate I think global climate change is among the Nation and the world's most serious long term risk. It is clear that we are running some risk of potentially catastrophic changes to the climate which would have substantial effects on society and on the economy.

The difficulty really is in terms of timing. Moving away and we can come back to your second point. But moving away from the current fossil fuel based economy, will involve some up front costs, even if the technologies are already available.

Senator SANDERS. Yes, of course.

Mr. ORSZAG. So it's really a question of paying up front an insurance premium, almost, for reduced long term costs. That's one question. The second question is the global dimension of the problem.

Senator SANDERS. You didn't give me an example. There are some of my friends say, look, it's going to be very expensive to move forward. Fair question. A good point. What happens if we don't move forward? How much is it going to cost?

What we're paying in the supplemental bill, if my memory is correct, some $10 billion more for Katrina, $10 billion more. How much will flooding cost? What will drought cost? What will water cost us as we fight for limited resources?

Who wants to tell us how many trillions of dollars we will be spending on that? What will it mean to the people in Wyoming or the people in Vermont if we don't act? I mean because that's really what we're debating. Somebody will say, well, look it's expensive. We can't go forward.

But what I'm suggesting is disaster if we don't go forward. Second of all, I believe you are underestimating the potential of energy efficiency and the new sustainable energy that we can put online right now. If they are breaking ground almost now for a solar thermal plant in the Mohave Desert for $2 billion to provide 400,000 homes with electricity. The people tell me we can build dozens of those plants.

I'm afraid that I don't see such a great cause. Of course there's going to be economic dislocation. Am I underestimating the problem or is there more potential in terms of energy efficiency and sustainable energy than you guys are suggesting. Dr. McLean?

Mr. MCLEAN. On your first question on the impacts, I think this is an area that concerns us greatly. We have several people on my staff who are working on this area. But as you know it's been a very hard area to quantify.

Senator SANDERS. Sure.

Mr. MCLEAN. To monetize. It's an area that we need to make progress on and I agree with you. Because you have to compare what the alternative is. We're working on that as we speak.

On your second questions dealing with energy efficiency and renewables and actions we can take. There is a lot we can say about that. First of all, in these analyses we show a huge increase in reliance on renewables for energy production. That's a recognition of the kinds of points you're making that the technologies are evolving. As the cost, the relative cost for fossil rises, renewable costs decline. They come in.

Senator SANDERS. Dr. McLean, I'm sorry to interrupt. But let me ask you this. I'm reading from a document which says the building just 80 gigawatts of concentrating solar power, these solar plants, a target that is achievable in 2030 with sufficient public policies what which I believe is true, would produce enough electricity to power approximately 25 million homes and reduce carbon dioxide emissions by 6.6 percent compared to 2000 levels.

Does that seem like off the wall or does that seem—with strong public policy? We're saying that's what we're going to do. Can we do that? Are you looking at that type of magnitude?

Mr. MCLEAN. Yes. I can't give you an answer to that. I don't know the numbers without looking through that. I can say that we are showing a greater reliance, an increase in renewables. It has to do with policies as well as cost shifts in those technologies.

Senator SANDERS. Mr. Chairman, the problem that I'm having is if we look at global warming as a really, really serious problem that I believe it is. If we say we are going to commit resources to transform our economy and energy systems. I think we can make real progress.

I think somehow our friends may be underestimating the potential that exists if we really focus on a Manhattan type project. That would be my point. I thank the panelists very much.

The CHAIRMAN. Thank you very much.

Senator Corker.

Senator CORKER. Mr. Chairman, thank you. I just want to say that I love the passion that my friend, Bernie Sanders has. I traveled with him to Greenland where we had a chance to meet with scientists from Denmark and other places. It was most educational.

I certainly appreciate the leadership you've shown. A year ago you and I were in Europe meeting with the carbon traders, meeting with members of the European Commission, utility providers and others. This panel, and I hate that I didn't hear every panelists, but I have a general idea of what each of you has said.

I think what they're doing is shedding light on some of the pragmatic issues that we need to address. The fact is that my hope is that somehow we can take the passion, if you will, that so many have around the issue of the environment and global warming and link that simultaneously with our desire as a country in the short term to have energy security. I think that is possible. That's what over the last year I've been working with others to try to do.

Now we have a bill that's coming to the floor on June 2, possibly. It's a bill that I think is different than the bill we actually came in the room to discuss. My understanding there's a number of amendments and changes that came out at 10 o'clock this morning. So in some ways we're discussing a bill that's not the bill, if you will or not the vehicle.

But I do think that getting down and taking, if you will, that passion and linking it though in a pragmatic way so that we pass a bill that works and moves us in that Manhattan Project way toward energy efficiency, toward conservation. I think that to me, is the beauty of what we might be able to accomplish with cap and trade. That's why our office and so many other people have spent so much time on it.

I think on the other hand there are real decisions that we have to make that really affect people every day. I mean the fact is the bill, as it came out, is not simply a cap and trade bill. I mean, I'm actually a purist. I think in many ways, Bernie, excuse me, Senator Sanders, you and I have some similar views about the purity, if you will, of a bill.

This bill is not just a cap and trade bill though. It's a huge spending bill. I mean at the end of the day, I know it's going to be revised, revisited, revised right now, but right now it spends every penny that comes in in a non-discretionary way. I mean that's an unusual bill. We don't pass bills like that around here.

So we need to talk about that. I think the whole issue of allowances, and I understand Dr. Orszag, may have addressed in his testimony. That's a big deal because we're passing out what is like public shares in a public company.

I mean these things are marketable. How those get laid out is a big deal. I mean it affects so many things. I hope that what we'll do—I know the romance of this is interesting. That's what drives so many people to want to look at cap and trade legislation.

I'm interested in it for that reason. But the fact is that there's a lot underneath this that truly is going to affect us. We need to line up priorities in an appropriate way.

One of the—I'm just going to mention. I'm going to get down in the weeds now. Ok. We got these allocations of allocating out, transferring wealth, trillions of dollars of wealth out to people.

I think people should understand that $7.2 trillion between now and 2050. If carbon is at $13 a ton initially which is what the modeling projects.

Today in London carbon is selling from $38, $40 a ton, so we're talking maybe $20, $23 trillion, preset. Again, I just think that's a pretty important thing to talk about as to how that's allocated. Now I don't understand why in the world we would be allocating credits out to middlemen, to people that have absolutely nothing to do with the creation of energy.

This bill allocates out credits or allowances to States. Why would we do that? I mean, States have nothing what so ever to do with producing energy. What would a State do with public shares in IBM if we just transferred it out?

What would a State do with allowances that we're allocating out that are worth a lot of money? I'd like for one of you all to—and by the way there's numbers of middlemen. I don't mean to pick on States, but why would we do that? I'd like for one of you, any of you to share with me why in the world we do that? What public policy end would we meet in doing that?

Mr. ORSZAG. You'd be helping the State governments.

Senator CORKER. The State governments are actually.

Mr. ORSZAG. The recipients of a permit, I think the best way of viewing of when you give a permit away it is like you sold the permit for some amount of money. Then you just hand the money to the recipient of the permit. So the only objective that you're generally fulfilling is if you wanted to transfer money to those recipients. This accomplishes that objective.

Senator CORKER. So in essence this bill which is to focus on capping carbon emissions transfers out hundreds of billions of dollars to States for no reason.

Mr. ORSZAG. There also are requirements. I mean, the bill is a little bit more complicated because there also are requirements on sort of what happens. But I think focusing on the fact that this is a huge amount of money and handing out the permits is a windfall to many of the recipients is a key insight.

Senator CORKER. Ok. I just have to tell you that I don't understand why, I have no idea what thinking could be behind that. By the way there are numbers of other people that have nothing what so ever to do with reducing carbon that are given these allowances. It makes absolutely no sense. I hope it is something we will address.

The other issue that I bring up today, I have many others I'd like to talk about, but it's the international allowances. I listened to my friend again, Senator Sanders, who I like as much as anybody here in the Senate. I love his passion. He's talking about capping emissions here in our country.

Yet this bill provides for us to buy international credits. That does nothing what so ever to lower emissions in our country. All it does is allow people who are emitting to lower their costs.

What it does do is transfer out. I want to say in a time we have a trade deficit, ok. We're losing jobs here in our country. Again it transfers out hundreds of billions of dollars to other companies.

I will just say and Senator Bingaman and I have witnessed this in Europe, to projects that actually in many cases are fraught with fraud. I'd like for someone to please share with me on what public policy motive, if you will, we would allow our money here in this country to be transferred out to international credits to many coun-

tries that are not capping emissions. I'd love for somebody to support that notion.

I just want the record to show that——

The CHAIRMAN. You've got—we'll give another 10 seconds for an answer. Then we'll——

[Laughter.]

Senator CORKER. Ok.

The CHAIRMAN [continuing]. Move on to Senator Salazar.

Senator CORKER. Ok.

The CHAIRMAN. Yes, Dr. McLean.

Mr. MCLEAN.Yes. Can I take on your first question?

Senator CORKER. Sure.

Mr. MCLEAN.What would States do with money? I'm not defending the amount of money or even whether this is a good policy decision, but just to answer your question about some uses that it might be put to. Then you can decide whether those are worthy.

First of all, a lot of efficiency programs are run at the State level by energy offices and other offices within States, so some of that funding would go toward assistance in running those programs. There's assistance to low income——

Senator CORKER. Could be. The bill says could be.

Mr. MCLEAN. Right. So I'm not saying, you know, you can decide whether that's worded correctly or it accomplishes its purpose. But just to say there are purposes I think that people have in mind. A third area would be adaptation. I mean there's a whole issue of what do we do in response to the inevitable things in terms of infrastructure and responses there.

So there would be expenses and costs and some people believe that this would be a way of covering that. Now you can raise the question is this the right thing to do? Is this the right amount of money? There are certainly questions there. But it's not that there would be no purpose to it. But I understand your point.

Senator CORKER. Mr. Chairman, my time is up. I realize. I just would make one more comment. That is, I mean this with total sincerity, I think we have a chance in our country to quit the squabbling, to focus on our environment in a responsible way and to tie the concern for our environment responsibly to some pragmatic things to cause our country to be energy secure.

I think we can do so in a way that does away with all this picking of winners and losers and the subsidizing for 3 years and then not subsidizing. I think it's really incoherent what we do as a country. But I hope we will do as a Senate is to truly look at what this bill says. Then work together.

I mean this totally sincerely, work together toward a pragmatic end. I hope that what we do on June 2 is a dry run. I don't think enough people in the Senate actually understand what this bill really does.

I hope that we together can do something. I mean it to harness the passion for our environment with the absolute need for this country to have an energy policy that causes us to be more secure. I thank you so much for this hearing.

The CHAIRMAN. Thank you very much.

Senator Salazar.

Senator SALAZAR. Thank you very much, Mr. Chairman. I would be happy to be a co-sponsor of the Corker-Sanders Climate Change bill.

[Laughter.]

Senator SALAZAR. When they get it together given the passion that they bring to the issue. If they can get it together I think they might actually get a number of co-sponsors with the same practical approach that both Senator Corker and Senator Sanders were talking about.

Let me first say, Mr. Chairman, I think it is incredibly important that this committee exercise its jurisdiction over this issue because when you look at what's been happening in the last three and a half years that I've served on this committee. We have been trying to define a clean energy future for America. It is inextricably tied in to what happens with global climate change and what we do with the cap and trade systems.

So I think your holding this hearing is very important because at the end of the day what we're doing is defining the new energy future for America. I think in fact that I would suggest, Mr. Chairman, I don't know that we have time between now and June 2. But hopefully it will be something that will be a continuing feature of what we do here in this committee. I know we've already had hearings, but I think also this is an area where, as Senator Corker pointed out, there's a lot of information, a lot of learning yet to be held.

I'm going to ask a question that I wanted to Dr. Orszag and Dr. Gruenspecht to respond. That is on the allocation on the auction revenues that are set forth in Lieberman-Warner. There are nine categories that are set forth there.

My question to you, as you think about that, is whether or not those allocations are correct. Whether changing those allocations, given the sensitivity of the models in terms of technology investment, might make a major difference in terms of our GDP as well as in terms of the effects on consumers. Let me give you, as your thinking about that question, just a comment.

You know for me when I look at the practical reality of what we've done out of this committee in my State of Colorado. In 2005 we were producing no power at all from wind energy. As a result of what this committee has done, today we're over 1,000 megawatts of energy from my State, almost 1,500 megawatts equivalent of what 5 mid-size coal-fired power plants.

We had no biofuel industry to speak of 3 years ago. As a result of what we've done here with renewable fuel standards and other incentives we now have 5 ethanol plants producing several hundred million gallons of ethanol a year. As a result of what we've done in this committee as well as the Finance Committee and the Agriculture Committee, we're creating great incentives for cellulosic ethanol that hopefully the President will sign into law with the Farm bill that will override soon. We're looking at a whole host of other things. Geothermal and solar, biomasses and all the rest of what we include within the renewable energy portfolio.

As we've worked on these issues over the last three and a half years so closely with Senator Bingaman and Senator Domenici and their leadership. I've always viewed the energy future for us as a

tied into first of all, efficiency. That's a low hanging fruit. Many in the business community very much support what we're trying to do to create incentives to be much more efficient than how we use our energy.

Second, opening up this new door of opportunity to renewable and alternative fuels, which we're working together with the Administration on and many of the legislation that we passed.

Third, the new technology. When we talk about hybrid plug-ins or we talk about IGCC, that all is incredibly important in terms of getting us to where we want to be on energy independence.

Fourth, we're going to continue to use some of our conventional fuels whether that would be coal or that would be oil or natural gas out of the Gulf, domestic production we're going to continue to do that as we make this transition.

My question is at the end of the day whatever global climate legislation we pass there's going to be created a pot of money. It could be a very large pot of money. I think in the Finance Committee Dr. Orszag testified it was several hundred billion dollars a year that might be created from this cap and trade system.

Ultimately the question I think we're going to face here is what is the best way of investing those proceeds. Because last year when Secretary Bodman, wonderful leader, who said that we were not going to move forward with FutureGen because we couldn't find the money to move forward with carbon capture and sequestration with new coal technology. We didn't have the money to do it.

So at the end of the day it seems to me what Lieberman-Warner is trying to do in allocation of the nine categories is try to figure out a way how we fund these new technologies. So we can develop this new energy future that will be good for the economy, good for the climate. Get it done so we're not at a point where we just don't have the money to do it.

So my question to both of you, if you can spend a couple of minutes on it, is is this the right allocation?

Mr. ORSZAG. I'm not going to talk to right or wrong. But in terms of achieving—it depends really what your objective is. They're different objectives. You can try to cushion the blow for low income households. You can try to reduce the macro economic costs. You can try to accelerate over time the adoption and deployment of technology.

Depending on what your objective is this may or may not be the right thing to do. So, for example, on macro economic costs, at least with regard to the short run, a more effective approach would be to auction the permits. Then use that auction revenue to reduce other distortionary taxes, like payroll taxes or corporate income taxes. That was one of the points I made in one of the slides. You can have a significant effect on economic efficiency through that kind of approach. If instead you wanted to more cushion the blow for low income households you'd go in that direction.

I don't know because I wasn't present in the drafting whether——

Senator SALAZAR. Let me ask you, Dr. Orszag. A lot of people, a lot of my colleagues on both sides of the aisle have talked about a Manhattan Project. We heard Senator Corker talking about it. I heard Senator Sanders. A lot of people.

They're talking about the kinds of resources that embark on Manhattan style type of project. Would it be better to invest that money in the new technology pot as opposed to softening the blow on low income consumers that might be affected? How can we essentially launch a Manhattan style project that ultimately would be effective?

Mr. ORSZAG. Two things quickly. One is, I mean there is only—it's big. But there is only a given size of the pot. So you can't do all things for all people at all times. It is significant that, you know, a trillion dollars or more over the 10-year window.

Second we do need to remember in terms of the deployment and adoption of new technologies there will be something that happens just through the price signal that would occur through pricing carbon emissions.

Then finally if you wanted to go beyond that, one could, yes, either auction the revenue and explicitly fund new R and D or one alternatively could allocate the permits to the entities that are undertaking R and D. In general that's less—that's more opaque and may not lead to as a good policy outcome.

Senator SALAZAR. Mr. Chairman, could I have Dr. Gruenspecht——

The CHAIRMAN. Yes, Dr., why don't you go ahead? Respond. Then I'll call on Senator Domenici.

Mr. GRUENSPECHT. I would actually associate myself with a lot of Peter's remarks. I would say they're really issues on the economic side. There's issues of economic efficiency and concerns related to what I would call fairness, whether its the impact on low income consumers or other such things. The weight you put on those would matter.

On the energy side there's energy efficiency and then there's energy technology and the weight you put on those would matter. But really that is a policy call. I don't think EIA is really well placed to say what the right ways are, so other than framing the question I would defer.

Senator SALAZAR. If I may, Mr. Chairman, just 15 seconds on this. I think that at the end of the day that's one of the huge issues obviously, that we'll be debating. If we create this pot of money where are you going to make the investment?

You know, I've had conversations with you and Senator Domenici over the years that we have these great thoughts and these great programs and at the end of the day the question is well, where is the money? We can talk about plug-in hybrids and clean coal technology, but if you don't have the money to move forward with that then we really have an empty policy. So I think this is an opportunity for us to marry up our work with what we're trying to do on global climate change to make our vision a reality.

The CHAIRMAN. Thank you very much.

Senator Domenici.

Senator DOMENICI. Let me say to my friend from Colorado and to the rest of my Senate colleagues, as well as those people at the table, I haven't been here because I had to go to a budget meeting, and for once in my life I didn't have to do any work there. They wanted to give me a present—they gave me a big gavel.

Senator CRAIG. Was it money?

Senator DOMENICI. No, it was not money. That's the point I'm going to get to—they gave me a gavel. I assured them that while I cleaned up my office and put things in boxes that I wouldn't throw this one away. It was too nice. I thought I'd keep it.

But let me just say I've been looking at the so-called Manhattan Project approach, which came from ideas out of the brain of Senator Bingaman and some thoughts out of mine. I really don't think we need to have a cap-and-trade regime, and rely upon the money it raises to create a Manhattan Project. What's evolving from the Manhattan Project idea is the notion that we don't need one. We need a bunch of mini-Manhattan Projects instead.

You need to pick about 8 or 10 issues that you must solve. You can take them and put them into a Manhattan Project context. You certainly can do that within the current wealth of our Nation without producing a new engine of wealth, which is what the rights to pollute which we're talking about here really are.

I wanted to say to you, Mr. Orszag, that at a various point in time in this place, the CBO Director called something we were doing differently than everybody else had been calling it, and became a very big hero. Your predecessor, third removed, whose name slips my mind, made a decision in the middle of the discussions of health care by the Clinton Administration.

Mr. ORSZAG. Mr. Reischauer.

Senator DOMENICI. Reischauer. Regarding the Clinton Administration's plan for health care, he ruled all on his own over there and it became binding that that health care plan was a tax. You might remember that, and that, in my opinion, was a realistic analysis of the plan. It denied the plan's effectiveness because it was going to be too big a tax.

You have come along and I don't know if you're first and alone. But you're talking realistically about this program as if it were another gigantic Federal reserve system or another gigantic banking system that what would be created. These credits would be worth billions, if not trillions of dollars that are going to be floating around this economy. We don't know who's going to end up owning them and who's going to end up losing them.

But you have made it eminently clear as an expert that we need in our government to understand what cap and trade is. I understand that much better because of the way you've addressed it. I thank you for that. I think more people are going to understand it and be very quizzical about what in the world we are doing when we attempt to do this.

I'm going to ask you a question. If it doesn't make sense then don't answer it. But I believe——

Mr. ORSZAG. What a luxury.

Senator DOMENICI. Ok. I believe that what we really need to do is develop new technology at the most rapid pace possible to reduce greenhouse gas emissions. How does that strike you and your understanding of what we're doing here? What if we said we're going to spend $30 or $40 billion and get these new technology requirements achieved? Tell me. Answer that for me.

Mr. ORSZAG. Sure. With respect. I do think that pricing carbon will be a spur to the adoption and diffusion of lower carbon technologies. So the thought that the technologies will just develop and

then be, especially, be deployed aggressively in the absence of a price on carbon is unlikely to be as realistic as in a context in which carbon emissions have some price associated with them.

If you look at current energy efficient technologies that they often don't diffuse as widely as some experts believe both because of the price signal. I also think we have to pay and this is a broader point, I think we have to be paying a lot more attention in public policy, not just the financial incentives and those matter.

But also to, basically to behavioral psychology, the way people actually behave. The way things would get adopted. The way things are framed for example and what's presented first, whether the energy efficient refrigerator or something else can have a very substantial effect on outcomes. We haven't really gone very far along that road in hearing both financial incentives and things like defaults and how things are presented in changing behavior.

Senator DOMENICI. Ok. To change the subject a little bit. Before the Senate Finance Committee on April 24, you asserted that research has suggested a tax on greenhouse gas emissions could achieve a long-term target at roughly one-fifth the cost of an inflexible cap and trade regime. Could you characterize S. 2191 in terms of its flexibility or inflexibility?

