

REGULATORY ASPECTS OF CARBON CAPTURE, TRANSPORTATION, AND SEQUESTRATION

HEARING BEFORE THE COMMITTEE ON ENERGY AND NATURAL RESOURCES UNITED STATES SENATE ONE HUNDRED TENTH CONGRESS

SECOND SESSION

TO

RECEIVE TESTIMONY ON THE REGULATORY ASPECTS OF CARBON CAPTURE, TRANSPORTATION, AND SEQUESTRATION AND TO RECEIVE TESTIMONY ON TWO RELATED BILLS: S. 2323, A BILL TO PROVIDE FOR THE CONDUCT OF CARBON CAPTURE AND STORAGE TECHNOLOGY RESEARCH, DEVELOPMENT AND DEMONSTRATION PROJECTS, AND FOR OTHER PURPOSES; AND S. 2144, A BILL TO REQUIRE THE SECRETARY OF ENERGY TO CONDUCT A STUDY OF THE FEASIBILITY RELATING TO THE CONSTRUCTION AND OPERATION OF PIPELINES AND CARBON DIOXIDE SEQUESTRATION FACILITIES, AND FOR OTHER PURPOSES

JANUARY 31, 2007



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CONTENTS

STATEMENTS

| | Page |
|---|------|
| Allred, C. Stephen, Assistant Secretary, Land and Minerals Management, Department of the Interior | 24 |
| Anderson, Scott, Environmental Defense, Austin, TX | 53 |
| Bengal, Lawrence, E., Arkansas Oil and Gas Commission, Little Rock, AK | 48 |
| Bingaman, Hon. Jeff, U.S. Senator From New Mexico | 1 |
| Coleman, Hon. Norm, U.S. Senator From Minnesota | 7 |
| Domenici, Hon. Pete V., U.S. Senator From New Mexico | 11 |
| Edwards, Krista L., Deputy Administrator, Pipeline and Hazardous Materials Safety Administration, Department of Transportation | 15 |
| Evans, Ronald T., Denbury Resources, Inc., Plano, TX | 58 |
| Grumbles, Benjamin H., Assistant Administrator for Water, Environmental Protection Agency | 20 |
| Kelliher, Joseph T., Chairman, Federal Energy Regulatory Commission | 12 |
| Kerry, Hon. John, U.S. Senator From Massachusetts | 4 |
| Salazar, Hon. Ken, U.S. Senator From Colorado | 3 |
| Slutz, James, Acting Principal Deputy Assistant Secretary, Office of Fossil Energy, Department of Energy | 27 |

APPENDIXES

APPENDIX I

| | |
|---|----|
| Responses to additional questions | 71 |
|---|----|

APPENDIX II

| | |
|--|----|
| Additional material submitted for the record | 93 |
|--|----|

REGULATORY ASPECTS OF CARBON CAPTURE, TRANSPORTATION, AND SEQUESTRATION

THURSDAY, JANUARY 31, 2008

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

The committee met, pursuant to notice, at 2:05 p.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. Why don't we get started here? I'm informed Senator Domenici is on his way.

We have two of our colleagues here to talk first about the legislation that is the subject of our hearing. Let me give a very short opening statement and then turn to them.

I'd like to welcome everybody and thank the witnesses who are testifying before the committee. This is a legislative hearing on two bills, S. 2144, that Senator Coleman and some others have introduced, and S. 2323, that Senator Kerry has introduced along with several of our colleagues.

These two bills focus on important policy aspects of carbon dioxide capture, transportation and storage. S. 2144 focuses on the issue of expanding the existing carbon dioxide pipeline infrastructure. S. 2323 focuses more broadly on carbon capture and storage research, development and demonstration projects and perhaps more pertinent to today's hearing also focuses on developing a policy framework for rapid implementation of integrated carbon dioxide capture and storage systems.

The topic of reducing greenhouse gases, particularly carbon dioxide emissions is a topic of great concern to myself and to all members of this committee. Carbon capture and geologic storage holds promise as a measure that can be used to mitigate global climate change while still allowing the use of fossil fuels at electricity generating plants and industrial facilities. Discussion centered on coal use in a carbon constrained world, integrated carbon capture and storage systems may present the most immediate solution for continued use of coal than other carbon intensive fuels while not contributing further to carbon dioxide emissions and global warming.

Last December a historic piece of legislation was passed into law, the Energy Independence and Security Act of 2007. It included key

provisions for expanding critical research and development programs aimed at bringing integrated carbon capture and storage systems to the full technological deployment stage. The new law is important for focusing research and development efforts on technologies that are essential for reducing carbon dioxide emissions.

This legislation was a first step, a key first step, in advancing carbon capture and storage projects, but additional legislation will be needed to advance these storage projects into full commercial deployment. The next phase in fast tracking deployment of these technologies is establishing a policy framework that will assist early industry movers in selecting the appropriate geologic storage sites, in operation of their facilities and in managing the facilities for decades following the closure of a geologic storage operation. The aim of this hearing is to receive testimony on these two bills and their contribution to developing a carbon dioxide capture, transport and storage policy framework.

Let me defer to Senator Domenici for any comments he has before I call on Senator Coleman and Senator Kerry for their comments.

Senator DOMENICI. Mr. Chairman, considering the time I would ask that you let the two witnesses, the two Senators give their remarks and then I will give mine.

The CHAIRMAN. Alright. We will proceed that way. There's no particular order here. Senator Coleman, you were the first one here and Senator Kerry is the taller of the two. Which of you would like to go?

[Laughter.]

Senator COLEMAN. I'll certainly defer to my senior colleague, Senator Kerry.

The CHAIRMAN. Senator Kerry, go right ahead, please. Thank you for being here.

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

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

I'd like to welcome everyone here today and thank the witnesses who are testifying before the committee for this legislative hearing on bills S. 2144 and S. 2323. These two bills focus on important policy aspects of carbon dioxide capture, transportation, and storage. S. 2144 focuses on the issue of expanding the existing carbon dioxide pipeline infrastructure. S. 2323 focuses more broadly on carbon capture and storage research, development and demonstration projects, and perhaps more pertinent to today's hearing it also focuses on developing a policy framework for rapid implementation of integrated carbon dioxide capture and storage systems.

The topic of reducing greenhouse gases, particularly carbon dioxide emissions, is a topic of great concern to myself and the members of this committee. Carbon capture and geologic storage holds promise as a measure that can be used to mitigate global climate change, while still allowing the use of fossil fuels at electricity-generating plants and industrial facilities. With discussion centered on coal use in a carbon-constrained world, integrated carbon capture and storage systems may present the most immediate solution for continued use of coal and other carbon intensive fuels while not contributing further to carbon dioxide emissions and global warming.

Last December a historic piece of legislation was passed into law, the Energy Independence and Security Act of 2007, which included key provisions for expanding critical research and development programs, aimed at bringing integrated carbon capture and storage systems to the full technological deployment stage. The new law is important for focusing research and development efforts on technologies that are essential for reducing carbon dioxide emissions. This legislation was a key first step

in advancing carbon capture and storage projects, but additional legislation will be needed to advance these storage projects into full commercial deployment.

The next phase in fast-tracking deployment of these technologies is establishing a policy framework that will assist early industry movers in selecting the appropriate geologic storage sites, operation of their facilities, and managing the facilities for decades following the closure of a geologic storage operation. The aim of this hearing is to receive testimony on S. 2144 and S. 2323 and their contribution to developing a carbon dioxide capture, transport, and storage policy framework.

I would like to begin the hearing by welcoming the original bill sponsors who have come to speak on the bills today, Senator Kerry will speak on S. 2323 and Senator Coleman will speak on S. 2144.

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

Thank you Chairman Bingaman and Ranking Member Domenici for holding this hearing on the regulatory aspects of carbon capture, transportation, and sequestration.

Capturing carbon dioxide at its source and safely storing it to avoid its release into the atmosphere will be essential to reducing greenhouse gas emissions. I believe carbon capture and storage (CCS) should be a top priority in our nation's energy policy. There is little doubt that a successful domestic CCS program will boost our nation's coal industry, and that a low-carbon footprint coal industry is critical to our nation's energy and environmental security.

To make CCS an effective, reliable, and cost-feasible reality, we need to move forward simultaneously on two fronts: we need to aggressively develop both the technical knowledge necessary and the regulatory framework for CCS infrastructure development.

On the technical front, I sponsored the provision of the new energy bill that directs the United States Geological Survey and the Departments of Energy and the Interior to coordinate a national assessment of our carbon dioxide storage capacity. I also fought to include the provisions that will expand DOE's CCS research and development programs, with a particular eye towards the large-scale CCS demonstration projects that are crucial to achieving commercial viability. I am looking forward to learning about DOE's most recent progress today.

I am glad that today's hearing will focus attention on the second front—the regulatory front. We need to establish a regulatory framework for the transport and storage of carbon dioxide. As you know I am an original co-sponsor of S. 2144, the Carbon Dioxide Pipeline Study Act of 2007, which would instruct the federal agencies present today to perform a broad feasibility study of the construction and operation of a national CCS infrastructure.

There are open questions about what it will take to create a national CCS infrastructure. We need a thorough assessment of our nation's geologic CO₂ storage capacity and a critical appraisal of the pipeline network required and the issues of transporting carbon dioxide from its sources to storage sites. Even though short-haul carbon dioxide pipelines already exist in the U.S. for the purposes of enhanced oil recovery—we've been employing these techniques in my state of Colorado for more than thirty years—a more expansive carbon dioxide pipeline network clearly raises new issues about pipeline network requirements and regulation, regulatory classification of carbon dioxide, and pipeline safety.

The DOE through its Carbon Sequestration Regional Partnerships, the DOT through the independent U.S. Surface Transportation Board with regulatory jurisdiction for transporting carbon dioxide, the FERC with its experience in the regulation of natural gas and oil pipelines, and the EPA through its underground injection control program have the necessary expertise to assess the important issues dealing with carbon dioxide pipelines that would be needed to handle large-scale carbon sequestration in this country.

