S. HRG. 111-310

POLICY OPTIONS FOR REDUCING GREENHOUSE GAS EMISSIONS

HEARING

BEFORE THE

COMMITTEE ON ENERGY AND NATURAL RESOURCES UNITED STATES SENATE

ONE HUNDRED ELEVENTH CONGRESS

FIRST SESSION

TO

RECEIVE TESTIMONY ON POLICY OPTIONS FOR REDUCING GREENHOUSE GAS EMISSIONS

DECEMBER 2, 2009

Printed for the use of the
Committee on Energy and Natural Resources

U.S. GOVERNMENT PRINTING OFFICE

55-432 PDF WASHINGTON : 2010

For sale by the Superintendent of Documents, U.S. Government Printing Office
Internet: bookstore.gpo.gov Phone: toll free (866) 512–1800; DC area (202) 512–1800
Fax: (202) 512–2104 Mail: Stop IDCC, Washington, DC 20402–0001

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POLICY OPTIONS FOR REDUCING GREENHOUSE GAS EMISSIONS

WEDNESDAY, DECEMBER 2, 2009

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. All right. Let us get started.

Today the committee will hear testimony on policy options for reducing greenhouse gas emissions. Over the last 2 months, the committee has held several hearings on global climate change policy, most of which specifically investigated the impacts of cap-and-trade programs on the energy sector and consumers. These hearings, I think, have been useful in educating members of the committee and helping us engage in a dialog about the important components of sound climate policy. At many of the hearings, we've heard a number of alternative policies to reduce greenhouse gas emissions mentioned that have been cited as either more or less desirable than cap-and-trade.

I've long supported trying to put in place a cap-and-trade mechanism to reduce greenhouse gas emissions. I believe, based on what I've learned to date, that it's preferable to many of the other alternatives. I also, however, understand that there's value in understanding the pros and cons of other policy options that may have the ability to achieve the same level of reductions of greenhouse gas emissions.

This hearing evolved as some of the members of the committee asked us to take a step back—Senator Murkowski urged that—and to engage in a more general discussion to evaluate the pros and cons of various policy options. The options that will be discussed today include cap-and-trade, carbon taxes, REC regulation, sector-specific approaches, and technological innovation.

It's important to note that these policies are not mutually exclusive. In fact, it will more than likely be necessary to rely on a suite of these policies to ensure that we are effective in addressing global warming.

Let me call on Senator Murkowski for any comment she has.

[The prepared statement of Senator Bunning follows:]

PREPARED STATEMENT OF HON. JIM BUNNING, U.S. SENATOR FROM KENTUCKY

Mr. Chairman, thank you. I am pleased the Committee was able to reschedule this hearing.

We need to be careful of moving too quickly in addressing the issue of climate change especially as we are still debating the science behind it.

Some groups have proposed mandatory caps; I do not believe they are the answer.

Like some of our witnesses here today, I support providing incentives for new technology, moving to lower emission technologies, and improving energy efficiency.

This is precisely what we have done in the Senate. We have been addressing the climate issue with a variety of immediate impact policies.

In the past I have authored legislation and worked to expand provisions in our recently passed energy bill on clean coal technologies.

Over half of our nation's electricity comes from coal power plants and adopting new and cleaner technology would lead to significant reductions.

We have also seen good results in improving energy efficiency in the last decade. Since 1990, the U.S. industry has improved its energy efficiency by over 20%.

Our automobiles are becoming more efficient, running at a higher fuel efficiency today than they did just a few years ago.

I support common sense options to reduce greenhouse gas emissions that will achieve immediate and long-term results.

These policy options should be consistent with our existing trade agreements and do not put us at a competitive disadvantage with both developed and developing nations.

I thank the witnesses for appearing before the committee today and appreciate their comments.

I look forward to continuing the conversation on this issue and discussing the entire scope of climate change.

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

Senator MURKOWSKI. Thank you, Mr. Chairman.

I'd like to welcome our witnesses. Thank you for joining us.

As you've indicated, Mr. Chairman, we're here to discuss some of the different policy options that are out there for reducing greenhouse emissions. It may come as a surprise that we're just now looking at this broader range, or this broader suite, of options. But, I think that, at this point, Congress has little choice but to do just that. For the past year, and really throughout the history of this debate, we've focused on an economywide cap-and-trade approach to greenhouse gas reductions, and once again we, here in Congress, find ourselves in a familiar position: the debate has stalled, the bills that are currently out there, most people believe, have very little chance of being signed into law.

I think we recognize that bipartisan support is required to pass a bill, certainly a bill of this nature, in terms of the impact to the economy. But, for multiple reasons, we can't seem to bridge that divide. It is apparent, at least in my mind, that the policy itself is perhaps at least partly to blame for this quandary.

The main argument for cap-and-trade is that it would create a new market in which economically efficient and environmentally compliant decisions could be made. Yet, despite this, the House and the Senate bills display a clear lack of faith in the ability of a carbon market to function on its own. Both bills fail to fully preempt EPA regulation, and they also include a mountain of new regulations to be imposed on top of a cap.

If a given policy purports to reduce emissions, it should be allowed to do just that. Additional layers of bureaucratic regulation, which are duplicative, inefficient, or are counterproductive, should

be taken off the table. If a policy is not up to the task, either in theory or in practice, then we need to consider our alternatives.

It's not just those of us here in Congress that are wavering on this issue; we've seen a fair amount out there. In just the year or so, two of the economists that originally developed the concept of cap-and-trade have discussed how poorly suited it is to reducing greenhouse gas emissions. We had two long-serving EPA attorneys who were similarly compelled to speak out against this approach. Then we look at the experience of the world's early adopter, the European Union, has struggled to make its system function.

I believe we need to dispense with this somewhat blind loyalty to an economywide cap-and-trade, or at least not be afraid to question whether or not it's warranted. We should objectively review the strengths and the weaknesses of our policy options and develop a measure that protects both our economy and our environment. Promoting cleaner energy is a laudable goal, but measures to make it a reality must provide a net benefit to our economy. Unfortunately, the bills that we have considered thus far will, in my opinion, harm the economy rather that help it.

It's also worth noting, and perhaps accepting, that the rhetorical battle is over. Americans rightly view a cap-and-trade proposal as a tax, because they understand that it's going to cost money to reduce our Nation's emissions. We need to be honest about these costs, and ensure that the revenues that are associated with them are returned to the people who will bear the burden of compliance.

As we take stock of our options, I think that one of the things that we should fairly explore is perhaps pairing a tax cut with a price on emissions. Academics and economists suggest that climate policy offers an opportunity to improve the efficiency of our tax code and benefit our economy. Instituting a tax on something that we want less of, such as greenhouse gas emissions, would allow us to reduce or eliminate taxes on the things that we wish to promote, whether it's work or savings or investment. Rather than increasing taxes, we could change how and why they're paid. Some, of course, call this approach a "tax shift."

Now, in testimony before this committee, we've already heard about the advantages of relying on the existing tax code instead of trying to create a new carbon market susceptible to manipulation by special interests. This could greatly reduce new bureaucracy and administrative expenses. A specific and predictable price on carbon would minimize volatile price fluctuations. It could even facilitate greater international cooperation.

Yesterday, there was a poll that was released by Hart Research Associates, and it suggests that Americans would prefer a carbon tax over a cap-and-trade. The numbers suggest that they prefer this by a rather wide margin. In looking at the reasoning behind it, it's not hard to understand why. They're choosing the option that promises greater simplicity, efficiency, certainty, and, clearly, transparency.

Now, before everybody gets excited out there, I want to make sure that I'm not suggesting that cap-and-trade or any other approach is taken off the table. I'm also not intending to introduce a tax reform bill at this point in time. But, I do think that it is very, very important that we be considering all of our options. A

more inclusive debate will allow us to recognize the risks associated with policies that don't match the preferences of the American people or that fail to attain what is in their best interests, and then act accordingly.

As we look at the political landscape, I would suggest that it's going to be many months before climate legislation is brought up on the Senate floor. I believe that we need to take this time, during this interval, to ensure that we're developing the best possible climate policy.

I think today's testimony will help enlighten us somewhat, and I'm looking forward to the comments of the distinguished panel before us.

The CHAIRMAN. Thank you.

Let me just introduce our witnesses. First, Dr. Ray Kopp, who is a senior fellow and director of climate—the Climate Policy Program at Resources for the Future; next, Dr. Ted Gayer, who is co-director of economic studies and a senior fellow at the Brookings Institution; Dr. David Hawkins, who is a regular witness before our committee, a director of climate programs with the Natural Resources Defense Council, here in Washington; Mr. Jonathan Banks, who is climate policy coordinator with the Clean Air Task Force in Brunswick, Maine; and Dr. John Alic, who is an independent consultant residing in Avon, North Carolina.

Thank you all very much for being here. If each of you would take about 6 minutes and sort of hit the high points that we need to understand.

Senator Dorgan wanted to make a statement before we start with the testimony.

Go ahead.

STATEMENT OF HON. BYRON L. DORGAN, U.S. SENATOR FROM NORTH DAKOTA

Senator DORGAN. Mr. Chairman, thank you. I know that this hearing is held, in part, because I had asked—and I think Senator Murkowski had asked—for alternative policy options on reducing greenhouse gases. We have heard about cap-and-trade, a carbon fee, command-and-control, and others. There are energy toolbox options. So, there's lots of different ways to deal with this. Most of the discussion here in Congress has been about cap-and-trade. I think this hearing is a really excellent way to begin this wider discussion.

Regrettably, at 10:30, I'm chairing another hearing, as you know, on the sixth floor, on jobs. So, I'm sorry I'm not able to stay for the entire hearing. But, I'm going to have an opportunity to review the testimony. I just wanted to say, to the witnesses and Senator Murkowski, who joined me in asking for this kind of a hearing, that I'm sorry I can't stay for the entire hearing, but chairing another one at this timeframe makes that impossible.

Thank you, Mr. Chairman.

The CHAIRMAN. Thank you.

Dr. Kopp, why don't you go right ahead.

STATEMENT OF RAY KOPP, SENIOR FELLOW AND DIRECTOR, CLIMATE POLICY PROGRAM, RESOURCES FOR THE FUTURE

Mr. KOPP. Mr. Chairman, Senator Murkowski, and members of the committee, thank you for the opportunity to testify today.

I am a senior fellow at Resources for the Future, a 57-year-old research institution that focuses on environment, energy, and natural resource issues. Resources for the Future does not lobby or take positions on specific legislative and regulatory proposals, and thus, I emphasize, the views I present today are my own.

My testimony focuses on the approaches for the regulation of greenhouse gas emissions. When evaluating and choosing among regulatory approaches, it is important to keep four attributes of such regulation in mind:

First attribute concerns the scale—concerns to goals of the regulation. The goal of stabilizing greenhouse gas concentrations, to achieve a maximum 2 degrees Celsius increase in global mean temperature has been embraced by the U.S. and G8 this past July. Such a goal requires global net greenhouse gas emissions to eventually decline to zero and, in turn, requires regulatory policies that will lead to a full decarbonization of the U.S. economy over the next several decades.

Second attribute concerns technology. Reducing emissions in the developed world consistent with the 2-degree goal using existing technology will likely be very expensive. Doing so in the developing world, with existing expensive technology, is likely to be impossible.

The third attribute concerns the scale and required efficiency of the effort. The U.S. economy is composed of millions of greenhouse gas sources, from very large to very small, and everywhere in between. We don't need to control them all, but certainly must control 90 percent of them by volume. Importantly, the cost of controlling emissions varies greatly among these sources. Therefore, to be efficient, we must gain the greatest reductions from the least expensive sources.

The fourth attribute is cost. While it is a well-worn cliche among economists, it is not invoked nearly enough: There is no free lunch. There will be costs, and those costs are unlikely to be distributed evenly across regions, demography, and economic sectors.

These four attributes call for a regulatory program that, first and foremost, places a price on the emissions of greenhouse gases from as many sources as possible. The economywide emissions price provides economic incentives for all sources to reduce their emissions. It also provides important incentives for investment in the development and deployment of new and more economically efficient mitigation options, options that, at present, may be completely unknown.

Perhaps most important, an economywide emission price ensures economic efficiency, in terms of actions taken to reduce emissions, and provides incentives for all sources to continually search for emission mitigation options that can be deployed for less than the emissions price.

While an emissions price is an absolute requirement for an efficient regulatory framework, it is likely not the sole requirement. Due to imperfections in a market economy, price signals may be

dampened or, in fact, be short-circuited. This is particularly true in the market for research and development, where firms have incentives to underinvest in R&D. In this case, the emissions price cannot fully motivate the R&D market, and therefore, a well-designed regulatory program will contain provisions for government funding of R&D.

Witnesses today will discuss five different regulatory approaches. I will address cap-and-trade.

The two most important elements of a cap-and-trade program are the cap and the allowance price serving as the price on greenhouse gas emissions. When combined with allowance trading, economic efficiency is achieved, meaning that, at any point in time, those most able to reduce emissions at the lowest cost are motivated to do so. When the program allows for banking of allowances, economic efficiency is gained over time and into the distant future.

The scope of the program—that is, the sources that can be regulated under the cap—is limited only by the ability to effectively and efficiently monitor emissions. Therefore, the program can be truly economywide. Given an economywide program, the price signals tells all sources deploying existing mitigations technology options, and provides incentives to deploy and develop new technology.

Emission caps can be set decades into the future, serving to alter household and business expectations, thereby affecting current and near-term investment decisions and accelerating the transformation of the economy.

Allowances have value, and allocating allowances moves wealth around in the economy. This is desirable, for two reasons. The first, a portion of the wealth can be used to deal with the equity and distributional issues that I mentioned previously. Second, a portion can be used to finance long-term government support for R&D.

When the pricing mechanism and the allowance allocation options are combined, a cap-and-trade program matches up very well with the four attributes of greenhouse gas control noted earlier in my testimony.

In short, greenhouse gas emission regulation should include as many sources as possible, within a regulatory program, be hyperefficient, getting the absolute most out of every dollar spent, incentivize all actions to reduce emissions, especially incentivize all new technology, be robust and adaptable over a very long period of time, and recognize and address issues of equity.

Thank you, Mr. Chairman, I look forward to your questions.

[The prepared statement of Mr. Kopp follows:]

PREPARED STATEMENT OF RAY KOPP, SENIOR FELLOW AND DIRECTOR, CLIMATE POLICY PROGRAM, RESOURCES FOR THE FUTURE

Mr. Chairman, Senator Murkowski, members of the committee, thank you for the opportunity to testify before the Senate Committee on Energy and Natural Resources. My name is Ray Kopp, and I am a senior fellow and director of the Climate Policy Program at Resources for the Future (RFF), a 57-year-old research institution based in Washington, DC, that focuses on energy, environmental, and natural resource issues. RFF is independent and nonpartisan, and shares the results of its economic and policy analyses with environmental and business advocates, academics, government agencies and legislative staff, members of the press, and interested citizens. RFF neither lobbies nor takes positions on specific legislative or regulatory proposals. I emphasize that the views I present today are my own.

My testimony today will focus on approaches for the regulation of greenhouse gas (GHG) emissions. When evaluating and choosing among regulatory approaches, it important to keep four attributes of such regulation in mind.

The first attribute concerns the goals of regulation. The goal of stabilizing GHG concentrations to achieve a maximum 2 degrees Celsius increase in global mean temperature has been embraced by the G8 and the United States at their July meeting in L'Aquila, Italy. Such a goal requires global net GHG emissions to eventually decline to zero, and that in turn requires regulatory policies that will lead to a full de-carbonization of the U.S. economy over the next several decades,

The second attribute concerns technology. Attaining the 2 degree goal in the United States with existing technology will likely be very expensive. Doing so in the developing world with existing expensive technology is likely to be impossible.

The third attribute concerns the scale and required efficiency of the effort. The U.S. economy is composed of millions of GHG sources from very large to very small and everywhere in between. We don't need to control them all, but certainly we must control 90 percent of them by volume. And importantly, the cost of controlling emissions varies greatly among these sources. Therefore, to be efficient we must gain the greatest reductions from the least expensive sources.

The fourth attribute is cost. While it is a well-worn cliché among economists, it is not invoked nearly enough—there is no free lunch. There will be costs that are unlikely to be distributed evenly across regions, demography, and economic sectors.

Attribute 1, goals, points to the enormity of the task in front of us. Achieving full global de-carbonization will require a great deal of effort and investment over a very long period of time. Therefore, the policies we put in place to drive that transformation must be highly efficient, robust over time, and able to withstand changing economic, political, and social conditions, as well as adapt to new scientific information regarding the process of climate change.

Attribute 2, technology, mandates a policy that will substantially enhance our ability to invent, develop, and—importantly—finance and globally deploy a wide range of inexpensive, low- and zero-carbon technologies over the next 50 years.

Attribute 3, the scope and varied nature of current emission sources, requires a regulatory policy that is politically, socially and economically tractable, environmentally effective, applicable across an incredibly varied economy, and one that encourages and incentivizes every sector of our economy to continually reduce emissions.

Attribute 4 reminds us this task will be economically challenging and therefore the regulatory policy must be hyper efficient. We must be prepared to address issues of equity resulting from the uneven distribution of costs across society due to the regulatory program.

Economists generally agree that these four attributes call for a regulatory program that first and foremost places a price on the emission of GHGs from as many sources throughout the economy as is logistically possible. An economy-wide emissions price provides economic incentives for all GHG sources to reduce their emissions. Working through the private market spurs all mitigation activity, whether or not those activities are known to the regulator. And an emissions price will generate investment in the development and deployment of new and more economically efficient mitigation options—options that at present may be completely unknown.

An economy-wide emissions price ensures economic efficiency in terms of action taken to reduce emissions. Those sources that can reduce them for less than the emissions price will continue to do so until the cost of reducing the last ton equals the price.

As the price rises over time, higher cost mitigation options will come into play, but in an efficient manner with the least-cost options being deployed first. An emissions price that is perceived by all sectors of the economy to rise over time will alter the expectations of both households and firms with respect to long-lived investment decisions and accelerate the transition to a low carbon economy.

Importantly, an emissions price provides incentives for sources to continually search for mitigation options that can be deployed for less than the emissions price. This incentive behavior is in sharp contrast to standards- or technology-based regulation where all incentives to reduce emissions disappear once the standard is met or the technology installed.

While an emissions price is an absolute requirement for an efficient regulatory framework, it is likely not the sole requirement. Due to some imperfections in any market economy, price signals may be dampened or be short circuited. This is particularly true in the market for research and development, where it is well known that firms have incentives to under?invest in research and development (R&D) due to the fact they cannot capture all the returns to R&D—some of those returns spill over to others in the market that did not invest as much. In this case, the emissions

price cannot fully motivate the R&D market and therefore a well-designed regulatory program will contain a role for government funding of R&D. One important point, the economic case for support of government funding grows weaker as one moves from R&D to demonstration and deployment.

In addition to the economic rational for government support of R&D, there is a political case to be made. Spurring R&D and demonstration and deployment of financially risky technology investments may require an emissions price that is not politically viable (that is, it is too high to be politically acceptable). In this case, absent the market imperfections above, the price is simply too low to generate the needed investments and government must step in to support the required levels of from R&D and demonstration and deployment.

The requirement for some level of government support of technology implies the need for a source of revenue. Moreover, given the diverse nature of the U.S. economy in terms of its use of energy, the sectoral, geographic, and income distribution of the burden of a GHG mitigation program will be uneven. Efforts to even this distribution through transfer payments of one form or another will also require a source of revenue.

Witnesses today will address five different regulatory approaches including cap and trade, GHG taxes, direct regulation under the Clean Air Act, sector-specific regulatory approaches, and technology policy. The attributes of GHG regulation mentioned above can give some guidance when evaluating them. In short, new emissions regulations should:

- Include as many sources a possible within the regulatory program.
- Be hyper-efficient—get the absolute most out of every dollar spent.
- Incentivize all actions to reduce emissions, especially all new technology.
- Be robust and adaptable over a very long period of time.
- Recognize and address issues of equity.

CAP AND TRADE

The basic steps in the design and implementation of a cap-and-trade program for GHG mitigation are now widely known and include:

- identification of the sources of emissions that will fall under the regulatory program,
- a series of annual caps (tonnage restrictions) on emissions,
- issuance of allowances in amounts equal to the caps and requirements of sources to surrender allowances equal to their annual emissions, and
- provisions for the creation of a private market in allowances.

The two most important elements of a cap-and-trade program are the cap and the allowance price serving as the price on GHG emissions. When combined with allowance trading, economic efficiency is achieved meaning that at any point in time those most able to reduce emissions at the lowest cost are motivated to do so. When the program allows for banking of allowances economic efficiency is gained over time.

The scope of a cap-and-trade program, that is the sources that can be regulated under the cap, is limited only by the ability to effectively and efficiently monitor emissions and therefore the program can be truly economy-wide. Given an economy-wide program, the price signal tells all sources to deploy existing technology options to control emissions and gives an incentive to the private sector to develop and deploy new technology.

Emissions caps can be set decades into the future serving to alter household and business expectations, thereby affecting current and near-term investment decisions. If climate science requires more severe reductions than initially planned, the distant year caps can be tightened leaving the rest of the program unchanged. However, such an adjustment—if unanticipated—will bring with it a concurrent cost.