Mr. ORSZAG. There's some degree and this point is the same one that I was trying to make through a price ceiling and a price floor within a cap and trade system. The key is timing flexibility. A tax actually provides you timing flexibility to undertake the emission reductions when they're cheapest.

The Lieberman-Warner legislation has some limited timing flexibility through the banking and borrowing provisions and through the related Carbon Market Efficiency Board. But it is not as much as would be achieved through the kind of dynamic price system that we discussed earlier or through a tax.

Senator DOMENICI. This commodity, which is a right to emit, will presumably have a value in the global market. What is the impact on American economic competitiveness, of imposing a cost in the U.S. that is not imposed in emerging economies, if in fact we are creating "creating a commodity" as you asserted the Lieberman-Warner bill would do in your testimony before the Finance Committee.

Mr. ORSZAG. There are really two issues here. One is an environmental question and the so called leakage question about whether production and other activities and therefore emissions move to other countries. The second is the sectors in the United States and sort of what is happening to their production.

The concern is most salient with regard to, on that later point, with regard to a very limited number of sectors, aluminum, uranium processing. There a bunch of sectors that are very energy intensive. The legislation has a component in it to try to cushion the blow on those sectors.

But it is the case that the, those, and it's a limited number, but those energy intensive sectors will likely experience some shifting in their production patterns relative to other countries.

Senator DOMENICI. Thank you, Mr. Chairman.

The CHAIRMAN. Thank you.

Senator Sessions.

Senator SESSIONS. Thank you. There will be, likely some shifting patterns. What you mean is, I was talking to a chemical company person whose plants in maybe 50 countries in the world who told me that natural gas prices are high in the United States relative to a number of other places. Those plants exist. With increased cost of natural gas energy in the United States if their company decides to expand production it will not be in the United States.

In fact they hadn't expanded at that plant in years. Senator Voinovich says that the chemical industry has been devastated in Ohio as a result of this. This is not academic.

You drive up the cost here whereas our competitors in China and other places which already have wage advantages also have now energy advantages. It really begins to put our people, our jobs at stake. I want to mention that.

Mr. Chairman, thank you so much for having this hearing. I find it almost breathtaking that our EPW colleagues who voted out this cap and trade bill did not have a serious hearing on the cost that it would incur on the American people and our economy. I thank you also, several years ago, couple of years ago for having a hearing on cap and trade.

We had Europeans testify and other experts. I went into that hearing more positive about cap and trade. When I came out of it I was more uneasy.

My unease has increased having read a, I think, a fabulous article in Scientific American who went into great detail saying first, if you're going to do this, a simple tax is better. But if you do a cap and trade these are the difficulties you have to work through and the lawsuits and the fraud and all the problems that go with it. When I got through reading it I realized I concluded it wasn't a very good idea. Second they noted at the conclusion it's still better to have a simple tax than the cap and trade, although they favor a massive reductions and are concerned about global warming.

Senator Corker and I agree. I think most of us in this Congress have come to a conclusion that we need to do something that works. I have made that decision.

It's going to cost money. It's going to cause us to change what we're doing. But a seven to $23 billion cost to John Q. Citizen is what we are, trillion, $7 to $23 trillion cost is what we're talking about imposing on our constituents. That's the average working American. So we have to be careful about that. We really got to be careful.

I think it's an intoxicating concept that we can empower what would be masters of the universe to sort of control this economy. That's a seductive concept. A lot of people just can't wait to be empowered to start regulating all of these things and passing out credits and picking winners and losers and that kind of thing. I think it's very, very dangerous. It worries me.

I would note this. Before I would say that. I want to agree with Senator Domenici.

My basic concept is kind of let's do the things that work. Let's get busy doing them now. Let's find out what is impeding those things that work from occurring now. Let's figure out how to eliminate those road blocks. Let's do it and sooner rather than later.

But I want to point out for a perspective that between 2000 and 2010, according to the University of California study that just the growth in China's greenhouse gas emissions will be approximately six times greater than all the commitments to reduce carbon made by all the developed countries signatories to Kyoto in the same time period. Any of you familiar with that or want to dispute that? That's a significant thing.

Also I would point out to my colleagues that according to the International Panel on Climate Change, as I understand the numbers, they project that if we and the world signs on the Kyoto and we go forward with these very strict controls by 2060 it will reduce the growth of temperature onto the climate models by less than one tenth of one degree centigrade, really .07 percent of a degree centigrade, which is almost unmeasurable. So we've got to be humbled here before we start thinking about imposing great burdens on the American people. I just want to make that point.

You, Mr. Gruenspecht, talked about the nuclear component. You indicate it's unlikely we would achieve the projections that some have considered. The EPA analysis of the America's Climate Security Act assumes substantial growth, Dr. McLean, in nuclear generation, approximately 150 percent from the 782 billable kilowatt hours in 2005 to 1,982 billable kilowatt hours in 2050. This is about 200 new nuclear plants.

Today there are 104 power plants in America. I think Senator Domenici and I agree that one of the things we need to be doing, perhaps on a higher priority than cap and trade is to figure out how to make that happen. Do you see, is it going to take legislation and other actions in Congress to move to that kind of growth in nuclear power? Is it important to have this kind of nuclear power growth to meet our global greenhouse gas emission goals?

Mr. GRUENSPECHT. I think we'll try to split that.

Senator SESSIONS. Good.

Mr. GRUENSPECHT. Like an ice cream sundae. Nuclear power exists. It's carbon free. I think there are real challenges to public acceptance.

I think one of the issues is that, you know, issues and problems need to be prioritized. I know there are some concerns that some people have with nuclear power, but the sense is if global climate change is prioritized as a very high challenge, the thought is that you already have nuclear power technology.

In one sense looking for technologies is very important because one technology is not going to do it. I think everyone agrees with that. On the other hand, with nuclear power you have a technology that, again, is very attractive in terms of greenhouse gas emissions.

So the real issue is that choices have to be made, as you, as a Senator, are involved in every day and know very well. I guess it's really a policy design question that I danced around a little bit in my testimony. But that technology is very important. Public acceptance is also very important and designing programs in a way——

Senator SESSIONS. Let me just suggest, I don't think that as a professional politician I'm not as worried about public acceptance. Some are. I think it's a question of how we can get there.

Mr. GRUENSPECHT. Ok.

Senator SESSIONS. Feasibility, economically, technologically.

Mr. GRUENSPECHT. I think it's fairly attractive with a significant carbon price, nuclear power is attractive.

The CHAIRMAN. Dr. McLean, did you want to add something?

Mr. MCLEAN. Yes, just a little bit. I basically agree with the points that Howard was making. But in our analysis we project a little bit lower nuclear than he does.

But one of our constraints we added was just how much have we ever produced in the past. So we sort of looked at the last 30, 40 years when we were building in nuclear. We sort of said that's how much we can do in a 10-year timeframe. So it reduced it a little bit.

But the basic element is that both of our models look at this as an economic issue. These are economic models. Economically this becomes more attractive as an alternative than it is today. The issues are not the economics of building these facilities.

The issues are as you know proliferation, waste and safety which he's referring to as public, sort of, acceptance. How you address those and how you overcome those will determine the extent to which it's used. Not the economics or the ability to construct it.

Senator SESSIONS. Thank you, Mr. Chairman.

The CHAIRMAN. Thank you.

Senator Murkowski.

Senator MURKOWSKI. Thank you, Mr. Chairman for calling this hearing. I would agree with all of my colleagues. This information that we're getting this morning is exceptionally important for us as we consider whether it's Senators Warner and Lieberman's legislation that we'll be taking up or whether it's your legislation, Mr. Chairman that I have signed on to.

But we need to understand what it is that we are doing as we embark on policies that are enormous in terms of a departure from where we currently are. Analyzing and understanding the costs behind our policy decision are something that we just can't hope that we get it right. I think some of us are looking at the decisions that we have made when it comes to ethanol and our reliance on corn based ethanol that is having an impact on the price of food. We're kind of walking this land of unintended consequences.

I want to make sure that when or to the fullest extent possible that as we move forward into this new world of cap and trade, new to this country, that we're not waking up and saying, oh, my gosh, what have we wrought. I, in preparing for this hearing this morning, talking to my staff who spent a fair amount of time yesterday reviewing the 74 page report from CRS. He described it as mind numbing. I think that that was probably a polite way to put it.

[Laughter.]

Senator MURKOWSKI. But I will tell you I came away from the exchange that we had yesterday and recognizing the various reports that are out there with an understanding that you've got a whole multitude of different reports. Modeling based on different assumptions generating vastly different results. I think we would agree that there's some uniformity of opinion that Warner-Lieberman will reduce our Gross Domestic Product, but by how much.

I will attribute this to my staff, but when he was looking at the EPA model, the Clean Air Task Force, NAMs, EIAs, he comes back

and he tells me there's a cumulative difference between all of these reports of nearly four trillion dollars between these models. So you kind of say, well, so what does this mean? Who's right? Who's using the assumptions that are most likely?

When you look at what it means to our constituents. That's where we've got an obligation to try to do better than just, kind of, second guess. When you look at the computer models that the EIA uses, they peg the cost to the average household somewhere between $76 and $723 in 2030. This is quite a spread.

But the NAM model puts that spread at between $4,000 and $6,750 per household in 2003. The EPA model puts it at between $446 and $608 into 2020. But this is less than half of what Charles Rivers Associates predicts.

So I said well, what does it mean. This is again, mind boggling. Mind numbing. What does it mean for my constituents in Alaska?

So we're looking into some of the specific studies and NAM predicts it will cost the average Alaskan household between about $4,500 and $8,200 a year in higher energy costs. It will cut jobs in the State between 6,400 and 8,500 in 2030. Then you go to the Heritage Foundations model and they put Alaska's job loss at 1,800 by 2025. Meanwhile the University of Alaska with their economic modeling, they imply that the cost will be far less, especially in terms of jobs.

So I'm looking at this and I'm saying, who's right? My constituents are saying to me, well Lisa, if we're going to embark on this kind of a policy, what does it mean to me and my household because right now we're getting socked when it comes to the cost of energy. That's not only in Alaska, that's all over the country.

So we've got an obligation to be fair and honest with them when we move forward with policies like this. Because if they say, you know what, the cost really is worth it. If they agree with Representative Sanders that the price of doing nothing is not something we're willing to take on. We still need to give them some assurance of what we're looking at.

I'm not convinced that we know. As Senator Corker said, we're going to go to the floor after the Memorial Day break with legislation that you all haven't really modeled yet. Now I don't know how long it takes to do these models but I don't think you're going to be able to do it over the Memorial Day break.

So, Dr. Parker, Mr. Yacobucci, is it even fair to ask the question of you of all the models that are out there and yeah, there's a new one out today. The NERA Economic Consulting that was done at the request of the National Petroleum and Refiners Associations. So the reports are coming out all the time.

Is it fair to ask you which model you think is perhaps best? Can you rank them? Does it really all depend on the level of assumptions? I know you're going to create friends and enemies here. But we need a little better sense as to where we really look. Can you help me out?

Mr. PARKER. Is it fair? Probably, no.

[Laughter.]

Mr. PARKER. I think it depends on what you're asking out of the models. How reliable or predictable they are. If you're looking for one of the models to give you the answer that this is what the

world will look like in 20 years and this is what it will cost. None of the models will give you that answer. Not reliably.

You know, it would be if they could, perhaps we could make them our stockbrokers and make lots of money because they could predict the future. What the models can do is to tell you have we designed this bill so that under different circumstances we have kept the price down as low as possible. What element in this bill helped hold the price down? What elements in this bill tend to increase price and how could they be modified so that we are bringing these reductions in at the most cost effective level. That is what the models can do for you.

So for the analyses that have done the most sensitivity analysis on these different technological, economic and behavioral assumptions are the ones that are going to be the most useful. So do that——

Senator MURKOWSKI. But the most useful but for whose end? If I'm opposed to cap and trade legislation I'm probably going to look at the NAM model because that predicts that the costs are going to be higher. If I'm a supporter, I might be looking at somebody else's modeling and the assumptions that are there.

So I think we also need to recognize that we can use these models, use these projections just as, you know, we use statistics to support our particular situations. So you're saying that really nobody's right, nobody's wrong. It just depends on the level of assumptions that are going into it. Is that correct? Dr. Gruenspecht?

Mr. GRUENSPECHT. I guess Larry still has all his friends.

[Laughter.]

Senator MURKOWSKI. He's a politician there.

Mr. GRUENSPECHT. I'm going to lose some. I think you have to realize the different studies, you know, in part they start from different baselines. As EPA said, if they looked at the Annual Energy Outlook 2008 which includes the bill that Congress passed that was enacted last year, the Energy Independence and Security Act, they may come out someplace different.

They start from different baselines. They analyze different provisions. You mentioned the Charles River Associates analysis. They get a fairly big impact early from the low carbon fuel standard. I don't think any of the other analyses looked at the low carbon fuel standard. In our case we felt it wasn't specified in the bill enough as to what it was. So we just didn't want to make assumptions about it.

I already had a fairly long discussion with the chairman regarding the NAM and the issue that they may have wrapped up the effect of S. 2191 with the effect of a different oil price scenario. So, you know, there is going to be a range, I think, so you could try to standardize some of those things and probably narrow the set a little bit.

But again, it's technology and technology acceptance by the public in some cases. A lot of times people want to make assumptions that may lower the cost. Then you might suspect that some of those same people would be the people who would oppose those technologies after the bill was enacted.

So it's hard for me to give you advice. But if one designs one's policy so that the incentives after enactment are consistent with

the assumptions made about technologies and costs and market penetration while the bill is being debated, that's probably your best chance to avoid this kind of concern—that an assumption is made and then you find opposition to that assumption once the proposal is enacted.

Senator MURKOWSKI. Thank you, Mr. Chairman.

The CHAIRMAN. Thank you very much.

Senator Craig.

Senator CRAIG. Mr. Chairman, thank you. Let me pick up where Senator Murkowski left off. I think we're all frustrated about where we are or where we might be. I don't know whether I'm willing to risk Idahoans on the environmental models of climate change or the economic models of climate change. Neither of them are accurate.

This committee under the leadership of Senator Domenici and Senator Bingaman a few years ago passed a sweeping energy policy act in 2005. We had spent years shaping it. We knew what it would do. It's in large part doing it.

Here we are now looking at models and legislation that none of you had a chance to really examine. As you can see you're all over the field, as is the country. In probably an effort that Congress has never undertaken before in micromanaging the economy of this country to this magnitude.

I'm not quite sure I can remember. Our staff has done a little research. Have we ever as a Congress tried to micromanage the marketplace in a way with the magnitude that these bills are offering? I think the answer is no, Mr. Chairman. That's never happened before.

So when Senator Murkowski asked the question that is asked of her constituent. She better be right if she votes for this and so had I and everybody else. Because I'm not quite sure that we'll build the switches accurately enough so that we can turn them quickly enough.

Once we've told the world to go invest in this direction. We find out that it's inaccurate or it's dislocating in a way that we can't live with. So we say, no, we'll turn the switch a little more in this direction. We'll shift trillions of dollars of investment in another way. But that's kind of the game that wants to get played here.

Models are models. Let's look at this model. This is Heritage's model based on all the accuracy. It says that somewhere out there there's a three million job loss.

Most of it comes in the manufacturing sector. That's the dislocation that Senator Sessions is talking about. About a million of it comes in the household sector.

I'm not one of those who certainly says we get it. If we're going to do this we better get it right instead of play the politics of a Presidential year. I wish the chairman was here, that our leader now wants to do because somehow this has magnitude in it of political value. I serve on two committees the EPW Committee, so I've marked up Lieberman-Warner as have several on this committee. We probably have a better grasp of that then others of this committee do.

We were pushing the chairman to get allocation figures. She's now come out with them: $911 billion to consumers to help energy

costs, $566 billion to States to deal with greenhouse gas cuts, $307 billion to fossil fuel electric utilities, $254 billion to States that rely on manufacturing of coal, $253 billion to States and tribal adaptations and 237 billion to wildlife conservation and $213 billion to carbon intensive manufacturing of iron, steel, paper, etc, etc. Phenomenal redistribution of wealth, I think that word has been used here before.

So whether it is old think or new think or green think. The reality is we're not thinking at this moment because we don't have the model. We don't have the legislation, Mr. Chairman that will ultimately go to the floor in a way that this committee has to be able to examine it in great detail and listen to these gentlemen and their staffs after they've had a chance to look at it and model it and work on it extensively.

We get this one wrong, we're in deep trouble. If we're talking about trillions of dollars that we're going to flow out there in a way that many have spoken to this, here's another little irony. I tried to get a forestry sequestration amendment in the Warner-Lieberman bill on EPW. Not allowed, not allowed.

Yet I now find the chairman of that committee's going to offer an amendment on the floor that will allow 10 percent of the bill's compliance requirements to fund international reforestation. Now somebody used to chair the Forestry Committee. I can't find a dime to reforest U.S. forests. But we're going to ask ratepayers and industry to gain the system at 10 percent to reforest somebody else's forests.

That's green speak folks. That has nothing to do with economics. That's purely environmental politics across the top. You can't model that one. Don't try.

I'm not going to ask the question because you've all worked hard. I've looked at it. I'm reading your material. It's as valid as the day it was written and tomorrow it will be invalid because we're going to write it differently. Then we're going to ask you to come back and turn the dials on your models a little to see if you can readjust.

But I believe, Mr. Chairman, there are a few simple conclusions to be made. This committee, no other committee of the U.S. Congress has ever tried to micromanage the U.S. economy in the way we're attempting to do it today. The long-term impact, if we get it wrong, is devastating.

So let me conclude with this idea. It's a different way of measuring. If climate change is creating radical factors in the climates of our world, and it may. I'm not going to say it isn't.

Right now we're averaging about 1.9 hurricanes a year in the United States. Now that's at an average of $5 billion. Ok.

Do you know what the impact of this if all of the modeling is reasonably accurate is on the economy of our country and our peoples? It's between 300 to 900 hurricanes from now to 2030. You don't have hurricanes in Alaska. Nor do I in Idaho. But you will now.

Because we've spread the hurricane hit nationwide. All of these States of the Nation. It isn't just Florida, the Gulf Coast and possibly some of the Southern East Coast. It's all of the U.S. economy now gets hurricanes between 200 to 900 additional hurricanes between now and 2030 from an economic point of view, instead of the

five billion a year spread somewhere along the Gulf Coast and up the East Coast.

Mr. Chairman, we've got a lot more struggling to do with this issue before we get it anywhere near a way that we can take to the American people to say this is the right thing to do. I would hope that you as chairman and this ranking member fight to allow that to happen, instead of the politics that is getting played with this at the moment for the sake of politics. Old speak, new speak, or green speak, I'm not sure where we are. But right now I suspect no speak is the safest for our citizens and our constituents as we attempt to figure out which way to go.

Thank you. Thank you all very much for being here.

The CHAIRMAN. Thank you. We've all had a chance to ask some questions. Let me do a short second round if we can. Let me ask a couple of questions.

Dr. Parker, you and Mr. Yacobucci, in your report which I complement you on. I think it's very useful. You have this statement which I thought was good about how long-term cost projections are at best speculative and should be viewed with an attentive skepticism.

I think that's a good phrase. Attentive skepticism. That's what you develop around this place. Attentive skepticism.

Senator DOMENICI. Attentive.

The CHAIRMAN. Right. It strikes me that projections of job loss or job creation are also extremely speculative. It's much easier to project job loss than it is to project job creation when you are seeing a transition of an economy from a high carbon based economy to a low carbon based economy, which is sort of what we're looking at for the next couple decades.

I'd be interested in your reaction to that, Dr. Parker, if you agree with that or disagree, and if any of the rest of you that wanted to comment.

Mr. PARKER. First, let me state that yes, once you move from primary economic impacts to secondary economic impacts you have added another layer of uncertainty in your analysis. I'm saying this is a cost to translating that into an employment impact means you're already making assumptions, what you believe. Not only the impact of what the bill is. But what you believe future productivity is going to be. What future life going to be. What it's going to be in terms of future leisure opportunities. You're making a whole host of assumptions about future quality of life that a generation will be making that currently doesn't even work.

So therefore, you have added an entire new layer of uncertainty on top of your analysis. So the attentive skepticism becomes even more attentive because you have numbers that are even farther away from the economic analysis in the first ones were. So my general concerns about these analyses would be increased when you were talking about employment numbers.

The CHAIRMAN. Dr. Orszag, did you have any thoughts on the ability to use these kinds of models of potential cap and trade systems to project impact on employment?

Mr. ORSZAG. There is, I would just reinforce. There's a significant amount of uncertainty surrounding any of these point estimates. Most of the effect, if you're talking about jobs, most of the effect

will be on the type of job, at least over the medium to long term and not the number thereof.

That's a general phenomena in the economy does, even with a reduction in GDP will adjust the types of jobs. They may be a different set of jobs. But the typically analysis that's done that studies the number of jobs is often excludes the dynamic adjustment of the economy over time to new conditions.