We introduced this pipeline study bill because there has been a void at the federal level in the attention given to the infrastructure needed to bring CCS to fruition. We believe your agencies have the regulatory authority to begin such a feasibility study now, but I am concerned by the lack of coordinated federal action to answer these fundamental questions. I look forward to having a frank discussion regarding our path forward.

Thank you, Mr. Chairman.

**STATEMENT OF HON. JOHN KERRY, U.S. SENATOR
FROM MASSACHUSETTS**

Senator KERRY. Thanks, Mr. Chairman, Senator Domenici and the rest of the Senators on the committee. Thank you very, very much for giving us an opportunity just to share a few thoughts with you. I particularly appreciate the opportunity to talk about S. 2323 which is a bill that Senator Stevens and I have jointly introduced and I'll say a word about it in a moment.

But I just want to remind the committee of the underlying importance of what drives both pieces of legislation and our being here today. We all know that last year the Nobel Prize winning intergovernmental panel on climate change issued its latest and most comprehensive report reflecting the consensus of over 2,000 of the world's most respected climate scientists. That report established beyond any reasonable doubt the urgency of acting to address climate change.

I had the privilege of representing the Senate for a brief 36 hours, because of our votes at the end of the year, in Bali at the climate change negotiations. I must say I've been attending those conferences since 1992 when Al Gore, Tim Wirth and a bunch of us went down to Rio to the Earth Summit. I've met with the various delegations over the course of time including the Chinese.

This time I found the Chinese transformed, engaged, prepared to discuss how to measure what they do, obviously not quite at the same rate and same scale. It was an entirely different conversation than any that we have had yet and opens the door to what really needs to be done because China will be at our levels of emissions within 10 years. So, obviously, we're going to have to find a way to achieve this. But this is part of that mosaic, if you will, Mr. Chairman.

The science shows that—and I also found there a sense of urgency among finance ministers, prime ministers, foreign ministers, environment ministers, trade ministers, presidents, an unbelievable sense of urgency about this issue. The science also shows that coal combustion is one of the greatest contributors to climate change. Those of us that seek to deal with this issue understand we're going to have to deal with this component of it.

Coal is not going to go away in the near term, no matter how much we wish that in terms of its negative impact. Not the positive, but the negative. It's cheap. It's abundant here in America. Countries such as China are using it extensively. They're building approximately one coal fired plant per week, pulverized coal fired plant, without modern technology right now. Coal accounts for 80 percent of their CO₂ emissions.

So they are building infrastructure that's effectively going to pollute for years to come. We will get the results of that pollution because it blows over us and falls in rain and so forth. Frankly it's my judgment, I think the judgment of a lot of people that the international community needs to be far more concerned about this and urgent about this than it is.

That's why we have to rapidly develop and implement carbon capture and storage technology, which is the purpose of this hearing. It was recommended last year in a similar report by the Massachusetts Institute of Technology. This technology will enable us,

providing it works according to all of the designs and ways in which they believe it will, to capture the emissions from power plants and other industrial facilities and permanently bury them in deep saline aquifers and other geological formations.

Two recent reports identified carbon capture and sequestration as the most promising area for emission reductions in the electric power sector. A December 2007 McKinsey study determined that by 2030, 9 percent of U.S. electricity could come from coal plants equipped with CCS. The Electric Power Research Institute, the research arm of the electric power industry, estimated this number at 15 percent.

I might say that I hope those figures reflect a growth without the level of intervention that ought to take place because if it isn't, it isn't going to get the job done. All of us need to understand that. If you believe the scientists and you heed their warnings and you have to keep the climate change to a two degree centigrade level and 450 parts per million of greenhouse gases. There is no way to achieve that at that level of coal fired growth. So we have an enormous challenge ahead of us.

These studies demonstrate the potential however for the application of CCS. The purpose behind our bill and I think Senator Coleman's bill is to accelerate this effort so we can let the marketplace decide what works. We're not going to pick a winner or loser. We want to get the technology out there. Let the marketplace decide which technology in fact works the best and most effectively.

Now the energy bill that you passed—that we passed in the Senate last summer is a great start. I extend my gratitude to this committee for the provisions to inventory the sequestration capacity and to conduct essential demonstration projects. The legislation Senator Stevens and I have introduced which is the Carbon Capture and Storage Technology Act of 2007 would establish three to five commercial scale sequestration facilities and three to five coal fired demonstration plants with carbon capture.

Now there are benefits to these that are not the purpose of this hearing today so I won't go into those. But today's hearing is specifically, I gather, focused on one provision of the bill, which is the regulatory framework that must be established to oversee carbon capture and storage activities. The regulatory framework is as urgent as getting the technology out. Obviously they go hand in hand.

We have to make sure that we implement these projects correctly. We've never conducted sequestration here in the United States on the scale that we're contemplating. In fact only three sites in the entire world have projects of this magnitude.

First and foremost we need to guarantee the permanent storage of the CO₂ that we inject in the ground. CO₂ is naturally buoyant. When it's injected into the earth it will seek the earth's surface at all times. So, all of our aggressive efforts to develop CCS technology would be wasted if we don't make the right choices about where to inject the CO₂ to avoid leakage that releases the CO₂ back into the atmosphere.

Second, as we advance this technology we'll be making site specific decisions about appropriate sequestration locations. We need to ensure that these injection sites, whether in deep saline formations or oil or gas fields are safe, secure and permanent. We need

to develop national siting guidelines that will provide confidence in the injectivity, capacity and effectiveness of storage sites. We need to develop consistent and reliable monitoring and verification protocols that will assist with site assessment and planning and baseline and operational monitoring to ensure that the CO₂ remains permanently sequestered. Finally we need an early warning system that will alert us to potential leakage or failure issues at these sites.

Now many of these elements are highly technical, but they are all essential to ensuring the success of this technology in addressing climate change and in providing companies, investors and the public with confidence that they're getting what they pay for when they invest in carbon credits associated with CCS. Siting monitoring and verification regulation are also necessary to provide us with certainty they're avoiding any potential harmful public health or environmental outcome. For example precautions have to ensure that CO₂ injection sites don't result in seepage into drinking water aquifers and the release of heavy metals.

As we think through the regulatory framework for CCS, we have to be mindful that any CO₂ leakage within a contained environment could result in additional health or safety risks if not done properly. So for that reason the regulatory scheme is going to be critical. It will also determine whether or not this is going to work, folks. That is going to determine, very significantly, what our options are with respect to global climate change. So the faster we get about this business and the faster we get the demonstration projects out there properly, the better we're going to be able public choices for the long term.

To resolve these issues I've developed a provision in this legislation that directs the key agencies, including EPA, DOE and Interior to create a task force to develop comprehensive regulations to address the issues of leakage, public safety and environmental protection. These regulations would establish the regulatory framework to oversee the entire CCS process in a comprehensive fashion linking the complicated mechanisms for capture, transport, injection and storage of CO₂. The task force is specifically directed to consult with the industry as well as the technical experts in developing these regulations. The involvement of these experts, who've been involved in large scale sequestration projects abroad or enhanced oil recovery, which many of you are familiar with.

We have used this effort to drive oil out and capture oil today. So we have it in certain scale. But we need to develop the ability for the regulatory scheme to govern this process. Many of those individuals, incidentally, are behind me here testifying today. I'm eager to learn about their input as to how we do this most appropriately. I look forward to working with the committee as we try to meet this urgent challenge. Thank you, Mr. Chairman.

[The prepared statement of Senator Kerry follows:]

PREPARED STATEMENT OF HON. JOHN KERRY, U.S. SENATOR FROM MASSACHUSETTS

Chairman Bingaman, Senator Domenici and colleagues—thank you for inviting me to testify today. I appreciate the opportunity to introduce an issue and a piece of legislation that I believe are critical to our efforts to combat global climate change.

Last year, the Nobel Prize-winning Intergovernmental Panel on Climate Change issued its latest and most comprehensive report, reflecting the consensus of over 2,000 of the world's most respected climate scientists. The report established beyond any real doubt the urgency of acting to address climate change.

In the last 250 years, carbon dioxide levels in the atmosphere have risen from 280 parts per million to 380—higher today than at any time in the past 650,000 years. Scientists tell us that we have to keep CO₂ concentration below 450 parts per million—which corresponds to an increase of 2 degrees Celsius—to avoid a large scale catastrophe. And we only have ten years in which to act. But unless we take dramatic action, we're expected to reach 600–700 parts per million by the year 2100. This is urgent. It is being driven by facts and by the alarms that scientists across the planet are sounding today.

We who seek to fight climate change must face the reality that, in the foreseeable future, coal isn't going away. It's cheap and abundant here in America and in places like China, which is growing at 11% a year and building one coal-fired power plant per week. Today coal accounts for 80% of China's CO₂ emissions, and they and others are building infrastructure that will pollute for decades to come.

That is why it is critical that we run, not walk, to develop and implement carbon capture and storage technology, as recommended last year in a seminal report by the Massachusetts Institute of Technology. This technology will enable us to capture the emissions from power plants and other industrial facilities, and permanently bury them in deep saline aquifers and other geological formations.

In fact, two recent reports identified CCS as the most promising area for emission reductions in the electric power sector. A December 2007 McKinsey study determined that, by 2030, 9% of US electricity could come from coal plants equipped with CCS. The Electric Power Research Institute, the research arm of the electric power industry, estimated this number at 15%. These studies demonstrate the tremendous potential for the application of CCS. Our government should be making significant commitments to advancing this technology.

The Energy Bill was a very good start—and I would like to extend my thanks to this committee for its leadership on key provisions to inventory our country's sequestration capacity and conduct essential demonstration projects.