Allowances in a cap-and-trade program have value since the holder of an allowance can emit GHGs. Creating allowances does not create wealth in the economy; what it does is move wealth around. This is desirable for two reasons. First, a portion of that wealth can be used to deal with equity issues, and second, a portion can be used finance government support for R&D.

When the pricing mechanism and the allowance allocation options are combined, a cap-and-trade program matches up very well with the attributes of GHG control identified above.

GHG TAXES

Taxes on GHGs (often referred to as carbon taxes) have many of same desirable attributes as cap and trade. First and foremost, taxes place a price on emissions. However, unlike cap and trade where the price is set by the private market, under a tax system the price is set by the tax rate. This provides the greatest difference between the two regulatory approaches. A tax program provides no uncertainty with respect to the price of emissions, but there is uncertainty with respect to the quantity of emissions abated. In contrast, cap and trade provides a good deal of certainty over emissions (limited by the cap), but the price can vary and is uncertain. Concerns about price volatility in a cap-and-trade program have given rise to the price collars contained in the recent cap-and-trade bills.

Cap-and-trade and tax programs share many other features. A tax approach can be as broad as a cap-and-trade one, and emissions source coverage is only limited by the ability to effectively and efficiently monitor emissions. A tax approach is also economically efficient, ensuring GHG reductions are obtained at least cost. And, like emissions caps, tax rates can be established quite far into the future and adjusted as new climate science becomes known—but, like changing caps, altered out-year tax rates can entail adjustment costs.

The revenue from GHG taxes can play the same role as allowance value in addressing equity and the need for government technology funds. The emissions price, as specified by the tax rate can be established quite far into the future, thereby altering future expectations, affecting long-lived investment decisions and speeding the transformation of the economy.

OTHER FORMS OF GHG REGULATION

Looking beyond economy-wide GHG pricing approaches like cap-and-trade programs and GHG taxes, many other approaches are already in place, including renewable energy portfolio standards, efficiency standards for buildings and appliances, as well as subsidy programs for the production of energy from renewable resources.

One obvious alternative to an economy-wide regulatory program would begin with the regulation of GHG emissions on a modest scale, starting with a single sector like electricity generation, and then adding others over a period of time. Such staged regulation may prove to be more politically achievable than a full-scale economy-wide approach since the number and influence of regulated entities at each stage can be made relatively small. However, while perhaps politically expedient, staged regulation has drawbacks, the most obvious being the need for political will to continue adding sectors to the regulatory structure over time.

A second drawback is the loss in economic efficiency that could arise from a piecemeal approach. The staged approach could begin with a cap-and-trade program for electricity generation, but as the scope of regulation is expanded to include other large stationary sources, a standards approach to regulation might be applied to the new sources. Mixing a price-based approach like cap and trade with a standards approach will guarantee a loss in economic efficiency across sources when compared to a single cap and trade applied to all sources.

Following the U.S. Supreme Court decision in Massachusetts v. EPA in 2007, the EPA has the authority to regulate GHGs under the Clean Air Act (CAA). A staged approach to GHG regulation could logically flow from the CAA in the absence of congressional action on a comprehensive approach. Some argue that an economically efficient cap-and-trade program for carbon dioxide emissions from the electric power generation sector could be established, but such a price-based program would likely be paired with "tail pipe" and other standards for mobile sources and technology-based standards for all other sources.

In contrast to an economy-wide emission pricing program, an approach such as that described above would not be economically efficient, would not push all emission sources to adopt abatement activities, would not provide incentives for continual emission reductions, and importantly, would not provide incentives for R&D and demonstration and deployment of advanced low-carbon technologies. Finally, nonpricing regulatory approaches provide no sources of funds for government R&D programs or for programs to address equity issues.

It is often remarked that we cannot meet the challenge of climate change with existing technology and that what is needed is a wave of innovation giving rise to perhaps unimagined new zero-carbon technologies. I agree with this presumption; however, the question that logically arises is what public policies would stimulate this wave of innovation? At this point, economists and technologists usually part company with those economists pleading for a pricing mechanism to create a demand for the new technologies as well as some supply-side technology push.

The CHAIRMAN. Thank you very much.
Mr. Gayer.

STATEMENT OF TED GAYER, THE BROOKINGS INSTITUTION

Mr. GAYER. Chairman Bingaman, Senator Murkowski, and members of the committee, I appreciate the opportunity to be here today to discuss to merits of a carbon tax.

I will discuss 5 advantages of a carbon tax over alternative policies:

First, a carbon tax—or, for that matter, a cap-and-trade—will result in substantially lower economic costs than command-and-control regulations that mandate technologies, fuels, or efficiency standards. A carbon tax is similar to a cap-and-trade, in that they both relay on sending market signals to raise the price of carbon, rather than relying on more inflexible, and thus, more costly, technology and fuel-efficiency mandates to achieve carbon reductions.

Command-and-control regulations, such as technology standards, might be preferable to market-based regulations when measuring emissions is costlier and feasible. However, this is not the case with carbon emissions. I believe to over-reliance on inflexible command-and-control regulations will result in much higher economic costs than would relying strictly on a carbon tax or just cap-and-trade. Indeed, were cap-and-trade or a carbon tax to be enacted, the additional regulations would likely add to the overall costs of the program without accruing any climate benefits.

Second, there's a well-known finding in the economics literature that a tax and cap-and-trade yield different economic results when there is uncertainty about the costs of reducing pollution. It's long literature, so I won't go into the details. But, the general finding is that, with respect to climate policy, a carbon tax yields more economically efficient results than a cap-and-trade, due to cost uncertainty.

A third point, which is a related point, a carbon tax is preferable to a cap-and-trade, because the latter is susceptible to price volatility which would cause economic disruptions and complicate investment decisions, including long-term investments in low-carbon technologies. Price volatility would also be unsettling for consumers, possibly leading to political pressure on Congress to repeal or substantially loosen the cap in the future, thus adding to the uncertainty of the price signal.

Price volatility, as well as my previous concern about cost uncertainty, could be largely addressed within a cap-and-trade program by including a safety-valve price in which the government offers to sell additional allowances above the cap at a pre-established price. Unfortunately, the current bills do not—the current proposals do not include any such provision.

Fourth, a carbon tax in which the revenues are used to offset economically harmful taxes or to pay down our deficit would substantially lower the costs of climate policy, compared to a cap-and-trade program that gives away allowances for free. A cap-and-trade program generates public revenue only when the allowances are auctioned off by the government. In practice, this rarely happens, and the allowances are instead given away for free to regulated entities. Failing to capture and direct this public revenue to reducing eco-

nomically harmful taxes and deficits would substantially increase the cost of any policy.

Fifth, the current proposed cap-and-trade programs rely heavily on offsets to reduce to overall costs of cap-and-trade. Given the substantial potential value of offsets, there is a very real concern that offset integrity will not be maintained. This would result in a weakening of the cap, undermining its environmental benefits. In a cap-and-trade system, an offset is a reduction in carbon emissions from sources that are not subject to the mandatory cap. The advantage of offsets is that they can provide many sources of low-cost reductions, thus significantly reducing the overall cost of achieving an emissions reduction goal.

But, offsets also pose a substantial problem, in that they are very difficult to measure. The enforcement of a carbon tax or a cap-and-trade program relies on measuring emissions, typically by measuring the carbon content of fuel inputs. Offsets, on the other hand, rely on measuring emission reductions rather than emissions. This introduces a host of problems, because it is difficult to know what would have happened to emissions, absent a given offset project.

The difficulty of measuring emission reductions could lead to honest mismeasurements in which reported reductions are not real. Given the substantial value of offsets in the proposed cap-and-trade programs, it could lead to deliberate mismeasurements of carbon reductions. Unless the integrity of carbon offsets can be assured at relatively low costs, the environmental benefits of a cap-and-trade program could be substantially undermined, resulting in a program that amounts to a massive wealth transfer without achieving real climate benefits. Given the financial crisis of the past few years, we should be cautious about creating an active market in a poorly measured financial instrument.

In conclusion, I have to acknowledge that my arguments in favor of a hypothetical carbon tax over cap-and-trade are made easier, in that I am comparing my ideal hypothetical carbon tax to the actual cap-and-trade programs that are making its way through the Congress. Indeed, a cap-and-trade program that included a safety valve and that auctioned allowances would achieve many of the economic advantages of a carbon tax. The current proposals fail to include these features, and they fail to exclude expensive and unnecessary command-and-control mandates. I think a cleaner, simpler carbon tax or a cap-and-trade program that included a safety valve and auctioned allowances is worth serious consideration by this committee.

Thank you very much.

[The prepared statement of Mr. Gayer follows:]

PREPARED STATEMENT OF TED GAYER, THE BROOKINGS INSTITUTION

Chairman Bingaman, Ranking Member Murkowsi, and Members of the Committee, I appreciate the opportunity to appear before you today to discuss the merits of a carbon tax. I commend the Committee for its interest in examining all feasible policy tools to address climate change.

My testimony will make the following points:

1. Either a carbon tax or a cap-and-trade program will result in substantially lower economic costs than command-and-control regulations that mandate technologies, fuels, or energy efficiency standards.

2. Given the uncertainty of the future costs of climate policy, a carbon tax is more economically efficient than cap-and-trade.

3. Carbon allowances in a cap-and-trade program would be susceptible to price volatility. Price volatility causes economic disruptions and complicates investment decisions. It also could lead to political pressure on Congress to repeal or substantially loosen the cap.

4. A carbon tax, in which the revenues are used to offset economically harmful taxes or to pay down our deficit, would substantially lower the cost of climate policy compared to a cap-and-trade program that gives away allowances for free.

5. The currently proposed climate bills rely heavily on offsets to reduce the overall costs of cap-and-trade. Given the substantial potential value of offsets, there is a very real concern that offset integrity will not be maintained. This would result in a weakening of the cap, undermining its environmental benefits.

Please allow me to elaborate on these points.

1. CARBON TAX AND CAP-AND-TRADE ARE PREFERABLE TO COMMAND-AND-CONTROL

A carbon tax is similar to cap-and-trade in that they both rely on sending market signals to raise the price of carbon, rather than relying on more inflexible—and thus more costly—technology and fuel efficiency mandates to achieve carbon reductions.[1] For existing air pollution regulations, command-and-control mandates result in up to 22 times the cost relative to a market-based approach.[2] Command-and-control regulations, such as technology standards, might be preferable to market-based regulations when measuring emissions is costly or infeasible. However, this is not the case with carbon emissions.

I believe the over-reliance on inflexible command-and-control regulations in the existing Clean Air Act and in the House energy bill [HR 2454] will result in much higher economic costs than would reliance strictly on a carbon tax or cap-and-trade. Indeed, were cap-and-trade or a carbon tax to be enacted, the additional command-and-control regulations—such as the renewable fuel mandate, the renewable electricity mandate, and the various energy efficiency requirements—would likely just add to the overall cost of the program without accruing any climate benefits.

2. GIVEN COST UNCERTAINTY, A CARBON TAX IS MORE ECONOMICALLY EFFICIENT THAN CAP-AND-TRADE

When there is uncertainty about the costs of reducing a pollutant, a carbon tax and cap-and-trade yield different results with respect to economic efficiency.[3] With respect to climate change, the benefits of carbon reduction are related to the stock of the pollutant, whereas the costs are related to the flow of the pollutant. Under these circumstances, a carbon tax yields more economically efficient results than cap-and-trade.[4]

3. CARBON ALLOWANCES IN A CAP-AND-TRADE PROGRAM COULD BE SUSCEPTIBLE TO PRICE VOLATILITY

The main distinction between a carbon tax and cap-and-trade is that the former gives certainty about the price of carbon, whereas the latter gives certainty about the quantity of carbon emitted. Market participants prefer stability of prices, in order to better plan capital decisions, including long-term investments in low-carbon technologies. The price volatility of a cap-and-trade program would likely also increase pressure on policymakers to eliminate or substantially weaken the cap, thus creating more uncertainty about future prices.

Price volatility, as well as my previous concern about cost uncertainty, could be addressed relatively easily within a cap-and-trade program. For example, a cap-and-trade program that included a safety valve price—in which the government offers to sell additional allowances above the cap at a pre-established price—would eliminate the risk of high-end price volatility. A Congressional Budget Office study on the policy options for reducing carbon emissions also

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[1] See, for example, Ted Gayer and John K. Horowitz (2005), "Market-based Approaches to Environmental Regulations," *Foundations and Trends in Microeconomics* 1(4).

[2] See *Economic Report of the President, 2003*, Washington, DC: US Government Printing Office, 2003.

[3] See Martin L. Weitzman (1974), "Prices vs. Quantities," *Review of Economic Studies* 41(4): 477-491.

[4] See William A. Pizer (1998), "Prices vs. Quantities Revisited: The Case of Climate Change," Discussion Paper 98-02, Resources for the Future.

noted that a safety valve would limit the cost of a cap-and-trade program.[5] And a recent paper by my colleagues at Brookings suggested a price collar, which would establish both a price floor and a price ceiling for cap-and-trade allowances, thus addressing the problem of price volatility.[6] Unfortunately, the House energy bill does not include any such provisions. A carbon tax could offer a cleaner approach to tackling the issue of price volatility.

4. A CARBON TAX THAT USES THE REVENUE TO OFFSET HARMFUL TAXES WOULD SUBSTANTIALLY REDUCE COSTS

A carbon tax generates public revenue. A cap-and-trade program generates public revenue only when the allowances are auctioned off by the government. In practice, this rarely happens, and the allowances are instead given away for free to regulated entities. Failing to capture and direct this public revenue to reducing economically harmful taxes and deficits would substantially increase the cost of any policy.

Any successful climate policy would increase the prices of such things as electricity and transportation. These price increases amount to a reduction in real incomes, which in turn magnifies the economic inefficiencies in our overall tax system.[7] These inefficiencies—known as the tax-interaction effect—can substantially increase the overall cost of any environmental regulation, even in some cases leading to negative net benefits.[8]

The way to address this problem is to use public revenues from a carbon tax to offset inefficient taxes or deficits. A carbon tax set at a similar stringency to the House energy bill's cap-and-trade program would likely result in $60 to $100 billion per year[9] that can be used to reduce other economically harmful taxes. A revenue-neutral carbon tax would achieve former Vice President Al Gore's aim to "tax what we burn, not what we earn."[10]

5. CARBON OFFSETS COULD UNDERMINE A CAP-AND-TRADE PROGRAM

In a cap-and-trade system, an offset is a reduction in carbon emissions from sources that are not subject to the mandatory cap. The advantage of offsets is that they can provide many sources of low-cost reductions, thus significantly reducing the overall cost of achieving an emissions reduction goal. This can be seen in the currently proposed climate bills, which rely heavily on offsets to reduce overall costs of cap-and-trade. According to the EPA's analysis of the House energy bill, international offsets would average over 1 billion metric tons of carbon dioxide equivalent per year.[11] Without international offsets, the allowance price would increase 89 percent.[12]

But offsets also pose a substantial problem in that they are difficult to measure. The enforcement of a carbon tax or a cap-and-trade program relies on measuring carbon emissions, typically by measuring the carbon content of fuel inputs. Offsets, on the other hand, rely on measuring emission reductions, rather than emissions. This introduces a host of problems, because it is difficult to know what would have happened to emissions absent a given offset project. For example, planting a tree will only lead to a net reduction in carbon emissions if 1) the tree would not have been planted without the offset provision, and 2) the tree will not be subsequently destroyed after the offset purchase takes place.

The difficulty of measuring emission reductions could lead to honest mismeasurements, in which reported reductions are not real. And given the substantial value of offsets in the proposed cap-and-trade programs, it could lead to deliberate mismeasurements of carbon reductions. A similar problem that also arises with cap-and-trade is the treatment of early reduction credits. These are credits given to count against the cap, based on reductions that have

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[5] See Congressional Budget Office, "Policy Options for Reducing CO_2 Emissions," February 2008.

[6] See Adele Morris, Warwick J. McKibbin, and Peter J. Wilcoxen (2009), "A Copenhagen Collar: Achieving Comparable Effort through Carbon Price Agreements," Brookings Institution.

[7] See, for example, Agnar Sandmo (1975), "Optimal Taxation in the Presence of Externalities," *Swedish Journal of Economics* 77(1).

[8] See Lawrence H. Goulder (1998), "Environmental Policy Making in a Second-best Setting," *Journal of Applied Economics* 1(2): 279-328.

[9] See http://www.epa.gov/climatechange/economics/pdfs/HR2454—Analysis.pdf

[10] See Al Gore's Speech at Constitution Hall in Washington, July 17, 2008: http://www.npr.org/templates/story/story.php?storyId=92638501

[11] See http://www.epa.gov/climatechange/economics/pdfs/HR2454__Analysis.pdf

[12] See http://www.epa.gov/climatechange/economics/pdfs/HR2454__Analysis.pdf

occurred in years past. These early reductions are even more difficult to measure than any future offsets, so are more likely to undermine the integrity of the cap-and-trade program.

Unless the integrity of carbon offsets and early reduction credits can be assured at relatively low cost, the environmental benefits of a cap-and-trade program could be substantially undermined, resulting in a program that transfers wealth without achieving climate benefits. Given the financial crisis of the past few years, we should be cautious about creating an active market in a poorly-measured financial instrument.

CONCLUSION

I acknowledge that my arguments in favor of a carbon tax over cap-and-trade are made easier in that I am comparing my ideal hypothetical carbon tax to the actual cap-and-trade programs either passed by the House or proposed in the Senate. Indeed, a cap-and-trade program that included a safety valve and that auctioned allowances would achieve many of the economic advantages of a carbon tax.

The most frequent criticism of a carbon tax is that it would be politically unpopular. But to quote Milton Friedman, I think my role is to "prescribe what should be done in light of what can be done, politics aside, and not to predict what is 'politically feasible' and then to recommend it." You, of course, have the more difficult task of determining what is politically feasible. But given the magnitudes of the costs and benefits associated with any climate policy, I recommend to you a careful consideration of the merits of a carbon tax.

The CHAIRMAN. Thank you very much.

Mr. Hawkins, we're glad to have you here. Thanks.

STATEMENT OF DAVID G. HAWKINS, DIRECTOR OF CLIMATE PROGRAMS, NATURAL RESOURCES DEFENSE COUNCIL

Mr. HAWKINS. Yes. Thank you, Mr. Chairman, Senator Murkowski, and members of the committee. Thank you for inviting me to talk about the role of performance standards as a climate protection tool.

First, I want to mention that NRDC is a member of the U.S. Climate Action Partnership. But, I want to stress that my statement here today, and my testimony, is on behalf of NRDC and not on behalf of USCAP. USCAP has not taken a position on which, if any, of the performance standard or other provisions under the current Clean Air Act ought to be retained in a climate protection bill.

My core message to the committee is that there is no silver policy bullet for climate protection. Rather, we need a combination of tools to reduce emissions in a predictable and an efficient manner.

NRDC believes that a steadily declining cap on emissions, combined with performance standards for key sectors, is required to achieve large, sustained reductions in greenhouse gas emissions.

This is not an unfamiliar approach. Since 1970, the Clean Air Act has combined broad-scope environmental quality objectives with performance standards for major pollution source categories, such as tailpipe standards for motor vehicles, fuel quality standards, and emissions standards for major stationary sources—powerplants, refineries, paper mills, et cetera.

A question that's often asked is, If we have a cap, why do we need additional performance standards? Senator Murkowski, you raised those questions in your opening statement. The first point I would make is that, without some assured rate of progress for key emitters, there is a significant risk of default. We saw this with the reclaim cap program in California in the 1990s. There, powerplant owners that were subject only to a cap on their nitrogen-oxide emissions waited until the last minute, relied heavily on offsets,

and when the hour of compliance approached, they said, "You have a choice: Turn the lights off or give us a compliance waiver." Guess which option the public officials chose? We—this could have been avoided if we'd had some backstop provisions for performance standards to assure steady progress, rather than sole reliance on a cap.

A second argument for performance standards is that they compensate for the real-world compromises that will occur in designing a cap program. We can talk all we like about ideal concepts, but Congress doesn't enact ideal concepts. It's a give-and-take among real-world interests that result in compromises. The bills moving through Congress set targets that are substantially less than what we really should be doing to protect the climate. Very large amounts of offsets are allowed for compliance, which Dr. Gayer just mentioned. Other cost-containment provisions that could impair environmental performance are still under debate.

In the real world, the cap that Congress passes will be a compromise, not a requirement that is fully protective. Performance standards can help fill the gap between ideal and reality.

Both the House and Senate bills contain performance standards for new coal plants, but their treatment of existing fossil-fuel plants is very different. The Senate bill would retain existing Clean Air Act performance-standard authorities to cover existing fossil-fuel plants. But, the House bill repeals those provisions of the Clean Air Act, leaving nothing but the cap to address emissions from those plants. We believe this is not a robust approach. It runs the risk of keeping demand for allowances higher than is needed, raising allowance prices for everyone. It runs the risk of future noncompliance as the cap shrinks, if investments in cleaner generation systems have not been made on a timely basis.

I want to address one myth about performance standards under the Clean Air Act. The argument has been made that performance standards under the law would result in regulatory chaos if applied to carbon-dioxide sources. The reason that we think this is a myth is that there is both a regulatory and a statutory fix to any concern in this regard. Congress is not handcuffed in this matter. EPA has already proposed to set a cutoff for performance standards that would apply only to truly large sources. If Congress has any doubt about the legal robustness of that regulatory approach, it's very easy to adopt surgical amendments that would truly limit performance standards to the big sources that are appropriate.