The CHAIRMAN. I assume that that's the case with the various models that we've looked at here or that have been done on this. There's no effort to incorporate any kind of dynamic adjustment.

Mr. ORSZAG. I tend not to focus very much on the jobs numbers that come out of these sorts of analyses.

The CHAIRMAN. Ok. Alright. Dr. Parker, did you want to add anything.

Mr. PARKER. I would just completely agree with that last comment by the CBO that we don't tend to focus on those numbers either. We consider them very, very uncertain. Therefore we are very skeptical of them.

The CHAIRMAN. Why don't we go ahead and see if Senator Corker has additional questions?

Senator CORKER. I'm going to make some additional comments. Again, I think this hearing has been outstanding, our testimony. Many of you have been in our offices for some of these numbing presentations and we appreciate the tremendous amount of time that you spent with us both here and there.

Senator Salazar did ask about technology. I just want to say that the way that this bill now talks about technology is 52 percent of the auction proceeds which again we need to be deciding how much is auctioned and how much is not. But 52 percent of the auction proceeds actually go into technology development.

The way this is set up a five person board, not the Congress which maybe that's a great thing based on what I've seen in 16 months. But a 5-person board decides how this money is spent. So just to give it, you know, at $13 a ton as a beginning assumption, which I think is the basis for this modeling in the first place.

Again I'd like to add that in Europe today, that carbon is selling for $38 to $40 a ton. So we could be talking about vastly different numbers. Through the life of this bill, $2.3 trillion would be spent on technology development. It would be decided by a 5-person board, generally speaking, as to how that money was spent.

Again, some of these factoids I think are things that people in the Senate and the House and certainly this country should care a great deal about.

Senator DOMENICI. How much money was that?

Senator CORKER. It's $2.3 trillion at a $13 ton beginning price. I mean if you look it could be $6 trillion, $7 trillion and again a 5-person board deciding where these moneys go.

Let me move to another point. We talked about upstream verses downstream. With a board with this distinguished, mind numbing panel, agree that if you in essence have upstream allowances that's in essence pretty much a direct tax. A downstream allowances an indirect tax. Would you all like to—in other words if you're taxing petroleum out of the refinery based on the number of gallons because we know, you know, how much carbon content it has. In es-

sence that's a pretty direct tax. Is it not, if that's how we're doing the allocations, upstream?

Mr. ORSZAG. I guess in economics, direct and indirect taxes have these sort of technical meanings. But ultimately regardless of whether you applied it upstream or downstream consumer prices are going to go up. Consumers will bear most, if not all, of the burden involved.

The upstream verses downstream question should really be one in terms of administrative efficiency and what's the simplest to administer.

Senator CORKER. Ok. I understand that refining it is easier to do upstream. Utilities you can do it downstream because of some of the monitoring systems we have in place.

I guess what I'm leading up to is that in essence this is a tax. By the way, I think we all understand that. We're still focused on this piece of legislation. It is in fact a carbon tax.

What's happened though in the process of this bill, interest groups have gathered around the table which I don't blame them when we're talking about trillions of dollars and have made a, what could have been very simple with a carbon tax, something very complicated and many people are going to benefit. I mean, we see them walking up and down the hallways non stop. I mean this is a transference of wealth of monumental—it's monumental what's occurring if this bill were to pass.

I'd like for each of you to quickly address the efficacy of just having a carbon tax. I mean at the end of the day what we're about, I think, is trying to change behavior. Ok. A carbon tax that, you know, that's what this bill is intending to do anyway.

A carbon tax that's started at a certain amount, but increased in amount so that over time it became increasingly painful, ok, to be emitting carbon emissions. I'd love for each of you to sort of reflect upon that verses, if you will, this comprehensive bill, if you will, that has many subtleties that most people, I think in the Senate today don't understand.

Mr. ORSZAG. I guess I'll start. Economic analysis generally suggests that a tax is more efficient than a simple cap and trade system. You can make the cap and trade system approach the efficiency of a tax through auctioning the permits and through providing significant flexibility in terms of when the emission reductions occur.

Senator CORKER. That's if you auction all of them.

Mr. ORSZAG. That's correct.

Senator CORKER. Right now we're giving away about 70 percent of them on the front end. Is that correct?

Mr. ORSZAG. That, actually at the very front end a little bit more than that. That does impair the efficiency of what you're trying to do.

Senator CORKER. Ok.

Mr. YACOBUCCI. I think one key thing to keep in mind with all of this is regardless of whether you're talking a carbon tax or a cap and trade system, especially if you're auctioning or running a tax. You're either giving these allowances out for free or you are selling the right in one form or other to emit, whether it's a tax or an al-

lowance. Regardless you are talking huge sums of money being controlled by the government.

If you went to a tax you would still deal with many of the same questions of allocation of revenue. In this case it would be tax revenue. The government would still need to decide, Congress would still need to decide where that money goes. So you don't necessarily put these questions of allocation that you've raised aside if you move to a tax.

Senator CORKER. Mr. Chairman, I know my time is up. Again, you do an outstanding job. Both you and the ranking member making sure that this committee truly looks at issues in a real way.

We're going to be offering an amendment to this bill that actually returns all of the revenues back to the citizens who are paying them, ok. All of the revenues. Congress can decide over time whether it can certainly with that amendment whether to pass or not.

But let me just say. I think it's so ironic that on June 2 we're going to be debating on the floor of the U.S. Senate a tax. Everybody at this panel and everybody up here at the Dias knows that this is a tax.

We have two Presidential candidates who've actually asked for a gas tax holiday. Ok. This summer with gas prices approaching $4 a gallon, we're going to be debating a tax on citizens through the year 2050.

I just think that all of us need to be very transparent about that as we discuss it. So again, I think this is, I understand altering behavior. I just think citizens around America need to know that in trying to alter that behavior when in essence, directly not indirectly, directly driving up the cost of petroleum which may be very necessary.

I'm not debating against that. I just hope we'll be very transparent. I thank you, Mr. Chairman.

The CHAIRMAN. Thank you very much. Let me ask if either Senator Domenici or Senator Murkowski has additional questions.

Senator DOMENICI. No. I just wanted to say, Senator, before you leave, that I have spoken to you before as your ranking member about the need for your involvement in this bill. After today's hearing, I want to reiterate that point.

You say you haven't been here very long, but we're very fortunate on our side that you are here. I do believe it's urgent that you remain involved because the things you have said, Senators must know. It's going to be hard to get the word out on what you have described and the way you've described the tax and the implications of this bill. So I commend you and I ask that you stay involved as much as you can.

I don't have a question, but before she proceeds, could I just make one observation. I wanted to say to you, Senator, that the people from Alaska certainly know that you're concerned about the impact this bill will have on them.

We certainly talked enough about a tax and the burden it comes with today. I'm not sure we spent enough time on how much benefit there would be after we've done all this. Because that too is a very important issue, and it's the benefit in terms of the global consequence which is what we're talking about. Not our con-

sequence, but the global consequence. The American contribution, if the rest of the world isn't contributing, is very, very small after we've gone through all of this manipulation that worries you. One final question. Why do you think there's so much support for cap and trade and so little for carbon tax, which seems just in discussing things here, to be a far more direct way to do this? Do you have any thoughts, Mr. CBO?

Mr. ORSZAG. I guess I would only say that it is a general phenomenon that the consensus among economists is often not the consensus among policymakers. That seems to be the case here too.

Senator DOMENICI. Thank you.

The CHAIRMAN. Senator Murkowski.

Senator MURKOWSKI. Thank you, Mr. Chairman. Senator Domenici, I appreciate the observation about the benefits. I am one who very firmly believes that we will resolve our issues as they relate to emissions. We will have good policies when we have the technology that allows us to do what you're all speculating and prognosticating that we need to do.

As I look at the various bills that are out there the concern that I have is we've got this schedule. We've got this timeline that requires all this to be in place. Our reality is that we're going to be paying for the technology after the auction proceeds come in. But I'm wondering whether or not, by front loading the technology whether it's capture and sequestration of carbon or the various technologies out there that will allow us to meet the reduction in emissions by the time that we want.

Senator Craig has pointed out the job loss. We've been focusing a lot about the actual costs. But there are other issues out there that if we can get the technology in place first, perhaps we won't see the loss in manufacturing jobs. Perhaps we won't see the regional impact in those States that are more coal producing.

Given your analysis of all that is out there is it fair to say that if we allow the technology to somehow or other be front loaded. I haven't figured out how we do that, whether we—what it is that we have to do from the governmental prospective to get that technology in place first. Does that perhaps reduce some of the cost to the economy whether it's actual cost or job loss? Is it an approach we should be looking at a little more carefully or do we just revise our timelines or do we just hunker down and make it happen regardless of the cost?

Mr. Orszag.

Mr. ORSZAG. I will take a crack at that. I think it's hard. You know, the key question of how you accelerate that is the elephant in the room and that pricing carbon will create a strong incentive for more technologies to be developed and for them to be diffused in a, sort of in a broader way. The thought that we can just sort of create it out of nothing and then have it diffused rapidly doesn't seem consistent with all of the experience that we've had to date.

Senator MURKOWSKI. So you think the policy message out there is enough to incent the companies to make the investment and make the technology happen?

Mr. ORSZAG. No, putting a price on carbon would create a significant incentive. It could be supplemented with government efforts

but if you priced something that firms want to avoid, they will invest in trying to avoid it, including in this case carbon emissions.

Senator MURKOWSKI. Again the impact in some areas may be more difficult and problematic than others.

Dr. Orszag.

Mr. ORSZAG. Admittedly, yes.

Senator MURKOWSKI. Yes.

Mr. MCLEAN. I wanted to second that and maybe more answer your question. I think there are two pieces to this. One is the research and development aspect, which we are investing in at very high levels and maybe people think we should be doing more.

The second one is the price signal that Peter mentioned. So I think you have to have both of them there. If you have only one, you're going to have a problem. You raised the concern. What if we mandate this, but there's no technology. That's a problem.

So, I think we need to do both. The timing is very important in these policies. You can say I want you to do it today or you can say I'm telling you today that I want you to do it in 10 years. That's a very different signal and it gives people the time between when they know it's a policy and when they have to respond to the policies. So that would be the third aspect.

Senator MURKOWSKI. Thanks, Mr. Chairman. They've been very kind with their time. I appreciate yours as well.

The CHAIRMAN. Thank you all very much. I think it's been very useful testimony. I appreciate it. That will conclude our hearing.

[Whereupon, at 12:27 p.m. the hearing was adjourned.]

[The following statement was received for the record.]

STATEMENT OF BRYAN HANNEGAN, VICE PRESIDENT, ENVIRONMENT AND GENERATION, THE ELECTRIC POWER RESEARCH INSTITUTE

On behalf of the Electric Power Research Institute (EPRI) I submit this written testimony to the full Committee oversight hearing on May 20, 2008 to receive testimony on energy and related economic effects of global climate change legislation.

On May 8, 2008, EPRI convened a workshop in Washington, DC to develop further understanding of the wide range of cost estimates (Figure 1)* that have been made public over the last 6 months. Below is a summary of the workshop.

EPRI appreciates the opportunity to provide this testimony to the Committee.

EPRI WORKSHOP EXPLORES COST ESTIMATES OF LIEBERMAN-WARNER CLIMATE LEGISLATION

EPRI convened a May 8 workshop in Washington, DC to develop further understanding of the wide range of cost estimates (Figure 1) that have been made public over the last 6 months. The meeting was attended by Congressional staff, government officials, energy-economy modelers, and electricity company staff.

Workshop presenters included modeling teams from the Energy Information Administration (EIA); the American Council on Capital Formation (ACCF); the Clean Air Task Force (CATF); the Environmental Protection Agency (EPA), Massachusetts Institute of Technology (MIT) and CRA International (CRAI).

While there are important differences in the modeling approaches and models used, much of the variation in the cost estimates appears driven by a handful of key assumptions, several of which are highlighted here:

Reference case. Most modeling efforts rely on the Energy Information Administration's Annual Energy Outlook (AEO) to develop their reference case. In general, models that use an earlier projection of the baseline (AEO 2006 or AEO2007) have to find more emission reductions to achieve the Lieberman-Warner targets and have higher costs—everything else equal—than those using the recent AEO2008 projection (Figure 2).

*Figures 1–3 have been retained in committee files.

Technology cost and deployment. In general, scenarios that limit the use of advanced, low and non-emitting electricity generation technologies result in higher costs; those that let them enter freely result in lower costs. Model results presented at this workshop show dramatic variations in renewable, coal with CCS and nuclear capacity additions (Figure 3).

- Emission offsets. In general, scenarios that allow for compliance using offsets (emission reductions that are made outside of an emissions cap) show a much lower cost than those scenarios without offsets. Most groups do not model offsets in detail, but rather make relatively crude assumptions about their cost and quantity. Several teams did not include any international offsets in their analyses based upon their interpretation of the bill.
- Time horizon. The EIA's NEMS model runs (used by several groups) extend through 2030, but most of the other models run through 2050. Different time horizons can affect compliance behavior (e.g. banking of extra credits), choice of technology deployments, and other aspects of model economics.
- Discount rates. The models use discount rates (which define the time preference for money) ranging from 4 to 7%. This affects the time period in which emissions reductions are viewed to be most attractive from an economic point of view, and leads to differences in total economic cost.

Workshop participants agreed that presentation of their modeling assumptions and results in a common format could provide important insights for decisionmakers and reduce confusion on how to interpret different estimates of costs. Links to the meeting agenda, presentations (and underlying analyses) are provided below.

Presenter	Presentation	External Link to Analysis
Tom Wilson, EPRI	Introduction	
Howard Gruenspecht, EIA	NEMS	http://www.eia.doe.gov/oiaf/servicerpt/s2191/index.html
Margo Thorning, ACCF	NEMS	http://www.accf.org/nam.html
Jonathan Banks, CATF	NEMS	http://www.catf.us/publications/presentations/CATF_LWCSA_Short_Hill_Briefing_with_CAFE.pdf
Allen Fawcett, EPA	ADAGE, IGEM, IPM	http://www.epa.gov/climatechange/economics/economicanalyses.html#s2191
John Reilly, MIT	EPPA	http://web.mit.edu/afs/athena.mit.edu/org/g/globalchange/www/abstracts.html#a146
Anne Smith, CRAI	MRN-NEEM	http://www.crai.com/uploadedFiles/RELATING_MATERIALS/Publications/BC/Energy_and_Environment/files/CRA_NMA_S2191_April08_2008.pdf
Bob Shackleton, CBO	Crosscutting Analysis	

APPENDIX

RESPONSES TO ADDITIONAL QUESTIONS

RESPONSES OF HOWARD GRUENSPECHT TO QUESTIONS FROM SENATOR BINGAMAN

GDP IMPACTS OF THE ACCF/NAM STUDY

Question 1. Can you please provide more detail about what you said at the hearing? Please explain in more detail why GDP impacts are disproportionately so much higher in the ACCF/NAM study than in the EIA study compared to the difference in allowance prices?

Answer. Our review of the ACCF/NAM analysis performed by SAIC identified problems in the methodology used in the macroeconomic modeling. These problems arose from how modifications were made to the baseline used in their analysis (using the *Annual Energy Outlook 2007* reference case) to reflect the effects of the Energy Independence and Security Act of 2007 and the lower macroeconomic growth in the subsequent *AE02008* reference case. These problems magnified the size of the economic impacts identified in the ACCF/NAM study.

The analysis attempted to adjust their baseline to reflect higher world oil prices by using the EIA high oil price scenario as part of their Lieberman-Warner policy scenario. Unfortunately, they compared the results to a baseline with much lower oil prices. This led to larger reported energy price and macroeconomic impacts than would be associated with the S. 2191 policy alone, since it also included the effects of the higher world oil prices in the policy case. In the SAIC analysis, these impacts are solely attributed to the effect of the greenhouse gas cap-andtrade policy. We shared this concern with both the contractor and the report sponsors.

STATE-BY-STATE RESULTS

Question 2. The ACCF/NAM study also provides state-by-state results for a whole range of possible impacts, such as impacts on gross state product, energy prices, and jobs. These state-level results were presumably derived from the NEMS modeling analysis done by ACCF and NAM. Does NEMS provide state-level results? Do you know how these results were derived from the NEMS model for the ACCF/NAM analysis?

Answer. The National Energy Modeling System (NEMS) does not produce state-level results. The regional-level results it produces vary by module (energy sector). All of the energy demand modules (including the macroeconomic module) provide regional results for each of the nine census divisions. The energy supply modules produce regional results for differently defined regions, depending on the markets that they are trying to represent. Appendix F of the Annual Energy Outlook 2007, which can be found on the EIA website, illustrates the regions used in the NEMS.

According to page 19 of ACCF/NAM analysis, it used the census division results and applied historical trends based on Census state population projections and historical relationships between states and Census regions to obtain population and gross-state-product-weighted results for income, jobs, industrial production and state-level prices. These results were not based on a detailed state model.

RESPONSES OF HOWARD GRUENSPECHT TO QUESTIONS FROM SENATOR DOMENICI

KYOTO PROTOCOL MISSES EMISSIONS REDUCTION TARGETS

Question 1. What are the major factors causing signatories to the Kyoto Protocol to miss their greenhouse gas emission reduction targets and are those shortcomings similarly foreseeable for the United States under a cap and trade regime?

Answer. The first commitment period for the Kyoto Protocol signatories began this year and runs through 2012. Greenhouse gas emissions in the European Union (EU) have risen slightly in recent years, reducing the likelihood of meeting the Kyoto tar-

gets. In a recent report on the emissions cap and trade system set up in the EU for a 2005 to 2007 "trial" period, "The European Union's Emissions Trading System in Perspective," the authors from MIT argue (page iii) that the challenges faced in implementing the Emissions Trading System (ETS) were not unexpected. They go on to state that

> The development of the EU ETS and the experience with the trial period provides a number of useful lessons for the U.S. and other countries.

- Suppliers quickly factor the price of emissions allowances into their pricing and output behavior.
- Liquid bilateral markets and public allowance exchanges emerge rapidly and the "law of one price" for allowances with the same attributes prevails.
- The development of efficient allowance markets is facilitated by the frequent dissemination of information about emissions and allowance utilization.
- Allowance price volatility can be dampened by including allowance banking and borrowing and by allocating allowances for longer trading periods.
- The redistributive aspects of the allocation process can be handled without distorting abatement efficiency or competition despite the significant political maneuvering over allowance allocations. However, allocations that are tied to future emissions through investment and closure decisions can distort behavior.
- The interaction between allowance allocation, allowance markets, and the unsettled state of electricity sector liberalization and regulation must be confronted as part of program design to avoid mistakes and unintended consequences. This will be especially important in the U.S. where 50 percent of the electricity is generated with coal.(pages iii-iv)

EPA SULFUR DIOXIDE PROGRAM CONTRAST

Question 2. I hear supporters of a cap and trade approach to global climate change mitigation consistently refer to the sulfur dioxide program at the Environmental Protection Agency and compare it to the potential implementation of this legislation. Please compare the size and scope, including the ways in which regulated entities complied with sulfur dioxide limits and can be expected to comply with limits on carbon dioxide, of the two programs so that we may have a better sense of perspective on this comparison.

Answer. Compared to the greenhouse gas cap and trade program called for in S. 2191, the sulfur dioxide (SO_2) cap and trade program created in the Clean Air Act Amendthents of 1990 affected a relatively small group of large power plants and industrial facilities. With approximately 9.5 million allowances issued every year and a current SO_2 allowance price trending towards $400 per ton, the total market value of the SO_2 allowances issued each year is approximately $3.8 billion dollars. In contrast, in EIA's analysis of S. 2191, the market value of the allowances issued in 2030 ranged from $235 billion to $603 billion, roughly 2 orders of magnitude larger. We defer to EPA regarding the behavior of regulated utilities under the two programs.

NUCLEAR PLANT CONSTRUCTION LIMITATIONS

Question 3. The NRC anticipates 29 applications for new nuclear reactor units by the end of this year. Those applications represent approximately 40 gigawatts of new capacity and are likely to be the majority of new reactor license applications that the NRC will receive by the end of 2010. Even under the very ambitious schedules, only the very first of these plants will be coming on line in the 2015 to 2020 time-frame.

How do you justify the assumption made in your model that 264 gigawatts—over 6 times the 40 gigawatt estimate—of new nuclear generating capacity will become available by 2030?

Answer. EIA agrees that many factors may constrain the amount of new nuclear capacity that can be added between now and 2030. These include material costs, manufacturing limits, labor shortages, potential permitting bottlenecks, and public acceptance problems. As a result, our analysis of S. 2191 analysis includes alternative cases that assume higher costs and limited availability for new nuclear facilities. The amount of new nuclear added across the S. 2191 cases ranges from 17 gigawatts to 286 gigawatts.

While we agree that it is very unlikely that anything approaching the higher end of this range would occur, the existence of an allowance cost on fossil fuel use will make new nuclear plants very attractive and will likely stimulate increased investments in all segments of the industry. In addition, the existing fleet of approxi-

mately 100 gigawatts of nuclear capacity was nearly all added over a 20-year period, during which another 150 gigawatts of planned nuclear capacity was cancelled.