In addition, I have introduced legislation with Senator Stevens—the Carbon Capture and Storage Technology Act of 2007—which would establish 3–5 commercial-scale sequestration facilities and 3–5 coal-fired demonstration plants with carbon capture.

I would be happy to discuss the benefits of these projects, but today's hearing is focused on another component of the bill—the regulatory framework that we need to put in place to oversee carbon capture and sequestration activities. My bill establishes an interagency task force, chaired by the Administrator of the EPA, to develop regulations governing the complicated mechanisms and requirements for the capture, transport, injection and storage of carbon dioxide. The task force is specifically directed to consult with industry, as well as technical and legal experts, in developing these regulations—and the individuals who will be testifying this morning are some of the leading authorities in the country on these issues. I am eager to hear their thoughts.

I look forward to continuing to work with my colleagues to advance carbon capture and storage technology, and I thank you again for the opportunity to testify this morning.

The CHAIRMAN. Thank you very much.
Senator Coleman.

STATEMENT OF HON. NORM COLEMAN, U.S. SENATOR FROM MINNESOTA

Senator COLEMAN. Thank you, Mr. Chairman. It's a pleasure to be sitting by the side of my colleague Senator Kerry. Both of our approaches here proceed with a firm belief that it's important to get the technology out there. I firmly believe in it.

Thinking about the Chinese experience and what they're doing. The country that gets the technology out there, I think, is going to dominate the 21st century on economic terms. The Chinese are going to have to buy it. They're choking to death they're going to have to buy it from us. So we have this, I think, huge incentive to move forward and you have to have a framework for that incentive.

When I was a young person I dreamed of being a basketball player. My heroes were guys like Bob Cousy, Oscar Robertson, Earl the Pearl Monroe. I'm dating myself here by the way. That all ended when a coach told me, Coleman, you may be small, but you can't jump. It is bad when you have two reinforcing problems.

Our Nation has that. We are highly dependent on foreign sources of energy and we produce dangerous amounts of greenhouse gases. How do we solve one problem without exacerbating the other?

Mr. Chairman this committee under your leadership and that of the ranking member has boldly moved to address both. You've crafted two landmark pieces of legislation in the past several years: the Energy Independence Security Act of 2007 and the Energy Policy Act of 2005. These comprehensive bills address numerous critical energy and environmental challenges facing our Nation and they establish a firm foundation on which to build our Nation's energy future.

I firmly believe that a big part of that future is going to require figuring out how to utilize America's 250 year supply of coal in an environmentally friendly manner. By taking CO₂ produced in coal power plants and piping that CO₂ to a location where it can be permanently stored, I believe we can greatly add to the country's economic and even national security. That's why I've introduced the CO₂ Pipeline Study Act which is another step in this committee's efforts to address these issues in an informed and timely manner.

I want to thank a number of members of this committee who are original co-sponsors of the CO₂ Pipeline Study Act for their leadership. Senator Murkowski, who's here today, Senator Salazar, Landrieu, Johnson, Martinez and Bunning, your guidance and assistance were invaluable in drafting this legislation. The fact is we have an immense supply of coal available in this country. It is a relatively low cost energy source we do not need to import. Accordingly we do not need to send our valuable dollars overseas to hostile regimes in order to keep the lights on. We simply must find a way to use coal without jeopardizing the climate. Indeed coal already supplies about half our Nation's electric power.

The good news is my colleague Senator Kerry has testified about in greater detail is that we can take the CO₂ out of the emissions of a coal power plant and store it underground. More research needs to be done. But the future of CO₂ free coal plants looks bright. One of the key components of making CO₂ free coal is a reality of how to transport this gas from the power plant to the ground.

Currently there are many uncertainties about the rules and costs that will exist with the construction and operation of CO₂ pipelines. The CO₂ Pipeline Study Act will answer these questions. It will provide certainty to industry and to consumers. The CO₂ Pipeline Study Act seeks the input of a number of Federal agencies and departments: the Department of Energy, Interior, Transportation, the Federal Energy Regulatory Commission, FERC, the Environmental Protection Agency. Each of these has expertise about a variety of issues associated with the building of pipelines.

These agencies are required to conduct the study of any technical, siting, financing or regulatory barriers that might prevent or impede the development of a carbon dioxide pipeline industry.

They're also asked to address any safety and integrity issues associated with constructing carbon dioxide pipelines. I anticipate the recommendations in their study may well serve as a basis of future congressional action on these issues.

In short, this bill will lay out the groundwork for CO₂ free coal plants that will allow America to move forward quickly, but carefully and responsibly to its piping CO₂. The CO₂ Pipeline Study Act also works in tandem with and complements the actions on that broader carbon dioxide issue taken in S. 2323, Senator Kerry's bill, also the Energy Independence and Securities Act of 2007 and the Energy Policy Act of 2005. These bills address carbon capture at the point of creation, for example at a coal fired power plant and the storage of carbon dioxide at an appropriate geologic formation.

However unless the coal fired plant happens to be near a suitable storage location, the carbon dioxide will have to be piped to an appropriate geologic formation to sequestration. That is what the Pipeline Study Act answers. It addresses the issues associated with transporting carbon dioxide from its point of capture to its point of storage for use in enhanced coal recovery.

We have an enormous potential domestic supply of energy. It can be used to cool and heat our homes, power our businesses and industries and create enumerable new jobs. However, our Nation will only realize these benefits if we can produce and use this energy in an environmentally sensitive manner. The CO₂ Pipeline Study Act is an important step in our efforts to develop this energy resource in an environmentally responsible way. We need to have the regulatory framework in place if we are going to get the technology out in time. Senator Kerry's bill and my bill begin that necessary and important conversation.

Chairman Bingaman, Ranking Member Domenici and members of this committee, I thank you for this opportunity to speak on behalf of S. 2144, the CO₂ Pipeline Study Act. With your leadership we are turning a national dilemma throwing energy dependence and greenhouse gas production into a win-win with the help of our people, our economy and ultimately our national security. Thank you, Mr. Chairman.

[The prepared statement of Senator Coleman follows:]

PREPARED STATEMENT OF HON. NORM COLEMAN, U.S. SENATOR FROM MINNESOTA

First, I want to thank Chairman Bingaman and Ranking Member Domenici for holding this important hearing today and inviting me to speak on behalf of the Carbon Dioxide Pipeline Study Act.

When I was a young person I dreamed of being a basketball player like Bob Cousy or Earl The Pearl Monroe. That all ended when a coach told me, "Coleman, you may be small, but you can't jump." It's bad when you have two reinforcing problems.

Our nation has that. We are highly dependent on foreign sources of energy and we produce dangerous amounts of greenhouse gases. How do we solve one problem without exacerbating the other?

This committee, under your leadership, has boldly moved to address both. You have crafted two landmark pieces of legislation in the past several years: the Energy Independence and Security Act of 2007 and the Energy Policy Act of 2005. These comprehensive bills address numerous critical energy and environmental challenges facing our nation, and they establish a firm foundation on which to build our nation's energy future.

I firmly believe that a big part of that future is going to require figuring out how to utilize America's 250 year supply of coal in an environmentally friendly manner. By taking CO₂ produced in coal power plants and piping that CO₂ to a location

where it can be permanently stored, I believe we can greatly add to the country's economic and even national security. That's why I've introduced the CO₂ Pipeline Study Act, which is another step in this committee's efforts to address these issues in an informed and timely manner.

I want to thank a number of Members of this committee who are original co-sponsors of the CO₂ Pipeline Study Act for their leadership: Senators Salazar, Murkowski, Landrieu, Johnson, Martinez and Bunning. Your guidance and assistance were invaluable in drafting this legislation.

The fact is, we have an immense supply of coal available in this country—it's an energy source we do not need to import, and accordingly, we do not need to send our valuable dollars overseas to hostile regimes in order to keep the lights on.

We simply must find a way use coal without jeopardizing the climate. Indeed, coal already supplies about half of our nation's electric power. The good news, as my colleague Senator Kerry has testified about in greater detail, is that we can take the CO₂ out of the emissions of a coal power plant and we can store it underground. More research needs to be done, but the future of CO₂-free coal plants looks bright. Yet one of the key components of making CO₂-free coal a reality is how to transport this gas from the power plant to the ground.

Currently, there are many uncertainties about the rules and costs that will exist for the construction and operation of CO₂ pipelines. The CO₂ Pipeline Study Act will answer these questions, it will provide certainty to industry and consumers.

The CO₂ Pipeline Study Act seeks the input of a number of federal agencies and departments—the Departments of Energy, Interior, and Transportation, the Federal Energy Regulatory Commission (FERC) and the Environmental Protection Agency (EPA). Each of these has expertise about a variety of issues associated with the building of pipelines.

The agencies are required to conduct a study of any technical, siting, financing, or regulatory barriers that might prevent or impede the development of a carbon dioxide pipeline industry. They are also asked to address any safety and integrity issues associated with constructing carbon dioxide pipelines. I anticipate the recommendations in their study may serve as a basis for future Congressional action on these issues. In short, this bill will lay the groundwork for CO₂-free coal plants, it will allow America to move forward quickly, but also carefully and responsibly toward piping CO₂.

The CO₂ Pipeline Study Act works in tandem with and compliments the actions on the broader carbon dioxide issue taken in S. 2323, the Carbon Capture and Storage Technology Act, the Energy Independence and Security Act of 2007 and the Energy Policy Act of 2005. These bills address carbon capture at the point of creation—for example at a coal fired power plant—and the storage of carbon dioxide at an appropriate geologic formation.

However, unless the coal fired power plant happens to be near a suitable storage location, the carbon dioxide will have to be "piped" to an appropriate geologic formation for sequestration. This is what the CO₂ Pipeline Study Act answers. It addresses the issues associated with transporting carbon dioxide from its point of capture to its point of storage or for use in enhanced oil recovery.