A final point is that, under the law, performance standards do not, and may not, demand the impossible. They must be reasonable, taking into account technical and economic feasibility. One has to ask oneself, Why, as a matter of policy, would one want to avoid setting reasonable standards for key sectors that are major sources of greenhouse gas emissions?

Now, the current NSPS—New Source Performance Standard—and Prevention of Significant Deterioration Review programs are not the only possible method to set performance standards for key sectors. But, simply repealing them and replacing them with nothing but a cap would be a major policy mistake.

Thank you.

[The prepared statement of Mr. Hawkins follows:]

PREPARED STATEMENT OF DAVID G. HAWKINS, DIRECTOR OF CLIMATE PROGRAMS, NATURAL RESOURCES DEFENSE COUNCIL

Thank you, Chairman Bingaman and Ranking Member Murkowski, for the opportunity to testify today on policy tools to build a clean energy economy and reduce global warming pollution. My name is David Hawkins. I am Director of Climate Programs at the Natural Resources Defense Council (NRDC). NRDC is a national, nonprofit organization of scientists, lawyers and environmental specialists dedicated to protecting public health and the environment. Founded in 1970, NRDC has more than 1.3 million members and online activists nationwide, served from offices in New York, Washington, Los Angeles, San Francisco, Chicago and Beijing.

NRDC is a member of the U.S. Climate Action Partnership (USCAP), the businessenvironmental coalition that supports enacting comprehensive climate legislation this year and NRDC is a member of the labor-environmental Blue-Green Alliance, which also supports this objective. Today my testimony is presented on behalf of NRDC.

Helping Congress pass effective climate legislation is NRDC's highest priority. It is vital to enact legislation this year—to help deliver economic, energy, and climate security. As President Obama has said, the choice is "between a slow decline and renewed prosperity; between the past and the future." Clean, sustainable energy is one of the pillars of growth and prosperity in the 21st Century, and enacting comprehensive energy and climate legislation is the way to put that pillar in place. The time to act is now.

I understand this hearing seeks testimony on policy tools other than the approach known as cap-and-trade. The major point I would like to make today is that as members of Congress would make a mistake if you saw your role as selecting a single policy tool to attack the intertwined issues of energy supply, technology innovation and reduction in global warming pollution. The best policy approach is one that does not rely exclusively on one tool but recognizes that real world versions of policy tools have limits that require use of several complementary techniques to help assure success. NRDC believes the best policy package to tackle these challenges of energy security, technology innovation and climate protection is a comprehensive limit or cap on global warming pollution that becomes tighter each year, combined with complementary programs to drive improved performance in key sectors.

USCAP in its January 2009 Blueprint for Legislative Action, also embraces the view that a cap-and-trade program, complemented by additional policies and measures is the sounder approach:

> . . .we believe our nation's climate protection goals can be met in the most cost effective manner through an economy-wide, market-driven approach that includes a cap-and-trade program as a core element. . . .
>
> In addition, policies and measures that are complementary to a cap-and-trade program are needed to create incentives for rapid technology transformation and to assure actual reductions occur in capped sectors where market barriers and imperfections may prevent the price signal from achieving significant reductions in emissions within those sectors.

Today my testimony will focus on the ability of the Clean Air Act to provide a set of complementary global warming pollution performance standards. This combination of a cap and performance standards would further our clean energy objectives and help achieve a comprehensive limit on global warming pollution, patterned on the very successful model and programs of our current Clean Air Act. In order to set the stage for this discussion, I will briefly cover our successful experience gained from nearly forty years of regulating air pollution under the Clean Air Act.

1) BACKGROUND: THE CLEAN AIR ACT'S DUAL-TRACK AIR QUALITY STRATEGY

In 1970 Congress adopted a dual-track program to protect and enhance our nation's air quality. The first track of that program called on states to adopt comprehensive pollution control programs under state law to achieve air quality objectives set forth in National Ambient Air Quality Standards (NAAQS) adopted by EPA. This ambient program is an example of the "assimilative capacity" approach to environmental management—based on the belief that the environment can assimilate a certain amount of pollution or toxins released from human activities without causing identifiable harm. This approach starts by identifying exposure levels of pollution that current research indicates may be tolerable for humans and ecosystems and then seeks to reduce emissions from pollution sources enough to meet the maximum tolerable exposure targets.

There is a comparable concept for global warming pollution. Our planet, its natural systems and our health will suffer myriad harms due to increases in atmos-

pheric concentrations of CO_2 and other so-called "greenhouse" gases that in turn disrupt our planet's climate systems. Climate scientists use global average temperature increases as a warning indicator of this climate disruption and they tell us that we face extreme dangers if global average temperatures are allowed to increase by more than 2 degrees Fahrenheit from today's levels (equivalent to 2 degrees Celsius over pre-industrial levels). National and global caps on annual emissions of CO_2 and other global warming gases by themselves are another example of the "assimilative capacity" approach to environmental management.

The Clean Air Act provides an important model for Congress to examine as it crafts climate protection legislation. The 1970 Act's ambient management program strengthened previous efforts enacted by Congress in the 1960s and relied on states to set control rules for pollution sources at levels just tough enough to bring total air pollution down to the level of the national ambient standards.

But Congress did not rely exclusively on the assimilative approach to air quality protection in the 1970 Act. Congress adopted another strategy designed to minimize air pollution by requiring sources to meet emission performance standards based on modern "best practices" in pollution abatement. The performance standard approach does not set required levels of control based on atmospheric concentrations of pollutants in particular areas or nationally. Rather, the emission reductions required by performance standards are set by assessing how much traditional polluting processes can be cleaned up, taking account of technical and economic constraints.

Congress included this complementary tool in the law because it anticipated that future air quality goals would likely be more ambitious than those defined in 1970 and wanted an independent program that would be effective in reducing total emissions over time. Congress' intent in the performance standard program was to incorporate advances in pollution prevention and control when major new sources and capital investments were pursued since that is an opportune time to design in clean technology.

Congress applied the performance standard approach to both stationary sources (e.g., power plants, oil refineries) and mobile sources but with some important distinctions. In the mobile source area (cars, trucks, buses), only entirely new vehicles were subject to federallyestablished modern performance standards. Congress was presented with analyses demonstrating that with traditional rates of "fleet turnover," most of the benefits of tighter new car standards would be experienced in less than 10 years.

In requiring performance standards for stationary sources, Congress adopted a broader approach. The Act requires that both new and modified existing stationary sources must meet modern performance standards. The 1970 Act's principal tool for improved air pollution control for new and modified sources was the New Source Performance Standard (NSPS), a national, categorical requirement based on very good, but not the best, pollution minimizing practices. In 1977, when the Act was amended, Congress adopted the new source review (NSR) and prevention of significant deterioration (PSD) programs to strengthen efforts to minimize emissions and air quality impacts from new and modified sources.[1]

In the 1977 Amendments, Congress expanded both the scope of the rigor of the requirements for improved performance from new and modified sources. A key new concept was that the level of the performance requirement would not be tied to often out-of-date NSPS; rather case-by-case determinations of current best performance would be required.

Finally, in the 1990 Amendments Congress expanded the scope and rigor of the performance requirements yet again, recognizing the value of subjecting new and existing pollution sources to modern performance standards in order to both manage air pollution growth and reduce actual pollution levels. Notably, Congress retained and expanded these performance standard approaches—PSD, NSR and NSPS—for the electric power sector at the same time that Congress created the 1990 Amendments' successful acid rain program. This program, of course, relies upon a cap on sulfur dioxide emissions from the electric power sector, coupled with the ability to trade pollution allowances in order to meet a facility's obligation under the cap.

The ambient management program has been a central program of the Clean Air Act since 1970 and it should continue. Critics occasionally have asserted that we should rely on the ambient standards approach as the only strategy for improving and protecting air quality. And today some contend that climate legislation should rely exclusively upon cap-and-trade and dispense with performance standards and other source-specific pollution management tools.

The 1970 and later Clean Air Acts reflect a judgment by Congress that the ambient standards approach should be complemented by other independently functioning

[1] For simplicity, for this testimony I will refer to these programs generally as NSR.

programs such as the NSR and Mobile Source Emission Standards programs. I think that this judgment was a wise one. The history of air pollution control efforts both before and after the 1970 Act reveals that broad concentration or emissions loading concepts like the ambient standards approach, while conceptually sound, have their weak spots, which when exploited, can prevent the program from solving air quality problems in a timely fashion.

The Clean Air Act's dual track approach to air quality management employs the principle of diversification to reduce risks. In an uncertain world, a prudent investor will forego putting all his money into the one stock with the apparent highest yield. Instead she will spread her risk by selecting a range of investments—some which offer high risk and high yield and others which offer less risk and less yield. The Clean Air Act is also like a stable ecosystem, which has a diversity of species. Such systems are much less likely to fail when stressed than systems that have no diversity.

2) THE EXAMPLE OF ACID RAIN

The argument has been made that with an overall cap or budget on greenhouse gas emissions, we should simply not care about the amount of emissions from individual sources or even entire sectors. This argument was rejected by Congress in the 1990 amendments to the Clean Air Act when it both enacted a cap on sulfur dioxide emissions from the electric power sector to combat acid rain, and retained the NSPS and NSR programs for the sources covered under the acid rain trading program. Those programs have jointly continued to function well to minimize emissions from new sources, thereby reducing pressure on the sulfur dioxide cap and demonstrating improved and less expensive means of emission reduction that can be used to reduce emissions from existing sources as well.

When we have ignored the value of complementary programs, we have seen unfortunate results. The RECLAIM program in Southern California is an example of overreliance on the cap mechanism alone: there, exclusive reliance on a cap program led to long delays in reducing emissions from major sources, and to a totally avoidable compliance crisis when the final deadline arrived.

3) IDEAL VERSUS REAL-WORLD CAPS

Like for acid rain, the cap on total greenhouse gas emissions is a core element of an effective greenhouse gas reduction strategy. It creates a market for the many innovations that will be required to achieve the deep reductions we need to protect the climate. But we should not rely on the cap alone. Theoretical arguments that other programs are not needed once we have a cap are misplaced because they ignore the reality that the cap enacted by Congress will involve compromises. The cap schedule set in this legislation is not likely to reduce emissions as fast as may be environmentally and economically prudent. The inclusion of cost-containment provisions may also mean that cap-driven reductions fall short of those that can be implemented cost-effectively in some key sectors.

4) THE EXAMPLE OF COAL: INCENTIVES AND OFFSETS

The goal of reducing emissions by 80% from 1990 levels by 2050 is like a marathon: we cannot hope to complete the race if we do not set and maintain a pace of technology improvement for key sectors from the start of the race. This is especially true for long-lived, high capital investment projects like coal-fired power plants. For good reasons most cap-and-trade proposals include substantial provision for the use of offsets for compliance with the cap. But overreliance on such offsets can lead to problematic results. In this sector, the ability to purchase offsets rather than retrofit existing plants or develop new technologies could result in decisions that seem wise from the perspective of the individual firm but collectively result in higher allowance costs and make it more difficult to achieve longer-term reduction goals. However, the answer is not to eliminate offsets but to complement that flexibility with measures that provide for minimum emission progress paths in major emitting sectors.

Even if offsets in a cap-and-trade structure are of the highest quality and represent emission reductions fully equivalent to emissions from covered sources, overreliance on such offsets by key sectors will leave those sectors poorly positioned to achieve the deep reductions that are required to meet the longer-term cap objectives of the legislation. And if, as is likely, some fraction of offsets do not achieve fully equivalent reductions, then system-wide emissions will be higher than required to meet the legislation's objectives. While the bill that passed the House includes performance standards for new coal plants, it does not include any performance metrics

for the existing coal fleet and repeals tools in the existing Act that could be used to achieve reductions from that sector and from other sectors.

If we do not craft a program that will reduce actual emissions from the existing fleet of coal-fired power plants at a reasonable but steady pace we run the risk of facing claims of threatened power shortages or destructively large electric rate increases as an aging fleet reaches the point where major retrofits or retirements are required for a huge fraction of the fleet in a very short period of time. In the absence of policies to secure steady reductions from existing sources, high-emitting old plants are likely to operate for a long time, increasing demand for allowances and thereby putting upward pressure on allowance prices for all sectors.

EPA analyzed the House bill, which repealed the NSPS and NSR programs for carbon dioxide emissions from existing plants. EPA's analysis indicated that only 8 percent of existing coal generation capacity will be retired by 2025, with most of the retired capacity occurring at "marginal units with low capacity" that are "part of larger plants that are expected to continue generating."

5) MYTH: RETAINING PERFORMANCE STANDARDS WOULD PRODUCE REGULATORY CHAOS

NRDC disagrees with claims that implementing current Clean Air Act performance standard authorities for major sources would be disruptive. EPA's proposed rule to apply these programs only to truly large sources concludes that such a program would be administratively reasonable and not interfere with the investments that we all want for a growing economy.

Critics have complained that applying NSR to carbon pollution would result in burdensome coverage of barbecues and donut shops. That concern is easily addressed by raising the NSR threshold to a level that would cover only truly large industrial sources, such as 25,000 tons per year of CO_2-equivalent emissions. EPA has proposed raising the threshold to that level in a recent Clean Air Act rulemaking. We support inclusion of such a threshold in comprehensive climate legislation.

Establishing higher emissions thresholds under the Act will allow EPA and the states to focus on a small number of the largest sources of GHG emissions. As structured, the performance standards and reviews simply would not apply to the smaller and more numerous but relatively insignificant sources of such emissions. EPA estimates that at a 25,000-tpy CO_2e applicability threshold for PSD major sources, approximately 400 additional new or modified facilities would be subject to PSD review in a given year. This estimate compares to the 280 PSD permits that are currently issued in a typical year. 74 Fed. Reg. 55,331.

With respect to the Act's Title V operating permit program, EPA estimates that currently there are approximately 14,700 Title V operating permits nationwide. According to the agency, at a 25,000-tpy CO_2e permitting threshold, about 13,600 existing facilities would be classified as "major sources" for their CO_2e emissions. EPA "expect[s] that many of the 13,600 existing facilities that would exceed the proposed 25,000-tpy CO_2e threshold—the majority of which consist of electric generating units and industrial facilities—already have a title V operating permit for other regulated pollutants, and thus would potentially require only a permit revision or modification to address GHGs." 74 Fed. Reg. 55,335.

What would GHG performance standards look like? Clean Air Act section 111 authorizes EPA to establish national new source performance standards (NSPS) for new and existing stationary sources. EPA establishes performance standards based on the best demonstrated systems of emissions reduction, taking into consideration factors such as technical feasibility, cost, and energy requirements. EPA also has discretion concerning the sizes and types (source categories) of facilities to be regulated.

In the early years for some industrial sectors, NSPS and Best Available Control Technology (BACT) under PSD may be limited to application of demonstrated process efficiency methods and consideration of lower-carbon feed stocks, (e.g., biomass co-firing). As advanced approaches are demonstrated they too will become part of the suite of options that are considered. As with any other pollutant, technical feasibility and economics will determine what standards are reasonable for application to various source categories.

6) FEDERALISM AND PROTECTION OF STATES' RIGHTS

New legislation should retain important provisions of the current Clean Air Act that protect the rights of states to go beyond federal minimum requirements for control of global warming pollution. States have been pioneers in the control of greenhouse gas emissions from vehicles and they developed effective programs to deploy energy efficiency and renewable energy resources. States, and entities that states

regulate (such as local distribution companies), have program delivery capabilities that the federal government cannot match. States can help drive innovation in low-carbon technologies and processes by exercising the tools that have been created under the current Clean Air Act. Their ability to do so should be protected.

Revocation of NSPS and NSR authority for covered sources of greenhouse gases as proposed in the House bill would cripple many states' ability to drive innovation through these programs. The National Association of Clean Air Agencies has estimated that at least half the states have laws or policies prohibiting state regulators from adopting environmental and public health regulations or other safeguards more stringent than those contained in federal law. These so-called no-more-stringent-than laws prevent state permitting authorities from innovating and protecting their citizens to a greater degree than EPA does under federal law. Accordingly, repealing these NSPS and NSR authorities in federal law would effectively repeal the authority of many states, forcing such states to seek new legislation from their state legislatures to replace authority they currently have. This would be a dramatic departure from the relationship between federal and state authority that has developed over the past four decades.

7) CONCLUSION

In conclusion, the NRDC believes that the NSR and NSPS provisions of the CAA are important complement to the cap-and-trade program in new clean energy and climate legislation. The Clean Air Act has been one of our most successful laws, based upon a portfolio approach to air quality protection that combines ambient approaches, performance standards (technologybased or otherwise) and market-based mechanisms like cap-and-trade. Hard experience has taught us that we must not rely exclusively upon one or another of these air management approaches. Accordingly, each successive version of clean air legislation has ratified and expanded a complementary measures strategy, providing us with a balanced toolbox to address these challenges. And when new programs have been created, like the 1990 Amendments' capand-trade program for acid rain pollution, Congress wisely preserved the existing tools, like emission performance standards. Climate and clean energy legislation should not disregard these lessons or abandon these successes. Technology-forcing components are critical to the success of our pollution reduction programs, and NSR and NSPS provide important tools to ensuring the transition to a clean energy economy. These programs have been proven to be compatible with industries' desires to make timely investments and by focussing them on truly large emission sources they can and should be employed in our efforts to cut global warming pollution as an important complement to a comprehensive cap approach.

The CHAIRMAN. Thank you very much.

Mr. BANKS.

STATEMENT OF JONATHAN M. BANKS, CLIMATE POLICY COORDINATOR, CLEAN AIR TASK FORCE, BRUNSWICK, ME

Mr. BANKS. Thank you, sir. Good morning.

I appreciate the opportunity to speak with you today regarding different options for reducing greenhouse gas emissions.

Before I get started, let me say that CATF supports immediate and comprehensive action to deal with climate change. We've worked closely with members of the House and Senate to help enact a Federal climate policy, including the Waxman-Markey bill and the Kerry-Boxer bill, here in the Senate. We cannot, however, afford another multiyear delay. We need to pass a mandatory climate policy in this Congress.

If the politics of Congress demand it, we may need to have alternatives available for dealing with climate change. Our work to date has made us realize that the best climate policies may actually be hybrids that include elements of all the ideas we'll be hearing about here today.

One more caveat. Many of us on this panel are speaking about policies that have not undergone the legislative process. What may appear on paper as a simple policy may not be so simple when it's

put through the rigors of the legislative process here in the Senate and the House. For instance, have you ever seen a simple piece of enacted tax legislation? This caveat applies equally to cap-and-trade, cap-and-dividend, carbon tax, or sectoral policies, which is what I'm here to speak about today.

The climate debate in Congress is hinged on a number of key issues: costs, jobs, impacts to coal in the industrial sector, believable technology pathways, gasoline prices, and action by sectors other than just the power sector, to name a few. Many policy options have been proposed to deal with these concerns, but we focused our work to date on creating believable technology pathways, shared responsibility amongst the major sectors, and, a related issue, bending the curve on transportation-sector emissions.

In an economywide policy, the price signal of the cap can be muted in some sectors of the economy; most notably, the transportation sector. With an upstream cap on petroleum products, refiners pass the price of an allowance on to the consumer. But, a $50-a-ton CO_2 allowance price translates into about 50 cents at the gas pump. While this may be a political liability for you all, it would not be a—likely be a huge driver of CO_2 emission reductions.

Instead, the petroleum industry will pay the power sector to further reduce its emissions. Indeed, modeling of the current economywide proposals suggests that almost all the reductions between now and 2030 would come from two sources: offsets and overcompliance in the power sector. This sounds like good economics—that is, finding the cheapest tons throughout the economy, and getting our reductions there—but, it raises some significant concerns. With most of the reductions coming from the power sector, we need to make sure the reductions are achievable and believable. But EIA's modeling of H.R. 2454 predicts that 100 gigawatts of nuclear power, 70 gigawatts of carbon capture and storage, 90 gigawatts of renewables will be necessary by 2030. To put that in perspective, 100 gigawatts of nuclear plants by 2030 would require us to complete seven very large nuclear reactors every year from about 2016 to 2030. While models spit these numbers out without a problem, in the real world they are likely to be a—very difficult to achieve.

If the power sector cannot achieve these reductions, then other sectors will have to make up the difference. We cannot wait until 2020 or 2030 to develop these policies that will drive the other sectors' emissions down.

Back in the fall of 2008, following the defeat of the Lieberman-Warner bill, we embarked on an exploration of alternative climate policies. The policy we are exploring represents economywide coverage without an economywide cap. It is a work in progress, and the results we are sharing with you today are preliminary, but very promising.

Here's what we modeled: a cap on power- and industrial-sector emissions on a trajectory equaling 90 percent below 1990 levels by 2050; an accelerated CAFE program, reaching 45 miles per gallon by 2030; technology incentives for renewables and carbon capture and sequestration; and increases in Federal energy efficiency standards.

We continue to refine these elements, as well as develop additional policies, such as an HFC cap-and-trade program, a program for black carbon and methane reductions, additional transportation policies, a program to develop and deploy advanced renewable technologies such as dispatchable wind, a program for marine and aviation emissions, and a comprehensive but realistic CCS commercialization program.

So, what does all this achieve? Relative to the current economywide bills, the answer is considerable greenhouse gas reductions, lower allowance prices, and, in our view, more believable technology pathways.