NUCLEAR COMPONENT FABRICATION

Question 4. We currently have no domestic capacity for the fabrication of large nuclear components such as pressure vessels, and we are told that our existing workforce can support the construction of no more than three reactors at a time.

Have you analyzed how many reactors we are physically capable of building by 2030?

Answer. EIA has not prepared an analysis of how many reactors could physically be built in the U.S. by 2030. Moreover, as noted in the answer to the previous question, EIA agrees that many factors may constrain the amount of new nuclear capacity that can be added between now and 2030. These factors are what led us to include alternative cases about the potential cost and availability of new nuclear plants in our analysis of S. 2191. However, a greenhouse gas cap and trade program, by increasing the costs of continuing to rely on fossil fuels for electricity generation, should provide substantial incentive for increased investment in all sectors of the nuclear industry. Only a few years ago there were no new nuclear license applications at the Nuclear Regulatory Commission, but they now report having received combined license applications for 15 new nuclear generating units (as of April 18, 2008) and the Nuclear Energy Institute has compiled a list of 14 additional units that are expected to file applications shortly. Colleges are also beginning to report growing enrollment in nuclear engineering programs. For example, the University of California at Berkeley reported that between 1996 and 2006 the number of nuclear engineering majors nearly tripled, while the number of freshman applications for the major doubled over five years (Mass High Tech, May 12, 2006). Similarly, a recent study of the 31 U.S. universities with nuclear engineering programs reported that 346 bachelor's degrees were awarded in 2006, the highest number reported in ten years and a 30 percent increase from 2005 (Oak Ridge Institute of Science and Education, June 20, 2007).

HOW DO HIGHER NATURAL GAS PRICES AFFECT PROPOSED LIEBERMAN-WARNER LEGISLATION COMPLIANCE COSTS

Question 5. The Annual Energy Outlook for 2008 forecasts that in 2015, natural gas prices will be $5.21 per million BTU. The current price is much higher than that, and NYMEX futures contracts for May 2015 are at around $9.00 per million BTU right now. Many of the models in these studies rely upon your baseline prices to determine the cost of compliance with a cap and trade regime.

Given that, how significant would the impact of higher-than-projected natural gas prices be on the costs of compliance with the Lieberman-Warner legislation?

Answer. Generally, higher natural gas prices would make natural gas less attractive as a greenhouse gas (GHG) compliance fuel, and would make switching to natural gas for GHG compliance more expensive than would otherwise be the case under lower natural gas prices. However, in our Lieberman-Warner analysis cases that allow for the rapid adoption of nuclear, coal with carbon capture and sequestration, and renewables, such as the "core" case, natural gas consumption is lower than in the reference case because considerable energy production shifts to nuclear and renewables. Therefore, higher natural gas prices would generally not increase GHG compliance costs. In cases where nuclear and renewables are constrained, such as in the "limited alternatives" cases in our analysis, natural gas consumption is higher with the legislation, GHG compliance costs are higher than the "core" case results, and the GHG compliance cost risk is more directly related to the price of natural gas.

Selected S. 2191 Analysis Results for 2030 (Prices in 2006$)

	2006	Reference	Core	Limited Alternatives
Total GHG Emissions (million tons)	7,014	8,441	5,429	6,179
Allowance Price ($ per ton)	-	-	61	91
Natural Gas Consumption (quadrillion Btu)	22.3	23.4	19.4	26.2
Natural Gas Price to Power Sector ($ per MCF)	7.07	7.13	9.95	13.95

LONG-TERM NATURAL GAS SUPPLY PROSPECTS

Question 6. I am very concerned about the long-term supply prospects for natural gas. Rumors of a natural gas cartel continue to make the news and U.S. production of natural gas is trending toward a steep decline in the coming years.

Has EIA changed its import projections in recent years to account for these and other developments? If a natural gas cartel is formed and U.S. natural gas production declines steeply, are you capable of modeling its potential impact on supply and prices for natural gas?

Answer. EIA does not expect an effective natural gas cartel to form in the future, nor do we expect steep declines in U.S. natural gas production in the coming years. In fact, our reference case projections of future natural gas imports have declined in recent years as higher natural gas prices are expected to limit demand growth, especially in the power sector, and stimulate increased domestic natural gas production. We are capable of modeling the effects of reduced global gas supply (the expected effect of a gas cartel) and reductions in U.S. natural gas production. The soon to be released Annual Energy Outlook 2008 will include a "Limited Natural Gas Supply" side case that presents the supply and price effects of such a scenario.

The natural gas market is becoming increasingly globalized, but the formation of an effective cartel seems unlikely, for a number of reasons. The primary reason is that natural gas demand is more elastic than oil demand, since natural gas must compete with coal, nuclear, and renewables in the power sector. The existence of these viable alternatives greatly reduces the market power of a potential cartel. In addition, natural gas reserves are more widely dispersed than oil reserves.

We do not see evidence that U.S. natural gas production is trending toward a steep decline. Production for December 2007 was 1700 billion cubic feet, the highest since 1980. While we are seeing clear sustained declines in a number of areas where conventional production sources dominate, other areas such as in the deep waters of the Gulf of Mexico and unconventional plays, such as gas shales, are showing strong gains. The growth in these areas is the result of both higher natural gas prices and significant technological advances.

COMPLIANCE MECHANISM

Question 7. These anayses tend to list natural gas, nuclear clean coal, renewables and other forms of electrical generation as ways n which the caps in S.2191 cab be adhered to. As a result, we get some odd results that are likely impossible to achieve.

Do any of the models you have looked at allow for economic slow-down as a compliance mechanism?

Answer. All of the greenhouse gas mitigation proposals that have recently been analyzed by EIA rely on mechanisms to reduce greenhouse gas emissions or promote low or no carbon technologies that pass the cost of compliance along to consumers through energy prices. The economy is only affected through the impact these proposals have on energy suppliers and consumers. There are, no doubt, other command and control mechanisms that, if implemented, would more directly impact the economy, but they have not been examined by EIA.

ALLOWANCE PERMITS

Question 8. As we discuss issues that relate to the share of allowances that will be be auctioned or given away, what would be the consequences of these permits being bought up by people who don't intend to emit greenhouse gases?

What would that do to the cost to emitters and their ability to comply with S. 2191?

Answer. In an efficient carbon allowance market, the price of allowances would depend on the quantity supplied and demanded. If the owners of allowances intend to limit the supply, then, all else being equal, the price would increase. The economic burden imposed on a particular firm in a carbon reduction program depends on its ability to pass through costs, the price elasticity of consumer demand, and emission reduction opportunities. Some available research indicates that consumers and businesses at the end of the energy supply chain may bear the largest share of costs. Also, certain firms or industrial sectors may face difficulty in passing through increased costs and would pay an increased share of the burden, such as those firms that compete with foreign suppliers that do not face similar emission constraints. For an effective carbon reduction program, all energy producers and users should face the same incentive to reduce emissions.

BASELOAD GENERATION EXPANSION

Question 9. Our country hasn't had to increase its baseline generation for nearly two decades, but that trend will soon come to an end. What impact does this impending shift have on your economic analysis, particularly in light of local opposition to infrastructure construction?

Answer. Since 1990, nearly 320 gigawatts of new generating capacity has been added and integrated into the U.S. electricity grid. While nearly 83 percent of this capacity reported natural gas as their primary fuel, it still represents a fairly large investment in infrastructure. Over the same time period, there has been a significant increase in both coal and nuclear generation, but it has come from the increased use of existing plants rather than the addition of new plants. In fact, between 1990 and 2006, the combined increase in generation from coal and nuclear plants, 605 billion kilowatthours, exceeded the 435 billion kilowatthour increase in generation from natural gas plants.

In EIA's *Annual Energy Outlook 2008*, we do see the need for renewed investment in large baseload facilities such as new coal and nuclear plants, but the bulk of these facilities are expected to be needed in 2015 and beyond. If local opposition were to preclude these additions, the industry likely would continue to invest in new natural gas capacity and consumers would face higher electricity prices. In our analysis of S. 2191, we included cases limiting the addition of new baseload capacity like nuclear and coal power plants with carbon capture and sequestration. In the most limiting scenario, the Limited Alternatives / No International Offsets case, the allowance price reached $156 per metric ton carbon dioxide equivalent, much higher than the $61 per metric ton carbon dioxide equivalent reached in the most optimistic case. Similarly, electricity prices in the most limiting case were 64 percent above the reference case level in 2030, again much higher than the 11 percent increase seen in the most optimistic case. Natural gas generation in this limiting case was over 2.4 times the level seen in the reference case in 2030.

RESPONSES OF HOWARD GRUENSPECHT TO QUESTIONS FROM SENATOR MENENDEZ

IMPACT UNDER HIGHER ENERGY PRICES

Question 1a. Current oil prices are nearly double those assumed in EIA's and EPA's analysis of climate policy. We can already see that high gasoline prices are inducing changes in consumer driving and vehicle purchasing behavior. Goldman Sachs recently estimated that oil prices might climb to $150-$200 per barrel within the near future. How might the projected costs of Lieberman-Warner and other climate policies change if the models were run with the higher (and more realistic) energy prices that we are already seeing today?

Answer. There are two opposing effects of higher energy prices on compliance costs that cloud the issue: a cost-reducing effect arising because the emissions reduction to meet a given cap is less under high prices, and a cost-increasing effect that can occur if increased use of natural gas occurs in the effort to comply with the capand-trade policy. Under the first effect, projected costs of emission cap and trade policies would tend to be lower under higher energy price scenarios, because higher energy prices would tend to suppress the projected growth in fossil fuel use and carbon dioxide emissions in the absence of a cap. Therefore, the reduction in emissions required to meet a given emissions cap would also tend to be lower under higher energy prices, and the allowance prices, a key indicator of compliance costs, would be driven lower. For example, relative to the EIA's *Annual Energy Outlook 2008* (*AE02008*) reference case, meeting the S. 2191 emission cap requires a cumulative reduction in emissions from 2012 to 2030 of 37.7 billion metric tons in carbon dioxide equivalence. Relative to emissions in the forthcoming *AE02008* high price case, which assumes higher oil and natural gas prices than in the reference case, the required emissions reduction over the same period is 35.1 billion metric tons (6 percent lower than in the reference case).

An opposing effect would arise if compliance with a cap-and-trade policy led to an increased use of natural gas, as might occur if alternatives such as nuclear, biomass, or offsets were not available or more costly. Under higher energy prices, the cost of any incremental use of natural gas would be higher, leading to higher compliance expenditures.

Question 1b. Does this mean that allowance prices and the total cost to the economy of the cap will be lower than current models suggest? Can the EPA or EIA rerun the models with estimates that reflect a future with sustained high prices for petroleum and other fossil fuels?

Answer. Allowance prices and the effect on the economy could tend to be somewhat lower under a higher energy price scenario because the emissions reduction

to meet the cap would be lower. However, in cases where compliance resulted in increased use of natural gas, an opposing effect on compliance costs would influence the results, as explained in the response to the first part of the question. Given the time necessary to conduct, review, and present additional modeling cases, EIA could not publish any further modeling cases of S. 2191 prior to planned floor debates in early June. As illustrated by the range of results in the five cases presented in EIA's analysis, the economic impacts of the bill can vary widely based on assumptions about technology availability and costs, as well as offset assumptions. While the cost results would be shifted somewhat under higher energy price assumptions, the overall conclusions drawn by the report would not be changed materially.

RESPONSES OF HOWARD GRUENSPECHT TO QUESTIONS FROM SENATOR SANDERS

ASSUMPTIONS ABOUT OFFSETS

Question 1a. The use of offsets is being defined in the models as a cost avoidance mechanism, but there is more to offsets than cost avoidance. Now, I understand the theory that paying someone to do something can be easier than changing your own behavior, but if we don't actually ensure emissions reductions, it doesn't really matter.

What are the assumptions regarding the actual emissions reductions from offsets? Do the models assume a 1 to 1 relationship or do the models include some calculation for the fact that offsets can be difficult to quantify, or even difficult to verify?

Answer. EIA assumes that the domestic offsets from certified greenhouse gas mitigation projects represent actual emission reductions, in the sense that emissions projections assume that any offsets supplied represent actual reductions from the baseline or reference case emission levels. However, in defining the market potential of offsets, EIA discounts the potential supply to account for such factors as additionality, which is a test that demonstrates that the emission reductions from a project or action are additional to what would have happened in the absence of the project or action, and permanence, and further reduces the economic potential to reflect a gradual market penetration of offsets over time.

EIA's model focuses on energy and reductions in energy-related carbon dioxide emissions. For projections of non-CO_2 greenhouse gases, EIA relies in part on information from the Environmental Protection Agency (EPA). EPA provided EIA with economic relationships that characterize the economics of offset projects in terms of "marginal abatement cost" curves. The curves were developed in a series of engineering-economic studies EPA conducted in recent 20 years. The curves indicate the emission reductions that would be cost-effective to develop at various allowance prices. In evaluating the information, EIA assumed that the quantity of domestic offsets actually supplied at a given allowance price would be reduced 25 percent from the cost-effective level given by the abatement curves, based on market factors and the transaction costs of certification and verification. In addition, EIA assumed that market penetration of offsets would not occur immediately, but be introduced gradually into the market over time.

OFFSETS

Question 1b. Does the usage of offsets create opportunity costs for the adaptation of renewable technologies, such as wind and solar, that reduce our overall emissions? Said another way: does the use of offsets have the potential to, in any way, delay a transition to renewables, since polluters could just pay someone to plant a tree instead of actually moving to sustainable energy?

Answer. Since offsets provide an alternative means of complying with allowance obligations, offsets may compete, in a sense, with renewable energy. If offsets were not permitted, and the overall emissions cap was not relaxed accordingly, then the price of allowances would be driven higher. At higher allowance prices, additional sources of renewable energy would become economical. For example, in EIA's S. 2191 No International Offsets case, projected consumption of renewable energy in 2030 is 18.2 quadrillion British thermal units (Btu), compared to 16.7 quadrillion Btu in the S. 2191 Core case which assumes that up to 15 percent international offsets are allowed and generally competitive.

PERMANENCE

Question 1c. Also, what are the assumptions in the models that determine the permanence of offsets? Is there a discount factor for offsets that fail because of natural or manmade reasons?

Answer. In developing assumptions for offsets, EIA has discounted the economical potential for offsets to account for certification and other transaction costs, as well

as other market penetration issues. S. 2191 requires that the EPA administrator issue regulations to certify offset allowances to "ensure that those offsets represent real, verifiable, additional, permanent, and enforceable reductions in greenhouse gas emissions or increases in sequestration." The bill also describes accounting standards for offsets that would be developed for agriculture and forestry sequestration projects and specifies discounting factors to reflect uncertainty. EIA assumed that these regulations and procedures would be reflected in the offset market and affect the supply available. Therefore, EIA applied a 25 percent discount factor to abatement cost curves provided by EPA.

ADDITIONALITY

Question 1d. How is additionality worked into the models?

Answer. This answer has been provided in the response to questions A1(a) and A1(c).

FAILURE TO ASSESS THE BENEFITS OF ACTION ON GLOBAL WARMING

To date, all of the analyses of Lieberman-Warner and other bills assess only the costs of acting—they do not assess the benefits of acting and avoiding or mitigating global warming. Agencies typically analyze the costs AND benefits of their regulations. However, in the case of climate change, economists have a long way to go in monetizing benefits, assuming many of the benefits like preventing catastrophic events such as hurricanes, droughts, and other extreme weather events, along with the spread of diseases, wars over resources, and the extinction of specie's—can even be monetized. The analyses of Lieberman-Warner by EIA and EPA do not attempt to quantify the benefits. They thus run the risk of focusing attention on the costs of climate legislation without balancing that information with the benefits of reducing climate change.

Question 2a. Do your analyses assess the benefits of avoiding or mitigating climate change? Aren't there important benefits that have not been considered at all? Examples that come to mind include the avoidance of risks from increased or more severe droughts, floods, hurricanes and wildfires: increases air pollution; catastrophic events such as melting ice sheets; unrest overseas affecting U.S. national security and changing disease patterns.

Answer. The Energy Information Administration (EIA) analyses focus on the energy market impacts of the proposed rules, regulations or legislation that we are asked to review. EIA does not have expertise in climate system analysis that would be required to assess the potential benefits of avoiding or mitigating climate change.

Question 2b. A related, but different, question is: do the "Business as Usual" scenarios included in your models (or the models you have seen, in the case of CRS) assume increased costs from the types of events I just mentioned, given that we are told that the events will become increasingly common unless we reduce global warming.

Answer. EIA does attempt to capture the impacts of changing climate trends on energy supply and demand. However, the types of models that address the impact of greenhouse gas emissions on climate conditions are usually referred to as Integrated Assessment Models. These models are very complex because they attempt to capture all of the interactions of the climate system. As a result, they do not focus on energy markets and can not address the types of questions from the energy committees of the Congress and others to which the energy models typically respond.

Question 2c. What efforts is your agency making to assess the value of the benefits of climate change mitigation?

Answer. Consistent with our legislative mandate, EIA analyses focus on the energy market and economic impacts of the proposed rules, regulations or legislation that we are asked to review. EIA does not have expertise in climate system analysis that would be required to assess the potential benefits of avoiding or mitigating climate change.

UNTAPPED POTENTIAL FOR RENEWABLES AND ENERGY EFFICIENCY

Electricity from coal, nuclear power, and other traditional energy sources appear prominently in the modeling of Lieberman-Warner. Several renewable technologies, however, are available today that can generate inexpensive electricity without emitting carbon.

Concentrating Solar Power uses the sun to provide heat that drives a steam power plant. This one resource could provide up to 17% of our nation's electricity. A typical CSP plant being built today produces 250 Megawatts of power, emits very little CO_2, and costs 1-2 billion dollars (about the same as a traditional coal plant and significantly less than a new nuclear plant, which can run between 4-12 billion).

Over its operating life, today's CSP plants deliver power at $0.13 per kilowatt-hour, but the Department of Energy estimates that the costs for CSP will drop below $0.08 per kilowatt-hour once economies of scale are achieved. There are close to 400 Megawatts of CSP already operating in the southwest, and at least 3,000 Megawatts are in various stages of development.

Wind is another major opportunity. Just last week the Department of Energy's National Renewable Energy Laboratory released a report showing that wind could provide up to 20% of our nation's electricity needs by 2030. This resource will only cost $0.05 per kilowatt-hour, which is competitive with what we are paying for coal today.

Geothermal is another great opportunity. A report for the U.S. Department of Energy by the Massachusetts Institute of Technology suggests that geothermal energy could provide 100,000 Megawatts of new carbon-free electricity at less than $0.10 per kilowatt-hour, comparable to cost projections for coal with carbon capture and storage. This single renewable resource could account for almost 10% of our nation's electricity needs in the future.

There are many other the possibilities, for biomass, photovoltaics, hydropower, and other renewable technologies, for example. But, once you add it all up, the United States could meet 2/3 of its electricity needs from sustainable energy.

Now, add on what we could be doing with energy efficiency, and it gets really exciting. According to the McKinsey Report, released last year, we have the technologies needed to reduce greenhouse gases at our disposal today.

Question 3. Do your analyses take into account the strategies identified in the McKinsey Report for reducing greenhouse gases, including improving the economy's energy efficiency?

Answer. With regard to your discussion of renewable generation technologies, we agree that theses sources have considerable potential to make an increased contribution to electricity generation, particularly if actions are taken to limit energy-related carbon dioxide emissions. The mix of renewable and non-renewable low- and no-carbon technologies that will ultimately be deployed will depend on the relative costs of different technologies, technology characteristics such as intermittency and dispatch ability, and public acceptance issues surrounding both renewable and non-renewable technologies.

Decisions regarding additions of new generation capacity, both renewable and non-renewable, reflect competition among different technologies that might be added as well as competition between those technologies and existing capacity. Displacement of existing capacity, whose fixed costs are already invested, can present significant economic challenges even for renewable technologies that are well-placed to compete with other new capacity sources. For example, over 300,000 megawatts of existing conventional coal-fired generation currently provides about one-half of the nation's total electric generation. At average delivered prices of coal well under $2.00 per million Btu, the forward-looking costs of operating existing coal plants is roughly $0.02 per kilowatt hour. In the absence of actions to limit greenhouse gas emissions, EIA would expect the vast majority of the existing coal-powered fleet to remain in use through 2030, with many units continuing to operate after that date. Replacing existing coal-fired capacity with alternative renewable or non-renewable sources, which many believe are among the most cost-effective actions to reduce greenhouse gas emissions, is likely to engender significant costs, even under optimistic assumptions about the costs of low-and no-carbon technologies for new generation capacity.