We have an enormous potential domestic supply of energy. It can be used to cool and heat our homes, power our businesses and industries and create innumerable new jobs. However, our nation will only realize these benefits if it can be produce and use this energy in an environmentally sensitive manner.

The CO₂ Pipeline Study Act is an important step in our efforts to develop this energy resource in an environmentally responsible way.

Chairman Bingaman, Ranking Member Domenici and members of this committee—thank you for this opportunity to speak on behalf of S. 2144, the CO₂ Pipeline Study Act.

With your leadership you are turning a national dilemma—growing energy dependence and greenhouse gases production—into a "win-win" for the health of our people, our economy and ultimately our national security.

CHAIRMAN. Thank you both very much. I think you made a contribution by the introduction of these bills and the efforts you've put into educating us on them.

Let me now either dismiss these witnesses, unless anybody has a question that's burning that they want to ask. We will allow you folks to get on with your other activities. But thank you again for being here.

We have two panels. Let me turn to Senator Domenici to make his opening statement and then I will call the first panel forward.

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

Senator DOMENICI. Thank you very much, Mr. Chairman. Good afternoon. I want to thank Senator Bingaman for scheduling this hearing and the witnesses for appearing. I'd like to thank Senators Coleman and Kerry for their work in drafting the measures before us.

Carbon sequestration, Mr. Chairman, holds real promise for reducing the emissions of greenhouse gases. Today however, that promise is far from realized. The technology has not been commercialized and a massive investment in infrastructure, pipelines, etc. is needed. As a result carbon sequestration must be viewed for what it is; a small piece of the solution to what is a larger issue of global climate change.

The recently passed energy bill included many provisions on this subject. It is recognized that an appropriate Federal role exists for researching, developing and commercializing cleaner technologies. It will be one thing to implement the Federal laws that we have passed, but we must also remember the economic law of diminishing returns.

Carbon sequestration as we know it is a classic example of that concept. The more aggressively we pursue it, the more it will cost. Because climate change is very much a global challenge, the benefits we derive will be incrementally smaller. America can be a leader in carbon sequestration. We have experience in the form of enhanced oil recovery to guide our investment and regulatory decisions.

Yes, if the United States acts unilaterally to reduce its emissions we risk saddling taxpayers with a steep price for minimal results. Other nations are on the verge of passing the United States in annual greenhouse gas emissions on a per capita basis, some already have. As greenhouse gas emissions decrease here at home increases in developing countries will more than offset our progress. Discussions of the carbon sequestration process are worthy of our committee's time.

I'll keep an open mind. I hope to learn what more can be done. But I also urge that my colleagues not put the cart before the horse. While we can and should advance this promising concept, we must know for sure that other countries will join us in this effort. I look forward to hearing from the witnesses that we have scheduled. I thank you again, Mr. Chairman.

The CHAIRMAN. Thank you very much. Let me call the first panel forward. First we have Chairman Kelliher from the Federal Energy Regulatory Commission. Benjamin Grumbles from the EPA. James Slutz, who is the Deputy Assistant Secretary in the Office of Oil and Natural Gas in the Department of Energy. Krista Edwards, Deputy Administrator with the Pipeline and Hazardous Materials Safety Administration in the Department of Transportation. Stephen Allred who is the Assistant Secretary for Land and Minerals Management in the Department of the Interior.

Thank you all very much for being here. If you could each take 5 to 6 minutes and just summarize the main points of your testimony for us, we will include your full testimony in the record, but I'm sure there will be questions of all of you.

Let me start with Chairman Kelliher and then Krista Edwards, Mr. Grumbles, Steve Allred and Mr. Slutz. So go right ahead Mr. Chairman. Thank you for being here.

**STATEMENT OF JOSEPH T. KELLIHER, CHAIRMAN, FEDERAL
ENERGY REGULATORY COMMISSION**

Mr. KELLIHER. Thank you, Mr. Chairman. Let me say first of all, thank you for the opportunity to be here today and the possibility of being here. My term of office would have expired at the end of last session. But in the waning minutes of the session I was confirmed along with my colleague Jon Wellinohoff. It reminded me a little bit like the Georgetown/West Virginia game the other night except the shot wasn't blocked at the last second. So I'm grateful for the support of the chairman, Senator Domenici, committee members and the staff.

Mr. Chairman, members of the committee, thank you for the opportunity to speak with you today about the regulatory aspects of carbon capture, transportation, sequestration and related legislation. My written testimony offers comments on the legislation before the committee and but in particular I want to say that FERC would be pleased to participate in the study required by S. 2144. We believe we can contribute to an examination of the regulatory barriers and regulatory options relating to the construction and operation of carbon dioxide pipelines.

I'm going to focus my oral testimony on the regulatory aspects of carbon transportation, the area where FERC's experience regarding pipelines may have the most value to the committee. While there are questions about carbon capture and sequestration technology, carbon dioxide transportation has been proven and storage of carbon dioxide has taken place for years. A network of carbon dioxide pipelines has been developed, mostly since the 1980s to promote enhanced oil recovery in declining oil fields. There is also some experience with storage of carbon dioxide.

Now up to this point the injection of carbon dioxide into oil production reservoirs has been a means of increasing oil production rather than an end unto itself. Storage takes place in the oil production fields rather than in reservoirs dedicated to carbon dioxide sequestration. Construction of the U.S. carbon dioxide pipeline network began over 25 years ago and that network now spans more than 3,900 miles. Siting of carbon dioxide pipelines has been governed by State law and to my knowledge state siting has worked well.

Under current law there is no Federal role in siting carbon dioxide pipelines. While operators of interstate carbon dioxide pipelines are free to set their own rates in terms of service, the U.S. Department of Transportation's Surface Transportation Board may hold proceedings to determine that rates are reasonable if a third party files a complaint. U.S. Department of Transportation's Office of Pipeline Safety within the Pipelines and Hazardous Material Safe-

ty Administration administers safety regulations governing interstate carbon dioxide pipelines.

The committee expressed an interest in exploring the regulatory aspects of carbon dioxide transportation. FERC is an infrastructure agency with nearly 90 years of experience regulating a broad range of energy infrastructure projects including oil and natural gas pipelines and related facilities. The United States has used three different regulatory schemes for pipeline transportation that might be relevant to congressional consideration of the regulatory aspects of carbon dioxide transportation.

First there is the model that has governed the existing carbon dioxide pipeline network. Under this approach pipelines are sited under State law. Transportation rates are set by the Surface Transportation Board when a complaint filed regarding rates is filed. The Office of Pipeline Safety ensures safety.

Second there is the oil pipeline model. Under this model oil pipelines are sited under State law. FERC sets the transportation rate. FERC has no siting or safety role with safety issues being handled by the Department of Transportation Office of Pipeline Safety. This model also has worked well for decades.

The third model is the natural gas pipeline model. Under the current version of this model FERC both sites interstate natural gas pipelines and sets their transportation rates. It may be useful to note however, that the original version of the Natural Gas Act, the 1938 Act, provided for state siting of interstate natural gas pipelines.

In 1947 however, Congress reached the conclusion that State siting of natural gas pipelines had failed and that it was necessary to resort to Federal siting. Congress amended the Natural Gas Act and provided for exclusive and preemptive Federal siting of interstate natural gas pipelines. While the Commission, while FERC is responsible for safety issues during the siting and construction phases, safety jurisdiction shifts to the Department of Transportation through the Pipeline and Hazardous Materials Safety Administration once construction is complete.

Now in my view any of these three approaches could prove effective in regulating a network of carbon dioxide pipelines. I have no reason to believe the existing regulatory scheme administered by the Surface Transportation Board is inadequate. In particular I would not recommend that Congress preempt the states in siting carbon dioxide pipelines by providing for exclusive and preemptive Federal siting. The precondition that led Congress to such a course for siting natural gas pipelines, the failure of State siting, does not appear to exist here. Further I would not recommend that Congress alter the safety role of the Pipeline and Hazardous Materials Safety Administration.

I appreciate the opportunity to testify here today and would be pleased to answer any questions you might have. Thank you.

[The prepared statement of Mr. Kelliher follows:]

PREPARED STATEMENT OF JOSEPH T. KELLIHER, CHAIRMAN, FEDERAL ENERGY REGULATORY COMMISSION

Mr. Chairman and members of the committee, thank you for the opportunity to speak with you today about the regulatory aspects of carbon capture, transportation,

and sequestration and two related bills, namely S. 2144, the “Carbon Dioxide Pipeline Study Act of 2007”, and S. 2323, the “Carbon Capture and Storage Technology Act of 2007”. I commend the committee for holding this hearing.

CARBON CAPTURE AND SEQUESTRATION TECHNOLOGY

Development of carbon capture and sequestration technology is an important need. There are questions about carbon capture and sequestration technology. The two bills that are the subject of this hearing address this need by requiring studies and funding research and development and demonstration projects. If these efforts are successful, carbon capture and sequestration may become a practical reality.

S. 2144

S. 2144 would direct the Secretary of Energy, in coordination with the Federal Energy Regulatory Commission (FERC), the Secretary of Transportation, the Administrator of the U.S. Environmental Protection Agency, and the Secretary of the Interior, to conduct a study to assess the feasibility of the construction and operation of pipelines to be used for the transportation of carbon dioxide for the purpose of sequestration or enhanced oil recovery and carbon dioxide sequestration facilities.

FERC has extensive experience in the siting and regulation of a wide variety of energy infrastructure projects, and we would be pleased to participate in the study required by S. 2144. In particular, FERC can play a helpful role examining regulatory barriers and regulatory options relating to the construction and operation of carbon dioxide pipelines, as provided by section 2(b) of the bill.