In my written testimony, I elaborated on these results, but, in the interest of time, I will briefly summarize them: CO_2 allowance prices are cut in half; the size of the market is reduced by about 65 percent; total greenhouse gas emissions are 21 percent below 2000—2005 levels by 2030, which is considerably higher than H.R. 2454; transportation-sector emissions are lower, but still trending up; coal production is roughly equal to today's levels; coal power generation remains the dominant source of electricity; natural gas generation and nuclear generation remain fairly stable with today's levels; renewables grow to 20 percents of generation; gasoline prices are actually slightly lower than business as usual, and almost 50 cents lower than in H.R. 2454; electricity prices are slightly lower for all sectors.

The reaction to these kinds of numbers can sometimes take completely different directions; either this is the best thing since sliced bread or it's going to let the planet burn. The reality is that it's neither. We recognize that the policy entails a mix of positives and negatives, some of which can be dealt with through further policy development. Our goal is to continue to refine the policy to get total greenhouse gas emissions down to levels comparable to the Obama Administration's stated targets.

What you and your colleagues will have to decide is whether the concerns expressed regarding the current climate policies require further refinement or, in the end, whether it will be necessary to look to policy alternatives. Regardless of the answer to that question, we believe that targeted sectoral policies will be necessary, either on their own or in conjunction with an economywide policy, in order to drive the necessary emission reductions.

I'd be happy to answer any questions you might have. Again, thank you for the opportunity to speak to you today.

[The prepared statement of Mr. Banks follows:]

PREPARED STATEMENT OF JONATHAN M. BANKS, CLIMATE POLICY COORDINATOR, CLEAN AIR TASK FORCE, BRUNSWICK, ME

Mr. Chairman, members of the Energy and Natural Resources Committee, good morning, my name is Jonathan Banks, and I am the Climate Policy Coordinator of the Clean Air Task Force. I appreciate the opportunity to speak to you today. Based in Boston, the Clean Air Task Force is a nonprofit organization with offices in the US and China dedicated to reducing atmospheric pollution through research, advocacy, and private sector collaboration. Our staff and consultants include scientists, attorneys, economists, and engineers. Our board consists of private sector leaders as well as environmental advocates.

In the fall of 2007, following the cloture failure of the Lieberman-Warner bill, CATF began to investigate a number of alternative polices that could be used to deal with climate change. Our work to date has made us realize that in terms of policy design there is no "right answer" for climate policy as long as it reduces the

requisite tons and is passed into law. Rather, the best climate policies are "hybrids" that incorporate good ideas in a combination that can improve both the economics and overall environmental performance.

First, let me say that CATF supports immediate and comprehensive action to deal with climate change. We have supported the House climate process that lead to the successful passage of the Waxman-Markey climate bill earlier this year. We have also been working to help enable passage of the Kerry-Boxer proposal in the Senate. We cannot, however, afford another multi-year delay in passage of the nation's first climate policy. If the politics of the U.S. Senate demand it, we need to have alternatives to the current proposals available to policy makers. It is in that vein that we embarked on an exploration of alternatives to economy wide policies, not as a competitor, but as an alternative that may offer a realistic and enactable set of policies to help us get started dealing with climate change.

One more caveat before I speak to the work we have done. All of us here on this panel are speaking about climate policies that have not undergone the legislative process. What may appear in a white paper as a much more simplified way of dealing with climate change, will not be simple when it is put thorough the rigors of the Senate and House legislative process. For instance, have you ever seen a "simple" piece of enacted tax legislation? This caveat applies equally to cap and trade, cap and dividend, carbon tax, or sectoral policies—which is what I came here to speak about. All of these policy alternatives have strengths and weaknesses and they are not mutually exclusive.

The debate surrounding Lieberman-Warner, as well as the debate this year over the Waxman-Markey bill (HR 2454) and the Kerry-Boxer bill has hinged on a number of key issues. Many of these issues were highlighted at the end of the Lieberman-Warner debate by a group of Senators known as the "Gang of 15", many of whom serve on this committee. The issues highlighted include: costs, both to consumers and companies; US manufacturing jobs and impact on manufacturing; impacts to the coal industry and coal dependent power companies; believable technology pathways; gasoline prices; action by sectors other than just the power sector; and the size of the carbon market, to name a few.

In response, policy makers have explored a number of options: safety valves, price collars, strategic reserves, expansion of offsets, weakening of the interim caps, protectionist trade measures, incentives for various technologies, and additional layers of programs and regulations to force reductions in other sectors.

There are, however, some areas where no amount of tinkering will suffice to deal with the real world issues raised by the Gang of 15. Gasoline prices will go up if we put in place an upstream cap or tax on petroleum products. The sheer size of the market, which is simply the number of allowances times the price of allowances, cannot be constrained without containing allowance prices or eliminating covered sectors. And the pathway to compliance, what we call "technology pathways," presents a question mark in any economy wide policy, whether tax or cap, because we cannot be certain precisely how the market will react to the price signal.

In an economy-wide policy the price signal of the cap can be muted in some sectors of the economy, primarily the transportation sector and to a lesser degree the residential and commercial sectors. With an upstream cap on petroleum products, refiners pass the price of an allowance on to the consumer. But a $50 a ton CO_2 allowance price, translates into you and I paying about 50 cents at the pump. While this may be a political liability for all of you, it would not likely be a huge driver of transportation sector emissions reductions. Instead, the petroleum industry will pay the power sector to further reduce emissions.

This sounds like good economics, that is, finding the cheapest tons throughout the economy and getting our reductions there. But, it raises two potentially significant problems.

First, the Energy Information Administration's (EIA) modeling suggests that almost all the reductions come from two sources: offsets and reductions in the power sector (see figure 1 below). This chart shows what sectors EIA believes will contribute to the GHG abatement under HR 2454. As you can see almost all of the predicted abatement comes from offsets and reductions in the power sector. Again, we would expect to see this outcome in response to all economy wide proposals be they tax, cap and trade or cap and dividend.

Second, with most of the action coming in the power sector, we need to make sure that the needed reductions from that sector are achievable and therefore believable. However, when we look at the energy technology build-out necessary to meet these caps that rely on power sector over-compliance the problem comes into focus: EIA's modeling of the Waxman-Markey bill predicts that 100 GWs of nuclear power, 70 GWs of carbon capture and storage (CCS), and 90 GWs of renewables, will be built

by 2030. To put that in perspective, 100 GWs of nuclear plants by 2030 would require completing 7 very large nuclear plants every year from 2016 to 2030.[1]

While models spit these numbers out without a problem, in the real world this is likely to be very difficult to achieve. This, though, is not just a near term problem, EIA states in its most recent work on HR 2454:

> *Unless substantial progress is made in identifying low-and no-carbon technologies outside of electricity generation, the ACESA emissions targets for the 2030-to-2050 period are likely to be very challenging as opportunities for further reductions in power sector emissions are exhausted and reductions in other sectors are thought to be more expensive."*[2]

If the power sector cannot achieve these reductions, then other sectors will have to make up the difference. We cannot wait till 2020 or 2030 to develop policies that set other sectors on a path to contribute to the necessary reductions.

CATF chose to explore a combination of policies that target specific sectors, with the goals of reducing costs, creating more believable technology pathways, and maintaining environmental integrity. This policy represents economy-wide coverage, without an economy-wide cap. We conducted an initial set of modeling runs on a set of proxy policies using EIA's National Energy Modeling System (NEMS). Since then, the economic downturn, and a number of additional changes have dramatically altered EIA's view of business as usual (BAU). Just recently, we updated our initial set of runs to reflect these changes and pegged the work to modeling EIA has performed on HR 2454.[3] Our formulation represents a work in progress and the results we are sharing with you today are preliminary, but very promising.

After a number of rounds of tweaking, our latest work employs the following policies:

- A cap on power and industrial sector emissions on a trajectory equaling 90% below 1990 levels by 2050;
- An accelerated light duty vehicle fuel economy program reaching 45 miles per gallon by 2030;
- Technology incentives for renewable energy generation and coal with carbon capture and sequestration (CCS);
- Proxies that reflect significant but achievable increases in federal energy efficiency standards for energy using equipment; and
- An HFC cap and trade program.

We are continuing to refine these elements, as well as develop additional policies (and the necessary analytics to be able to better model them) such as:

- A program to spur domestic black carbon and methane reductions;
- Additional transportation policies, primarily focused on commercial vehicle efficiency, that would "bend the curve" on emissions from the transportation sector so that total transportation GHG emissions are declining before 2030;
- A program to develop and deploy advanced renewable technologies such as dispatchable wind;
- A comprehensive, but realistic CCS commercialization program to include broad deployment of post combustion CO_2 capture technology and geologic carbon sequestration at existing coal and gas plants;
- Cost characterization for underground coal gasification with CCS; and,
- Realistic model constraints on CCS, nuclear, and renewable generation expansion through 2030.

So what does all of this achieve? The answer is a policy that achieves considerable greenhouse gas reductions at a lower cost and, in our view, with more believable technology pathways. But, we recognize that the policy entails a mix of positives and negatives, some of which can be dealt with through further refinement of the policy proposal. And, some of the results could be viewed as both positive and negative depending on where you stand.

First, allowance prices for the power and industrial sector cap and trade are cut in half as compared to EIA's modeling of HR 2454, with prices reaching about $34 in 2030 (vs. $64 for HR 2454). The size of the market and the revenue generated by it is also considerably lower (about 67% lower) as would be expected with a cap that covers only a portion of the economy and one whose allowance prices are so

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[1] 2016 is the earliest date NEMS will complete new nuclear facilities.

[2] EIA, Energy Market and Economic Impacts of HR 2454, the ACESA of 2009.

[3] We used EIA's interpretation of the offset provisions, CCS incentives, banking provisions and allowance distribution system all scaled to a program that covers 60% of energy related GHG emissions.

much lower. Of course, this would also mean less allowance value and/or auction proceeds that could be devoted to all the purposes included in the Waxman-Markey bill. Although more analysis is needed, we feel that a major emitter cap at this stringency could be structured to protect electricity consumers and fund the necessary power sector technology innovation.

Under our modeled sectoral policy, total economy wide emissions are somewhat higher than HR 2454 (see figure 2 below). However, in the early years of the program, covered emissions reductions are the primary source of reductions, meaning more reductions are happening on system than in an economy wide program. For the power and industrial sectors their emissions are higher than in HR 2454 because they are not doing the work of the transportation sector.

On the other hand, transportation sector emissions are lower than Waxman-Markey due simply to the accelerated CAFE program (see figure 3 above). The incorporation of the suite of additional transportation policies we are developing, may allow us to achieve full comparability (for total GHG emissions) with the current economy wide cap and trade policies. These additional policies would go beyond the light duty CAFE increases we have already modeled, and likely include:

- Establishment of CAFE for commercial vehicles with annual increases
- Requiring anti-idling technologies for all commercial vehicles
- Funding/credits for hybrid commercial vehicles
- A feebate program for low mileage/high mileage cars
- Incentives or rebates as well as funding for light duty electric vehicle development and deployment.

Additional results show that under our sectoral approach coal continues to remain the dominant source of power through 2030 (45% of generation) and renewable generation jumps up to 20%. However, natural gas power generation drops, and nuclear power stays roughly at today's levels (see figure 4), with only about 4GWs of new nuclear generation being built by 2030.

We expect that in the real world, the amount of CCS built would be less than the 63GWs we show in our work, that the nuclear industry will be successful in building a number of new reactors, and that any remaining gap will be filled by natural gas generation as a bridge fuel for later carbon reductions through increased efficiency, renewables, CCS, and nuclear. We are currently developing a modeling run that would place realistic constraints on CCS, nuclear and renewables development to test this idea.

Coal production in the sectoral case remains roughly even with levels in EIA's reference case (although coal power is producing 23% less CO_2 per megawatt hour as compared to the reference case). There are several factors at play. First the sectoral policy builds 63GWs of new CCS power. It retires about 33GWs of coal vs. HR 2454, which retires 130GWs. While some coal-powered units would be running less frequently, taken all together, coal production stays relatively stable as compared to the Waxman-Markey economy wide cap. The big piece is the difference in the number of retirements.

Gasoline prices are actually slightly lower than BAU due to decreased demand from the accelerated CAFE program, and almost 50 cents lower than HR 2454. For electricity prices, the sectoral policy shows lower prices to all end users, but mostly after 2025 when HR 2454's cap declines considerably. For natural gas, there is no upstream cap. When we combine that with the efficiency gains and less demand for natural gas in the power sector, prices of natural gas are lower than HR 2454 as well as lower than BAU.

Offsets continue to play a prominent role in GHG abatement under the sectoral policy. Under both HR 2454 and the sectoral policy, offsets make up a nearly identical fraction (45%) of the total greenhouse gas reductions in 2030. However, the year-to-year fractions are quite different with HR 2454 compensating with offsets to a much higher degree in the early years (see figure 5). Importantly, the sectoral policy uses far fewer total offsets but that is because of the cap differences. International offsets make up identical percentages in both cases but there is slower ramp up of total offset demand that could help allay some concerns about the speed with which an international offset market could develop (see figure 6).

What modeling does not show is the complexity (both political and technological) of creating and enacting any climate policy, including a sectoral-based approach. For sectoral, some of this complexity could be managed by passing multiple pieces of legislation or sectoral titles. This would allow for fine-tuning of the program, and could provide a more adaptable policy framework over the long haul. This would also narrow the number of key stakeholders to a more manageable set of groups that need to come to the table on each piece of the policy.

Currently many in the power and industrial sector have publicly stated that they do not want a sectoral climate policy. What exactly drives this, we do not know with certainty. It could be the fear of potentially being the only industry regulated. It may also be simply that economy wide policy is the devil we know. It has been the subject of the legislative process for the last 8 years. Industry and members of Congress have engaged and have staked out positions and voiced their concerns. Of course, the launch pad for the last eight years was actually a sectoral approach known as the Clean Smokestacks Act.

What you and your colleagues have to decide is whether the concerns expressed regarding the current proposals in the Senate are best dealt with through further refinement of the overall economy wide proposal, or in the end whether it will be necessary to look to policy alternatives. Regardless of the answer to that question, the imperative to take the first step forward on climate remains. I would be happy to answer any questions you might have.

For more information and additional charts, please visit our website: www.catf.us/advocacy/legal/

The CHAIRMAN. Thank you very much.

Mr. ALIC.

STATEMENT OF JOHN ALIC, INDEPENDENT CONSULTANT, AVON, NC

Mr. ALIC. Thank you. Senator Bingaman, Senator Murkowski, members of the committee, it's a pleasure for me to be here this morning.

The first author of our written statement, Dr. Dan Sarewitz, is a professor at Arizona State University. He has to teach today. We both worked on a study of innovation pathways as a means of dealing with two linked problems. One is climate change, the other is decarbonization of our energy system. The two problems are separate, but they're closely related. I'm going to summarize, not our entire study, but some of the main points that perhaps you haven't really heard in great detail about before.

The first point I'd like to make is that this is a massive technological change that we're facing. It is probably, in its overall dimensions, going to be comparable to the so-called Information Revolution that we've been through over the last four or five decades. It's going to penetrate every sector of our economy. It's going to involve thousands of firms, tens of thousands, perhaps hundreds of thousands of engineers and scientists. When our economy emerges from this transformation, which is likely to be decades into the future, because these things take time, the world around us really will be very different. The question before us as a Nation is, How do we approach this transformation? How do we do it in a smart kind of way? To answer that question, I think we have to think hard about how innovation takes place.

I'd like to read you a quotation. This is not in our written statement, so I'll read it carefully. It's from a recent interview with Edmund Phelps, an economist who won the Nobel Prize in economics a couple years ago. He said, "Once in a while there is a big leap which creates the ground for a surge of innovations to follow. Nowadays, we realize that an awful lot of innovation just comes from businesspeople operating at the grassroots, having ideas on the basis what they see around them, nothing to do with science; it's just creative humankind chipping away at things."

That's a very profound statement. It describes how innovation actually takes place. Research is very important. Research, by and large, does not pay off in the near term; it takes decades for the

results of research breakthroughs, true breakthroughs, the sort that win Nobel Prizes, to emerge and have economic effect. Sometimes that doesn't even happen.

I spent many years on the staff of the Office of Technology Assessment. At the request of this committee and other committees, I did a study, back in the 1980s, of high-temperature superconductivity. That led to a Nobel Prize in physics. It has not yet, after more than 20 years, led to any meaningful impacts on our energy system. Maybe it will, maybe it won't.

We cannot count on research breakthroughs, but we can drive forward technological change. We know how to do that. There are many lessons to be drawn, from other parts of our economy, that can be applied to climate change and the energy system.

In our report and in our written statement, we talk about the lessons that can be taken from national defense in which, in effect, we—we won the cold war in large part through technological innovation. That was a government-industry partnership. The innovation came from industry. Government paid the bills. The bills were costly. We decided as a Nation that that was something that needed to be done. If the Nation commits itself to dealing with climate change, to decarbonizing our energy system, we need to build a similar sort of innovation machine. We are not geared up to do that today. We are trying to do that indirectly, because, of course, if we raise the prices of energy, if we regulate greenhouse gas emissions, one of the consequences that everybody is counting on is that it will generate more innovation. That's true, but that's not the only source of innovation.

One of the messages of our report is that if we take the view that greenhouse gas warming and decarbonization are public goods, public missions, and if we gear ourselves to treat those as an investment in the future, there are many agencies in the government, many smart people who can contribute to that, and many lessons to be drawn from other parts of the economy, not only defense, but industries that have been long a vital part of our economy, such as agriculture, where government, again, has greatly boosted the productivity of that sector.

Thank you again for inviting me to appear today.

[The joint prepared statement of Mr. Alic and Mr. Sarewitz follows:]

JOINT PREPARED STATEMENT OF JOHN ALIC, INDEPENDENT CONSULTANT, AVON, NC, AND DANIEL SAREWITZ, PROFESSOR OF SCIENCE AND SOCIETY, ARIZONA STATE UNIVERSITY, AND CO-DIRECTOR, CONSORTIUM FOR SCIENCE, POLICY, AND OUTCOMES

Mr. Chairman and members of the Committee, thank you for inviting our testimony. My name is John Alic. Now an independent scholar, I worked for more than fifteen years at the Office of Technology Assessment. The first author of this statement, Daniel Sarewitz is a former House Science Committee staff member and now Professor of Science and Society at Arizona State University and co-Director of the Consortium for Science, Policy, and Outcomes, which he helped to found in 1999. Dr. Sarewitz's research focuses on how science and technology policies can help to achieve important societal goals, with a particular focus on problems of uncertainty in policy making, and the role of technology in meeting human needs.

Our statement draws and expands on a recently released study "Innovation Policy for Climate Change" (available at: http://www.cspo.org/projects/eisbu/), which was carried out jointly by the Consortium for Science, Policy, and Outcomes, and the Clean Air Task Force, and funded by the National Commission on Energy Policy.

In my remarks today I would like to make a few very important points about how to think through the greenhouse gas problem. The first, quite simply, is that limiting the concentration of greenhouse gases (GHGs) in the atmosphere is largely a problem of technological innovation. If this nation, and the world, decides that it is necessary to transform the global energy system to radically reduce GHG emissions, that means embarking on a path of profound technological transformation. It follows that effective innovation policies will be the necessary complement to whatever other options Congress may choose to pursue in grappling with the immensely difficult challenge of climate change, all the more so in that fossil fuel prices are likely to remain low relative to other sources of energy over the next decade or more, and markets for some of the key technologies that will be necessary do not yet exist.

The second point, again a simple one, is just to emphasize that for the past century and more the United States has led the world in innovation. If we decide to turn this unmatched capacity to the climate change problem, we know, in principle, what to do and how to do it. What is daunting is the scale and scope of the problem. But it is not without precedent. After World War II, the U.S. government put in place a suite of policies aimed at stimulating innovation that helped make possible our Cold War victory and fueled continued economic growth and job creation. We know what works, based on our experience. Yet so far we are not sufficiently applying what we know about innovation to address energy technologies and climate change.

Let me then briefly review our Cold War innovation policies, which took on their fundamental shape at the time of the Korean War, for which the United States was woefully unprepared. Over the next several years, technological innovation became a central pillar in our larger Cold War strategy. In the technological response that took shape, intense competition among and within the military services combined with greatly increased budgets for R&D and procurement in a long-running search for "force multipliers" to offset the numerical advantages of the Soviet Union and its allies, especially in Europe. The Department of Defense (DoD) paid the bills, which were large and carried charges for much waste and duplication but also brought forth a flood of innovations from the defense and aerospace industries and virtually created the digital electronics industry, and the fields of computer science and materials science.

High-tech military advances created by Cold War innovation policies included nuclear submarines in the 1950s, intelligence satellites in the 1960s, precision-guided missiles in the 1970s, and stealth aircraft in the 1980s.[1] Advances in military technology during the Cold War also spawned civilian applications, innovations, and industries that fueled economic growth and created the high technology infrastructure that we depend on today, from our communications systems to our aviation network.

The nation's Cold War commitment to technological innovation was neither justified nor rationalized by market logic. We committed ourselves to a path of technological innovation in pursuit of a public good—national defense—and that commitment created powerful incentives for market actors to produce improved technologies for both military and civilian applications.[2] Table 1 sets the Cold War innovation system alongside an approach to innovation appropriate to the scale and scope of global climate change and the restructuring of the nation's energy system.