Turning to the strategies identified in the recent McKinsey report, our view is that while it identifies a large technical potential for improving energy efficiency and investing in renewable technologies, it is silent on the policies that might be needed to take advantage of these options. In fact, a letter included in the report from the Conference Board, co-publishers of the report, states:

> The McKinsey team looked primarily at the technical feasibility and cost of those options. How quickly consumers modify behavior and adopt different options will have a major effect on the ultimate economic benefits of those options.—Preface letter

The report goes on to say:

> Unlocking the negative cost options would require overcoming persistent barriers to market efficiency, such as mismatches between who pays the cost of an option and who gains the benefit...—page xii

In EIA's analysis of S. 2191, large improvements in energy efficiency and increased investment in renewables are stimulated by the higher costs of continuing to use fossil fuels under a greenhouse gas cap-and-trade program. For example, the

average annual growth in electricity demand between 2006 and 2030 falls from 1.1 percent in the reference case to between 0.9 percent and 0.6 percent in the S. 2191 cases. These rates of growth are all less than half the 2.4 percent annual growth that occurred in the 1990s. With respect to renewables, between 112 gigawatts and 357 gigawatts of new renewable generation capacity are added in the S. 2191 cases; much more than the 47 gigawatts that are added in the reference case without S. 2191.

RESPONSES OF HOWARD GRUENSPECHT TO QUESTIONS FROM SENATOR AKAKA

HAWAII ELECTRIC PRODUCTION TRANSITION TO BIOFUELS

Question 1. Hawaiian Electric Company is uniquely a liquid fuel utility, with over 75% of its electricity produced from imported oil. We understand Hawaiian Electric Company is moving toward biofuel substitution for fossil fuel in their existing generating units. How can we assure that whatever program is put in place at the national level will create incentives for this Hawaii utility to proceed expeditiously with biofuel substitution? Equally important, how can we be assured that a broad national program will not produce barriers to this fuel transition?

Answer. The allowance costs associated with the national greenhouse gas cap-and-trade program called for in S. 2191 will increase the costs of continuing to use fossil fuel in power generation, and should make increasing the use of biofuels as a substitute for oil more attractive. In EIA's analysis, average distillate fuel oil prices—including the costs of holding allowances—are 21 percent to 52 percent higher than in the reference case in the S. 2191 cases.

PREMIUM FOR LOCAL OFFSET PROJECTS

Question 2. Do you see any categorical problem with states such as Hawaii considering a premium local payment for locally developed and implemented offset projects, with the objective of retaining funds within the state economy?

Answer. It does not appear that categorical funding restrictions under S. 2191 would restrict the use of proceeds from States' allowance allocation for subsidizing local offset projects. Under S. 2191, States will be allocated 4.5 percent of allowances based on the state shares of population, LIHEAP program expenditures, and carbon dioxide embodied in coal mined, natural gas processed, and oil refined in the State. State proceeds from the sales of those allowances could be considered categorical funds because the bill specifies that 95 percent of the allowance proceeds be used for any of a list of 15 distinct purposes, which include the following:

- to encourage advances in energy technology that reduce or sequester greenhouse gases,
- to address local or regional impacts of climate change policy, including providing assistance to displaced workers, and
- to fund any other purpose the States determine to be necessary to mitigate any negative impacts as a result of global warming or new regulatory requirements resulting from the Climate Security Act.

Therefore, using allowance proceeds to subsidize local offset projects would appear to be a legitimate use of funds.

Provisions of S. 2191 suggest that State governments could purchase specific offset allowances associated with projects developed in their States, or enter into agreements with developers to finance offset projects through premium payments or other means. Under Sec. 2402, a unique serial number would be assigned to offset allowances, and the project developer would own the offset allowance initially, unless otherwise specified in a legally-binding contract or agreement. The offset allowances may then be sold, traded, or transferred, which would allow State governments to purchase offsets from projects originating in the State.

PLUG-IN HYBRIDS

Question 3. Plug-in hybrid electric vehicles will effectively transfer greenhouse gas emissions from the transportation sector to the electric utility sector, although on a reduced basis. How will this beneficial potential be taken into account in the allocation of credits under a cap and trade program? Can market mechanisms be structured to promote rather than impede the development and commercialization of plug-in hybrid electric vehicles?

Answer. Under S. 2191, the allowance allocation provisions do not appear to have any negative material impact on economic incentives for plug-in hybrid electric vehicles. Under S. 2191, the primary market incentive that could affect the economics of plug-in hybrids is the allowance requirement for carbon dioxide emitted by fossil

fuels, directly increasing the price of petroleum fuels and indirectly raising the cost of electricity. The differential cost impacts on electricity and petroleum would influence the relative economics of plug-in hybrids versus other vehicles.

RESPONSES OF LARRY PARKER AND BRENT YACOBUCCI TO QUESTIONS FROM SENATOR BINGAMAN

Question 1. [For Larry Parker]. Your testimony and report ask us to take a skeptical stance toward modeling, because of the larger number of assumptions that need to be made in order to arrive at any particular economic conclusion. In this regard, it seems that one should approach regional (state-level) projections and projections about jobs with even greater skepticism because of the greater number of assumptions that need to be invoked in these cases. To follow-up on our discussion at the hearing, what is your sense of the reliability of regional estimates, sectoral estimates and estimates of job creation and loss in such models compared to the reliability of aggregate estimates?

Answer. As noted on page 15 of the CRS report, "the uncertainty about the future direction of the basic drivers of greenhouse gas emissions and the economy's responsiveness (economically, technologically, and behaviorally) illustrate the inability of models to predict the ultimate macroeconomic costs of reducing greenhouse gases." If one cannot project the fundamental drivers of a dynamic, additional complexity in the form of aggregation or disaggregation (depending on the architecture of the specific model) may not increase accuracy and, indeed, may further mask the underlying uncertainties. For models that use a modular construction with separate sector-level models, CRS noted on page 70: "baseline forecasts are even less accurate at a sector level than they are at an aggregate national level. As noted by Winebrake and Sakva, sector level baseline forecasts have significantly higher errors compared with aggregate estimates, nor have sector estimates improved over the past two decades:

> We find that low errors for total energy consumption are concealing much larger sectoral errors that cancel each other out when aggregated. For example, 5-year forecasts made between 1982 and 1998 demonstrate a mean percentage error for total energy consumption of 0.1%. Yet, this hides the fact that the industrial sector was overestimated by an average of 5.9%, and the transportation sector was underestimated by an average of 4.5% We also find no evidence that forecasts within each sector have improved over the two decades studied here.[1]

Interestingly, the largest forecasting errors have occurred for the areas of the industrial sector (over-estimated energy use) and for transportation (under-estimated energy)—two key sectors frequently targeted for controlling greenhouse gas emissions. This is not to say that disaggregation is inherently misleading; there are regional differences in energy supply that, all else being equal, would result in potentially higher costs for some regions under S. 2191. However, to move beyond recognition of regional differences in energy supply to then make precise state-by state projections of impacts (frequently to two or more "significant" digits) 20 years after enactment of legislation propels the analysis from "worthy of some skepticism" toward a "fallacy of misplaced concreteness."[2]

This situation is compounded further when attempting to estimate secondary cost impacts, such as jobs. At this level of analysis, an additional layer of assumptions must be added to the calculus, including: worker productivity trends, wage rates (usually national averages), and workweek trends (usually national averages). Projecting these trends out to 2030 or 2050 is more an act of faith than analysis. Add to this effects on industry of S. 2191 that are likely very site-specific (p. 70), and one sees projections that are based more on philosophy than analysis.

Question 1. [For Brent Yacobucci]. Your results suggest that the Low Carbon Fuel Standard could raise energy prices dramatically. Could you explain how this standard interacts with the underlying cap-and-trade system and why prices rise so significantly in the presence of such a standard if the overall emissions cap remains unchanged?

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[1] James J. Winebrake and Denys Sakva, "An Evaluation of Errors in US Energy Forecasts: 1982-2003," Energy Policy 34 (2006), p. 3475.

[2] "Fallacy of misplaced concreteness" is a term used by the philosopher Alfred North Whitehead to describe a situation where someone mistakes an abstract belief, opinion or concept about the way things are for a physical (i.e., "concrete") reality. See: Alfred North Whitehead, An Enquiry concerning the Principles of Natural Knowledge (1925).

Answer. One of the key reasons that the Low Carbon Fuel Standard (LCFS) could raise energy prices is that the standard, as proposed in S. 2191, would have no interaction with the capand-trade system. As noted in the report (p. 56):

> The assumptions for the amount of low-carbon fuel available, the expected emission reductions for that fuel, and the total amount of fuel subject to the requirements would significantly affect the costs and feasibility of the LCFS program. The way the provisions are written in S. 2191, the LCFS program is separate from the cap-and-trade program, and there is no way to purchase credits or offsets from other sectors. If the necessary amount of low-carbon fuel is not available, then under the program fuel providers must reduce the amount of fuel they sell, or pay civil penalties. In its analysis of S. 2191, NMA/CRA states that in 2015 the LCFS "can only be met by a decrease in gasoline consumption to allow the limited supplies of low carbon biofuel to meet the averaging requirements of the standard."[3] Further, the model estimates that because of the decrease in supply, motor fuel prices increase 140% in 2015 over the baseline case.[4] The NMA/CRA analysis suggests that if the LCFS is construed to include all ground transportation fuels without exception, then it may be difficult to achieve it without reducing fuel demand.

The magnitude of price increases projected by CRA may or may not be valid, but CRA's analysis does point out the lack of flexibility in S. 2191's LCFS provision. Also, recent experience suggests that fuel demand is very price inelastic (i.e., it takes a very large increase in price before demand decreases significantly).

Responses of Larry Parker and Brent Yacobucci to Questions From Senator Domenici

Question 1. What are the major factors causing signatories to the Kyoto Protocol to miss their greenhouse gas emission reduction targets and are those shortcomings similarly foreseeable for the United States under a cap and trade regime?

Answer. While the domestic emissions of some parties to the Kyoto Protocol may exceed their emissions targets, many of these countries maintain that they will meet their obligations through the use of credits from other countries, as allowed under the Protocol. As noted in CRS Report RL33826, Climate Change: The Kyoto Protocol, Bali "Action Plan," and International Actions, by Susan R. Fletcher and Larry Parker (p. 13):

> The EU [European Union] has consistently stated that it will meet its commitments under the Kyoto Protocol and is currently developing targets for the post-2012 period. In 2006, the European Environmental Agency (EEA) projected the 15 EU Members that had jointly agreed to reduce GHGs by 8% below 1990 levels during the Kyoto compliance period would meet their obligation as a whole, although seven of those countries would not meet their individual obligations.

Meeting the EU target on a regional basis is allowed by the Protocol. As shown in Figure 1 (p. 15) of the same report, emissions above Kyoto targets by Canada, the EU-15, and Japan could be more than offset through emissions credits from Eastern Europe, Russia, and Ukraine. This experience outlines the valuable role that international offsets and credits can play in a cap-and-trade system. To the extent that a U.S. program allows international offsets, costs faced by covered entities would be lower than without offsets, at least in the short-term.

Specific reasons for the difficulties some countries are experiencing in achieving Kyoto targets differ. For example, the rising level of greenhouse gas emissions from 1999-2004 in the EU-15 countries was the result of increased electricity and heat generation from coal-fired facilities and increased energy use in the transport sector. However, these trends reversed between 2004 and 2005 as the EU-15 countries reduced their reliance on coal-fired generation, overall transportation CO_2 emissions declined, and Europe experienced a milder winter than previous years.[5] These sorts of uncertainty are reflected in the wide range of baseline estimates of U.S. greenhouse gas emissions provided in the report. Under S. 2191, the higher the baseline

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[3] CRA International, Economic Analysis of the Lieberman-Warner Climate Security Act of 2007 Using CRA's MRN-NEEM Model (April 8, 2008). p. 29.

[4] Ibid. p. 22.

[5] European Environment Agency, Greenhouse Gas Emission Trends and Projections in Europe 2007 (Copenhagen, 2007), pp. 25-26.

emissions, the greater the reductions necessary to meet the proposed emissions cap, and the more difficult it would be to comply with the cap.

Question 2. I hear supporters of a cap and trade approach to global climate change mitigation consistently refer to the sulfur dioxide program at the Environmental Protection Agency and compare it to the potential implementation of this legislation.

Please compare the size and scope, including the ways in which regulated entities complied with sulfur dioxide limits and can be expected to comply with limits on carbon dioxide, of the two programs so that we may have a better sense of perspective on this comparison.

Answer. On pages 17 and 18, CRS makes some comparisons of the size and scope of the SO_2 program and a program to limit greenhouse gases:

> Compared with the complexity of implementing a greenhouse gas cap-and trade scheme, the SO_2 program was trivial. Conceptually, a CO_2 tradeable permit program could work similarly to the SO_2 program. However, significant differences exist between acid rain and possible global warming that affect current abilities to model responses. For example, the acid rain program involves up to 3,000 new and existing electric generating units that contribute two-thirds of the country's SO_2. This concentration of sources makes the logistics of allowance trading administratively manageable and enforceable. The imposition of the allowance requirement is straightforward. The acid rain program is a "downstream" program focused on the electric utility industry. The allowance requirement is imposed at the point of SO_2 emissions so the participant has a clear price signal to respond to. The basic dynamic of the program is simple, although not necessarily predictable.
>
> A comprehensive greenhouse gas cap-and-trade program would not be as straightforward to implement. Greenhouse gas emissions sources are not concentrated. Although over 80% of the greenhouse gases generated comes from fossil fuel combustion, only about 33% comes from electricity generation. Transportation accounts for about 26%, direct residential and commercial use about 8%, agriculture about 6%, and direct industrial use about 16%.[6] Thus, small dispersed sources in transportation, residential/commercial, agriculture, and the industrial sectors are far more important in controlling greenhouse gas emissions than they are in controlling SO_2 emissions. This greatly increases the economic sectors and individual entities that may be required to reduce emissions.

Further, the report notes that "the diversity of sources creates significant administrative and enforcement problems for a tradeable permit program if it is meant to be comprehensive (p. 17)."

However, the report also comments that (p. 18):

> The flexibility envisioned by most cap-and-trade programs exceeds that of the SO_2 program. Acid rain is a regional problem that resulted in independent responses by the United States and Canada. The United States chose a cap-and-trade program that included important flexibility mechanisms like banking; Canada chose a variety of approaches and the entire process was later codified by treaty. Offsets (emission reductions made by entities not directly covered by the program) are not a major component of the SO_2 program. Uncovered industrial entities that want to participate in the program must become covered entities with their own baselines and monitoring equipment. The bill also sets up a small reserve of allowances to reward reductions through conservation and renewable energy efforts. With the sulfur dioxide cap-andtrade system being limited to the United States, there is no international trading in the acid rain program.
>
> In contrast, most GHG cap-and-trade proposals expand the supply of available allowances by permitting offsets from a wide variety of sources, including agricultural practices, forestry projects, sequestration activities, and alternative energy projects. These diverse sources multiply as the trading extends globally and as other non-CO_2 greenhouse gases are included in the supply mix. Finally, the interaction of these various supply sources and the demand of other countries also reducing emissions (or who may decide to reduce in the future) provide for an almost infinite number of possible scenarios. Crucially, the availability of offsets may have a significant impact on compliance costs, particularly in the short-term.

[6] U.S. Environmental Protection Agency, U.S. Inventory of Greenhouse Gas Emissions and Sinks: 1990-2006 (April 2008), p. ES-8.

It should also be noted that there were several options available in 1990 for reducing SO_2 emissions (e.g., scrubbers, low-sulfur coal). With greenhouse gases, widespread technical solutions may not be as readily available. However, it should be noted that before the SO_2 program was enacted, many thought that it would not be feasible to use low-sulfur western coal in boilers originally designed to use higher-sulfur eastern coal. As events unfolded, the development of the ability to use such coal in these boilers has been an important factor in keeping down the cost of the SO_2 program. This experience highlights the difficult nature of predicting the use, availability, and cost-effectiveness of future technology in the absence of a market currently for that technology.

Question 3. According to the Congressional Budget Office's cost estimate for S. 2191, its cap and trade regime will generate roughly $1.2 trillion between 2009 and 2018.

How much would Congress have to raise the federal gas tax, which is currently at 18.4 cents per gallon, to generate the same amount of revenue between 2009 and 2018?

Answer. The Energy Information Administration projects that the United States will consume roughly 1.5 trillion gallons of motor gasoline between 2009 and 2018.[7] To generate an additional $1.2 trillion through increased gasoline tax revenue, the tax rate would need to increase by roughly 80 cents per gallon, assuming all gasoline is used for taxable purposes, and assuming no discount rate. Please note that this calculation assumes no reduction in gasoline demand resulting from the price increase and is based on gasoline use only; diesel fuel is not included.

Question 4. These analyses tend to list natural gas, nuclear, clean coal, renewables, and other forms of electrical generation as ways in which the caps in S. 2191 can be adhered to. As a result, we get some odd results that are likely impossible to achieve.

Do any of the models you have looked at allow for economic slow-down as a compliance mechanism?

Answer. All of the models allow for economic slowdown resulting from compliance with a greenhouse gas reduction program; however, economic contraction is not employed as a compliance mechanism, per se. The models also project slower GDP growth under S. 2191 than under their baseline ("business-as-usual") cases. For most of the cases, the effect on GDP per capita in 2030 was a 0.3%-2.7% reduction from their respective "business as usual" baselines. Instead of growing by between 62% to 85% from 2010 to 2030 in the baseline projections, GDP is projected to grow 61% to 84% under S. 2191.[8] In no case (including various sensitivity analyses) does the economy contract. As noted in the CRS report, the United States has a massive economy that can absorb substantial shocks with limited longterm effect (page 25).

Question 5. As we discuss issues related to the share of allowances that will be auctioned or given away, what would be the consequences of these permits being bought up by people who don't intend to emit greenhouse gases?

What would that do to the cost to emitters and their ability to comply with S. 2191?

Answer. There are two potential issues raised by your question. The first is the role of non-covered entities (e.g., states) that receive allowance allocations at no cost. The second is the role of non-covered entities in the secondary allowance market.

In the first case, most proposed legislation—including S. 2191—that gives allowances to non-covered entities, requires those entities to generate "fair market value" within some time frame, usually within one year of receipt. These non-covered entities may not bank or retire allowances. Likewise, since they must generate fair market value, they may not sell allowances at a reduced rate (or give them away) to preferred industries or firms.

The second case is the role of traders (who may or may not be covered entities). Under current law, carbon allowances would be regulated as an exempt commodity—any person or firm could buy and sell them like any other commodity. To the extent that market participants hold on to allowances for the future, reducing the available supply, prices are likely to increase. The potential for investor fraud,

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[7] Energy Information Administration, Annual Energy Outlook 2008 with Projections to 2030 (Revised Early Release) (March 2008), Reference Case Table 11.

[8] The cases with the largest reductions in GDP growth rest in the middle of the baseline cases. For example, EPA's IGEM model showed GDP growth from 2010 to 2030 dropping from 78% to 73% under S. 2191.

insider trading, and market manipulation in such a market is discussed in a separate CRS report.[9]

Question 6. The proposed Lieberman-Warner legislation seeks to reduce domestic greenhouse gas emissions by 66 percent by 2050. In the absence of international action, where other countries also take steps to reduce their emissions at similar rates, what effect would this domestic decrease have on projected global greenhouse gas emissions in 2050?

Answer. CRS attempts to put S. 2191 into a global context on pages 67-69. As climate change is a global problem, the potential effects on greenhouse gas concentrations from U.S. action must be considered in a global context. As noted by the Massachusetts Institute of Technology (MIT):

> ...it is not possible to connect specific U.S. policy targets with a particular global concentration or temperature target, and therefore the avoided damages, because any climate gains depend on efforts in the rest of the world.... If a cooperative solution is at all possible, therefore, a major strategic consideration in setting U.S. policy targets should be their value in leading other major countries to take on similar efforts.[10]

Based on the MIT analysis discussed on pages 67-69, the estimated effect of S. 2191 in conjunction with similar action by all other developed countries (Annex 1 countries) who are signatories to the Kyoto Protocol would be to reduce by 0.5 degrees C the projected 3.5 to 4.5 degree C increase in global mean temperatures suggested by the simulations (p. 67). Illustrating the need for global participation in responding to climate change, the report's conclusion notes (page 75):

> S. 2191's climate-related environmental benefit is best considered in a global context and the desire to engage the developing world in the reduction effort. It is in this context that the United States and other developed countries agreed both to reduce their own emissions to help stabilize atmospheric concentrations of greenhouse gases and to take the lead in reducing greenhouse gases when they ratified the 1992 United Nations Framework Convention on Climate Change (UNFCCC). This global scope raises two issues for S. 2191: (1) whether S. 2191's greenhouse gas reduction program and other provisions would be considered sufficiently credible by developing countries so that schemes for including them in future international agreements become more likely, and (2) whether S. 2191's reductions meet U.S. commitments to stabilization under the UNFCCC and occur in a timely fashion so that global stabilization may occur at an acceptable level. [Emphasis in original]

Question 7. I am greatly concerned about the securitization of carbon dioxide emissions credits, which could eventually lead to a situation similar to the recent housing crisis. What steps could be taken to prevent this from happening?