S. 2323

As I indicated above, there are questions relating to carbon capture and sequestration technology. This bill would address those questions directly, by funding carbon dioxide capture and storage research and development, and both carbon dioxide capture and sequestration demonstration projects. The bill has other provisions relating to establishment of an interagency task force to develop regulations for carbon dioxide capture and storage, an assessment of carbon dioxide storage capacity, and technology agreements.

REGULATORY ASPECTS OF CARBON DIOXIDE TRANSPORTATION

While there are questions about carbon capture and sequestration technology, carbon dioxide transportation has been proven and storage of carbon dioxide has taken place for years. A network of carbon dioxide pipelines has been developed, mostly since the 1980s, to promote enhanced oil recovery in declining oil fields. There is also some experience with storage of carbon dioxide.

Up to this point, the injection of carbon dioxide into oil production reservoirs has been a means of increasing oil production, rather than an end unto itself. Storage takes place in the oil production fields themselves, rather than in reservoirs dedicated to carbon dioxide sequestration. Enhanced oil recovery results in the storage of carbon dioxide in depleted production reservoirs.

I am not aware of whether any information has been developed regarding the leakage of carbon dioxide from the existing pipeline network or production fields. This might be an area worthy of research and development.

Besides enhanced oil recovery, carbon dioxide has been used for other purposes, including refrigeration and cooling, casting metal molds, welding, sandblasting, methanol and urea production, carbonation, and medical purposes.

Construction of the U.S. carbon dioxide pipeline network began over 25 years ago, and that network now spans more than 3,900 miles. Siting of carbon dioxide pipelines has been governed by state law, and to my knowledge state siting has worked well. Under current law, there is no federal role in siting carbon dioxide pipelines. While operators of interstate carbon dioxide pipelines are free to set their own rates and terms of service, the U.S. Department of Transportation’s Surface Transportation Board may hold proceedings to determine that rates are reasonable, but only if a third party files a complaint. Under the Interstate Commerce Termination Act of 1995, the Surface Transportation Board regulates interstate pipelines transporting commodities other than water, oil, or natural gas. The U.S. Department of Transportation’s Office of Pipeline Safety, within the Pipelines and Hazardous Materials Safety Administration (PHMSA), administers safety regulations governing interstate carbon dioxide pipelines.

The committee expressed an interest in exploring the regulatory aspects of carbon dioxide transportation. FERC has a great deal of experience regulating energy infrastructure. The original mission of the agency was development of energy infrastructure, specifically licensing and regulating non-federal hydropower projects. Our infrastructure role has expanded over time to include natural gas pipelines and associ-

ated facilities, oil pipelines, and more recently we have been given a limited role in electric transmission siting.

The U.S. has used three different regulatory schemes for transportation of energy resources by pipeline that might be relevant to Congressional consideration of the regulatory aspects of carbon dioxide transportation. First, there is the model that has governed the existing carbon dioxide pipeline network, namely continuing the current regulatory scheme for interstate carbon dioxide pipelines. Under this approach, pipelines are sited under state law, transportation rates are set by the Surface Transportation Board when a complaint regarding rates is filed, and the Office of Pipeline Safety ensures safety.

Second, there is the oil pipeline model. Under this model, oil pipelines are sited under state law and FERC sets the transportation rate. FERC has no siting role or safety role (safety issues being handled by the Department of Transportation). This model has worked well for decades.

The third model is the natural gas pipeline model. Under the current version of this model, FERC both sites interstate natural gas pipelines and sets their transportation rates. It may be useful to note that the original version of the 1933 Natural Gas Act provided for state siting of interstate natural gas pipelines. However, in 1947 Congress reached the conclusion that state siting of natural gas pipelines had failed, and it was necessary to resort to federal siting. Congress amended the Natural Gas Act and provided for exclusive and preemptive federal siting of interstate natural gas pipelines. While the Commission is responsible for safety issues during the siting and construction phases, safety jurisdiction shifts to the Department of Transportation, though PHMSA, once construction is complete.

In my view, any of these three approaches could prove effective in overseeing a network of carbon dioxide pipelines. I have no reason to believe the existing regulatory scheme administered by the Surface Transportation Board is inadequate. In particular, I would not recommend that Congress preempt the states on siting carbon dioxide pipelines, by providing for exclusive and preemptive federal siting of carbon dioxide pipelines. The precondition that led Congress to such a course for siting natural gas pipelines—the failure of state siting—does not exist here. Further, I would not recommend that Congress alter PHMSA's safety role.

I appreciate the opportunity to testify before you today and would be pleased to answer any questions you may have.

Senator Domenici [presiding]: Ms. Edwards, you're next, ma'am.

STATEMENT OF KRISTA L. EDWARDS, DEPUTY ADMINISTRATOR, PIPELINE AND HAZARDOUS MATERIALS SAFETY ADMINISTRATION, DEPARTMENT OF TRANSPORTATION

Ms. EDWARDS. Ah, yes. Ranking Member Domenici, members of the committee, I appreciate the opportunity to discuss the safety programs administered by the Department of Transportation's Pipeline and Hazardous Materials Safety Administration and PHMSA's role in overseeing the safe transportation of carbon dioxide.

First on behalf of Secretary Peters I want to express PHMSA's strong support for the committee's efforts. We share your commitment to energy security and environmental protection. We are pleased to have a seat at the table as the committee considers the transportation requirements associated with carbon capture and storage.

DOT has vast experience managing the risks of CO₂ in all modes of transportation. Under the hazardous materials transportation law the Department has long overseen the movement of CO₂ by rail, highway, air and vessel. PHMSA's hazardous materials regulations established standards for the design, testing and filling of tanks and other packages used to contain and store CO₂ in each of its physical states as a gas, liquid and solid.

Since 1991, DOT has also overseen the transportation of CO₂ by pipeline. Together with our State partners, PHMSA currently over-

sees the operation of nearly 4,000 miles of CO₂ pipelines. We expect that that number will grow as the Nation moves ahead with carbon capture and sequestration. So I am pleased to assure the committee that DOT existing pipeline safety program will fit new CO₂ pipelines however they may be configured.

Congress reauthorized the program only a little more than a year ago, we thank you for that, reflecting strong support for PHMSA's mission and approach. Our approach is performance based. We aim to protect people, property and the environment by preventing pipeline failures and by mitigating the consequences of those that occur. Our integrity management programs promote continuous improvement by requiring operators to identify all threats to pipeline integrity and to remedy safety problems in priority order, worse first. By identifying and reducing defects before they grow to failure our integrity management programs are driving significant improvement in safety performance and reliability.

Our national pipeline safety program provides seamless oversight of pipeline operations through PHMSA's five regional offices and strong partnerships with our pipeline safety programs. The State programs play a critical role directly overseeing the vast share of pipeline infrastructure including most intrastate pipelines.

To meet our goals PHMSA also must be more than a regulator. We are supporting the development of new technologies such as tools for improving assessment of pipelines and non-regulatory initiatives such as the nationwide campaign to promote safe excavation practices. We work with all stakeholders who can contribute to safety outcomes including communities near new, existing and planned pipelines. As part of a comprehensive approach to pipeline safety we believe in preparing communities to make risk informed land use decisions and in preparing local first responders to respond to pipeline incidents.

Although PHMSA has no authority over pipeline siting we work closely with FERC and DOI in reviewing designs for pipelines and in responding to local concerns about pipeline safety. These efforts are paying off in terms of improved safety, reliability of supply and public confidence. The number of significant pipeline incidents has reached historic lows even as the size of the pipeline network has grown. Within these data I'm very pleased to report that the safety record for CO₂ pipelines is particularly good. There's been no loss of life and no injuries on DOT regulated CO₂ pipelines.

In closing I want to reiterate our strong support for the development of new energy solutions. PHMSA is pleased to work with the committee, our Federal and State partners and industry to prepare for the safe operation of new and expanded CO₂ pipelines. We offer our agency's expertise and experience as the committee considers and addresses future requirements for carbon capture and storage.

Thank you again for the opportunity to testify. I'll be pleased to answer any questions.

[The prepared statement of Ms. Edwards follows:]

PREPARED STATEMENT OF KRISTA L. EDWARDS, DEPUTY ADMINISTRATOR, PIPELINE
AND HAZARDOUS MATERIALS SAFETY ADMINISTRATION, DEPARTMENT OF TRANSPORTATION

Chairman Bingaman, Ranking Member Domenici, members of the committee: Thank you for the opportunity to discuss the safety programs administered by the U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA) and our experience in overseeing the commercial transportation of carbon dioxide.

As the committee considers future requirements for carbon capture and sequestration, I am pleased to confirm that large volumes of carbon dioxide (CO₂) are shipped safely in the U.S. today, including by pipeline. PHMSA's existing programs and standards governing CO₂ transportation provide effective protection to life and property, with due regard for the efficiency and performance of the transportation system.

As the DOT agency with jurisdiction over the movement of hazardous materials by all transportation modes, PHMSA has extensive experience managing the risks of compressed CO₂, in each of its physical states: gas, liquid, and solid (dry ice). Unlike natural gas and other gases regulated as hazardous materials, CO₂ is non-combustible and nontoxic. A colorless, odorless by-product of human respiration, CO₂ is present naturally in the environment and, at normal atmospheric levels, is vital to plant life and poses no immediate hazard to people or animals. In higher concentrations, as when CO₂ is contained for transport or storage, exposure to CO₂ can cause respiratory problems, including suffocation. CO₂ reaches its liquid state at combinations of high pressure and low temperature. Both variables affect the consequence of a release of liquefied CO₂, in each case depending on the proximity of people and the location and surrounding conditions. In a remote, unpopulated area, even a large release of liquefied CO₂ will vaporize harmlessly into the atmosphere and is unlikely to cause serious injury. By contrast, a large, sudden release of liquefied CO₂ could have catastrophic consequences in a populated area. Because it is heavier than air, compressed CO₂ tends to pool near the ground, displacing all oxygen, and form a vapor cloud as it dissipates.