TABLE 1. INNOVATION SYSTEMS COMPARED

	Cold War Innovation System (ca. 1950-1990)	Energy-Climate Innovation System (Prospective)
Basic Problem	Offset numerical advantages of Soviet Union and Warsaw Pact through technologically superior military systems and equipment.	Mitigate climate change caused by carbon dioxide and other greenhouse gases through decarbonized energy technologies, greater energy conversion efficiency, and energy conservation.

[1] John A. Alic, Trillions for Military Technology: How the Pentagon Innovates and Why It Costs So Much (New York: Palgrave Macmillan, 2007).

[2] John A. Alic, Lewis M. Branscomb, Harvey Brooks, Ashton B. Carter, and Gerald L. Epstein, Beyond Spinoff: Military and Commercial Technologies in a Changing World (Boston: Harvard Business School Press, 1992).

TABLE 1. INNOVATION SYSTEMS COMPARED—Continued

	Cold War Innovation System (ca. 1950-1990)	Energy-Climate Innovation System (Prospective)
Primary Sub-Problems	Find acceptable balance between conventional and nuclear forces. Restrain the "military-industrial complex" through high-level civilian oversight and effective management of budgetary politics and process.	Speed diffusion of both new and existing lowcarbon technologies in face of massive sunk costs in the existing "energy system." Defuse politically powerful geographic and sectoral interests (e.g., coal and coal states) that threaten capture of policy process.
Guiding Principles	National security is a public good, the responsibility of government. The Soviet Union is the primary threat; for purposes of military technological innovation, all other threats can be considered (perhaps incorrectly, in retrospect) as lesser included cases.	Mitigation of climate change through control of greenhouse gases is a public good, the responsibility of government. CO_2 released in burning fossil fuels, especially coal for generating electricity, is the highest priority target.
Subsidiary (Design) Principles	Support a wide range of technologies and system concepts, accepting overlap and duplication caused by intra-and inter-service rivalry. Rely on private firms for system design and development based on new technology flowing from R&D also conducted primarily in the private sector. In the absence of market forces, rely on military professionals to select systems likely to prove effective in blunting a Soviet invasion of Western Europe.	Support a portfolio of technologies through a portfolio of policies tailored to fostering innovation in each. Create competition elsewhere in government for the Energy Department and its laboratories to discipline decision-making and boost organizational effectiveness. Build durable ties between federal agencies and private firms to encourage the latter to assign their best engineers, scientists, and managers to energy-climate projects. Rely to the extent possible on market feedback to guide technical improvements and reductions in costs.

As just one example, consider the evolution of the jet engine and gas turbine. Early jets were in one respect greatly inferior to the piston engines they replaced. They burned much more fuel, limiting combat radius for fighters to little more than 100 miles, a severe handicap in Korea. Defense agencies funded much jet propulsion R&D, while procurement contracts created potent incentives for private sector innovation, the more so once commercial sales began. After all, airlines too place a very high value on fuel efficiency, which affects their operating costs and profit margins directly. Feedback from operating experience in military and civilian applications led to continual technical improvements. Gains in fuel efficiency were such that by the mid-1980s, electric utilities began buying gas turbines to meet peak power demand. And while early jet engines needed to be overhauled every 100 hours or so, in commercial service today they remain "on wing" for 30,000 hours or more.

The jet engine story illustrates four key points for energy innovation policy:

First, promising technologies rarely make economic sense early in their evolution. They are pursued because they can do something different or better than existing technologies, or at least they hold that promise. When government is responsible for providing a public good like national defense—or public health—it may choose to pursue technologies (digital computation, genome mapping) based on their potential for providing that good, rather than on strict considerations of cost. The very process of applying technologies to the solution of societal problems may then lead to accelerated innovation, improved performance, reduced costs, creation of new markets and generation of new wealth.

Second, design and development is the core technical activity of innovation, and that capability resides mostly in private firms. Innovation does not proceed from basic science to applied to development and diffusion; rather it is a complex, incremental, iterative process of learning over time, much of this learning occurring through the real-world use and continued improvement of technologies based on producer and customer experience. Although most of this activity takes place in the private sector, government policies are immensely important for the overall enterprise. Congress well appreciates the significance of publicly-funded research, but research is only one component of effective government innovation policies. We have a portfolio of policy tools to draw from in encouraging and accelerating innovation, and different combinations of tools may be appropriate depending on the technology and on market conditions. The tools include procurement, tax credits and subsidies to producers and users, loan guarantees, patents, demonstration projects, technical standards, distribution of information, provision of technical support to firms, and education of consumers.

Third, government can be a crucial and demanding early-adopting customer, initiating the continuous incremental innovations that unfold over time to transform radical new technologies into everyday products and systems, such as the Internet. As firms scale up to meet government demand, they attract new, non-government customers and investors, and benefit from expanding sources of feedback, which speeds learning and fosters additional innovation. In the Cold War, the promise of future procurement contracts motivated defense firms to build up their innovative capacity, beginning by hiring the best engineers and scientists they could find, so as to be able to design and develop the complex technical systems sought by the armed services and intelligence agencies. And as we saw with the jet engine, procurement may also drive performance improvements that benefit civilian applications. The demonstration effect of government purchases can itself be a powerful stimulus for market development, as in the early years of microelectronics and computing.

Fourth, competition among government agencies, like competition among firms in market economies, is a powerful stimulus to innovation. Competition among the military services was a key part of the Cold War innovation story. Deprived of fixed-wing combat planes after the Air Force became independent, the Army innovated in helicopters, which grew more versatile as their gas turbine engines became more powerful. Innovation is inherently uncertain, competition breeds diversity, and diversity in energy-climate technologies promises more and better options for pursuing effective and efficient carbonfree pathways. Competition among agencies also increases incentives for risktaking and provides benchmarks for performance and accountability, again like competition among firms.

Of course, looking back at technological successes can mislead us. In 1940 no one knew if the jet engine would be a boom or a bust. Innovation is a highly complex and uncertain process, and with successes come failures. Uncertainties attach not only to technical performance (such as rates of improvement over time), but costs, compatibility with other technologies embedded in the economy, the outcomes of competition among technologies with similar applications, and acceptance by customers and society at large. The gas turbine never made it into passenger cars or highway trucks, despite much R&D and some prototypes. Video phones flopped when introduced in the 1960s, while mobile telephony from the beginning expanded at rates beyond all expectations. For nuclear power, bust followed initial boom. (Our report "Innovation Policy for Climate Change" explores the reasons).

The uncertainties inherent in technological innovation have crucial implications for policy. Government must of course invest robustly in research to sow seeds for future innovations, and there is no question that we have been under-investing for decades in energy-related R&D. But breakthroughs cannot be predicted. Indeed, they may even go unrecognized until some time after commercialization (as happened with the microprocessor). Policymakers, moreover, have few tools to use in search of breakthroughs, primarily basic research funding and intellectual property protection.

Pathways from breakthrough to adoption tend to be circuitous and subject to blockage, perhaps temporary but sometimes permanent. More research may overcome the obstacles, but no one can know (as for fusion energy). Consider high-temperature superconductivity, a breakthrough discovery in 1986 that seemed to promise virtually 100 percent efficient transmission of electrical power. At the time, one of us (Alic) directed an entire study by the Office of Technology Assessment at the request of this committee (and others). More than twenty years have now passed without significant applications. Innovation policies that presume technological breakthroughs will achieve particular goals, especially in the near-to-medium term, are unrealistic and irresponsible.

If the technological capacity to achieve GHG reductions needs to advance significantly in the coming decade or two, then energy-climate innovation policies will have to accelerate rates of performance improvement and cost reductions for existing technologies. While breakthroughs are unpredictable and sporadic, once in use many technologies undergo continual incremental improvements that lead to large gains over time.

Incremental innovation depends much less on major conceptual advances in science than on learning through experience, supported by research—basic or applied—aimed at market expansion, cost reduction, or focused on particular problems encountered by users. Over time, incremental innovations can add up to enormous gains, as we see in domains as disparate as agricultural productivity (which has risen by about 1.5 percent per year for the past 50 years) and the reliability of nuclear power plants (which reached 90 percent only in the early 2000s, after some forty years of experience). (Moore's law, which predicts a doubling of computer power every 18+ months, is the bestknown example of incremental gains, but digital electronics is atypical; given physical limits on energy efficiency, there can be no Moore's law for energyclimate technologies.)

Incremental gains may themselves lead to radical innovation. That is part of the jet engine/gas turbine story, for which the first patent was issued in 1872. The first working turbines followed three decades later. Another three decades passed before demonstration of jet engines that were "good enough" for aircraft.

In looking back at technological success stories, we sometimes forget that different technologies at different stages of evolutionary development responded to different policies. Effective technology and innovation policies make use of tools appropriate to the task at hand. For example, the unprecedented productivity increases in U.S. agriculture during the first half of the twentieth century were driven in part by research, but also by federal-state extension programs that diffused new knowledge and methods to small farmers, many of them initially resistant to "scientific agriculture." Yet nothing similar has been tried for other sectors and technologies, with the notable exception of manufacturing extension partnerships created under the 1988 Omnibus Trade and Competitiveness Act. Agricultural extension succeeded by showing farmers how to improve yields and productivity. New energy technologies have been slow to diffuse because of generally weak market pull, in part a result of historically subsidized energy supplies, yet the lesson from agriculture—that teaching and demonstration can accelerate the diffusion of innovations—has not yet been taken to heart.

With the observations above in mind, let me now turn to some specifics for how government can boost energy-climate innovation capacity. The Obama administration has begun by channeling more than $6 billion in stimulus funds (under the American Recovery and Reinvestment Act of 2009) to the nondefense R&D programs of the Department of Energy (DOE). These appropriations, to be spent during fiscal years 2009 and 2010, represent a 50 percent increase of DOE's energy R&D over the two-year period. That's a good start. But, as I have tried to make clear, R&D is only one indicator of innovative capacity, and sometimes it is overemphasized. If such investments are not accompanied by a comprehensive and systemic approach to energy innovation policy, they could generate impressive scientific results without making much difference, or could potentially allow others in the world energy technology market to capture the benefits.

The most important lesson for energy-climate innovation from our comparison with the Cold War innovation system is this: government, in addition to paying for basic and applied research, has many tools for accelerating and guiding technology development. Procurement will often be the most potent of these. If private sector innovators and entrepreneurs see government purchases as a meaningful market, they will design and develop products and services accordingly, tapping internal funds along with whatever R&D contracts they may win from DOE or other agencies.

In turn, government R&D investments are most valuable for innovation in the near-to-medium term when they respond to problems identified by private sector

innovators. By the 1950s, the U.S. military had come to accept its dependence on private industry, and had broken free of its earlier dependence on internal arsenals and supply bureaus. As firms began to uncover and define technical problems, DoD sponsored research aimed at overcoming them. This was the story for the development of more powerful and efficient jet engines and fly-by-wire control systems, reliable light-weight materials with reproducible properties, and digital hardware and software for signal processing at real-time speeds. Priorities for DoD-sponsored research, that is, reflected needs revealed in the course of engineering design and development in the private sector. DoD learned to cooperate with defense firms (and universities) in providing "just-in-time" research, as well as in advancing the knowledge base—and training the technical workforce—that underpinned new systems and equipment.

Today, while about four-fifths of DoD R&D funds support work conducted by private firms (even though the services have many R&D laboratories of their own), some three-quarters of DOE R&D funds (including those for defense programs) go to the agency's own laboratories (although some of the money passes through to firms and universities).[3] So long as government is not a customer for energy-climate technologies, DOE cannot, realistically, be expected to forge consistently close connections with the broad communities of firms and industries working to commercialize advanced energy-climate technologies. Yet without those connections, the type of innovationaccelerating system that the United States built during the Cold War may remain beyond reach. Should, on the other hand, the U.S. government decide to treat GHG reduction as a public good, and purchase goods and services with that as its direct objective, doing so in economically significant quantities (for example, by purchasing CO_2 itself, for sequestration; by buying and operating, or contracting for the operation of, direct air capture equipment; and by "greening" the federal government's enormous infrastructure), it will bring DOE closer to the market and pull innovative firms closer to government. Government purchasing power will boost U.S. energy-climate innovation capacity, and policymakers will be better positioned to learn what else is needed to foster the sort of innovations necessary for large-scale decarbonization of the energy system. (Table 2 expands on the principles we have been discussing.)

TABLE 2. PRINCIPLES FOR ENERGY-CLIMATE INNOVATION STRATEGY

Principle	Rationale
Recognize decarbonization of the energy system as a public good akin to national defense, provision of clean water and sewage treatment, and protection from natural disasters.	In providing public goods in the absence of viable markets, the U.S. government has often spurred technological innovation, notably in military and intelligence technologies during the Cold War and in public health.
Encourage interagency competition, within limits, among government bodies charged with responding to climate change and fostering energy-climate innovation.	Innovation occurs in response to "environmental pressures" such as those created by market forces and public policies (e.g., regulation). And just as market competition encourages innovation by business firms, competition within government encourages innovation by agencies. Although too much competition within government leads to wasteful overlap and duplication of effort, DOE's monopoly over energy has not been conducive to either technological advance or policy development.

[3] Science and Engineering Indicators 2008, Vol. 2 (Arlington, VA: National Science Board/National Science Foundation, 2008), Appendix table 4-30, p. A4-53.

TABLE 2. PRINCIPLES FOR ENERGY-CLIMATE INNOVATION STRATEGY—Continued

Principle	Rationale
Tailor innovation policies to particular technologies and suites of technologies.	The U.S. government can call on many well-proven policy tools in addition to R&D for stimulating innovation. By most accounts, for example, procurement of integrated circuits for military and space systems had more impact on early innovations in microelectronics than government R&D, while DoD's insistence on non-proprietary technologies had powerful long-term effects on computing and computer networks.
Rely on private firms for innovation.	Government has been a "smart customer" for military technological innovations, outlining requirements and offering incentives in the form of possible future contracts for design, testing, and production of defense and intelligence systems. For energy, the U.S. government has relied too heavily on the DOE laboratory system, which has some excellent research capabilities, many of them closer to pure science than to practical energy technologies, but has not had strong and stable incentives to develop and maintain effective working relationships with innovative firms.
Seek international agreements and arrangements conducive to indigenous innovation in developing economies such as China and India.	Many countries will have to take action if greenhouse gas emissions are to be controlled. Among the most powerful incentives for action is the prospect of home-grown innovations that can become a source of business profits, jobs, and exports. Viewing other countries primarily as passive recipients of "technology transfers," or as export markets for U.S.-based firms, would slow worldwide technological advance and hinder adoption of GHG-reducing innovations.

Let me close by offering the following recommendations. They are intentionally general, but not vague: they can be understood as criteria for both designing and assessing energy innovation policies.

1. To improve government performance, and expand innovation options and pathways, Congress and the administration should foster competition within government. Competition breeds innovation. That is true in economic markets and it holds for government too. Inter-agency competition has been an effective force in innovation across such diverse technologies as jet engines, genome mapping, and satellites. Insufficient competitive forces exist for energy-climate technologies. While ARPA-E provides a new capability within DoE that could productively boost intra-agency competition, appropriate expertise and experience also exist in many parts of the public sector, including the DoD, the Environmental Protection Agency, and state and local governments. As just one example, DoD's huge infrastructure offers a potential test-bed for a wide variety of advanced energy technologies that no other public agency or private sector entity could replicate.

2. To advance GHG-reducing technologies that lack a market rationale, government should selectively pursue energy-climate innovation using a public works model. There is no customer for innovations such as postcombustion capture of power plant CO_2 and air capture of CO_2. (Indeed, no more than about

two dozen people worldwide appear to be working on air capture at all—an unacceptably small number by any standard.) Recognition of GHG reduction as a public good redefines government as a customer, just as it is for, say, pandemic flu vaccines, flood control dams, or aircraft carriers. This perspective points to new approaches for creating energy-climate infrastructure, in support of innovation and GHG management. Some tasks might be delegated to state and local authorities, which already collect trash, maintain water and sewer systems, and attempt to safeguard urban air quality. The federal government currently budgets over $60 billion annually for infrastructure investments, and state and local governments spend about three times as much.[4] Policymakers could approach GHG control as a similar form of infrastructure investment. Indeed, many of the energy expenditures in the American Recovery and Reinvestment Act could be viewed as a down payment on such an approach.

3. To stimulate commercialization, policy makers must recognize the crucial role of demonstration projects in energy-climate innovation, especially for technologies with potential applications in the electric utility industry. Demonstrations in energy may have a poor reputation, but government-sponsored demonstration programs have a long-established place of importance in U.S. technology and innovation policy. In aviation, DoD and other federal agencies funded many demonstrations of unproven technologies, including the famous series of X-planes. In microelectronics and computing, government acted as a "lead customer," demonstrating what these then-new technologies could do, for all to see. The primary purpose of demonstration projects is to reduce technical and cost uncertainties, which means the private sector should be chiefly responsible for managing them. So long as government provides financial support, it should also see that results are disseminated openly, so that all parties can take advantage. Well-planned and conducted programs could push forward technologies such as CO_2 capture from power plants. While, for example, the DOE has supported exploratory R&D on advanced coal-burning power generation for several decades, it has only recently begun to address the issues raised by capturing CO_2 from the nation's existing coal-fired power plants, which produce over one-third of U.S. CO_2 emissions. We have emphasized the uncertainty of innovation, and no one can know whether a new generation of those advanced coal-burning plants will ever be built. On the other hand, technologies do exist for capturing CO_2 from a substantial portion of the 1500 or so coal-burning plants operating today, and they have not even been evaluated at full scale.

4. To catalyze and accelerate innovation, government should become a major consumer of innovative energy technology products and systems. The many billions of dollars DoD spends each year on procurement has been an enormously powerful influence on innovation. In contrast, the U.S. government has not systematically or strategically used its purchasing power to foster energy-related innovations. Yet each year, federal, state, and local governments spend large sums on goods and services with implications for GHG release and climate change, including office buildings, motor vehicles, and transit systems. Government can be a smart and demanding customer for the best energy-climate innovations, helping to demonstrate new approaches, create early markets, drive competition among firms, and foster confidence in advanced technologies, including those that are not yet price-competitive. The President's October 5 Executive Order establishing sustainability goals for Federal agencies is an excellent first step in this direction.

The private sector will be the main source of energy innovation, as it is for other areas of technology. That is where the knowledge and experience lie. So far, of course, the incentives have been lacking. But it will take more than a price on carbon, or regulatory inducements. Government must build stronger bridges to industry and become a smarter customer, just as DoD has often been a smart customer with deep pockets for military innovation. By treating climate mitigation as a public good and GHG reduction as a public works endeavor, analogous to public health and safety, vaccine stockpiles, dikes, levees, weather forecasts, and national defense, the United States can begin to show other countries how to build energy-climate technologies into the fabric of their innovation systems and their societies.

The nation's energy system—and the world's—is extraordinarily complex. Rapid technological transformation of such systems to achieve meaningful reductions in greenhouse gas emissions over the next twenty to thirty years is an enormous task, without precedent and hard even to comprehend—and much

[4] Issues and Options in Infrastructure Investment (Washington, DC: Congressional Budget Office, May 2008), Table 1, p. 4.

more complex than other environmental problems of recent decades. In seeking to understand how such a goal might be pursued, we have offered lessons from the nation's Cold War innovation experience. Whether the climate threat merits a response of this magnitude is of course something that Congress will continue to deliberate upon. Our goal in this statement has been simply to show that the experience of the United States provides essential yet thus-far neglected lessons for accelerating innovation in support of long-term national goals.

The CHAIRMAN. Thank you very much.

Let me start with a few questions.

Let me ask you, Jonathan Banks, first. Your sectoral approach, as I understand it, involves putting a cap on the power sector and the industrial sector, large emitters in those two areas. You calculate that by just doing it on those two sectors, rather than economywide, you will reduce the price of allowances, cut it in half. Also, I believe you said that you would anticipate that the price of electricity would be reduced.

Mr. BANKS. Slightly reduced.

The CHAIRMAN. Slightly reduced. I guess I'm having trouble understanding why going from economywide just to that sector would get a reduction of half in the allowance price. Maybe you could explain that a little.

Mr. BANKS. I'd be happy to, sir. The economywide proposals that are out there right now rely heavily on two things. They rely heavily on offsets and they rely heavily on an overcompliance from the power sector. That over-reliance on the power sector creates the higher allowance prices, it creates more-difficult-to-meet technology pathways. When we reduce the cap down to the stationary sources—the large industrial boilers and the power sector—what we do is, we set them on a trajectory to meet a very aggressive reduction, but over the course of between now and 2050, versus meeting—versus massive overcompliance in order to meet the economywide goals. So, you have the power sector on—and the industrial sector—on a slightly—on a less-steep curve, between now and, say, 2030, than they would be in order to comply with an economywide bill. That—because we're not over-relying on the power sector, that reduces the allowance prices considerably.

The CHAIRMAN. Let me ask if any of the other witnesses have a point of view on that.

Mr. Hawkins, did you have a perspective on that approach?

Mr. HAWKINS. Yes, Mr. Chairman. I think the easiest explanation is in figure 2 on page 6 of Mr. Banks' testimony. Essentially, the reason that allowance prices are cut in half is that the emission reductions are about half of what you'd get under an economywide bill. The emissions in—under the proposal that he has outlined would be a little shy of 6 billion tons of CO_2 in 2030, compared to 4 billion tons of CO_2 in 2030 under the Waxman-Markey approach. So, you get smaller—you get fewer emission reductions and you get a lower price per ton for the allowances.