Answer. CRS has a separate report on regulating carbon markets entitled Regulating a Carbon Market: Issues Raised By the European Carbon and U.S. Sulfur Dioxide Allowance Market.[11] Noting the potential regulatory fragmentation of the carbon market, CRS draws an analogy to the stock market crash of 1987. That event revealed differences of opinion among the CFTC, the SEC, and the Federal Reserve. In response, "President Reagan created the President's Working Group on Financial Markets, which remains active, conducting studies and making recommendations on intermarket issues, as well as providing a forum for regulatory coordination. A similar umbrella group might help to prevent regulatory gaps or conflicts in the emissions market."[12]

Question 8. Should the Carbon Market Efficiency Board have authority to provide bail-outs for covered entities, similar to the Federal Reserve's decision to open up its lending window for Bear Stearns earlier this year?

Answer. Under S. 2191, the Carbon Market Efficiency Board can only take actions that apply to all covered entities, for example allowing greater use of offsets or reducing the interest rate on borrowed allowances. CRS does not make recommendations on legislative proposals but could analyze the advantages and disadvantages of any future proposal to change the scope of the authority of the Board. Whether

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[9] For a further discussion of this subject, see CRS Report 34488, Regulating a Carbon Market: Issues Raised By the European Carbon and U.S. Sulfur Dioxide Allowance Markets by Mark Jickling and Larry Parker.

[10] 1Sergey Paltsev, et al., Assessment of U.S. Cap-and-Trade Proposals, MIT Joint Program on the Science and Policy of Global Change, Report No. 146 (April 2007). p. 55.

[11] CRS Report RL34488 by Mark Jickling and Larry Parker.

[12] ibid., p. 37-38.

the Board should have authority to address individual entities' concerns would depend on one's view of the proper role of Board.

RESPONSES OF LARRY PARKER AND BRENT YACOBUCCI TO QUESTIONS FROM SENATOR MENENDEZ

Question 1. Your report touches on the difficulty in monetizing the benefits of GHG reduction. Your illustrative example mentions the results of The Stern Report, and the conclusion that the net present value (NPV) of S. 2191 's estimated reductions would range from $4.2 trillion to $5.5 trillion. I note that this is very close to the costs estimated in the NMA/CRA analysis. As you know, the complexity inherent in interacting economic, social and political systems makes it very difficult to predict the costs and impacts of this legislation. Why is it any more difficult to predict the benefits of avoided warming?

All of the studies you considered exclude averted GW costs and other environmental benefits, the primary reason for climate change legislation. How small or large might these be compared to the regulatory costs projected by the models? Do you consider your illustrative example to be realistic?

As suggested on page 62, both long-term cost and benefit estimates are fraught with uncertainty. Many of the uncertainty issues are the same between long-term cost and benefit analyses (e.g., baseline uncertainty, unknown future events). As discussed on pages 25-29, the perspective of the modelers has a strong influence on both their view of projected costs and perceived benefits of addressing climate change. As illustrated on these pages, cost estimates reflect the technological, economic, and ecological perspective behind the assumptions used. As stated again later with respect to benefits, CRS quotes the Stern Review: "It is very important ... to stress that such estimates reflect a large number of underlying assumptions, many of which are very tentative or specific to the ethical perspectives adopted (page 67)." Benefit analysis may appear harder because the analyst is attempting to put impacts that currently have no markets or prices into an evaluative context of markets and prices. For example, as noted in the discussion of the impact of analysts' perspective on results (pages 25-29), some view issues such as intergenerational equity in ethical terms that should not be considered as commodities to be bought, sold, or discounted. Also, benefit analysis may appear harder because fewer resources have been devoted to it. As CRS notes on page 62: "more research and resources devoted to benefits analysis are necessary before more comprehensive reports will be available."

CRS's illustrative example is based on the assumptions of the Stern Review and the analytical methodology employed by the UK Government. If the analysis were conducted with the much lower social cost of carbon estimate used by the National Highway Traffic Safety Administration (NHTSA), then the benefit estimate would be much lower (page 66). As noted on pages 28-29, meta-analysis suggests that inclusion of climate-related benefits analysis can have a significant effect on lowering the overall costs of a greenhouse gas reduction program and that "as none of the models reviewed in this report quantify any environmental benefits in their analyses, all models' results can be considered 'worst-case' scenarios." (p. 29) The possibility that including all environmental benefits of a climate change program could result in a positive cost-benefit ratio is illustrated by Figure 1 on page 24. All the data points above the zero line indicate a positive cost-benefit result.

Question 2. Nobody wants to see massive global warming. The questions, then, are what to do and when to act. I would like to focus now on the latter. How much more expensive will it be to wait to begin reducing GHG emissions than to act now? Our country faces an urgent need to invest in its infrastructure, including the transportation and electrical systems. If we begin to invest without a plan to address global warming, what potential do you see for inefficient investment?

One of the arguments in favor of doing nothing is the idea that "technological advances" will occur which will make emissions reduction cheaper in the future. What lessons does the SO_2 cap and trade regime offer in that regard? Could the innovations which made that program cheaper than expected have materialized without legislative action?

Answer. In CRS report RL33799, Climate Change: Design Approaches for a Greenhouse Gas Reduction Program, we offer observations on the timing issue with respect to reducing greenhouse gas emissions (p. 12):

> This situation leads to disputes over how time should be managed under a GHG reduction program. One argument is that modest cuts (or slowing of the increase) early, followed by steeper cuts later, is the most cost-effective. Generally, three cost-related arguments are made in favor of this approach. First, over the long-term, sustained GHG reductions involve a turn-

> over in existing durable capital stock—a costly process. If the time frame of the reduction is long enough to permit that capital stock to be replaced as it wears out, the transitional costs are reduced. Second, increased time to comply would permit the development and deployment of new, less carbon-intensive technologies that are more cost-effective than existing technology. Third, assuming a positive rate of return on current investment, less money needs to be set aside today to meet those future compliance costs.[13]

A counter-argument to the above focuses on the risks of delay, both in terms of scientific uncertainty and technology development. First, in terms of scientific uncertainty, there is no consensus on what concentration of greenhouse gases should not be exceeded if undesirable climate change is to be avoided. If the stabilization level needed is relatively low, any delay in beginning reductions could be costly, both economically and environmentally.[14] Second, given the sometimes long lead times for technology development, both a long-term price signal and research and development funding may need to be initiated quickly to encourage technology development and deployment in time to hold GHG concentrations to a level that limits unacceptable damages. In the same vein, an early signal with respect to climate change policy is likely necessary to discourage investment in durable long-lived (50-60 years) carbon-intensive technologies.[15] As stated by Jaccard and Montgomery:

> The window of opportunity for reducing cost implies a need for immediate and continuing action to develop new low-carbon technologies and to begin shifting long-lived investment decisions toward alternatives that lower carbon emissions. Absent these actions, the rapid future emissions reductions included in the delayed emissions scenario may be more costly than more evenly paced, and earlier reductions.[16]

With respect to lessons from the acid rain program, CRS discusses the acid rain program on pages 10-12 of RL34489. As noted on page 11, lower than projected costs were the result of several factors, including lower transportation costs, productivity increases in coal production, costs for scrubbers that were cheaper than expected, and new boiler adaptations to allow use of different types of coals. With the exception of increasing boiler flexibility, none of these would be considered "technological advances" or innovations. The increased boiler flexibility probably would not have occurred in the absence of legislation as there would have been no need for it. With respect to the scrubber cost savings, the commercial availability of two dozen scrubber systems and a competitive market with European and Japanese manufacturers competing with U.S. manufacturers helped ensure market prices to utilities and sufficient capacity.[17]

Question 3. As was the case with the estimates of the cost of SO_2 regulation, none of the LW [Lieberman-Warner] cost studies assume that new legislation will occur that will advance investments in energy efficiency and alternatives, resulting in lowering the costs of LW. Can you discuss what some of the associated policies might be and how likely they are?

Answer. Projecting the likelihood of—and provisions of—future legislative initiatives over the long-term time frame of S. 2191, be it energy efficiency or other alternatives, would be an uncertain enterprise. There are currently over 350 energy efficiency and renewable energy bills introduced in the 110th Congress. These bills cover a wide range of policy and issue areas that include appropriations, authorizations, budget, research and development (R&D), grants, loans, financing, regulation (including a renewable fuel standard), tax incentives, goals, plans, impacts, and the environment/climate change. Most of these bills have focused on grants and tax incentives. The bills also cover a range of sectors and topics that include buildings, transportation, defense, education, federal lands and energy management, farms, American Indians, and international activities. Thus far, the sector of international activities has generated the greatest number of bills. For more information, see CRS

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[13] Robert Repetto and Duncan Austin, The Costs of Climate Protection: A Guide for the Perplexed (World Resources Institute, 1997), p. 21.

[14] Cambridge Energy Research Associates (CERA) Advisory Service, Design Issues for Market-based Greenhouse Gas Reduction Strategies: Special Report (February 2006), pp. 54-55.

[15] CERA Advisory Service, Design Issues for Market-based Greenhouse Gas Reduction Strategies: Special Report (February 2006), pp. 54-55; Robert Repetto and Duncan Austin, The Costs of Climate Protection: A Guide for the Perplexed (World Resources Institute, 1997) p. 22.

[16] M. Jaccard and W.D. Montgomery, "Costs of Reducing Greenhouse Gas Emissions in the USA and Canada," Energy Policy, Volume 24, Issues 10-11 (1996), pp. 889-898.

[17] See Larry Parker, "Scrubbers: A Proven Technology," Forum for Applied Research and Public Policy (Spring 1989), pp. 35-39.

Report RL33831, Energy Efficiency and Renewable Energy Legislation in the 110th Congress, by Fred Sissine, Lynn J. Cunningham, and Mark Gurevitz.

Responses of Larry Parker and Brent Yacobucci to Questions From Senator Sanders

ASSUMPTIONS ABOUT OFFSETS

The use of offsets is being defined in the models as a cost avoidance mechanism, but there is more to offsets than cost avoidance. Now, I understand the theory that paying someone to do something can be easier than changing your own behavior, but if we don't actually ensure emission reductions, it doesn't really matter.

Question 1. What are the assumptions regarding the actual emissions reductions from offsets? Do the models assume a 1 to 1 relationship or do the models include some calculation for the fact that offsets can be difficult to quantify, or even difficult to verify?

Does the usage of offsets create opportunity costs for the adaptation of renewable technologies, such as wind and solar, that reduce our overall emissions? Said another way: does the use of offsets have the potential to, in any way, delay a transition to renewables, since polluters could just pay someone to plant a tree instead of actually moving to sustainable energy?

Also, what are the assumptions in the models that determine the permanence of offsets? Is there a discount factor for offsets that fail because of natural or manmade reasons?

How is additionality worked into the models?

Answer. Based on the documentation provided by the various cases, there appears to be a one-to-one relationship assumed between offsets used and reduction achieved.

As noted in our testimony: "the cases generally indicate that domestic carbon offsets and international carbon credits could be valuable tools for entities covered by S. 2191 not only to potentially reduce costs, but combined with the bill's provisions permitting the banking of allowances, to provide companies more time to develop long-term investment and strategic plans, and to pursue new technologies." To the extent that offsets bring down allowance prices, there may be less incentive for developing new technology or employing renewable resources.[18]

Based on the documentation provided by the various cases, it appears that the cases assume the offsets are permanent. Likewise, there is no apparent discount factor for the possibility of offset failure.

CRS cannot determine from the documentation provided how, or if, the issue of additionality is addressed by the cases it examined.

FAILURE TO ASSESS THE BENEFITS OF ACTION ON GLOBAL WARMING

To date, all of the analyses of Lieberman-Warner and other bills assess only the costs of acting—they do not assess the benefits of acting and avoiding or mitigating global warming. Agencies typically analyze the costs AND benefits of their regulations. However, in the case of climate change, economists have a long way to go in monetizing benefits, assuming many of the benefits—like preventing catastrophic events such as hurricanes, droughts, and other extreme weather events, along with the spread of diseases, wars over resources, and the extinction of species—can even be monetized. The analyses of Lieberman-Warner by EIA and EPA do not attempt to quantify the benefits. They thus run the risk of focusing attention on the costs of climate legislation without balancing that information with the benefits of reducing climate change.

Question 2. Do your analyses assess the benefits of avoiding or mitigating climate change? Aren't there important benefits that have not been considered at all? Examples that come to mind include the avoidance of risks from increased or more severe droughts, floods, hurricanes and wildfires; increased air pollution; catastrophic events such as melting ice sheets; unrest overseas affecting U.S. national security; and changing disease patterns.

A related, but different, question is: do the "Business as Usual" scenarios included in your models (or the models you have seen, in the case of CRS) assume increased costs from the types of events I just mentioned, given that we are told that the events will become increasingly common unless we reduce global warming.

What efforts are others making in the public and private sectors?

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[18] See CRS Report RL34436, The Role of Offsets in a Greenhouse Gas Emissions Cap-and-Trade Program: Potential Benefits and Concerns, by Jonathan L. Ramseur, p. 22.

Answer. The CRS report addresses benefits on pages 62-70. Specifically, the report provides some illustrations of efforts to monetize benefits from reducing greenhouse gases, and attempts to put the reductions proposed by S. 2191 into a global context. With respect to climate risks, table 15 (page 64) provides a matrix of climate risks that illustrates the broad range of potential consequences of climate change and the difficulty in monetizing those potential effects. As stated in the report: (page 63)

> However, most current attempts to monetize environmental benefits are incomplete. The matrix presented in Table 15 illustrates the problem. Most studies that attempt to monetize benefits focus on the market impact of predictable, average changes in climate (the "easiest to measure" box of Table 15). Only a few attempt to value non-market impacts or extreme events and fewer still consider catastrophes or socially contingent impacts.[19] In reviewing 28 studies the UK Government had analyzed in re-examining its estimate of an appropriate Social Cost of Carbon, Ackerman and Stanton observed:
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> > That is, all of the studies that estimate the social cost of carbon base their numbers on an incomplete picture of climate risks—often encompassing only the simplest and most predictable corner of the vast, troubling canvas that has been painted by climate science. There is, of course, no way to assign monetary values to the global response to the possibility of widespread droughts across large parts of Asia, or an increase in the probability of a sudden change in ocean currents that would make the UK as cold as Canada, but in the understandable absence of such impossible monetary values, it is important to remember the disclaimer from the DEFRA [Department for Environment, Food & Rural Affairs] review: all estimates of the SCC [Social Cost of Carbon] omit some of the most important unpriced risks of climate change. The same disclaimer applies to virtually any quantitative economic estimate of climate impacts.[20]

None of the cases CRS examined included any increased costs or suppressed economic growth from the events listed in your question.

With respect to efforts by others to analyze benefits, CRS notes on page 62: "more research and resources devoted to benefits analysis are necessary before more comprehensive reports will be available." An example of recent work in this area is provided in a separate CRS report entitled Climate Change: Current Issues and Policy Tools which also discusses the challenges of benefit analysis, the potential global costs of climate change, and the potential costs of climate change to the U.S. economy.[21] (pages 13-17)

UNTAPPED POTENTIAL FOR RENEWABLES AND ENERGY EFFICIENCY

Electricity from coal, nuclear power, and other traditional energy sources appear prominently in the modeling of Lieberman-Warner. Several renewable technologies, however, are available today that can generate inexpensive electricity without emitting carbon.

Concentrating Solar Power uses the sun to provide heat that drives a steam power plant. This one resource could provide up to 17% of our nation's electricity. A typical CSP plant being built today produces 250 Megawatts of power, emits very little CO_2, and costs 1-2 billion dollars (about the same as a traditional coal plant and significantly less than a new nuclear plant, which can run between 4-12 billion). Over its operating life, today's CSP plants deliver power at $0.13 per kilowatt-hour, but the Department of Energy estimates that the costs for CSP will drop below $0.08 per kilowatt-hour once economies of scale are achieved. There are close to 400 Megawatts of CSP already operating in the southwest, and at least 3, 000 Megawatts are in various stages of development.

Wind is another major opportunity. Just last week the Department of Energy's National Renewable Energy Laboratory released a report showing that wind could provide up to 20% of our nation's electricity needs by 2030. This resource will only cost $0.05 per kilowatt-hour, which is competitive with what we are paying for coal today.

Geothermal is another great opportunity. A report for the U.S. Department of Energy by the Massachusetts Institute of Technology suggests that geothermal energy

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[19] Frank Ackerman and Elizabeth Stanton, Climate Change—the Costs of Inaction, Report to Friends of the Earth England, Wales and Northern Ireland (October 11, 2006), p. 26.

[20] ibid., p. 26.

[21] CRS Report RL34513, Climate Change: Current Issues and Policy Tools, by Jane A. Leggett.

could provide 100,000 Megawatts of new carbon-free electricity at less than $0.10 per kilowatt-hour, comparable to cost projections for coal with carbon capture and storage. This single renewable resource could account for almost 10% of our nation's electricity needs in the future.

There are many other possibilities, for biomass, photovoltaics, hydropower, and other renewable technologies, for example. But, once you add it all up, the United States could meet 2/3 of its electricity needs from sustainable energy.

Now, add on what we could be doing with energy efficiency, and it gets really exciting. According to the McKinsey Report, released last year, we have the technologies needed to reduce greenhouse gases at our disposal today.

Question 3. Do your analyses take into account the strategies identified in the McKinsey Report for reducing greenhouse gases, including improving the economy's energy efficiency?

Answer. CRS did not conduct an independent analysis of the technologies necessary to meet S. 2191's goals, but reviewed the results of six studies. The amount of renewables each model assumed would be built under S. 2191 is provided in Table 11 (p. 46). CRS notes on page 47 that the cases it examined result in a 10-30% reduction in electricity demand from basecase levels. However, CRS does not know if the models incorporated the specific technologies mentioned above. As noted in the report (page 53-54), two of the cases CRS examined used proxies to at least partially model the effects of the various incentives contained in S. 2191:

> Specifically, CATF/NEMS simulated the incentives for low and no carbon power technologies by using a production tax credit for CCS and extending the wind production tax credit to 2030. CATF/NEMS also used EIA's "Best Available Technology" case as a proxy for the appliance and building standards included in the bill. The results are some of the lowest overall cost estimates of any of the cases, along with substantial development of coal-fired CCS, nuclear power and renewables.
>
> Other innovative approaches were taken by EIA/NEMS, to attempt to mimic the impact of energy efficiency incentives by reducing the incremental cost of the most energy-efficient residential appliances by half—simulating a rebate for buying more efficient appliances. Likewise EIA/NEMS mimicked the incentives for stronger building codes by tightening the residential codes in the model by 30% in 2015 and 50% in 2025 compared with basecase levels. These proxies come in addition to the EISA [Energy Independence and Security Act of 2007] provisions that are contained in the preliminary AEO 2008 basecase used by EIA/NEMS. The proxies contribute to some of the lowest cost estimates of any of the cases.
>
> The only other model to incorporate these initiatives was NMA/CRA, which incorporated the preliminary AEO 2008 baseline that includes the EISA provisions. However, the NMA/CRA results do not separate out the efficiency standards from the new Corporate Average Fuel Economy (CAFE) or renewable fuel standard (RFS) requirements.

RESPONSES OF BRIAN J. MCLEAN TO QUESTIONS FROM SENATOR BINGAMAN

Question 1. In his testimony, Larry Parker from CRS aptly quoted a former director of EIA, Dr. Lincoln Moses, who said: "There are no facts about the future". I think we can all appreciate the relevance of this statement to the debate in front of us. Since EPA was heavily involved in the previous sulfur dioxide trading regime, I am wondering if you would care to comment on the factors that caused early estimates of SO_2 allowance prices to be lower than originally projected and on the relevance of those factors to the question of CO_2 allowance prices.

Answer. Two significant assumptions in our analysis of both SO_2 and NO_X programs led us to overestimate allowance prices. First, end-of-pipe pollution control solutions were more effective than expected. In the case of SO_2, incentives were put in the bill to encourage state-of-the-art scrubbers that achieved 90% efficiency, but as the bill was being finalized, scrubbers with 98% efficiency became available. Today new scrubbers routinely attain 98% emission removal efficiency. Similarly, in the case of NOx, we assumed selective catalytic reduction (SCR) could achieve 70% to 80% emission reductions and that the lowest rates that could be achieved were around 0.06 lbs of NOximmBtu. SCRs have performed better than that (upwards of 90%) and we have seen rates on many units below 0.06 lbs/mmbtu.

Second, we did not anticipate the full suite of low cost options that have been deployed. In the case of SO_2, competition among railroads shipping low-sulfur coal led to substantial reductions in transport costs, a major component of coal cost. As low-sulfur coal became more readily available, it competed with scrubber design and

equipment advances, reducing the cost of abatement. All of this contributed to medium-sulfur coal becoming marketable in the absence of a coal sulfur content limit which had existed under the traditional regulatory program. In the case of NOx, improved combustion controls reduced costs.

Depending on the precise terms of the legislation approved, EPA could expect to see similar performance as companies respond to the CO_2 price signal by developing and deploying technologies and innovative compliance strategies in ways that differ from the assumptions in our models.

Question 2. Both EIA and EPA project that the amount of CCS deployed under the Lieberman-Warner bill would be less than the amount deployed under the Bingaman-Specter bill, even though the implied bonus to CCS (on a per ton basis) is greater under the Lieberman-Warner bill. Could you comment on the factors driving these differences in CCS deployment? How do the costs of CCS compare the cost of nuclear in these models?