Because of these properties when compressed and/or in high concentrations, CO₂ has long been considered a hazardous material subject to the Hazardous Materials Transportation Laws, 49 U.S.C. 5101 et seq., and DOT's implementing regulations, 49 C.F.R. parts 171–180, governing transportation by air, rail, highway, and water. PHMSA's Hazardous Materials Regulations (HMR) prescribe a comprehensive risk management framework for CO₂ transport, covering classification, packaging, handling, and hazard communication (shipping documentation and labeling). The packaging standards for CO₂ transport vary based on volume, pressure, and transportation mode; in each case, the HMR mandate the use of an approved cylinder or tank, subject to specific requirements for design, testing, certification, and filling.

The Department assumed oversight of CO₂ pipelines in 1988, under legislation directing the Secretary to develop regulations for the safe transportation of CO₂ by pipeline. Pursuant to the mandate, in 1991, the Department extended its existing hazardous liquid pipeline rules (49 C.F.R. part 195) to these operations. CO₂ pipelines became subject to additional integrity management requirements when the liquid IM program was adopted in 2000.

As with liquid operations generally, PHMSA shares oversight of certain CO₂ pipelines with authorized State programs. Together with these State partners, PHMSA currently oversees close to 4,000 miles of CO₂ transmission pipelines (as depicted in *Figure 1)—amounting to roughly five percent of all hazardous liquid pipeline mileage under our jurisdiction. Of these CO₂ lines, approximately 66 percent are interstate (crossing State borders) pipelines with the remaining 34 percent classified as intrastate (within State borders). Located primarily in the States of Texas, New Mexico and Wyoming, these pipelines deliver CO₂ for a variety of industrial purposes, including enhanced oil recovery activities. Within the national pipeline network as a whole, the CO₂ lines are relatively new: approximately 91 percent were constructed after 1980.

As the Administration and Congress work to enhance our Nation's energy security and protect the environment, we understand the need to extend the transportation infrastructure—including the delivery of alternative fuels and the transport of CO₂ for sequestration or use in energy production. And we understand the importance of pipeline transportation for safe and efficient movement of large volumes of hazardous materials. With the right risk controls in place, pipelines can operate safely anywhere—it's not a matter of "if," but "how."

* Figures 1–2 have been retained in committee files.

PHMSA's pipeline safety program aims to promote continuous improvement in public safety, environmental protection, and system performance by identifying and addressing all threats to pipeline integrity and mitigating the consequences of pipeline failures. Our regulations cover the design, construction, maintenance, and operation of liquefied natural gas (LNG) facilities and hazardous liquid and natural gas pipelines, both interstate and intrastate, including the gas distribution systems that directly serve homes and businesses. We work closely with national and international standards organizations and encourage the development of consensus standards complementing our performance-based regulations.

Our integrity management regulations, which currently apply to transmission pipelines (liquid and gas), require operators to conduct risk assessments of the condition of their pipelines; develop and implement risk control measures to remedy safety problems, worst first; and evaluate and report on program progress and effectiveness. Under integrity management programs, operators are identifying and repairing pipeline defects before they grow to failure, producing steady declines in the numbers of serious incidents.

Along with risk-based standards and practices, technological advances are driving significant improvement in the control of pipeline risks. PHMSA administers a cooperative research program that promotes the development of new methods, materials, and tools for improving leak detection systems and detecting and preventing corrosion, outside force damage, and other threats to pipeline integrity. We work closely with informed stakeholders, including other Federal agencies, our State partners, and industry, to target our limited R&D funding on promising technologies to address the most urgent safety issues. Most recently, in preparation for the growing use of alternative fuels, our R&D program is focused extensively on technical issues associated with the movement by pipeline of ethanol and ethanol-blended fuels.

As an agency dedicated to the safe transportation of hazardous materials, PHMSA must be more than a regulator. Our success depends on our ability to leverage non-regulatory solutions and to work closely with all stakeholders who can contribute to safety outcomes, including communities in the path of existing or new pipelines. Although PHMSA has no authority in pipeline siting, we work closely with the Federal Energy Regulatory Commission (FERC) in reviewing designs for proposed gas transmission pipelines and liquefied natural gas (LNG) facilities and in responding to local concerns about pipeline safety. We consult with other Federal and State agencies on how our regulatory requirements relate to their permitting decisions about pipelines. Recognizing that public decisions affecting transportation and energy supply often must be made at a national level, we believe a pipeline safety program can and must involve local communities, including zoning and planning officials and emergency responders. As part of a comprehensive approach to pipeline safety, we believe in preparing communities to make risk-informed land use decisions and in building local capability to respond to pipeline incidents. PHMSA works closely with fire service organizations on numerous safety projects, including the development of training standards and educational materials concerning pipeline incident response.

To carry out our oversight responsibilities, PHMSA operates five regional pipeline safety offices and is authorized to employ 111 inspection and enforcement professionals for fiscal year 2008. In addition to compliance monitoring and enforcement, PHMSA's regional offices respond to and investigate pipeline incidents and participate in the development of pipeline safety rules and technical standards. Our regional offices also work closely with PHMSA's State program partners, which employ approximately 400 pipeline inspectors and directly oversee the largest share of the U.S. pipeline network, including most intrastate pipelines. Under our Congressionally-authorized Community Assistance and Technical Services (CATS) program, PHMSA's regional offices provide safety-focused community outreach and education. With the current wave of pipeline expansion, and increasing commercial and residential development around existing pipelines, the CATS program is serving a vital role in educating the public about pipeline safety and encouraging risk-informed land use planning and safe excavation practices.

With safety our top priority, under Secretary Peters' leadership, the Department is targeting the prevention of all transportation-related deaths and injuries. Although further improvement is needed, the safety record for hazardous materials transportation is good and getting better in all sectors, including hazardous liquid pipeline operations. Since the introduction of IM programs in 2000, the annual number of serious incidents involving hazardous liquid pipelines has reached historic lows, even as the size of the pipeline network has grown. Although the data sets are not yet large enough to make statistically significant comparisons, the trend line over the past 20 years (as depicted in *Figure 2) is favorable.

Within these data, the safety record for CO₂ pipelines is particularly good. Of the 3,695 serious accidents reported on hazardous liquid pipelines since 1994, only 36 involved CO₂ pipelines. Among the 36 incidents, only one injury, and no fatalities, was reported. In all other instances, the accidents were classified as serious based on the extent of property damage (including damage to the pipeline facility) or product loss.

With the benefit of this experience and record, PHMSA is pleased to work with the committee, our Federal and State partners, and industry to prepare for the safe operation of new or extended CO₂ pipelines. The existing pipeline safety program administered by PHMSA has provided effective oversight of CO₂ pipelines since 1991 and will accommodate new and expanded carbon dioxide pipelines, however they are configured. We are happy to work with the Department of Energy and other Federal partners to evaluate the feasibility of particular pipeline configurations and/or plan for their development.

Likewise, PHMSA is committed to working with any agency or agencies involved in siting CO₂ pipelines, just as we work with FERC today in connection with the licensing of gas transmission pipelines and LNG facilities. We offer our agency's considerable experience and technical expertise to the committee as it considers and addresses the transportation requirements associated with CO₂ capture and sequestration.

Mr. Chairman, I want to assure you and members of the committee that the Administration, Secretary Peters, and the dedicated men and women of PHMSA share your strong commitment to safe, clean, and reliable pipeline transportation. Like you, we understand the importance of PHMSA's mission to the Nation's economic prosperity and energy security, and we look forward to working with the committee to address the current challenges. Thank you.

Senator DOMENICI. Thank you very much. Senator, do you want me to proceed?

Senator DORGAN. Why don't you, the chairman will be here momentarily.

Senator DOMENICI. All right. Let me ask the two of you who have already testified, neither of you made a statement about quality of CO₂. Could I start with you, Mr. Chairman? Is CO₂ dangerous?

Mr. KELLIHER. Is CO₂ dangerous?

Senator DOMENICI. I said is it dangerous like natural gas?

Mr. KELLIHER. No, it's not like natural gas storage.

Senator DOMENICI. Does it blow up?

Mr. KELLIHER. No, sir.

Senator DOMENICI. Will it hurt people?

Mr. KELLIHER. Not in the way a natural gas leak could hurt people.

Senator DOMENICI. I imagine if you got too much you would go to sleep, right? Does it hurt people, ma'am?

Ms. EDWARDS. I'm pleased to speak to the hazard, thank you. We do regulate CO₂ in each of its forms as a hazardous material for the purposes of transportation. Certainly there are risks and hazards associated with it that's why it's under both of our safety programs.

On the other hand, as you pointed out, the hazards associated with this material are different and in many ways less than the hazards associated with other materials that are part of our—that we manage the oversight of through pipelines or significantly CO₂ in certain concentrations will cause respiratory problems in humans and could cause suffocation in a situation in which, you know, a human was exposed to intense concentrations. It tends—it's heavier than air as a liquid which is the form in which it's transported in pipelines so a massive release in a populated area without the right conditions and there are variables having to do with ventilation and temperature, of course, in terms of its vapor-

ization and the rate of vaporization. But, you know, there have been, again I reiterate that our safety record for CO₂ pipelines has been very good. But, you know, it is why we oversee its movement in transportation because it poses a hazard.

Congress directed us to take on this oversight in 1988.

Senator DOMENICI. Thank you very much, ma'am.

Proceed, sir.

**STATEMENT OF BENJAMIN H. GRUMBLES, ASSISTANT
ADMINISTRATOR FOR WATER, ENVIRONMENTAL PROTECTION
AGENCY**

Mr. GRUMBLES. Thank you, Senator.

Senator DOMENICI. You're welcome.

Mr. GRUMBLES. Members of the committee I'm Benjamin Grumbles. I'm the Assistant Administrator for Water at the U.S. EPA. I really appreciate the opportunity to discuss EPA's important work on the regulatory aspects of carbon sequestration.