It's like buying a 1-inch television or a 36-inch television. The 1-inch is cheaper and it's smaller.

The CHAIRMAN. Let me ask you, Mr. Hawkins, on a related issue—we've had quite a bit of testimony, at previous hearings, about the whole issue of offsets. I think several of the witnesses talked about the difficulty of verifying offsets and the fact that the economywide cap-and-trade proposals that we now have before us

contemplate a very substantial use of offsets. Does that give you folks concern? If so, what do you think should be done about it?

Mr. HAWKINS. It does present some challenges. I think the reality is that the ability of offsets to chase down emission reduction opportunities in sectors that won't be covered by the cap is very attractive, and its ability—the role of offsets in reducing the overall costs is also very attractive. So, I think the political reality is that a cap bill will almost certainly involve some offsets.

That will require, first and foremost, full transparency. We will need aggressive monitoring and reporting and a system in place so that everyone can track performance and we can have a constant-feedback mechanism to improve what we think will inevitably be subpar performance in the earlier—in the early years. But, as long as we have a transparent system, where we have close to real-time information, we can improve performance and try to get the maximum benefits out of the offset program, without the downsides.

The CHAIRMAN. Senator Murkowski.

Senator MURKOWSKI. Dr. Gayer, you mentioned the impact of price volatility, and we certainly appreciate that, as we're trying to look to policies that are rational, make sense and work, we need to understand what goes on within the volatility aspect. We're told that environmental certainty is best achieved under a cap type of a proposal. But, your testimony certainly suggests that the possibility of a price volatility under a cap presents itself, and then you have a situation where the pressures to eliminate the cap or possibly weaken it. We know, here in Congress, we are just as capable of adjusting a tax as we are adjusting a cap. In terms of providing the regulatory certainty that I think businesses are looking for, as we speak to the volatility issue, in your opinion is a tax or a cap more workable, more manageable when it comes to the issue of volatility? Most of your testimony was spent discussing the attributes of the carbon tax, but can you speak to this particular issue, as it relates to the two different options?

Mr. GAYER. Certainly. Yes, I think a lot of our discussions that we're having here are alluding to it. David talked about the risk of a cap being undermined later on.

Senator MURKOWSKI. Right.

Mr. GAYER. Then a regulatory response, and then saying Congress is not handcuffed, so, if that turns out to be too costly, Congress can respond to that. The kind of political economy of that, I think, is very difficult. But, all this discussion is coming along—coming down to the same thing, which is, we're concerned about the costs and the price signal. If you want to forestall this—both the uncertainty and the risk that you undermine it or something gets changed drastically, 1, 2 years, if you have a transient spike in gas prices, you can imagine a big, kind of, response to that, whereas a carbon tax or a safety valve would just limit the ability of that to happen. It would basically—the concern I think everybody has is, there's uncertainty, going forward, and we want to be able to, at some sense, cap the cost, at least at some high end. Otherwise, there could be all sorts of responses that undermine the whole existence of the program. So, I think a carbon tax or a reasonably set safety valve directly addresses that.

Senator MURKOWSKI. So, do you think that they're equal, in terms of their ability to reduce or eliminate the volatility?

Mr. GAYER. "They," being the safety valve or——

Senator MURKOWSKI. Safety valve.

Mr. GAYER. Yes. So, I think a carbon tax is—gives you more certainty on the price, so—depending on what—the safety valve would—it kind of depends where you set the safety valve—

Senator MURKOWSKI. Right.

Mr. GAYER [continuing]. The range of it. So, there is still a little bit. But, at the very least, I think it's—if you forgive me—the responsible thing to do, because there—I think everybody has a price by which it becomes too expensive. The debate is, What price is that? A carbon tax, I think, sets it.

On the climate benefits, I understand the desire to have certainty on the emissions, but the goal isn't necessarily certainty on emissions, it's certainty on environmental outcome. There's enough uncertainty about how those tie together that you're never really getting perfect certainty on the environmental outcome. So, there's an innate fuzziness there, anyway.

Then, additionally, on the environmental side, I do worry that, without fixing the price or capping the price, that, like I said, it can get undermined in the future. I think that's a real risk, both for investors in, kind of, you know, long-term capital decisions, if you worry about the response, and from an environmental point of view. I think it can undermine the goal.

Senator MURKOWSKI. As we are looking to how we define the carbon price signal, in the discussion this morning about permits and allocations, we recognize that you have real value with these permits. We saw the effort on the House side, everybody coming with their hand out saying, "Don't forget about us in our sector" and we certainly recognize that giving out permits for free, is just one of the options. In terms of how we can use the revenues, the question I'll ask to you, Mr. Gayer, or to anyone else, in the uses of these climate revenues, I would suggest that all uses are not necessarily created equal. Are there changes to the tax code that a carbon price could facilitate and would allow for stronger economic growth when we're talking about how we might utilize these revenues? Any comments?

Dr. Gayer.

Mr. GAYER. So, I'm going to remove myself from the political complications of such a thing. That's something you have to deal with, of course.

You had mentioned tax reform. I think we have a very narrow tax base and very high marginal tax rates. That, by all reasonable economic measures, inhibits economic growth. So, any tax revenues that can be directed toward reducing, or, you know, to doing some form of tax reform on—along those lines, certainly would help economic conditions.

Off topic a little bit, there is increasing discussion about payroll tax suspensions and other job-promoting activities. So, there's a long-term fiscal concern with any of these. If you talking about $100 billion a year of permit revenue or carbon tax revenue, that could be a substantial suspension of a payroll tax, for example, which would also promote the labor market.

So, I see lots of potential uses of the revenue. I'm sure it's not an easy thing to work out, so I'm deferential to that. But, from where I sit, I think there are efficiency gains for the economy.

Senator MURKOWSKI. Mr. Chairman, my time is expired, but perhaps we can have a second round.

The CHAIRMAN. All right.

Senator Bunning.

Senator BUNNING. Thank you, Mr. Chairman. I feel for you, because I went through the same thing last week. I just made a recommendation which helped me a great deal, and I see that you have already taken steps. So, I hope you feel better.

Mr. Alic, given the concerns over the effectiveness and whether or not Federal R&D programs have been good stewards of taxpayer dollars, what role to you see industry-led consortiums playing in advancing the development of new and breakthrough technologies?

Mr. ALIC. Innovation comes from industry. Government R&D is very important in building a technology base, knowledge and methods from which innovators draw. It's industry, the private sector, that knows how to innovate. They think in business terms. We're talking about altering the business conditions, the economic conditions to deal with this problem. We have to find more effective ways to create incentives for industrial innovation. Consortiums——

Senator BUNNING. In other words——

Mr. ALIC [continuing]. Are a part of that.

Senator BUNNING [continuing]. You don't think we are effectively doing that right now.

Mr. ALIC. No. The——

Senator BUNNING. Thank you.

Mr. ALIC [continuing]. Reason is—I think everybody in the room understands—is that prices for energy are simply too low. They don't create the powerful incentives that are needed for the fundamental transformations in these technologies.

Senator BUNNING. Prices for energy are too low for some, but for others who want to change the technologies, they're too high. In other words, if you look at the country in certain areas, the cost of energy in the middle Southwest or middle Atlantic, where coal is the number-one generator of the electricity, compared to California, compared to the Eastern seaboard, there is a disproportionate share of costs, because they use natural gas, they use imported energies. So, there wouldn't be the technology advancements, or the need to have technology advancements, except where the cost was very high.

Mr. ALIC. Yes, that's—you're certainly correct, Senator. The point I was making was that the costs are—on average, are—need to be very high to get this kind of innovation.

Senator BUNNING. If we do it—if we go it alone, you're absolutely right.

Mr. ALIC. Yes.

Senator BUNNING. If the United States takes it upon themselves to implement—whatever—a carbon tax, a cap-and-trade bill, or whatever—if we don't have a global agreement with China, Russia, India, whoever, who have said to us, flat out, "We're not going to do this. We're going to continue burning coal without any restric-

tions. We're going to continue to put—produce cheap energy because our economy is going to suffer too much if we do otherwise." I like to lead in this manner, but someone's got to follow.

I want to ask Dr. Gayer. Let's assume a carbon tax is implemented. Even if the consumer were provided tax relief to compensate for higher energy prices, wouldn't it be nearly impossible to make everyone whole?

Mr. GAYER. To make everybody whole. Certainly if you include any benefits of the environmental gains from it, then, yes, you would make them more than whole. But, on a strict pecuniary/monetary point of view——

Senator BUNNING. Yes. That's what I'm talking about.

Mr. GAYER. Yes, regulating carbon is going to be costly. But, not using the revenues wisely will make it more costly, was my point. So, if you——

Senator BUNNING. You've made some suggestions to Senator Murkowski about the use of the money.

Mr. GAYER. Certainly.

Senator BUNNING. We have a debt that's going to reach, you know——

Mr. GAYER. Yes.

Senator BUNNING.—$13 trillion, shortly.

Mr. GAYER. Yes.

Senator BUNNING. That's just the public debt. If you take in the interagency debt, we're getting close to $18 trillion. I've got 40 grandkids. They're not going to be able to pay the bill.

Mr. GAYER. I agree, which was why I was suggesting that if we were to do—and in my written testimony, every time I mention one can use the revenues to lower tax rates, I also say, "or pay down the deficit," for that very reason.

Senator BUNNING. That's very important to understand.

Mr. GAYER. No, I understand. I completely—which is—also, on the payroll-tax idea that I mentioned, just to clarify my thinking on my statement on that, if one were to do such a thing, this is a way in which to pay for it, as opposed to adding debt to your——

Senator BUNNING. You mentioned in your testimony "reducing other economically harmful taxes."

Mr. GAYER. Right.

Senator BUNNING. Give me an example.

Mr. GAYER. Any—I think Senator Murkowski mentioned it in her opening statements, as well. Economically harmful taxes are taxes that decrease the incentives for work, saving, and investment.

Senator BUNNING. How about the Federal Reserve's zero-based tax or zero-based interest rates. Who do you think that hurts?

Mr. GAYER. I don't think that's a tax on——

Senator BUNNING. Oh——

Mr. GAYER [continuing]. Savings.

Senator BUNNING [continuing]. It's a tax on me and anybody that has a penny to save—

Mr. GAYER. Yes.

Senator BUNNING [continuing]. Because, we can't get any income from anybody for saving. So, it's a disincentive to save.

Mr. GAYER. Yes. I would love—Fed policy might not be my specialty——

Senator BUNNING. Oh, no. But, I——

Mr. GAYER [continuing]. But it also is a——

Senator BUNNING. We're talking about taxes.

Mr. GAYER. Sure. So, it's a disincentive for you—for—you'll get a lower return on your savings, but, it's—the problem it's seeking to address is an—is the absent credit markets and the inability of small business to borrow, and other businesses to borrow.

Senator BUNNING. Absolutely. Thank you very much, Doctor.

The CHAIRMAN. Senator Corker.

Senator CORKER. Thank you, Mr. Chairman. Thanks for having the hearing, and, each of you, for your testimony.

My interest in this topic has been to figure out way that you take the emotion and energy around climate and use it to create energy security. There are a lot of things that keep that from happening. Certainly, I think the bills before us definitely do that.

But, Dr. Alic, you were talking about the way innovation occurs. You know, we had people in here a couple years ago that were trying to build cellulosic or ethanol facilities. Basically, they were saying, "Look, you know, the fact that we don't know exactly what the price of petroleum is hurts us, and we need a floor on petroleum." At that time, it was about 40 bucks a barrel, they were saying it needed to be, as a floor for them to continue to make investments.

It's interesting, people who now focus on cap-and-trade say, "Well, they want the market to fluctuate." What's happened, of course, with, you know, the economy going down around the world, and the price of carbon has dropped, and people are not making investments in innovation as it relates to energy, because there's no constant there. That's why the whole notion of a carbon tax, if you're going to do something like this, has always seemed like the more intelligent thing to do. It's a constant. You know that it's there. I wonder if you might respond to that.

Mr. ALIC. I think that's absolutely correct. Stability works to boost innovation. I think the essential point that I've tried to make in response to earlier questions is, the prices need to be a lot higher. I mean, if—and I understand the—I live in a small town in North Carolina, a working-class town. People struggle with energy costs in their households. But, you know, either you solve the problem or you don't. If we're going to solve the problem, we have to understand, as several of the Senators have said, that the costs are going to be much higher than they are today. It's a question of how—who pays from them, how they're distributed. If you want innovation, you need those signals to the private sector. You don't get innovation just by dumping money into R&D. You get innovation by sucking it into the economy through demand.

Senator CORKER. Dr. Gayer, I—the issue of transportation fuels, it seems to me that, whether you're dealing with cap-and-trade or a carbon tax, you really don't get there, because, just—I know, in years past, the Chairman offered a bill that had a safety valve, I think, at 17 bucks, or something like that, and I know that might change over time, if you offered a different bill. But, let's just say at 15 bucks a ton, that translates to about 15 cents a gallon. OK? It's just the way the math works out. Is there something about a carbon tax that is better, as it relates trying to change people's con-

sumption of transportation fuels, than cap-and-trade, or worse? I——

Mr. GAYER. I actually think they'd be equivalent. I think the issue there becomes on the stringency of the cap, relative to the stringency of the carbon tax. The only caveat, as we've already discussed, is, as we saw 2 years ago, you have spikes in gas prices, for example, that can then lead to a response that I think would be more likely to happen under a cap, maybe. So, I'm almost getting into the politics of it more. But, kind of, on the fact value of it, the translating the—whatever you do, whether or not it's a cap-and-trade to a carbon tax, into a price signal will really depend on the stringency of the relative—of the two different instruments that you're looking at, I think.

Senator CORKER. Is there—I know you've alluded to the safety-valve issue as—I mean, at the end of the day, if you set the cap low enough, by default you—the safety valve price ends up being the price of carbon, right? So, when you say that that's equivalent to a carbon tax, or it works almost as well, are you saying that because, politically, a cap—in your opinion, a cap-and-trade bill with a safety valves doesn't directly confront consumers with the fact that there's actually a tax, and, by default, you end up in the same place? Or doesn't a cap-and-trade bill—I assume you'd be talking about 100-percent auctions, if you did that, without any of the trickeries of offsets and free allowances and all of that. I wonder if you could expand.

Mr. GAYER. I think—I prefer the auctions, but I don't know that it's integral to it. I think the way I would design it would be that you would have a cap that would bind, and that you would have a safety valve set for these, kind of, transient shocks that happen in the economy, as we've seen. Where that is, I don't know. But, the idea of it is, we have some estimate of how much carbon reductions we want to get and what that's going to cost. We could be wrong in any given year; it could be much higher. The safety valve would trigger, but then, the next year, would could come back down.

So, in some senses, all I'm trying to do is for the—all I think that the safety valve would do is just for, kind of—for just these shocks that we get through the economy.

Senator CORKER. But, that just sets an upper limit.

Mr. GAYER. It sets an upper limit.

Senator CORKER. It doesn't set the lower limit that would disaffect or create a bigger problem for Dr. Alic, who wants to see innovation take place.

Mr. GAYER. Yes. So, that would be a price collar, where you set a lower limit. If you squeeze those enough, you're back to the carbon tax.

Senator CORKER. Might as well—back. So——

Mr. GAYER. Essentially, you're right. I would say—I mean, so there is this question, Are you just trying to backdoor a tax? I think Senator Murkowski is right, I mean, the goal here, is to raise the price of carbon, and I think people realize that, with a cap-and-trade or a carbon tax, that's what you're doing. To me, that's a feature, not a bug. But, I think that's the transparent way of doing it.

Senator CORKER. Mr. Chairman, I know my time is up. I have a couple more questions, but I don't know if you're going to have a second——

The CHAIRMAN. Yes.

Senator CORKER [continuing]. Round.

The CHAIRMAN. We'll just do another round, here.

Let me ask Mr. Banks. I understand your testimony is that you want to have an economywide plan for reducing greenhouse gas emissions, but do it sector by sector. Is that accurate? If that is your approach, do you believe that the appropriate regulations or limits or laws could be put in place, with regard to each sector, to get us to the same place that a economywide cap-and-trade would get us?

Mr. BANKS. That is our goal. We are looking to create—we are exploring a policy. What I've talked about here today is just kind of the initial pieces of it. We're still developing a number of additional policies that we would see as integral to this. But, our primary goal is to get the emission reductions down to levels that would be commensurate to, say, the Waxman-Markey proposal, over on the House side. We see that as just—it's the only way to get from here to where we want to go, as far as the emission reductions we need. The reason we go with the—we've been exploring the sectoral policy is because of this disconnect between the price signal at the gas pump that Senator Corker was speaking of. If we go economywide, or if we go with a carbon tax policy, we will still need these transportation policies to be layered on top on this. We can't get to where we need to go in the transportation sector without additional policies.

So, regardless of whether we do sectoral policies or whether we do economywide or whether we do carbon tax or cap-and-dividend or whatever the policy is, at the end of the day, we need to have targeted policies that deal with the inconsistencies of the price signal within the economy.

The CHAIRMAN. Let me ask about the EPA's proposed actions that they're starting at this point. I think, Mr. Hawkins, you made the distinction between the new coal plants and existing plants. Currently, we have a very different set of regulations applying to the 2. Do you see what EPA is proposing here as solving that, or do you think we're running the risk of, sort of, further reinforcing the continuation of power production from highly polluting plants?

Mr. HAWKINS. Senator, EPA has authority, under the current Clean Air Act, to address emissions, both from new plants as well as existing plants. The existing plant authority would be implemented through Section 111(d) of the Clean Air Act, which allows the agency to establish standards for existing plants that take into account the remaining useful life of the facilities and still have to meet the tests of economic and technical feasibility.

Our concern with that, by itself, is not that it would be cumbersome or difficult to implement, but that it would be slow and probably would not achieve the level of reductions fast enough that we need. That's why we think that—we need the overarching objective of the cap to help drive emissions.

If I could, I'd like to disagree with a statement that's been made by several, which is the—about the goals of this program. The

goals of the legislation, in our view, are not to raise the price of carbon or to raise the price of energy. The goals are to reduce emissions. We would be perfectly happy with an outcome that reduced emissions without raising the price of carbon or raising the price of emissions at all.

Now, economists may shake their head and say, "Well, that's impossible." The reality is that if we have a program that focuses on flexibility and drives efficiency, then householders can wind up with lower overall energy bills, even though the price per BTU may go up.

The price per BTU is not what consumers care about. They care about what they write on their check to their utility company. They care about the—what they put on their credit card at the gas pump more than they care about the price per gallon. The price per gallon is the obvious thing, but what they actually care about is the total number of gallons they have to pump in there, multiplied by the price. That's what a cap can do, if it's well designed, is to innovate—is to create that innovation.

The CHAIRMAN. Senator Murkowski.

Senator MURKOWSKI. Thank you, Mr. Chairman.

Just to follow up, Mr. Hawkins, as it relates to the EPA and the pending regulations. I said in my initial comments that additional layers of bureaucratic regulation that may be duplicative, inefficient, or counterproductive should be taken off the table. Now, I think we would agree that this threat out there of the EPA stepping in to regulate emissions has perhaps spurred some to come to the negotiating table, to sit down and talk about how we will advance a climate policy. But, if those EPA regulations don't go away, if EPA acts, what incentive is there for us to continue to pursue a climate policy, from the congressional perspective?

Mr. HAWKINS. That's an excellent question. My answer would be that there are several major reasons to consider this comprehensive legislation. The first is that it starts to head off a threat, which is only going to be more and more of a threat to the U.S. economy—that of climate disruption—the longer we wait to deal with it. The second is that if we start reducing business uncertainty, we're going to start creating a job-creation mechanism. This is something that the members—the business members of the U.S. Climate Action Partnership firmly believe in. They've testified before Congress, on a number occasions, saying, "We're not making investments now. Why? Because there's too much policy uncertainty." We've got a track record.

The third thing I would say about it is what Senator Corker had mentioned, which is energy security. For example, a cap-and-trade program with a stimulus program for carbon capture and storage can produce large quantities of CO_2 that can be used to enhance domestic oil production. This is a no-brainer. It's a win-win-win situation, where we can go into fields that are—don't involve going to new pristine areas, drill deeper in the holes that are already there, get more oil out, and dispose of the CO_2 at the same time. But, a program of that scale, that's actually going to make a dent in energy security—in energy—in oil imports, is not going to happen through the normal appropriations process. I would argue it's

not going to happen through the tax process. But, it could happen through dedication of allowances.

So, the main reason is not to remove the potential annoyance or threat of environmental regulations from EPA. Those can be streamlined. We've had experience with it under the acid rain program. We had the so-called "command-and-control" regulations that Congress stayed in place in 1990, even though we adopted a cap on sulfur dioxide emissions. It's worked just fine.

Senator MURKOWSKI. As I understand the position of USCAP, they don't think that the EPA regulation is the best tool to implement climate policy, and if what we're looking for is predictability you have the uncertainty that is thrown in through EPA regulation.

Let me ask, and again this probably goes back to you, Dr. Gayer or Dr. Kopp. We have been so focused on the issue of a cap-and-trade as a policy, and you look to some of the conversations that are in play right now in some of the European countries, there have been reports that political leaders in France, China, Japan are warming to the idea of a carbon tax.