Answer. While it is correct to say that the bonus ratio for CCS (on a per ton basis) is greater under the Lieberman-Warner bill, the total number of bonus allowances available for CCS projects is lower. In Section 3601 of S. 2191, the bill instructs the Administrator to create a Bonus Allowance Account for carbon capture and storage deployment and to allocate 4 percent of the emission allowances to the account for each calendar year from 2012 through 2030. The Bingaman-Specter bill does not contain any such limitation on the number of bonus allowances available for CCS projects. This limit on the total number of bonus allowances is the main factor driving the differences in EPA's modeled results of CCS deployment under the two bills.

Nuclear power is one of the lower-cost low-carbon generating options in our model when a carbon constraint is imposed, and the model builds as much as possible within the resource constraints. Advanced coal generation with CCS is a more expensive low-carbon electricity generation option that generally gets built after new nuclear generation capacity reaches the model constraint. During the 2015-2020 time period, our model finds that CCS is cost-effective only if the bonus allowances are available. Without the bonus allowance provisions, the model would not build CCS capacity until CO_2 allowance prices are high enough to make it attractive relative to other generation alternatives. The allowance prices reach this point by 2025 under EPA modeling and assumptions.

Question 3. All of the model analyses of Lieberman-Warner show that offsets are an important part of the compliance strategy in early years. If offsets are assumed not to be available as widely as the provisions allow, then the early targets become much more difficult to achieve at low cost. Since EPA generates the offset supply curves that other modeling groups employ, could you describe in some detail the steps that were taken to determine whether sufficient number of offsets would be available to meet the Lieberman-Warner targets and to calculate the cost and implied carbon price of such projects?

Answer. EPA drew on experience gained through its government-industry greenhouse gas partnership programs to develop mitigation cost data for the non-CO_2 greenhouse gases in the energy, waste and industrial sectors, as well as for the forestry and agriculture sectors. These analyses were peer reviewed and published in EPA reports on Global Mitigation of Non-CO_2 Greenhouse Gases (EPA 430-R-06-005, 2006) and Greenhouse Gas Mitigation Potential in U.S. Forestry and Agriculture (EPA 430-R-05-006, 2005). Domestic and international offset supply curves were initially developed for EPA's analysis of the Lieberman-McCain bill (S. 280) and described in EPA's March 26, 2007 memo to EIA. These offset supply curves were subsequently adapted for use in EPA's analyses of the Bingaman-Specter bill (S. 1766), and the Lieberman-Warner bill (S. 2191). In developing these offset supply curves EPA evaluated each individual domestic and international mitigation option to determine potential eligibility and feasibility over time for a future mitigation program. The offset supply curves therefore represent the costs associated with the "eligible" mitigation options. This detailed vetting of individual options, based on EPA's substantial emissions inventory and mitigation program expertise, substitutes and improves upon previous post-processing adjustments to the offset supply curves. The previous post-processing adjustments involved an across the board 50% reduction of the offset supply curves at every price. The detailed vetting of individual options results in a reduction of the offset supply curves that is similar in size to the previous post-processing adjustment.

The EPA reports, our memo to EIA, additional detailed explanations, and the data used for development of the offset supply curves which are all available on our web site: http://www.epa.gov/climatechange/economics/economicanalyses.html.

RESPONSES OF BRIAN J. MCLEAN TO QUESTIONS FROM SENATOR DOMENICI

Question 4. What are the major factors causing signatories to the Kyoto Protocol to miss their greenhouse gas emission reduction targets and are those shortcomings similarly foreseeable for the United States under a cap and trade regime?

Answer. Signatories to the Kyoto Protocol (KP) are required to meet their emission limitation and reduction commitment under the Protocol for the five-year period from 2008 to 2012. Parties are not expected to report emissions data for 2008 until 2010. Because these commitments can be met by domestic action, through emissions trading or by acquiring reductions from either the Clean Development Mechanism or through Joint Implementation activities, national inventories for one year do not necessarily indicate whether a country will be in compliance at the end of the commitment period. Compliance will be determined after 2012 on the basis of whether or not a Party has sufficient Kyoto allowances to cover its emissions over the entire five-year period.

Although the U.S. can learn from steps being taken under the Kyoto Protocol as well as lessons learned from current U.S. cap and trade programs, we are not bound to any shortcomings that might ultimately be found in the Kyoto Protocol system.

Question 5. I hear supporters of a cap and trade approach to global climate change mitigation consistently refer to the sulfur dioxide program at the Environmental Protection Agency and compare it to the potential implementation of this legislation.

Please compare the size and scope, including the ways in which regulated entities complied with sulfur dioxide limits and can be expected to comply with limits on carbon dioxide, of the two programs so that we may have a better sense of perspective on this comparison.

Answer. The U.S. experience with cap and trade since the passage of the 1990 Clean Air Act Amendments has been very successful and forms the basis on which other countries have modeled cap and trade programs, and are modeling their greenhouse gas (GHG) reduction programs.

The sulfur dioxide cap and trade program, known as the Acid Rain Program, began in 1995, targeting 110 coal-fired power plants (263 individual sources) in 21 eastern and Midwestern states. In 2000, Phase 2 of the program affecting virtually all electric power generators created the robust and dynamic market that has resulted in reducing emissions by nearly 50% and achieving the cap levels ahead of schedule. Currently, over 3,500 individual sources participate in the Acid Rain Program (2007 data). The flexibilities inherent in the program allowed for cost-effective decision making on a case-by-case basis by the owner or operator of a facility, without government interference, as to how a source chose to comply with the program requirements. If a source chose to change its method of compliance, it was free to do so without government review or approval. This resulted in huge economies of scale previously unimagined in traditional regulation (sometimes referred to as command-and-control). What made this possible were basic and straightforward requirements in the cap and trade program design that were easily understood by everyone: each ton of SO_2 emissions had to be offset by an allowance; if you wished to reduce below your allocation, you were free to sell your extra allowances or bank them for future use; if you emitted beyond your allocation, you needed to and were able to buy allowances from the market; at the end of the year, your emissions had to be equal to or less than the allowances you held in your account. A firm cap ensured the environmental goal was met and stringent continuous monitoring and reporting assured the integrity of every allowance, while providing the accountability that makes flexibility possible. All program data is made publicly available. Market and data transparency instilled public confidence in the process. Compliance is over 99%; the few instances of excess emissions have had compensating allowances automatically subtracted from accounts and stiff penalties automatically applied. EPA has issued a progress report every year on the status of the program. (For more detailed information, please see http://www.epa.gov/airmarkets/progress/progress-reports.html.)

The scope of the SO_2 program and a potential U.S. GHG mitigation program would be different. Currently, there are roughly 1,200 facilities covered by the existing Acid Rain Program (or roughly 3,500 individual sources of emissions). EPA estimates that 2,0003,000 facilities would be covered by S. 2191. The primary difference is that the source category for the Acid Rain Program focuses on electricity generators; while for the Lieberman-Warner proposal, source categories contributing to GHG emissions that cover the breadth of the economy have been discussed. The scale of the needed emission reductions under a future CO_2 program, as specified in bills EPA has analyzed, is both larger and more complex than under the SO_2 program. The electricity generation sector made up over 70% of the SO_2 contribution of total nationwide emissions, and restricting those emissions greatly reduced the

acid rain problem and transport of SO_2. CO_2 emissions from electricity generation comprise about 30% of the total U.S. CO_2 emissions and other sectors, such as industry and transportation, contribute a significant portion of the total emissions.

Even though the scale of the problem is different, much of the experience that has been gained from the existing EPA cap and trade programs can be applied to GHG cap and trade programs, including the establishment of a robust market, a strong institutional infrastructure, and cooperative relationships with States and industry that focus on results and assisting with compliance.

It might also be useful to consider how a GHG cap and trade program would compare to the NOx cap and trade program used to reduce ozone transport in the Eastern U.S. In that case electricity generators and other industrial sources included in the program represented about 30% of the NOx emissions. The NOx Budget Trading Program successfully reduced those emissions by more than 70%. Because NOx contributes to the formation of ground level ozone, such reductions significantly contributed to a reduction in ozone transport. Coupled with significant reductions from mobile sources, 80% of the ozone nonattainment areas in the East were brought into attainment.

Question 6. I am concerned that the effect Lieberman-Warner would have on global greenhouse gas concentrations, as opposed to emissions, has been consistently overlooked. In the absence of meaningful reductions by other countries, I am told that your agency's analysis of S. 2191 finds that global concentrations would be reduced by about 1 percent by 2050.

What is the probable impact of a 1 percent reduction in global greenhouse gas concentrations? What potential consequences of global climate change would such a reduction prevent?

Answer. Legislative action by any one country—including the U.S.—would not be able to reduce GHG concentrations in the atmosphere enough to have much impact on the climate challenge. Global participation—especially by major economies—is needed. Our analysis of the Lieberman-Warner bill presents both the impact of the US acting alone, which would result in a 1.3% reduction in global CO_2 concentrations by 2050 taking into account the emissions leakage; and one possible assumption, based on a recent MIT report, where the Annex I Kyoto countries (except Russia) gradually reduce emission levels to 50% below 1990 levels and the rest of the world gradually reaches 2000 levels by 2050, which would result in a 9.7% reduction in global CO_2 concentrations. However, it is noteworthy that only the European Union and Norway have made pledges to meet or exceed the 50% target by 2050 and very few countries have policies in place to set them on a trajectory to meet such targets.

The current analytic capabilities of EPA, and of the climate change research community in general, do not allow us to quantify with confidence what the specific change in endpoint impacts (e.g., on human health, agricultural production, water resource availability) would be due to an incremental change in concentrations. The climate change research community has traditionally not examined the differences in potential future impacts between two incrementally different scenarios, but has instead focused on the impacts associated with different scenarios that diverge more significantly over time.

Nevertheless, because we know, from the scientific literature assessed by the Intergovernmental Panel on Climate Change, that risk to human health, society and the environment increases as the rate and magnitude of climate change increases, near term mitigation actions reduce long-term risks (including risk of exceeding critical thresholds), and increase our chances of eventually reaching lower stabilization targets.

Question 7. We currently have no domestic capacity for the fabrication of large nuclear components such as pressure vessels, and we are told that our existing workforce can support the construction of no more than three reactors at a time.

Have you analyzed how many reactors we are physically capable of building by 2030?

Answer. We have not performed a comprehensive analysis of the number of new reactors that could be built in the U.S. by 2030; however, a 2005 study performed for the Department of Energy concluded that the necessary infrastructure is available or can be readily available to support the construction of 8 units in the 2010 to 2017 time period. In developing our projections for nuclear power, we drew on analyses performed for the Climate Change Science Program as well as the Electric Power Research Institute. Currently there are a number of factors constraining the ability to build reactors. For example, there is only one manufacturer (located in Japan) currently capable of manufacturing nuclear-grade, ultra-heavy (>350 tons) forgings needed to build a nuclear reactor and since there has been limited activity in the nuclear field since the early 1990s there is only a small trained US workforce

in this area. However, Japan Steel Works has indicated that it is going to increase capacity and a number of other manufacturers have indicated their intention to develop capabilities needed for increased nuclear construction. In addition, the nuclear industry, recognizing the potential shortage of skilled workers and professionals, is actively recruiting and implementing training programs to ensure workforce adequacy for new construction.

Question 8. These analyses tend to list natural gas, nuclear, clean coal, renewables, and other forms of electrical generation as ways in which the caps in S. 2191 can be adhered to. As a result, we get some odd results that are likely impossible to achieve.

Do any of the models you have looked at allow for economic slow-down as a compliance mechanism?

Answer. EPA's models do not use an economic slow-down as a compliance mechanism. In EPA's analysis, the first step is to develop a reference case for projected economic growth, technology deployment, and GHG emissions. EPA's reference case is traditionally benchmarked to the reference case in EIA's *Annual Energy Outlook*. The next step in the analysis is to estimate the effect of changes in technology investments that result from the climate mitigation policy on reductions in GHG emissions, economic growth, and energy and other commodity prices.

Question 9. As we discuss issues related to the share of allowances that will be auctioned or given away, what would be the consequences of these permits being bought up by people who don't intend to emit greenhouse gases?

What would that do to the cost to emitters and their ability to comply with S. 2191?

Answer. It is possible that individuals or institutions may purchase allowances with no intention of submitting them as compliance for the targeted emission levels of greenhouse gases. Such purchases may be made for several reasons. The purchase of an allowance could be used as a financial asset in the hope that this investment may result in higher returns than may be available elsewhere.

Individuals or groups may also decide to purchase allowances simply to retire them, thus effectively lowering the cap. This has occurred to a very limited extent in the Acid Rain program, but has not been enough to significantly affect the cap or allowance prices. Given the size of the market created by a bill like S .2191, EPA does not believe that such purchases would significantly affect the cap level or costs.

RESPONSES OF BRIAN J. MCLEAN TO QUESTIONS FROM SENATOR MENENDEZ

Question 10. Current oil prices are nearly double those assumed in EIA's and EPA's analysis of climate policy. We can already see that high gasoline prices are inducing changes in consumer driving and vehicle purchasing behavior. Goldman Sachs recently estimated that oil prices might climb to $150-$200 per barrel within the near future. How might the projected costs of Lieberman-Warner and other climate policies change if the models were run with the higher (and more realistic) energy prices that we are already seeing today?

Does this mean that allowance prices and the total cost to the economy of the cap will be lower than current models suggest? Can the EPA or EIA rerun the models with estimates that reflect a future with sustained high prices for petroleum and other fossil fuels?

Answer. EPA's economy-wide models are designed to compare responses across policy and reference scenarios, not to forecast energy prices. To compare policy responses, we benchmark the EPA models to reference scenarios from EIA's Annual Energy Outlook. If we were to benchmark the models to the EIA High Energy Price Case, GDP would be slightly lower and total GHG emissions would also be lower compared to our standard reference case that had lower energy prices. If we modeled the Lieberman-Warner bill off of the High Price case, allowance prices would likely be lower than in our standard case, although it is difficult to estimate the precise impact. In a scenario that also limits the availability of nuclear and carbon capture and storage technologies, where we expect to see an increase in natural gas usage in the electricity sector, the increased cost of natural gas usage would likely offset some of the potential decrease in allowance prices.

Yes, EPA can run scenarios with sustained high prices for petroleum and other fossil fuels.

RESPONSES OF BRIAN J. MCLEAN TO QUESTIONS FROM SENATOR SANDERS

ASSUMPTIONS ABOUT OFFSETS

Question 11a. The use of offsets is being defined in the models as a cost avoidance mechanism, but there is more to offsets than cost avoidance. Now, I understand the

theory that paying someone to do something can be easier than changing your own behavior, but if we don't actually ensure emission reductions, it doesn't really matter.

What are the assumptions regarding the actual emissions reductions from offsets? Do the models assume a 1 to 1 relationship or do the models include some calculation for the fact that offsets can be difficult to quantify, or even difficult to verify?

Answer. The data and approach developed for EPA's assessment of offset potential is described in the answer to Senator Bingaman's third question. When applying the offset supply curves, EPA evaluates a variety of issues related to each mitigation option and adjusts the curve accordingly. The adjustments account for challenges in measuring, monitoring, and verifying offset reductions, as well as the lack of a clear market signal that the allowance price in the model run assumes.

To illustrate the approach, for international energy-related CO_2 emissions, the full abatement potential is included in the offset supply curve when a region has a market based greenhouse gas policy in place. When a region does not have a market-based emissions policy in place, the abatement potential is reduced by 90 or 75 percent, depending on the year. The approach used to estimate both domestic offsets and international credits is described in detail in EPA's March 26, 2007 memo to EIA which is on our web site: http://www.epa.goviclimatechange/economics/economicanalyses.html.

Question 11b. Does the usage of offsets create opportunity costs for the adoption of renewable technologies, such as wind and solar, that reduce our overall emissions? Said another way: does the use of offsets have the potential to, in any way, delay a transition to renewables, since polluters could just pay someone to plant a tree instead of actually moving to sustainable energy?

Answer. To the extent offsets reduce the costs of achieving an emissions cap and the allowance price, they can delay the adoption of higher cost technologies. At the same time, the ability of offsets to reduce costs can provide the private sector more time to develop new advanced technologies, including renewables. Determining which higher-cost mitigation options might be delayed and by how much is dependent on the specific policy proposal as well as the assumptions made about the cost and performance of various technologies.

If one believed that offsets were delaying deployment of available technologies one could set a lower cap, set it sooner, or restrict the amount of offsets. Cap levels and timing and the availability of offsets should all be considered together.

Question 11c. Also, what are the assumptions in the models that determine the permanence of offsets? Is there a discount factor for offsets that fail because of natural or manmade reasons?

Answer. Our analysis takes a comprehensive accounting of GHG emissions, both crediting emission reductions and debiting emission increases. Therefore, we do not use a discount factor for offsets related to the possibility of failure.

Our analysis does include adjustments to the total amount of potential offsets. The adjustments made to mitigation potential for each offset category are designed to account for difficulties in measuring, monitoring, and verifying offset reductions in countries without a market-based greenhouse gas emissions policy. These adjustments include verifying that the offset emission reductions are achieved.

Question 11d. How is additionality worked into the models?

Answer. Since mitigation in our modeling is a function of a GHG allowance price, all mitigation undertaken is by definition additional to the reference case, that is, it would not have taken place in the absence of a GHG allowance price.

FAILURE TO ASSESS THE BENEFITS OF ACTION ON GLOBAL WARMING

Question 12a. To date, all of the analyses of Lieberman-Warner and other bills assess only the costs of acting—they do not assess the benefits of acting and avoiding or mitigating global warming. Agencies typically analyze the costs AND benefits of their regulations. However, in the case of climate change, economists have a long way to go in monetizing benefits, assuming many of the benefits—like preventing catastrophic events such as hurricanes, droughts, and other extreme weather events, along with the spread of diseases, wars over resources, and the extinction of species—can even be monetized. The analyses of Lieberman-Warner by EIA and EPA do not attempt to quantify the benefits. They thus run the risk of focusing attention on the costs of climate legislation without balancing that information with the benefits of reducing climate change.

Do your analyses assess the benefits of avoiding or mitigating climate change? Aren't there important benefits that have not been considered at all? Examples that come to mind include the avoidance of risks from increased or more severe droughts, floods, hurricanes and wildfires; increased air pollution; catastrophic events such as

melting ice sheets; unrest overseas affecting U.S. national security; and changing disease patterns.

Answer. Current analyses do not include the benefits of avoided climate change. At this time, these analyses only estimate the cost of achieving the levels of greenhouse gas emission reductions specified in the proposed legislation.

Although we cannot yet provide a cost-benefit analysis of proposed legislation, EPA is assessing the benefits of climate change mitigation. EPA has developed preliminary ranges of estimates for the marginal benefit of carbon dioxide reductions (Social Cost of Carbon). These estimates include many of the climate impacts listed in your question. We recognize, however, that the IPCC concluded that current estimates are still "very likely" to be underestimated because they do not include significant impacts that have yet to be monetized. Current estimates do not capture many of the main reasons for concern about climate change, i.e., non-market damages, the effects of climate variability, risks of potential extreme weather (e.g., droughts, heavy rains and wind), socially contingent effects (such as violent conflict), and potential long-term catastrophic events. We are thus reviewing available literature on a range of climate impacts to develop more robust and complete estimates of the benefits of greenhouse gas mitigation.

Question 12b. A related, but different, question is: do the "Business as Usual" scenarios included in your models (or the models you have seen, in the case of CRS) assume increased costs from the types of events I just mentioned, given that we are told that the events will become increasingly common unless we reduce global warming.

Answer. No, most modeling of legislative proposals do not address the costs of climate change impacts under Business as Usual scenarios.

Question 12c. What efforts is your agency making to assess the value of the benefits of climate change mitigation?

Answer. See answer to the first part of Question 2.

UNTAPPED POTENTIAL FOR RENEWABLES AND ENERGY EFFICIENCY

Question 13. Electricity from coal, nuclear power, and other traditional energy sources appear prominently in the modeling of Lieberman-Warner. Several renewable technologies, however, are available today that can generate inexpensive electricity without emitting carbon.

Concentrating Solar Power uses the sun to provide heat that drives a steam power plant. This one resource could provide up to 17% of our nation's electricity. A typical CSP plant being built today produces 250 Megawatts of power, emits very little CO_2, and costs 1-2 billion dollars (about the same as a traditional coal plant and significantly less than a new nuclear plant, which can run between 4-12 billion). Over its operating life, today's CSP plants deliver power at $0.13 per kilowatt-hour, but the Department of Energy estimates that the costs for CSP will drop below $0.08 per kilowatt-hour once economies of scale are achieved. There are close to 400 Megawatts of CSP already operating in the southwest, and at least 3,000 Megawatts are in various stages of development.

Wind is another major opportunity. Just last week the Department of Energy's National Renewable Energy Laboratory released a report showing that wind could provide up to 20% of our nation's electricity needs by 2030. This resource will only cost $0.05 per kilowatt-hour, which is competitive with what we are paying for coal today.