The Administration is committed to taking timely and responsible actions to confront the serious challenges of global climate change. EPA, in particular, believes innovative solutions will be critical to meeting this long term challenge including technologies and practices to mitigate greenhouse gas emissions. Carbon capture and storage is one of a portfolio of innovative technologies that could make a significant contribution to reducing greenhouse gas emissions. EPA is committed to advancing such efforts in a manner consistent with our obligations to safeguard public health and the environment as required by the Safe Drinking Water Act.

Carbon sequestration isn't a silver bullet, but it may be an ace in the hole for mitigating greenhouse gas emissions. We're very excited at EPA about the recent activities that the Administrator announced in October of last year that the Agency would move forward with a rulemaking under our authorities of the Safe Drinking Water Act. Our current schedule is an accelerated schedule. But our schedule is to propose regulations under the Safe Drinking Water Act's Underground Injection Control Program by the summer of this year.

The Agency is engaged in many efforts with our partners in Federal, State and local government and in the private sector on the wide array of carbon capture and storage and sequestration matters. But my testimony does focus on the regulatory aspects of injection and sequestration. Over the past several years we've been coordinating with the Department of Energy, the lead agency for research and development, and working with them on in support of their efforts on the carbon sequestration technology road map.

In March 2007, EPA issued technical guidance under our Safe Drinking Act authorities to help State and EPA regional managers in processing permit applications for experimental well permits for carbon sequestration. As I mentioned the Administrator then followed that up with an announcement in October 2007 that we are now fully committed to moving forward with a rulemaking, for full scale, not just experimental, but for full scale geo- sequestration of carbon dioxide recovered from emissions of coal fired power plants and other facilities. The proposed regulation which is currently in

development will take into account our UIC program requirements that we have for the existing classes under the UIC program.

The key components of the proposed regulation will include requirements related to geologic site characterization to ensure wells are sited in suitable areas to limit the potential for migration of injected and formation fluids into an underground source of drinking water. The proposed regulation that we're working on will include well construction and operation requirements to ensure wells are properly constructed and managed. Mechanical integrity testing for the wells, monitoring for the wells and also, importantly, well closure, post closure care and also financial responsibility requirements regarding the proper plugging and abandonment of injection wells.

Importantly we will also be discussing long term liability and seek further comment on the issue as part of the proposed rule-making. We recognize there will need to be a robust debate on this important issue. We're expecting that once this rule is proposed that we will take next steps, coordinate with our Federal colleagues, review public comments. We're estimating a final rule in late 2010 or sometime in 2011.

The rule will embrace the concept of adaptive management. We're using an adaptive approach that will allow the agency to collect information and use data from DOE demonstration and other early projects to inform the final regulation and any subsequent revisions, if necessary. The hallmark of progress for us on this is continued coordination at the Federal level, but also at the State level with our State partners, whether it's IOGCC or the Ground Water Protection Council and at the local level and the national laboratories and with the private sector.

Mr. Chairman, I would just underscore the importance of this. It's one of the Administrator's priorities in our agency's own climate change clean energy strategy. I look forward to answering questions members of the committee might have. Thank you, Mr. Chairman.

[The prepared statement of Mr. Grumbles follows:]

PREPARED STATEMENT OF BENJAMIN H. GRUMBLES, ASSISTANT ADMINISTRATOR FOR
WATER, ENVIRONMENTAL PROTECTION AGENCY

Thank you, Chairman Bingaman and Members of the committee. I am Benjamin H. Grumbles, the Assistant Administrator for Water at the EPA, and I appreciate the opportunity to describe the Agency's important work on regulatory aspects of carbon dioxide sequestration.

This Administration is committed to taking timely and responsible actions to confront the serious challenge of global climate change. EPA believes innovative solutions will be critical to meeting this long-term challenge, including technologies and practices to mitigate greenhouse gas emissions. The Administration is actively investigating the prospects for carbon capture and storage (CCS), a process that involves capturing carbon dioxide (CO₂) from power plants and other industrial sources and injecting it into deep subsurface geologic formations for long-term storage. CCS is one of a portfolio of innovative technologies that could make a significant contribution to reducing greenhouse gas emissions to the atmosphere and EPA is committed to advancing such efforts in a manner consistent with our obligation to safeguard public health and the environment as required by the Safe Drinking Water Act (SDWA).

EPA staff are evaluating many aspects of CCS technology and deployment, focusing our efforts in two areas: (1) partnering with public and private stakeholders to develop an understanding of the environmental aspects of carbon capture and storage that must be managed for the necessary technologies to become a viable strat-

egy for reducing greenhouse gases; and (2) ensuring carbon dioxide storage is conducted in a manner that protects underground sources of drinking water. My testimony focuses on the second of these two areas, EPA's development of a regulation for geologic sequestration (GS) of CO₂ and the collaboration taking place to support such efforts, all of which are relevant to your consideration of Section 5 of Senate Bill 2323.

Over the past several years, EPA has been coordinating with the Department of Energy (DOE), the lead agency for research and development of CCS technology. As DOE has developed a Carbon Sequestration Technology Roadmap for the development and deployment of this technology, EPA has been working to design an appropriate management framework for geologic sequestration. By engaging in DOE's expansive R&D program early and working with stakeholders on all sides of this issue, EPA is well positioned to help in the permitting of future carbon dioxide underground injection wells.

REGULATORY SCOPE, CONTENT, AND TIMEFRAME

EPA has statutory authority under the SDWA to carry out the Underground Injection Control (UIC) program to protect underground sources of drinking water from the injection of fluids for disposal or storage. In March 2007, EPA issued technical guidance to help State and EPA Regional UIC managers in processing permit applications for GS demonstration projects under the general UIC regulations. Recognizing that the technology is rapidly progressing towards full-scale deployment, Administrator Stephen Johnson announced, in October 2007, EPA's plans for developing national rules for full-scale GS of carbon dioxide recovered from emissions of coal-fired power plants and other facilities. EPA will propose regulations in the Federal Register this Summer to ensure that carbon dioxide injection is done in a manner that does not endanger underground sources of drinking water.

Under the SDWA, EPA develops minimum requirements for state UIC programs. States may develop their own regulations for injection wells in their State. These requirements must be at least as stringent as the federal requirements (and may be more stringent). Annually, billions of gallons of fluids are injected underground through wells authorized under State and Federal UIC Programs. This includes approximately 35 million tons of carbon dioxide that are injected for the purposes of enhancing oil and gas recovery. EPA's proposed regulations will build on the UIC Program's many years of experience in safely injecting fluids, including carbon dioxide, into the subsurface.

The proposed regulation, currently in development under an accelerated schedule, will take into account the EPA's existing UIC program requirements. Key components of the proposed regulation will include requirements related to: (1) geologic site characterization to ensure that wells are sited in suitable areas to limit the potential for migration of injected and formation fluids into an underground source of drinking water; (2) well construction and well operation to ensure that the wells are properly constructed and managed; (3) well integrity testing and monitoring to ensure that the wells perform as designed; and, (4) well closure, post-closure care and financial responsibility to ensure proper plugging and abandonment of the injection well. We will also discuss long-term liability and seek further comment on this issue as part of the proposed rulemaking.

Importantly, the proposal will also include public participation requirements that would be associated with issuance of permits. We will assess the costs of carrying out regulations for geologic sequestration programs as part of the economic analysis for the rulemaking.

EPA is reviewing available data on existing demonstration projects to inform our decision-making and development of the rule. Once a proposal is published, EPA will review public comments and take into account any new data and demonstration project outcomes prior to publishing a final rule by 2011. EPA's timeframe for the proposed rulemaking is consistent with the time frame for the DOE Roadmap, which projects fullscale project deployment to begin in the 2012–2020 timeframe. To ensure that GS can be deployed as rapidly and safely as possible, EPA is using an adaptive approach that will allow the Agency to collect information and use data from DOE demonstration and other early projects to inform the final regulation and any subsequent revisions, if necessary.

COORDINATION AND COLLABORATION

Within EPA, the Office of Water and Office of Air and Radiation are working together on all activities related to geologic sequestration in order to conduct technical and economic analyses, develop risk management strategies, collaborate with key

stakeholders, and clarify the relationships among various statutes (including the Safe Drinking Water Act and Clean Air Act) and EPA regulations.

EPA is working closely with DOE to leverage existing efforts and technical expertise. EPA and DOE are coordinating with Lawrence Berkeley National Laboratory to answer key technical questions regarding impacts on groundwater and underground formations. The Agency is also monitoring the progress of research being conducted by organizations such as the Pacific Northwest National Laboratory, Lawrence Livermore National Laboratory, and international projects such as Sleipner, In Salah, and Weyburn to help inform the regulatory framework.

The DOE's Regional Carbon Sequestration Partnerships are conducting demonstration projects to gather data on the effectiveness and safety of GS. These Regional Partnerships will implement many small and large-scale field tests of carbon dioxide injection throughout the country in a variety of geologic settings. One goal of the technical permitting guidance EPA issued in March of 2007 is to promote the exchange of information to support the development of a long-term GS management strategy.

EPA will also engage with the Department of Transportation, Department of Interior, States, and Tribes during the rulemaking process. EPA has worked closely with key organizations such as the Groundwater Protection Council (GWPC) and the Interstate Oil and Gas Compact Commission (IOGCC), which represent States that implement UIC programs, and we will continue to do so throughout the regulatory process. For example, the Agency has reviewed the IOGCC report entitled "Storage of Carbon Dioxide in Geologic Structures: A Legal and Regulatory Guide for States and Provinces." The document's discussion of issues such as permitting and property rights may be very useful as we develop regulations.