There was an interview last month. A gentleman from Oxford was asked about countries implementing a carbon tax, and he responded that, in Europe they have Finland, Sweden; Ireland's going down that route; France has just begun to go down that route; the U.K., possibly. Then, it's been suggested, by others here, that a tax on CO_2 emissions, not a cap-and-trade system, offers the best prospect of meaningfully engaging China and the U.S. while avoiding the prospect of unhinged environmental protectionism.

The question to you is, Are we seeing a change in the conversation about a carbon tax, as opposed to a cap-and-trade, or is there just too much invested, certainly from the European perspective, where the road that they're going down and a carbon tax is not part of those discussions? What kind of trends are we seeing, internationally?

Mr. GAYER. I guess I have two points. One is, there might be a change in the conversation or a leaning toward carbon tax, for the very reason you mentioned earlier, which is, the cap-and-trade does increase the price of carbon, as it's supposed to do. So, as I said, I think this is a feature, not a bug, but it is, effectively, a tax. So, if you're going to have a tax, then I think some people now realize, Why don't you do it more directly? So, that makes it a little bit, kind of, more presentable in public, I guess.

The other issue, from an international point of view, I mean, I think there's always a difficulty of negotiating baselines and what's the baseline year for each country and how do you deal with that. Ultimately, I go back to the point I alluded to earlier, with the domestic approach, which is, you're looking for some sort of comparability of effort across countries. To me, the phrase "comparability of effort" translates into price. You know, if you give me a target for a country, I need to figure out what would have happened relative to their 1990 or 2000 emissions. It's really hard to know how burdensome that would be for any particular country. If you give me a carbon tax, I know, here's what they're going to pay for on the marginal reduction. So, in some sense, when you're talking, internationally, about trying to come up with some sort of com-

parability, a tax, I think, presents itself as a very clear instrument to kind of make sure that everyone's bearing what is perceived as a fair burden.

Mr. KOPP. It's not entirely clear that the world is changing and switching totally in favor of a carbon tax, but a carbon tax was basically here first. I mean, the idea of dealing with environmental bads through a tax mechanism has been known by economists for 100 years, and carbon cap-and-trade systems are relatively new.

But, on the international scene, I mean, I think a lot of countries—Japan, in particular, is looking at both cap-and-trade programs and carbon taxes. When they make their distinction between the two, I think one of the things that has become fairly important now is the price certainty. This is what we've been talking about through this committee hearing quite a bit, and that is, Can we do something to ensure that the volatility, both the near-term volatility that might occur within particular years due to demand-and-supply imbalances, plus some structural instability that might occur from the fact that the cap is a lot tighter than we would like it to be for the allowance price, gives rise to these notions of putting some safety valves or some strategic reserves in place that keep those prices within some politically and economically acceptable bounds? Of course, a carbon tax does that with absolute certainty. It does, however, let the emissions move at will. So, you're always going to be balancing those two.

But, as we've seen already, you can approximate a carbon tax with a collar. It begins to look an awful lot like a carbon tax, particularly if you get stuck on the upper or the lower side. But, there really is not an awful—tremendous distinction between the two if you auction the revenues and you have a mechanism by which you're going to redistribute those revenues or use those for deficit reduction or offsetting distortionary taxes, and you do the same thing with the carbon tax revenues. From an economic perspective, these look almost the same. They do have very different environmental implications, with respect to the level of emissions, and a certainty with respect to those.

Senator MURKOWSKI. Thank you, Mr. Chairman.

The CHAIRMAN. Senator Bunning.

Senator BUNNING. Thank you.

Mr. Alic, given the need for long-term security, what type of policies could be implemented to secure a sound return on investments for private investors without assigning a high price or value to carbon? Is this even achievable, given the high capital costs required for those type of investments?

Mr. ALIC. I think it would be difficult to achieve, Senator, but not impossible. One way to think about that is to have the Federal Government buy carbon dioxide from electro-power plants—

Senator BUNNING. Whoever produces——

Mr. ALIC [continuing]. For sequestration. Create a predictable market. The technology exists to extract carbon dioxide from existing coal-fired powerplants. Those plants—there's only 1500 in the country—they account for fully 35 percent of U.S. carbon dioxide emissions. If the Federal Government was to say, "We're going to buy that carbon dioxide and, you know, inject it into geological formations"——

Senator BUNNING. Or wherever.
Mr. ALIC. Sorry.
Senator BUNNING. Or use it for—as suggested earlier, for oil——
Mr. ALIC. Yes.
Senator BUNNING. Just use it.
Mr. ALIC. Some of it can be used. I think there's probably too much. We don't drink that much soda pop in the country.
Senator BUNNING. No, I understand.
Mr. ALIC. Yes. So, yes——
Senator BUNNING. OK. You think the——
Mr. ALIC [continuing]. We can do that.
Senator BUNNING. OK.
I want to go back to Dr. Gayer. I would like to revisit my previous question on if it is possible to achieve equity without—with a carbon tax, even if it's—other harmful taxes were reduced. For example, people living in an area that is heavily dependent on coal. Ninety-five percent of all our electric generation in Kentucky is done by coal-fired generation. We would face much higher prices than people in other areas.
Also, it is very difficult to reach low-income families with tax relief, because many do not fill out tax returns. In your opinion, how should tax relief be structured to prevent the maximum amount of harm to consumers?
Mr. GAYER. So, let me begin with what—I think what I said earlier is, the revenue recycling, I think—I'm comparing to not-revenue recycling. So, there are going to be distributional burdens to people in coal or carbon-intensive consumers, for example——
Senator BUNNING. The Midwest——
Mr. GAYER [continuing]. If you don't——
Senator BUNNING. If you take the Midwest, if you take Indiana, Ohio——
Mr. GAYER. Sure.
Senator BUNNING [continuing]. Kentucky, West Virginia, and all of that area——
Mr. GAYER. Yes.
Senator BUNNING. They are going to be disproportionately affected——
Mr. GAYER. Yes.
Senator BUNNING [continuing]. With a carbon tax.
Mr. GAYER. Or with a cap-and-trade.
Senator BUNNING. Yes.
Mr. GAYER. Yes. I would say, any tax that we levy on any activity, including income tax or any other tax, will have distributional implications across the geographic landscape.
My only point is, if we are going to levy a tax or a cap-and-trade in order to address an environmental concern, that does yield revenues by which we can help to address some of those distributional and efficiency concerns.
Senator BUNNING. How do we do it with the low-income folks that do not file tax returns?
Mr. GAYER. I don't know, offhand, on how we do tax credits without tax returns. I think we did it with the Bush stimulus, did we not? I have to remember——
Senator BUNNING. We just sent that—no, we just——

Mr. GAYER. You could do it through——

Senator BUNNING [continuing]. Sent checks——

Mr. GAYER. For example, through payroll tax.

Senator BUNNING [continuing]. Added them to the deficit. I'm sorry.

Mr. GAYER. For example, through a payroll tax you could do it.

Senator BUNNING. Payroll tax.

Mr. GAYER. Yes, for example.

Senator BUNNING. OK.

Mr. GAYER. There's one example, because you don't have to file——

Senator BUNNING. Reduce to payroll tax.

Mr. GAYER. Reduce the payroll tax. In fact, I think Gill Metcalf, who's a professor at Tufts, suggested such a thing, where you reduce it for the first certain amount of payroll taxes that you earn, so in—it goes disproportionately——

Senator BUNNING. In other words, our Medicare and all these other things——

Mr. GAYER. But, you fund it—but it's funded. You don't—I mean, you have the revenue by which—that it replaces the taxes paid by low-income in their payroll tax. So, you can make it targeted toward low-income. I should add, if we're looking at job-promoting stimulus policies, it would effectively lower the cost of labor to employees.

Senator BUNNING. We've got to do it quickly, then, because we really need jobs.

Mr. GAYER. There you have it.

Senator BUNNING. Thank you very much.

Mr. GAYER. Sure.

Senator MURKOWSKI [presiding]. Senator Corker.

Senator CORKER. Thank you, Madam Chairman.

One of the things that people who talk about cap-and-trade a great deal envision is this—sort of, the world carbon market, where a ton of carbon here is traded with a ton of carbon some other place. Yet, when you're creating an artificial market for carbon by restricting the amount of carbon that can be emitted, the value of a ton of carbon is equal to the circumstances you've created to put that price in place. In other words, in Europe, if their baseline is 1990 and ours is 2005, or their—my point is, it's the artificial conditions that actually create the value of the carbon in the first place.

So, when I hear people—and I see Dr. Kopp and Dr. Gayer are both agreeing—the fact that people envision—and so many people who are pursuing this cap-and-trade bill say, "Well, we can create a world market for carbon." That's hooey, because in each area, the circumstances you're creating in that confined area are generating the price. First of all, is that not true?

Mr. KOPP. That's absolutely correct, Senator. But, I mean, let's examine—let's suppose, for example, the U.S. adopted a cap-and-trade program, and so did Canada. Under NAFTA rules, we decided to combine those two programs. If the Canadians had a very lax target, and therefore, a very low allowance price, and we had a very tight target and a high allowance price, then what would happen is, we would end up buying Canadian allowances, OK, and

they'd be selling them to the U.S. The combined reductions, then, would be equivalent to what Canada has achieved and what we've achieved. So, we would actually combine those, and permits would flow across the border one way, and money flow another way. If they were fairly close, then the allowance prices would be fairly similar and you wouldn't find those massive transfers.

But, this is exactly right. When you combine programs, permits will generally flow in one direction and money will flow in the other direction.

Senator CORKER. Whichever has the more lax standards, money will flow to, because those——

Mr. KOPP. That's exactly right.

Senator CORKER. So, I get back to the carbon tax issue, then. It seems to me, if one were going to, quote, "create a world regime," one would focus on, as we do with currency or something else, some carbon tax. I mean, that's a—people keep saying, "Well, with a carbon tax, you can't do that." That's absolutely not true; you can do it far more easily with a carbon tax than you create—than by creating a world market for carbon that, again, has these varying circumstances that are actually creating the value of that carbon per ton, anyway. Dr. Gayer, is that not true?

Mr. GAYER. Yes. I think that—both your points, I think, relate to each other, which is, you're looking for a system of harmonizing. I think you second point is right, it's probably easier to have harmonized carbon taxes than it would be to have harmonized quotas or caps. But, essentially you're right.

Senator CORKER. So, if you look at what the bills have been about, from my perspective, OK, it's been about money, OK. I mean, the fact is that the—all the bills that have been created so far have been about either buying constituencies with money or free allowances—and I hate to be so crass, but that's really what it's been about—or taking money out of the economy and using it for something else, but doing it in a disguised way. It has been about money. So, many of us have said, "Well, you know, if we could figure out a way to make this neutral, and it doesn't hurt the economy, that may be interesting to talk about." In other words, no money coming into the general fund of government, but all moneys being returned. By the way, groups on the left and right have supported that. I know USCAP doesn't, because they're making a lot of money off this by participating.

But, Dr. Kopp, what is an appropriate level of research and development that needs to take place in this country to meet the kind of goals that have commonly been discussed? I mean, how much consumption of any kind of a tax, whether it's a cap-and-trade system or carbon tax, is necessary, in your opinion—I would support, like, zero—but, from your perspective, how much is necessary to do the appropriate amount of research and development that you think is necessary?

Mr. KOPP. I guess I'm a little confused, Senator. How much money should the government spend——

Senator CORKER. Yes.

Mr. KOPP [continuing]. On R&D.

Senator CORKER. That's right.

Mr. KOPP. I wish I had the answer to that. Unfortunately, I don't. I mean, it's clear, from an economic perspective, that the incentives within the private sector to invest in R&D are affected by the fact that they cannot reap all the gains. So, there's a role for government. There have been estimates that we need to spend probably ten times as much as we're spending now on the basic R&D, and then you need to incentivize——

Senator CORKER. How much is ten times the basic R&D for energy today?

Mr. KOPP. I don't know, Senator.

Senator CORKER. Dr. Alic, do you have any idea what that ought to be?

Mr. ALIC. That would be roughly $60 billion a year. We spend about $6 billion a year.

Senator CORKER. On energy research and development.

Mr. ALIC. Yes, yes.

Senator CORKER. Let me ask you. Do you think ten times that number is an appropriate amount, or is that——

Mr. ALIC. I would like to see that level spent in the private sector, not by the Federal Government. I think the Federal Government certainly has a role to play. What we have to do, if we really want innovation, we have to get it from industry, because they're the people who know how to do it. They do it every day.

Senator CORKER. Mr. Hawkins is shaking his head up and down, which semi-surprises me, and I appreciate. So, what I'm hearing from the two of you is that, really, there's no need for government to invest, that, with a price signal, where people knew that there were going to be benefits to investing in the energy efficiencies and different types of energy, that the private sector could handle that. Don't let me put words in your mouths. But—so, if there's a way to, quote, "tax carbon," and yet, absolutely make it revenue-neutral, where somehow—or whether it's a payroll tax reduction or something else, there's an absolute lowering of some other tax so that no money is being taken out of the—out of Americans' pockets. You think that alone—through private-sector innovation, that alone would be sufficient to make this happen.

Mr. Hawkins, since I haven't really——

Mr. HAWKINS. Thank you, Senator.

Fundamentally, yes. But, as I said before, there's no silver bullet. I would say that the bulk of the investment that needs to be done should come from the private sector, and the way to make it happen is to create a market. That's what a cap on carbon is; it's a market-creation machine. It essentially tells entrepreneurs that goods and services that have a lower carbon footprint will be rewarded in the marketplace. That's when you get the attention of the board of directors and the CEOs, and they can rationalize putting more money into projects, which they cannot rationalize today. That money is going to be so many times larger than anything that plausibly comes out of the Federal Treasury. That's what we need to harness. The way to do it is to create this market with a predictable program that values carbon reduction.

Senator CORKER. Does a carbon tax do that, in your estimation?

Mr. HAWKINS. In theory, a carbon tax would do that. Our concern with a carbon tax, as a legislative policy matter, is that it's an indi-

rect mechanism of achieving the purposes of the legislation. As I said, before, our view—the purposes of this legislation, the reason we're talking about it, is not to raise money, it's to reduce emissions. That's the reason that we should be doing this. A tax is an indirect mechanism for doing it. In the real world of congressional taxwriting, we think that the risks are pretty large that the approach to it would be that, whatever that level of the tax is, the higher it is, the worse it is, from a political perspective. So, there'll be constant pressure to create exceptions.

Senator Bunning asked questions about tax equity, and I think it's predictable that the coal interests would have the same reaction to a tax as they do to a cap program. They'd be looking for modifications, variances, exceptions, transfers, in order to manage the transition. That's not a bad idea, but, the point is that a tax approach sounds simple when you're talking about it from a theoretical standpoint, but you're going to confront exactly the same considerations that you would with a cap.

I would also make that comment about the international aspects. I don't think that an international tax is any easier, and it may not be any more difficult, than an international cap program. The same set of national considerations are going to enter into any country that, as a sovereign matter, says, "I will accept this level of a cap," or "I will accept this level of a tax." They'll go through the same calculus.

Senator CORKER. I agree. I agree. I will—is it all right if I keep asking a——

Senator MURKOWSKI. It is.

Senator CORKER. You know, I will say that—you say the goal is not to create money. But, I offered an amendment to the Boxer bill, last summer, to return all of the money that was generated through a dividend program, and there sure wasn't a lot of support for that. I think that there is a lot about this that is about money. If you look at all the interest groups that benefit monetarily from the cap-and-trade bill that's being created, my guess is that a lot of the interest in the bill is being generated by the money that is going out to various groups in the form of either cash or free allowances, which, you know, let's face it, is a marketable security; it's just like a share of IBM stock that can be converted to cash immediately. So, I think it's nice of you to say that. I would just say, in the world we live in here today, climate has turned into being about money. OK? There's a lot of people that stand to benefit from that. I think some of us have said, "Look, if there's some way we can figure out this to make it—a way to make this neutral to the American citizen, it's an interesting thing to discuss, but there are a lot of old-time politicians around here, apparently, that still want to focus on the money."

Mr. HAWKINS. If I could just say, quickly, Senator, I think the key thing that you can do, as a design matter, is to make sure that, if there are free allowances, that those free allowances are used for public-benefit purposes. That's the key feature. So, for example, if there are free allowances to the electric sector, make sure that those free allowances are used to address consumer rate impacts and address industrial consumer rate impacts. If there are free allowances to the trade-exposed industry sector, make sure that

those free allowances are used to keep those businesses competitive and to keep them as employment centers.

So, those are techniques that are completely available to you, as a member of Congress, to make sure that whatever free allowances are there, they're used for public-benefit purposes, and that's what we advocate.

Senator CORKER. Yes. There's a lot of vagueness, just for what it's worth, in describing the public goodness that's being generated. I mean, I think you—it just seems to me, you'd be so much better off focusing on either a carbon tax or absolutely no free allowances whatsoever, and just returning the money back to the American people. I mean, that's a way you ensure that there's actually a public good that's taking place. Whereas, when you give companies—distributors the ability to make those decisions, and it's pretty vague, I think there's a lot of room for that not occurring. But——

This has been very good. May I ask another question?

Senator MURKOWSKI. Go ahead.

Senator CORKER. This is not a dig. I hope you can see I've been generally interested in this. I've tried to come to all the hearings we've had. I've traveled with our chairman and others, looking at this issue in other places. But, the whole notion of these emails that have just come out in the scientific community, what—is that—those of you who are most closely involved with that, is that a—do you consider that to be a major issue? I mean, is that—is there any bloom off the issue of focusing on climate change? Is that disturbing? Is this just nothing but a minor menace, or is this a—is this something that's of greater impact on the whole movement regarding climate change itself?

Mr. HAWKINS. I would offer a couple of comments, Senator. I think there are two issues involved with this email archive. One is, What does it say about the solidity of the scientific basis for concern about climate change? Second is, Is there an issue of personal behavior that needs to be addressed? They're 2 very different questions.

On the impact on science—and I actually was describing to my college class email list, a—what this was all about, so I pointed out that there are about eight scientific propositions that form the basis for the conclusion that human emissions are affecting the global climate and that the risk is great in the future, and they are: No. 1, that certain atmospheric gases absorb heat that would otherwise go back into space; No. 2, that annual emissions of these so-called "greenhouse gases" have increased dramatically over the last 100 years or so—CO_2 by a factor of ten, in the last century; No. 3, that global annual average surface temperatures have increased over the course of that century; No. 4, that the 10 warmest years in the instrumental record since 1880 have occurred between 1997 and 2008; No. 5, that some additional warming, beyond what we've already measured, is already locked in because of inertia in the atmosphere; No. 6, that the amount of future warming is going to be delivered—determined both by amount of future emissions and what's called "climate sensitivity"; and the last is that the impacts from future warming are going to be widespread and substantial, although the amount is uncertain.

Now, of those propositions, the emails don't challenge anything related to those findings. The emails are related, when you look at them, to arguments about one line of evidence that has been used in some models to estimate the level of future warming associated with different emissions pathways. Even if you decided, which would be an overreaction, to say, "Well, we're just going to assume that that line of evidence has no validity whatsoever," you have all these other lines of evidence pointing to estimates about what the level of warming will be in the future if we don't address these emissions.

The policy argument for acting now is not that we have a computer model, or five or six computer models, that says, "In the year 2100, we can predict that the temperature is going to be X." That's not the argument. The rationale for acting now is that we can't rule out really cataclysmic outcomes. We can't rule it out, because we don't have the tools to rule it out.

So, we have a policy challenge. What do we do with that information? We look at what the dynamics of the system are. The dynamics of the system are dominated by inertia. The powerplants, the factories we build that release these greenhouse gases have very long capital lives. So, that means you have a risk of sunk costs, of stranded costs, if you try to do something about it after they've been built.

The second thing is that the emissions we put into the atmosphere has a very long lifetime. Half of the emissions that we put into the air when fought World War I are still in the air today. One thousand years from now, 15 percent of those emissions will still be in the air.

So, as I said to my classmates, as Johnny Cochran might have said, "Once you've emitted, you're committed."

[Laughter.].

Mr. HAWKINS. This is the challenge we face. That's the argument for acting. These emails, even if they raise questions about the behavior of certain individuals, or certainly their judgment in expressing themselves, they touch nothing about the fundamental science.

Senator CORKER. Is it OK if we keep going, for a second?

Mr. GAYER. I just wanted to respond. I think I—independent of the implications for climate policy, I think I find—I found—and I've only—there's a lot to read, so I've only read parts of it, but I do find them a little bit troubling, mostly just as an empirical researcher. I think human nature—you, me, and everybody—tends to look more favorable on evidence that confirms our beliefs and less favorable on evidence that doesn't confirm our belief. I think everybody suffers from that. That's what is—that's part of human nature. It might be idealistic. The scientific process is to—is set up to establish a set of norms that resist those kind of confirmation bias. In other words, you should be welcoming opposing views and feel confident in your evidence to discredit those views. The most troubling parts isn't so much on the science, but, for me, with some of the evidence suggesting that there was a defensiveness to opposing views. I don't—you know, if you think somebody's publishing in a referee journal, and you disagree with the paper, you can respond to that paper, or you could not submit articles to that paper. But,

I don't think any additional pressure should be borne as if it's some sort of adversarial—unhealthy adversarial relationship.

So, as far as implications go, I don't think—as David said, I don't think it, kind of, reshapes the whole understanding of the climate knowledge. I think it's particular to these people and to these emails.