Geothermal is another great opportunity. A report for the U.S. Department of Energy by the Massachusetts Institute of Technology suggests that geothermal energy could provide 100,000 Megawatts of new carbon-free electricity at less than $0.10 per kilowatt-hour, comparable to cost projections for coal with carbon capture and storage. This single renewable 11 resource could account for almost 10% of our nation's electricity needs in the future.

There are many other the possibilities, for biomass, photovoltaics, hydropower, and other renewable technologies, for example. But, once you add it all up, the United States could meet 2/3 of its electricity needs from sustainable energy.

Now, add on what we could be doing with energy efficiency, and it gets really exciting. According to the McKinsey Report, released last year, we have the technologies needed to reduce greenhouse gases at our disposal today.

Do your analyses take into account the strategies identified in the McKinsey Report for reducing greenhouse gases, including improving the economy's energy efficiency?

Answer. EPA modeling takes into account many of the strategies identified in the McKinsey Report. Our model results show more than 55 GW of additional new renewable energy capacity relative to the reference case by 2025, and much of the new

capacity is from wind power. For energy efficiency, the models include the consumer response to higher electricity prices and capture some energy efficiency investments. EPA recognizes that energy efficiency is an important, readily available resource that can, under the right circumstances, be implemented at relatively low cost, and we are drawing on the expertise gained through these programs to improve the representation of energy efficiency opportunities in our models. Our review of the McKinsey analysis indicates that we have consistent estimates of mitigation available in 2030 for comparable costs. We also recognize that technologies continuously evolve and improve and thus we have an ongoing commitment to incorporate new information on cost and performance into our models.

The modeling approaches used by EPA and for the McKinsey analysis are different, however. The McKinsey analysis identifies a number of specific technologies and strategies to reduce emissions at a cost of less than $50 per ton of CO_2e. Our models do not explicitly represent individual end-use technologies, but rather represent changes in end-use demand for energy in aggregate. In addition, our models represent capital markets and can show the effect on the economy of increased investment in the energy sector, as well as mitigation tradeoffs across sectors. Despite these differences, the McKinsey analysis and our models have fairly consistent estimates of mitigation available in 2030 for similar CO_2 prices.

RESPONSES OF PETER R. ORSZAG TO QUESTIONS FROM SENATOR DOMENICI

Question 1. What are the major factors causing signatories to the Kyoto Protocol to miss their greenhouse gas emission reduction targets and are those shortcomings similarly foreseeable for the United States under a cap-and-trade regime?

Answer. While many of these countries actually increased emissions between 1997 and 2008, their commitments to reduce emissions are not binding until 2008 to 2012.

One reason why emissions did not fall during the initial pilot period was that some signatories allocated too many allowances, so there was no real need to reduce emissions. Furthermore, high natural gas prices during the period encouraged an increase in the use of coal to generate electricity. This pilot period was useful for the European countries in that it provided a great deal of data on emissions, enabling them to correctly allocate allowances for the 2008-2012 period in order to meet their commitments.

Provided that the United States implemented the cap "upstream" on producers and importers of fossil fuels or "downstream" only for large electricity generators, a U.S. program should be able to avoid this problem, because the country already has a great deal of detailed information on energy production and fossil-fuel imports. Furthermore, large electricity generators are already required to continuously monitor emissions of several pollutants, including carbon dioxide (CO_2).

The choice of 1990 as a base year for the Kyoto Protocol is another factor that has caused some countries' emission trends to exceed their Kyoto targets. The choice of 1990 made it difficult for signatory countries that have experienced high rates of economic growth since then (for example, Spain and Ireland) to meet their targets.

Question 2. I hear supporters of a cap-and-trade approach to global climate change mitigation consistently refer to the sulfur dioxide program at the Environmental Protection Agency and compare it to the potential implementation of this legislation.

Please compare the size and scope, including the ways in which regulated entities complied with sulfur dioxide limits and can be expected to comply with limits on carbon dioxide, of the two programs so that we may have a better sense of perspective on this comparison.

Answer. The size and scope of a market for carbon dioxide emissions will be a function of policy design. The number of covered entities may or may not be more or less similar to the number in the current sulfur dioxide (SO_2) program depending on the design of the CO_2 program, but the value of the emission allowances in the programs currently being considered by the Congress is considerably larger for CO_2 than for SO_2.

Should policymakers choose to place the cap upstream on producers or importers of fossil fuels or adopt a hybrid system that would directly cap large electricity generators but would place an upstream cap on other sources, then the number of regulated entities would be roughly comparable to the number in the current SO_2 program, which covers about 3,000 generating units. As was the case with SO_2, S. 2191 would allow nonregulated firms to participate in the allowance market—entities

that are not required to submit allowances for their emissions (such as brokers) would be allowed to buy and sell allowances.

In contrast to the number of regulated entities, the magnitude of the CO_2 market, as measured by the value of the allowances traded, is likely to be much larger than the roughly $3 billion SO_2 market. In November 2007, the Congressional Budget Office (CBO) estimated that the bills under consideration by the Congress at that time would result in an allowance market that totaled between $50 billion and $300 billion (in 2006 dollars) in 2020. On the basis of CBO's estimate of the cost of S. 2191, the value of the allowances in 2018 would be about $200 billion.

The SO_2 program is implemented largely by the U.S. Environmental Protection Agency (EPA) and is national in scope. The agency runs electronic allowance and emission registries and is responsible for verification of emission data. Regulated firms are allowed to comply either by reducing their emissions or by retiring an allowance for each ton of SO_2 that they emit. Firms are allowed to bank an unlimited amount of current allowances for use in future years. Banking provides an incentive for firms to undertake more emission reductions than are required to meet the cap in low-cost years and, thus, helps smooth allowance prices over time. In spite of this, researchers have found that prices for SO_2 allowances have been far more volatile than stock prices.

How similar or different firms' compliance options are under a CO_2 cap-and-trade program and the existing SO_2 program would depend on policymakers' decisions in designing the policy. Under S. 2191, firms would be able to comply by retiring an allowance or by purchasing a qualifying "offset," which could be obtained from entities that sequestered carbon emissions or from entities that reduced greenhouse gas emissions but were not subject to the cap. Should policymakers choose to include a "safety valve" in a cap-and-trade program (not included in S. 2191), regulated entities would have an additional compliance option: They could comply by purchasing an allowance from the government at the safety-valve price.

Question 3. According to your cost estimate of S. 2191, its cap-and-trade regime will generate roughly $1.2 trillion between 2009 and 2018.

How much would Congress have to raise the federal gas tax, which is currently at 18.4 cents per gallon, to generate the same amount of revenue between 2009 and 2018?

Answer. The Joint Committee on Taxation (JCT) has estimated that raising federal excise taxes on gasoline and diesel fuel by 50 cents per gallon, to 68.4 cents for gasoline and 74.4 cents for diesel fuel, would increase federal revenues by $49.3 billion in 2008 and by a total of $685.3 billion over the 10 years from 2008 through 2017 (CBO is required by law to use JCT's estimates for revenue proposals). Because excise taxes reduce the tax base of income and payroll taxes, higher excise taxes would lead to reductions in income and payroll tax revenues. The estimates reflect those reductions.

CBO is not aware of any published estimates by JCT of the effects of an increase beyond 50 cents per gallon. Estimates of the additional increase in excise taxes needed to generate $1.2 trillion over 10 years would depend on assumptions about the response of consumers to higher tax rates and the effects of higher rates on compliance.

Question 4. Your cost estimate looks at revenues and outlays through 2018, within the budget window. I am concerned about the costs of this legislation over a longer period of time.

Answer. CBO estimates that enacting S. 2191, as ordered reported by the Senate Committee on Environment and Public Works with an amendment, would increase revenues by about $1.21 trillion over the 2009-2018, net of income and payroll tax offsets. Over that period, we estimate that direct spending from distributing those proceeds would total about $1.13 trillion. The additional revenues would exceed the new direct spending by an estimated $78 billion, thus decreasing deficits (or increasing surpluses) by that amount over the next 10 years.

Assuming that the same pattern of revenue collection and spending would occur over the life of the program (2009-2050), the federal government would continue to collect revenue from the auctions and would spend some of those funds on a variety of programs as specified in the legislation. Because S. 2191 would require a portion of the auction proceeds to be deposited into a Climate Change Deficit Reduction Fund, and because that fund would be available for spending only as provided in future appropriations bill, CBO estimates that over the 2009-2050 period, net revenues also would exceed new direct spending.

Question 5. These analyses tend to list natural gas, nuclear, clean coal, renewables, and other forms of electrical generation as ways in which the caps in S. 2191 can be adhered to. As a result, we get some odd results that are likely impossible to achieve.

Do any of the models you have looked at allow for economic slow-down as a compliance mechanism?

Answer. Nearly all efforts to model the economic impacts of cap-and-trade programs include a feedback by which restrictions on emissions raise energy prices, reduce incomes and slow the macroeconomy, and thus modestly reduce energy demand and energy-related emissions.

Question 6. As we discuss issues related to the share of allowances that will be auctioned or given away, what would be the consequences of these allowances being bought up by people who don't intend to emit greenhouse gases?

What would that do to the cost to emitters and their ability to comply with S. 2191?

Answer. Factors that would affect allowance prices include the stringency of the cap, weather, conditions in energy markets, economic activity, available technologies for producing low- or zero-carbon energy and for sequestering carbon, and expectations about those factors. Permitting allowances to be bought and sold by entities that are not required to submit allowances for their emissions, but intend to resell them, would widen the market, creating a larger and potentially more diverse view of those key factors that influence current and future prices. Such broadening of the market would increase liquidity and could reduce volatility, provided that additional investors were well informed about the market.

Individual participants or groups of participants (for example, sovereign wealth funds or investment funds formed by energy-producing cartels) could influence the price of allowances only if they were able to obtain a sufficiently large share of the market. Given the size of the allowance market, it would take a large amount of wealth to influence the price of allowances.

In order to reduce the risk of market manipulation, current regulation to prevent manipulation of commodity markets could also be applied to CO_2 allowance trading. In addition, policymakers could choose to set an upper limit on the price of allowances by allowing firms to purchase them from the government at a safety-valve price.

Allowing nonemitters to purchase allowances would also create the possibility that entities could choose to buy allowances in order to retire them, thus making the cap more stringent. To the extent that that occurred, it would tend to increase the price of allowances.

Question 7. Before the Senate Finance Committee on April 24, 2008, you stated that, "Under a cap-and-trade program, firms would not ultimately bear most of the costs of the allowances but instead would pass them along to customers in the form of higher prices."

Would anyone be disproportionately impacted by these higher energy prices? And how would the revenues raised by S. 2191 be distributed—who, in effect, would be choosing which technologies are advanced, and which programs receive funding?

Answer. A cap-and-trade program would increase the prices of energy and energy-intensive goods and services. Those higher prices would impose a larger financial burden on low-income households than on high-income households for two reasons. First, energy-related expenditures make up a larger share of the purchases of low-income households than of high-income households. Second, low-income households typically spend a larger fraction of their income.

S. 2191 would require that auction proceeds be deposited into seven funds established by the Department of the Treasury:

- The Energy Assistance Fund ($64 billion) would support various energy assistance programs for low-income persons and other initiatives;
- The Climate Change Worker Training Fund ($12 billion) would primarily support training programs for workers;
- The Adaptation Fund ($31 billion) would primarily support research and education activities by the Department of the Interior to assist fish and wildlife in adapting to the impacts of climate change;
- The Climate Change and National Security Fund ($16 billion) would finance steps to implement recommendations stemming from the International Climate Change Adaptation and National Security Program established under this legislation;
- The Bureau of Land Management Emergency Firefighting Fund ($2 billion) would support fire suppression activities on federal wildlands;
- The Forest Service Emergency Firefighting Fund ($6 billion) would support fire suppression activities on federal wildlands; and
- The Energy Independence Acceleration Fund ($6 billion) would support research activities by the Department of Energy.

In addition, the legislation would establish the Climate Change Credit Corporation, which would be responsible for auctioning the allowances and using the proceeds to finance various initiatives through the Energy Technology Deployment Program. By CBO's estimates, spending for that program would total about $123 billion over the next 10 years. In total, direct spending from those funds (including the Energy Deployment Program) would total about $30 billion over the 2009-2013 period and about $260 billion over the 2009-2018 period, CBO estimates. In addition, some proceeds would be deposited into the Climate Security Act Management Fund; however, spending from that fund could not occur without further appropriation action.

Question 8. Commodities like gold, copper, natural gas, oil, corn, grain, and steel are experiencing unprecedented demand, and sharp price spikes as a result. Some point to supply-demand fundamentals altered by increased consumption in developing countries; others point to a speculative bubble as being responsible.

How does S. 2191 prevent this from happening to the commodity you refer to as the "right to emit carbon"?

Answer. As described above, numerous factors would influence the price of allowances. S. 2191 includes two provisions to help prevent price spikes (or prolonged high prices). S. 2191 would allow firms to "borrow" a limited number of future allowances for use in the current period as a method of addressing short-term price spikes. In addition, S. 2191 would establish a Carbon Market Efficiency Board, which would be allowed to take a variety of actions to lower prices, including transferring future allowances into the current period. Both of those provisions could help reduce the likelihood that prices would reach higher levels than policymakers had intended but would be a less reliable method of doing so than establishing a ceiling, or safety valve, for allowance prices. Moreover, giving the Carbon Market Efficiency Board overly broad discretionary powers to control prices or allowance quantities could undermine the integrity of the allowance market.

Question 9. This commodity—a right to emit—will presumably have a value in the global market. What is the impact on American economic competitiveness of imposing a cost in the U.S. that is not imposed in emerging economies if, in fact, we are creating a commodity?

Answer. A cap-and-trade program would increase prices for energy and energy-intensive goods and services and could, in some cases, cause a decrease in the demand for U.S. goods. Sectors that could potentially lose market share to foreign producers as a result of a carbon reduction policy are those with relatively high energy use and that have relatively high trade flows (that is, potentially a "covered good," as discussed in S. 2191). The Energy Information Administration lists the following manufacturing sectors as energy-intensive: food products, paper and pulp products, chemicals, glass products, cement products, iron and steel products, and aluminum products. Energy use from those seven sectors constitutes approximately 14 percent of total U.S. energy consumption and results in approximately 10 percent of total U.S. carbon emissions. Those sectors contribute approximately 9.5 percent of gross domestic product, 7.4 percent of U.S. imports, and 9.4 percent of U.S. exports. Of those sectors, the iron and steel sector has a relatively large amount of exports to and imports from China.

S. 2191 contains a provision that addresses cross-border adjustments for carbon-intensive goods. According to the bill, beginning in 2020, in order to import a "covered good" from a "covered country" (as defined in S. 2191), the importer shall verify that the good has an accompanying number of allowances purchased from the international reserve of allowances at a price set not to exceed the market price for domestic allowances. To calculate the number of allowances required per unit of covered good, the total emissions (above an established baseline) from the country's sector is divided by the total goods produced in that country. "Covered goods" are those goods that are primary products, manufactured items for consumption, or products that create greenhouse-gas emissions during their production and that are close substitutes for energy-intensive goods produced in the United States that will be affected by the Act (for example, iron, steel, aluminum, bulk glass, nonmetal minerals, and paper). If that country has implemented "comparable actions" to reduce greenhouse-gas emissions, then the country is not a "covered country." Similarly, if the country is either a "least developed country" or is a de minimis emitter of greenhouse gases, then the country is not a "covered country."

Question 10. I am greatly concerned about the securitization of carbon dioxide emissions credits, which could eventually lead to a situation similar to the recent housing crisis. What steps could be taken to prevent this from happening?

Answer. The securitization of allowances would be unlikely to create the same issues encountered in mortgage markets because, unlike mortgages, carbon allowances would be homogenous and, hence, would not require the endorsements or guarantees of performance that securitized mortgage pools require. The original

holders of allowances should be able to sell them without complex financial intermediation (such as the insurance, guarantees, and highly leveraged distribution vehicles that were used to shift mortgages off banks' balance sheets).

Some users of allowances might wish to trade options or futures contracts on allowances in order to secure access to allowances at a predetermined price at some future date instead of buying and holding them today. While such contracts are usually associated with minimizing risk, hedge funds and other speculative investors seeking to earn investment income on mispriced contracts will often take significant risks in these markets. Such risk-taking should not pose a threat to the integrity of the allowance trading program provided the trading rules ensured minimal risks to counterparties, as is the case in markets for commodity derivatives. For example, commodity derivative exchanges impose margin and capital requirements on participants, require daily settlement of open positions, and enforce the transfer of an insolvent participant's open positions to a solvent party.

Question 11. Should the Carbon Market Efficiency Board have authority to provide bailouts for covered entities, similar to the Federal Reserve's decision to open up its lending window for Bear Stearns earlier this year?

Answer. Providing bailouts could undermine a cap and the integrity of the cap-and-trade program. An alternative method of preventing the cost of complying with the cap from exceeding an acceptable level would be to establish a ceiling, or safety valve, on the price of allowances. If policymakers included both a price ceiling and a price floor in a cap-and-trade program, as well as provisions to modify the ceiling and floor over time, they could limit both price volatility and the overall cost of meeting a long-term target for emissions.

RESPONSE OF PETER R. ORSZAG TO QUESTION FROM SENATOR MENENDEZ

Question 1. Your analysis of S. 2191 accounts for decreases in federal revenues and the expenses associated with a cap-and-trade regime. But how do you account for the impacts of global warming in your baseline (business as usual) projections? For example, rising sea levels will bring a vast number of new costs to the federal government. So too will increases in tropical diseases, heat waves, water shortages, and violent storms. Last, but not least, we could face increased national security expenses due to political instability tied to climate change.

We have seen the devastation of Hurricane Katrina and the Myanmar cyclone, as well as unprecedented battles for water in the Southeast. Obviously, it is problematic to causally link these individual events to climate change. But we do know that we will see more of them as the planet warms.

What expense might the federal government incur if sea levels rise by 10's of feet? What impact would that have on the Federal Flood Insurance program?

Can the CBO undertake an analysis of S. 2191 which accounts for some of these events? Would the assumption that a large reduction in U.S. GHG [greenhouse-gas] emissions averts global warming dramatically change the scoring of S. 2191?

Answer. Human activities around the world—primarily fossil-fuel use, forestry, and agriculture—are producing growing emissions of greenhouse gases, most importantly carbon dioxide. The accumulation of those gases in the atmosphere and oceans is expected to have extensive, potentially serious, and costly but highly uncertain impacts on regional climate and ocean conditions throughout the world. Future developments are sufficiently uncertain that over the next century and beyond, climate-related changes could be relatively modest or very extensive. The uncertain links between carbon emissions, specific disasters or consequences of climate change, and the federal response to such events makes it extremely difficult to model or estimate changes in federal spending from reduced carbon emissions.

Moreover, the timing of costs and benefits of reducing emissions are very different. Reducing emissions would require firms and households to make changes in their behavior (for example, driving or flying less) and their investments (for example, investing in more energy-efficient equipment, relying on renewable energy sources, or investing in carbon capture and sequestration). Those actions would impose near-term costs.

The benefits of reducing emissions, in contrast, would be realized decades or even centuries after the reductions were made. The reason is that each ton of CO_2 generates a rise in the average global temperature that peaks 40 years after the CO_2 is emitted and then dissipates slowly, with a half-life of about 60 years. As a result, any reduction in federal spending that might be brought about by the benefits (such as potential decreases in hurricanes) resulting from S. 2191 would be well outside the 10-year window that CBO uses when it estimates the impact of legislation on the federal budget.

RESPONSE OF PETER R. ORSZAG TO QUESTION FROM SENATOR AKAKA

Question 1. A carbon tax seems like a more straightforward way of implementing greenhouse-gas regulation. During the hearing, you responded that a tax is more efficient; however, by using auctioning, and allowing significant flexibility in timing of efforts to reduce emissions (by using a floor and ceiling), cap-and-trade can be brought closer in line with a tax policy. Are there additional challenges that island states and U.S. territories face (in using a cap-and-trade instead of a tax credit), given their unique characteristics (e.g., being geographically separate from the continental U.S., relying exclusively on airlift and shipping for transporting goods, as well as being a "closed" energy system)?

Answer. Either a tax or a cap-and-trade program would reduce carbon dioxide emissions by increasing the price of fossil fuels, with the price increases reflecting the CO_2 released when the fuels were combusted. As a result, either approach would create an incentive for households and firms to reduce their use of such fuels. If the price of an allowance under a cap-and-trade program was equal to the level of a tax, either approach would be likely to impose roughly the same costs (with any distribution of the auction proceeds or tax revenues not considered). The price increases resulting from a cap-and-trade program, however, would be more uncertain. The price of allowances would need to climb high enough to reduce emissions to the level required by the cap. That price would fluctuate over time depending on economic activity, weather, technological developments, conditions in fossil-fuel markets, and other factors.

Since either a tax or a cap-and-trade program would induce reductions in emissions by driving up prices for energy and energy-intensive goods and services, it does not seem likely that either one would provide a relative advantage or challenge to island states or U.S. territories.

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