I do think, broadly speaking, it does bring up the issue of data-sharing and transparency, which, kind of, as a academic, is something we should always be promoting, and especially when there's large political or policy ramifications involved.

Mr. KOPP Senator, can I just make one last——

Senator CORKER. Sure.

Mr. KOPP [continuing]. Point? I mean, I think—we tend to all agree with what David said. I do think this doesn't undermine any of the scientific evidence. It just suggests that scientists, like everybody else, are people, like all of us. If you went through a set of economists' emails, back and forth, on different kinds of things they'd be talking about, it would probably be a lot more embarrassing than this. It's just the nature of the game.

I do think that there is a standard we all try to aspire to, but we don't necessarily attain, in our daily actions, and certainly with respect to our emails.

But, I think the underlying truth of this—and I've spoken with colleagues in the climate science community, at the major universities that we deal with, and this doesn't—has not affected any of the underlying protocols or any of the underlying conclusions that have come in that science that David talks about. So, I don't think it's—it's embarrassing, but it certainly doesn't change the nature of the game, at least as a social scientist views it, and, you know, someone who's uncapable of analyzing the science for themselves.

Senator CORKER. Yes, sir.

Mr. ALIC. I'm a scientist.

Senator CORKER. I can tell. You sound a lot more intelligent than any of us up here.

[Laughter.].

Mr. ALIC. I've lived in this world for decades. You know, scientists fight like cats and dogs over these things. It's not often visible to the public. Now it is. But, I think the essential point is that the huge rewards in science come from overturning the conventional wisdom. Anybody who could actually demonstrate and persuade the community that global warming, you know, is not happening, that's Nobel Prize stuff. I mean there's huge rewards for that. So, you know, this is noise, really. Yes, it's embarrassing, but it's not, I think, very meaningful.

May I go back and—I don't want to be misunderstood on some of the other subjects we've talked about. First, on Federal R&D. If we want innovation today, and we need it today, as has been very eloquently said, we get it from industry. If we want innovation in 20 or 30 years, we need to put more money into basic research in energy climate fields now so that we can reap the fruits later on. We will need to do that.

Second, on carbon tax. I think it's important to do kind of a back-of-the-envelope calculation of what kind of carbon tax it will take to have real impact on greenhouse gas emissions. When I do that,

I get a ballpark figure that's, like, $100 a ton. That's an awful lot of money.

Senator CORKER. Can I just close?

[Laughter.]

Senator CORKER. By the way, the—none of the cap-and-trade bills, I think, that have been discussed even generate that. OK?

So, if I could just close by, first of all, thanking—Madam Chairman, you're awfully generous. I appreciate you letting me go on as I have.

It seems to me that all of you would agree that every dime that's taken out of the private sector slows the economy, generally speaking. I mean, I—so, it seems to me that whatever we did as a country, if something is going to occur, we would focus on a policy that does not negatively impact the economy by taking additional moneys out. What we would do, if there's concern—I mean, there's a scientist that I met in Greenland, who said, "Look, we need a policy that, if we're right about global warming, the policy works, and if we're wrong about global warming, it works." What I mean by that, it drives us toward energy security. I've always been fascinated with that statement.

It seems to me that the cap-and-trade bills before us take money out of the economy. They do do that; regardless of what anybody says, they do. It seems to me that—going back to Dr. Gayer, that a carbon tax or a cap-and-dividend, where 100 percent of the money is returned, you end up potentially achieving a policy that is—especially with the carbon tax, that may be perceived to be beneficial, at the same time, doesn't take any money out of the economy, if you lower some other tax exactly equal to that. It just seems to me that climate enthusiasts—and I'm an energy-security enthusiast, OK—but, it seems to me that climate enthusiasts would just wise up to that and focus on that and—instead of using this as a way to take money out of the economy, which is going to slow the economy. I just have not been able to understand the desire to create a larger central government, which is what these bills do, in the process of trying to address climate change, when there are much more simpler, elegant ways of dealing with it that don't slow the economy. Does anybody disagree with that, at this——

I didn't mean to ask that question.

[Laughter.]

Senator CORKER. I'll see you all later.

Senator MURKOWSKI. Senator Corker, thank for engaging the panelists in, again, very thoughtful discussion.

I think this has been very helpful for the committee. I only wish that we had more of our committee members with us this morning to hear it, because I think it is important, as we look at how we meaningfully make reductions in emissions while at the same time absolutely ensuring that we're not harming the economy, I think we need to be encouraged to look to all of the alternatives. Unfortunately, so many of them have been kicked to the side with the discussion about a cap-and-trade. We have boxed ourselves in, and said, "This is the legislation, this is the way that we're going to approach it, and it's either all or nothing. You either take it or leave it." But, I think it is important, as we look to our tax policies and what is wrong with encouraging the things that we want to encour-

age, such as savings and investment and job creation, and utilizing a tax policy to discourage those things that we don't want to encourage? In this case, that relates to our level of emissions.

It is a good, healthy discussion. I think oftentimes we are afraid to talk about taxes, using the "T" word, for fear that we're going to be labeled with that. But, I do think that it needs to be part of our discussions. When we're talking about the reductions of emissions, I think we do appreciate, and, being intellectually honest about it, we recognize that there is a cost involved. How can we work to ensure that the cost to the economy, the cost to the individual consumer, is ameliorated? I think that there are ways, there are paths forward that we can take, but we have to be willing to have these discussions.

I appreciate the thoughtful input from each of you. Mr. Banks, you know, when you were talking about your hybrid approach and all the things that need to go into your proposal, I look at the energy bill that we produced here in this committee and passed out, on a bipartisan basis some months ago, that's now just sitting. There's a lot of those component pieces that you have spoken to, the efficiency piece, the renewable energy aspect of it, and how we advance that forward. That could be a real base for our beginning, and maybe it is a discussion about the sectoral approach. Maybe we do look to some other proposals. But, again, we ought not be afraid of having the conversations and just assuming that the deal has already been done, and that's cap-and-trade. So, I appreciate your input.

Senator Corker, thank you for providing so much to this very important conversation.

[Whereupon, at 11:52 a.m., the hearing was adjourned.]

[The following statements were received for the record.]

STATEMENT OF STEPHEN A. ALTERMAN, PRESIDENT, CARGO AIRLINE ASSOCIATION

Mr. Chairman and members of the Committee: My name is Steve Alterman and I am the president of the Cargo Airline Association ("the Association"), the nationwide voice of the all-cargo air carrier industry.[1] I also have the honor of serving as the current Chairman of the FAA's Environmental Subcommittee of the Agency's Research, Engineering and Development Advisory Committee (REDAC). As a key segment of the air transportation industry, the all-cargo carriers recognize the growing importance of addressing our industry's contribution to global climate change. At the same time, especially in a time of global economic uncertainty, any environmental legislation must take care not to impair our ability to compete in the worldwide marketplace. We are pleased you have chosen to hold this important hearing on policy options because we believe there are intelligent solutions to addressing our industry's emissions in addition to cap and trade.

BACKGROUND

The nation's aviation industry represents approximately 5.6% of the U.S. Gross Domestic Product (GDP); contributes over $1.2 trillion annually to the U.S. economy and is responsible for approximately 11 million jobs.[2] In addition to these economic facts, the industry has been in the forefront of addressing environmental issues associated with our operations. To a large extent, of course, the environmental record of the entire aviation community is a result of a search for greater fuel efficiency

[1] U.S. air carrier members of the Cargo Airline Association are ABX Air, Atlas Air, Capital Cargo, FedEx Express, Kalitta Air and UPS Airlines.

[2] FAA, *The Economic Impact of Civil Aviation on the U.S. Economy* (October 2008). This report is available at: http://www.faa.gov/about/office__org/headquarters__offices/ato/media/2008__Economic__Impact__Report__web.pdf

in an era of generally rising fuel prices. Nevertheless, the environmental benefits of this quest for fuel efficiency cannot be overlooked. For example:

- Emissions from aircraft now account for less than 3% of the total U.S. Greenhouse Gas emissions.[3]
- Over the past 40 years, fuel efficiency has improved by over 70%[4] and, compared to 2000, in 2007 the U.S. commercial airlines consumed 3% less fuel while transporting over 20% more passengers and cargo.

While these accomplishments are significant, we recognize that more must be done to meet the environmental challenges of the future. Many of the necessary improvements will come from advances in technology and the implementation of FAA airspace modernization initiatives. This process requires the cooperation of all parties to the aviation environmental debate—industry, Congress and the Administration.

AN INTERNATIONAL APPROACH

As a global industry, we believe the role of the International Civil Aviation Organization (ICAO) and its ongoing attempts to establish international standards for aircraft emissions that relate to climate change cannot be overlooked. Significant expertise rests with ICAO as does the ability to establish a framework that all air carriers worldwide may follow. Additionally, both aviation and the environment would benefit from taking a global approach with harmonized standards for aviation rather than a single country approach. However, we understand the political realities facing Congress and if legislation is enacted we have outlined below why our industry would be best served by a carbon tax.

"CAP AND TRADE" AND ITS IMPACT ON AVIATION

The entire aviation industry is extremely capital intensive and any move to impose significant additional costs on an industry already suffering in today's economy will reduce the industry's ability to make the investments necessary to service customers around the world. Unfortunately, some of the initiatives now being advanced for dealing with global climate change will have this negative effect. Specifically, a cap and trade regime potentially will have a severe dampening effect on aviation's global competitiveness. The Clean Energy Jobs and American Power Act legislation that has been introduced in the Senate (S.1733) appears to impose an "upstream" tax on aviation, with the industry forced to buy carbon credits from fuel producers who will pay the fees directly (or in a secondary market that will undoubtedly emerge). At least for aviation, this method of attempting to deal with global climate change is extremely problematical. Some of the obvious downsides of such a cap and trade system are:

- As noted above, such a system will, in effect, impose a significant additional tax burden on an already heavily taxed industry.
- These taxes will inhibit the ability of the industry to make the capital expenditures necessary to take advantage of a modernized airspace system—a system that will provide significant environmental benefits.
- As we understand the current proposals, they will potentially funnel monies collected to a variety of programs—none of which have any relation to aviation or modernization of the aviation system.
- The bureaucracy necessary to administer any cap and trade program will siphon off a significant portion of any funds collected.
- A cap and trade system is subject to market manipulation.[5]

POTENTIAL ALTERNATIVES TO "CAP AND TRADE"

Faced with these facts and potential pitfalls, is there another way for aviation to meet its environmental responsibilities, while, at the same time, remaining competitive in the world marketplace? We believe that there is. Rather than being subjected to a cap and trade system, a tailored revenue-neutral carbon tax for the commercial airline industry appears to make more sense.[6] Under such a system, the commercial

[3] This figure includes all segments of U.S. aviation, including commercial aviation, general aviation and the military. See, *Inventory of Greenhouse Emissions and Sinks: 1990-2006*, U.S. Environmental Protection Agency (April 15, 2008).

[4] International Civil Aviation Organization, *Environmental Report 2007*, page 107.

[5] See, for example, op ed piece by Rep. Peter DeFazio in the January 27, 2009, edition of the *Oregonian.*

[6] If a cap and trade system is enacted, however, with respect to aviation it should contain "safety valve" provisions to protect carriers if the price of oil escalates past a predetermined

airline industry could be further directly taxed on its use of aviation fuel (the source of pollutants contributing to global climate change),[7] with these levies offset by a corresponding decrease in the existing excise taxes paid by the airlines.[8] Such a scheme would provide a powerful incentive to modernize aircraft fleets, while, at the same time, retain the same overall level of industry taxation.[9] In addition, the funds collected could be used to assist in the effort to convert the nation's air traffic system into one based upon satellite technology rather than the existing reliance on decades-old ground-based radar. And, since such taxes would be collected at the pump, virtually 100% of the proceeds could be used on aviation programs that benefit the environment.[10] As noted by the non-partisan Congressional Budget Office (CBO), "A tax on emissions would be the most efficient incentive-based option for reducing emissions and could be relatively easy to implement."[11]

CONCLUSION

The challenge of dealing with global warming is not easy, and the all-cargo industry is supportive of exploring policy options beyond cap and trade that may achieve similar emissions reductions for our industry. We understand the reasons that legislation is being considered to ensure that global climate change is addressed—and addressed as expeditiously as possible. But that legislation must take care not to cripple an industry that is necessary for economic recovery and that has a long-standing record of environmental sensitivity.

We recognize that the suggestions made herein are broad overviews and that the details of any final plans to address global climate change will require difficult negotiations among both industry and government representatives. For our part, we stand ready to engage in this necessary dialogue. If the Committee, or its staff, wants to discuss these issues further, please do not hesitate to contact us.

Thank you very much.

NATIONAL ASSOCIATION OF ENERGY SERVICE COMPANIES (NAESCO),
Washington, DC, December 16, 2009.

Hon. JEFF BINGAMAN,
Chairman, Energy and Natural Resources Committee, 703 Hart Senate Office Building, Washington, DC.

DEAR SENATOR BINGAMAN: The National Association of Energy Service Companies (NAESCO) recognizes your leadership in developing the next generation of national energy policy, and is pleased to be able to submit this letter asking you to authorize substantial new funding for energy efficiency in the development of comprehensive energy and climate legislation by the Senate.

NAESCO BACKGROUND

NAESCO is a 26-year old organization whose current membership of about 65 organizations includes firms involved in the design, manufacture, financing and installation of energy efficiency and renewable energy equipment and the provision of energy efficiency and renewable energy services in the private and public sectors. NAESCO members deliver about $6 billion of energy efficiency, renewable energy and distributed generation projects each year—about equal to the total energy efficiency investment by all US utilities combined, according to a recent report by the Lawrence Berkeley National Laboratory.

NAESCO numbers among its members some of the most prominent companies in the world in the HVAC and energy control equipment business, including Honeywell, Johnson Controls, Siemens, Trane, Comfort Systems USA Energy Services, and Schneider. Our members also include many of the nation's largest utilities: Pacific Gas & Electric, Southern California Edison, New York Power Authority, and

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level and funds collected should be transferred to the Aviation Trust Fund for use in system modernization.

[7] Commercial airlines currently pay a fuel tax of 4.3 cents per gallon.

[8] The existing excise tax on air cargo is a 6.25% airway bill levy.

[9] We recognize that variations of the carbon tax possibility set forth herein have been suggested by various parties to the global climate change debate. Each of these other proposals should be analyzed for their merits and their impact on U.S global competitiveness.

[10] Other, ancillary, issues that should be included in the discussion of aviation's place in the global warming debate include the need for any federal action in this area to preempt any state and local action that would result in a patchwork quilt of regulations on an industry that operates nationwide.

[11] See, *Policy Options for Reducing CO_2 Emissions*, Congressional Budget Office, February 2008.

Oncor Energy. In addition, ESCO members include affiliates of several utilities including ConEdison Solutions, FPL Energy Services, Pepco Energy Services, Constellation Energy Projects and Services and Energy Systems Group. Prominent national and regional independent members include Atlantic Energy, AECOM Energy, NORESCO, Onsite Energy, EnergySolve Companies, Ameresco, UCONS, Chevron Energy Solutions, Synergy Companies, Wendel Energy Services, Control Technologies and Solutions, Clark Realty Capital, McClure, SAIC, and Lockheed Martin.

ENERGY EFFICIENCY IS THE FIRST FUEL

We respectfully submit that energy efficiency should be the centerpiece of future national energy policy for the simple reason that no sources of energy—renewables, clean coal, nuclear, oil or gas—is cheap enough to use inefficiently.

- Energy efficiency is much less expensive than any other source of energy;
- Energy efficiency is the logical first step in any national strategy to reduce carbon emissions, because energy efficiency can deliver massive carbon emissions reductions at less than zero cost;
- Energy efficiency is plentiful, even though it has delivered the equivalent of more than half of our new energy resources during the last forty years.
- Energy efficiency can deliver energy resources today and for the next decade, bridging the gap while we are developing the next generation of technologies that will make the other energy sources less expensive and more reliable; and,
- Energy efficiency delivers new equipment and improvements to residential, commercial and institutional buildings, as well as industrial processes, all paid for from energy savings. This is especially important during a time when our public facilities are starved for funds to maintain and modernize their facilities.

The experience of NAESCO member companies is a good example of the potential of energy efficiency. During the past twenty years, our industry has grown from virtually nothing to its current level, and has delivered:

- $35 billion of projects
- $50 billion of guaranteed energy and operations savings to customers
- 330,000 person-years of direct employment
- $25 billion of public infrastructure improvements
- 420 million tons of CO_2 emissions reductions, at no additional cost

ENERGY EFFICIENCY IS CHEAP

Experience in numerous states shows that efficiency improvements on average cost about 3 cents per lifetime kilowatt-hour saved[1] compared to about 7 cents to over 13 cents per kilowatthour for conventional electricity generation.[2] The graphic below,* derived from data developed by the investment bank Lazard, illustrates the cost differences between technologies.

ENERGY EFFICIENCY IS PLENTIFUL

The international consulting firm McKinsey estimated, in a recent report[3], that the U.S. can reduce its energy consumption in 2020 by about 23% by adopting a comprehensive portfolio of energy efficiency programs. McKinsey estimates that this portfolio would have a first cost of about $520 billion and would return about $1.2 trillion in savings over the life of the energy efficiency measures. The graphic below illustrates the efficiency potential in the U.S.

ENERGY EFFICIENCY IS THE LOGICAL FIRST STEP

Energy efficiency is the logical first step in any program to reduce CO_2 emissions, because energy efficiency reduces CO_2 emissions at less than zero cost. Most energy efficiency technologies repay their first cost in a fraction of their useful life, and the total value of the technologies is typically 2-4 times their first cost. There is no extra cost attached to the CO_2 emissions reductions. The graphic below, taken from a re-

[1] Kushler, York and Witte, 2004, *Five Years In: An Examination of the First Half Decade of Public Benefits Energy Efficiency Policies*. Report U042. Washington, DC: American Council for an Energy-Efficient Economy.

* All graphics have been retained in committee files.

[2] Lazard. June 2008. *Levelized Cost of Energy Analysis—Version 2.0*: http://www.narucmeetings.org/Presentations/2008%20EMP%20Levelized%20Cost%20of%20Energy%20-%20Master%20June%202008%20(2).pdf

[3] *Unlocking Energy Efficiency in the US Economy*, McKinsey Global Energy and Materials, July 2009

port by the international consulting firm McKinsey[4], illustrates the cost of various technologies that reduce CO_2 emissions. The horizontal line in the middle of the graphic is the zero cost line. The bars on the left side of the graphic below the zero cost line are, with the exception of sugarcane ethanol, all energy efficiency technologies.

ENERGY EFFICIENCY IS THE BRIDGE

If energy efficiency programs can reduce energy consumption by more than 20% in the next decade, then it can serve as the bridge to the next generation of energy supply technologies, (e.g., energy storage and grid management systems that facilitate the increased use of renewables, clean coal plants with carbon capture and sequestration (CCS) or modular nuclear power plants) that will require a decade to develop and pilot.

- Administrative Infrastructure in Place.—The essential elements of large-scale energy efficiency programs (marketing, energy audit standards, contract procedures and documents, technical assistance for customers, financing systems, savings monitoring and verification, and quality assurance) are in place across the country. These program elements have been refined through two decades of field experience and can be rapidly expended to meet new national mandates. One example of this infrastructure is the increasing number of states that have Energy Efficiency Resource Standards, mandates that utilities procure a minimum amount of their energy resources from energy efficiency. The graphic below, excerpted from a recent report from the American Council for an Energy Efficiency Economy (ACEEE)[5], illustrates this trend.
- Work Force in Place.—In contrast to other market sectors, the work force required to quickly implement a large volume of energy efficiency projects, particularly in large commercial and institutional buildings is in place and looking for work. The same contractors and skilled trades people who were working in commercial new construction a couple of years ago are now available to work in energy efficiency retrofit projects. They don't need training in how to install lighting and HVAC systems, and they are used to working with the federal laws (e.g., Davis-Bacon and Buy American) that pose a startup barrier in other market sectors.
- Leverage Allowance Values.—Energy efficiency programs can multiply the value of carbon cap-and-trade allowances or carbon emission allowance auction proceeds because the allowance value does not have to cover the whole cost of the carbon abatement. As noted above, energy efficiency improvements repay their entire cost from energy savings, producing emissions reductions as a no-cost side benefit. This is not a new concept. Tens of billions of dollars worth of energy efficiency improvements have been implemented in the past two decades with a combination of utility or state government incentives. Financial incentives like allowances, therefore, can be used to accelerate the implementation of energy efficiency projects, not pay their entire cost, with the balance of the first cost of the project supplied by private capital sources.

CONCLUSION

NAESCO urges you to authorize substantial new federal funding, through direct appropriations or the allocation of carbon emissions reduction allowances to energy efficiency programs. We believe that exploiting all available cost-effective energy efficiency should be the first priority in our national energy policy. Energy efficiency is plentiful and is much less expensive than other energy resources. Energy efficiency can produce the new energy resources we need now to bridge the decade we will need to develop and pilot the next generation of energy production technologies.

Thank you in advance for your consideration of this request.

Respectfully submitted by,

DONALD GILLIGAN,
President.

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[4] *The carbon productivity challenge: Curbing climate change and sustaining economic growth*, McKinsey Global Institute, June 2008

[5] *The 2009 State Energy Efficiency Scorecard*, ACEEE, Report Number E097, October 2009