In December 2007, EPA established a workgroup on geologic sequestration to provide input to the proposed regulation. The workgroup includes EPA and DOE staff, as well as representatives of four state agencies, two of whom were recommended by the IOGCC and two by GWPC. Thus far, the workgroup has provided input on various aspects of the regulatory framework and has begun to draft issue papers on key issues.

Over the past several years, the Agency has been holding workshops, attending conferences and meeting with public and private stakeholders including industry experts, legal experts, technical experts, and environmental advocates to gather useful input. Our past experience gives us confidence we can work closely with key stakeholders and experts to develop well-designed regulatory approaches.

This past December, EPA held a meeting that focused on the potential regulatory framework for geologic sequestration. The two day workshop, held in Washington, DC, was attended by more than 200 stakeholders representing government, research institutions, industry, public interest groups, law firms, and the general public. Another stakeholder meeting is planned for February 26 and 27, 2008 in Alexandria, Virginia. Additionally, over the past year EPA has held technical workshops with researchers and stakeholders to discuss technical considerations for establishing a GS framework.

CONCLUSION

EPA is committed to working with our public and private partners to accelerate the important work underway to realize the significant potential of carbon dioxide capture and geologic storage. EPA will continue to engage with other federal agencies and encourage participation of states, associations, public interest groups, industry, and other stakeholders as the Agency moves forward on this critical path towards development of a regulatory framework. Consistent with the goal of Senator Kerry's bill, our goal is to develop sound regulations that will enable full-scale CCS projects to move forward without endangering underground sources of drinking water.

Thank you, Mr. Chairman and members of the committee for this opportunity to describe EPA's important work on carbon sequestration. I would be happy to answer any questions you may have.

Senator DOMENICI. Mr. Grumbles, I just have one question that came to my mind. I don't understand; why does it take 4 years to make a rule regarding a substance of like CO₂?

Mr. GRUMBLES. We have a lot of experience with CO₂ already under the UIC program under the class two category for enhanced oil and gas recovery. But this is a whole new approach, a whole new opportunity when it comes to long term storage. It's a complex

issue and it requires public participation and discussion and also that 4 years will allow us to take into account lessons learned as the demonstration projects occur, whether they are DOE or other demonstration projects through the process.

Senator DOMENICI. All right. Thank you.

Mr. Allred.

**STATEMENT OF STEPHEN ALLRED, ASSISTANT SECRETARY
FOR LAND AND MINERALS MANAGEMENT, DEPARTMENT OF
THE INTERIOR**

Mr. ALLRED. Senator Domenici, members of the committee, it's a pleasure to be here and to represent the Department of the Interior. As you're aware, we deal with oil and gas, coal, geothermal and biomass as well as fish and wildlife issues on Federal lands and Federal resources. We're involved in a number of different strategies with regard to carbon sequestration, including the capture and storage through enhanced oil recovery of carbon dioxide and into geologic formations and also investigating the capture through air and terrestrial biomass, soils and trees of carbon dioxide on our lands.

One of the things that is probably not well known is the fact that currently carbon dioxide is a salable commodity under the mineral leasing laws of the United States. We currently collect revenues in the form of royalties from the sale of carbon dioxide produced in connection with oil and gas production on public lands. In 2007 the sale of carbon dioxide generated over 23 million dollars in royalty revenues in Colorado, New Mexico and Wyoming. I mention that because one of the things that I think as we look forward to carbon sequestration is that it may well be a valuable resource for the future that can be recovered as we need it.

Specifically I would like to talk a little bit more about the opportunity I think that we have to investigate and understand carbon dioxide sequestration because of the number of enhanced oil recovery projects that we have. Some of the largest new ones are in Senator Barrasso's area in Wyoming. I think we have an opportunity by adding perhaps another purpose to those projects to learn a lot from carbon sequestration that we can then apply to other areas. It's also interesting to note that there are estimates that we have the capacity, based on preliminary estimates of carbon dioxide production and volume in our oil reservoirs to sequester, if they were in the right places, 20 to 40 years of carbon dioxide production.

Public Law 110-140, enacted last year, gave the Department of the Interior a number of different responsibilities. We are to develop and are currently involved in the process of developing a methodology for and to conduct national assessments of geologic capacity for sequestration. We are in the process of preparing a national assessment of storage capacity of oil and gas and saline reservoirs through the USGS. We will conduct that in conjunction with the Department of Energy, with the input of the Environmental Protection Agency, and equally as important, the State geological surveys that we work with.

It is our intent to convene an independent panel of experts and stakeholders to provide a technical review of that effort. Upon completion of that review the methodology will be published and pro-

vided for public use. There are also a number of other things that are ongoing efforts that we'll also try to answer some of these questions, certainly to identify the criteria to determine candidate geologic sequestration sites in various different types of geologic settings.

We will also be involved in looking at a proposed regulatory framework for leasing decisions on public lands with regard to long term sequestration. We also were mandated to determine a means by which we can provide for public review and comment and to ensure that we protect the quality of natural and cultural resources in those areas. To suggest additional legislation that we feel might be important. Again I want to emphasize as we go forward with these we will consult with our Federal and State partners and the public.

We believe, in conclusion, that it is extremely important to No. 1, understand the effect and to determine the complex issues that we will have in sequestration and there are many interrelated components to that. Secondly, we believe that it is important to use the ongoing activities that are already in place to try to enhance the knowledge that we have. The Department of the Interior is looking forward to working with other agencies and working with Congress to answer these important questions. I'd be most happy to answer any questions. I have a couple of experts with me if I can't answer those today.

[The prepared statement of Mr. Allred follows:]

PREPARED STATEMENT OF STEPHEN ALLRED, ASSISTANT SECRETARY FOR LAND AND MINERALS MANAGEMENT, DEPARTMENT OF THE INTERIOR

INTRODUCTION

Mr. Chairman and Members of the committee, thank you for the opportunity to provide the Department of the Interior's views on S. 2323, the "Carbon Capture and Storage Technology Act of 2007" and S. 2144, the "Carbon Dioxide Pipeline Study Act of 2007." As both bills vest the Secretary of Energy with primary authority and the Secretary of the Interior is identified as a cooperator, I will defer to the Department of Energy for specific views on this legislation. My testimony today will address the Department of the Interior's perspective on carbon capture and storage as it relates to future work of the Department's bureaus, specifically the U.S. Geological Survey (USGS) and the Bureau of Land Management (BLM).

The challenges of addressing carbon dioxide accumulation in the atmosphere are significant. Fossil fuel usage, a major source of carbon dioxide emissions to the atmosphere, will continue for the foreseeable future in both industrialized and developing nations. Therefore, a variety of strategies are being investigated to reduce emissions and remove carbon dioxide from the atmosphere. Such strategies include the facilitated sequestration of carbon for the capture and storage of carbon dioxide by injection into geologic formations as well as capture from the air to terrestrial biomass, including soils and trees.

Carbon injection techniques also have useful practical applications in processes known as enhanced oil recovery (EOR), which currently takes place on some public lands managed by the Bureau of Land Management. Carbon dioxide is a saleable commodity under the Mineral Leasing Act of 1920. The Bureau of Land Management currently collects revenues in the form of royalties derived from the sale of carbon dioxide produced in connection with oil and gas production on public lands. In 2007, for example, the sale of carbon dioxide generated over \$23 million in royalty revenue in the states of Colorado, New Mexico, and Wyoming.

In addition to enhancing oil recovery, EOR's utilization of carbon injection may yield valuable data that will inform efforts to capture and sequester carbon dioxide effectively in geologic formations found on public lands. A critical issue for evaluation of storage capacity is the integrity and effectiveness of these formations for sealing carbon dioxide underground, thereby preventing its release into the atmosphere.

GEOLOGIC STORAGE OF CARBON

The current atmospheric carbon dioxide concentration is approximately 380 parts per million volume and rising at a rate of approximately 2 parts per million volume annually, according to the most recent information from the Intergovernmental Panel on Climate Change (IPCC). The 2005 IPCC Special Report on Carbon Dioxide Capture and Storage concluded that in emissions reductions scenarios striving to stabilize global atmospheric carbon dioxide concentrations at targets ranging from 450 to 750 parts per million volume, the global storage capacity of geologic formations may be able to accommodate most of the captured carbon dioxide. How much of this carbon dioxide storage capacity would be economically feasible (assuming some price on carbon), however, is not known. Also, geologic storage capacity may vary widely on a regional and national scale. A more refined understanding of geologic storage capacity is needed to address these knowledge gaps.

Geological storage of carbon dioxide in porous and permeable rocks involves injection of carbon dioxide into a subsurface rock unit and displacement of the fluid or formation water that initially occupied the pore space. This principle operates in all types of potential geological storage formations such as oil and gas fields, deep saline water-bearing formations, or coal beds. Most of the potential carbon dioxide storage capacity in the U.S. is in deep saline formations.

ONGOING EFFORTS

H.R. 6, the Energy Independence and Security Act of 2007 (EISA), which the President signed into law last month, includes provisions on Carbon Capture and Storage that the Department is working to implement. The requirement in Section 7 of S. 2323 directing the Secretary of the Interior, acting through the Director of the U.S. Geological Survey (USGS), to develop a methodology for and conduct a national assessment of geological storage capacity for carbon dioxide is very similar to Section 711 of EISA and therefore we believe inclusion of this provision in new legislation is unnecessary.

The Department has developed an implementation plan for Section 711. In fiscal year 2008, the Department will begin development of a methodology that could be used to conduct assessments of carbon dioxide storage capacity in oil and gas reservoirs and saline formations nationally. The methodology development will be conducted in coordination with a number of organizations in order to maximize the usefulness of the assessment for a variety of partners and stakeholders. These organizations include the Department of Energy, the Environmental Protection Agency, and State Geological Surveys. In particular, the Department will coordinate its work with Department of Energy's National Carbon Sequestration Database and Geographical Information System (NATCARB). The purpose of NatCarb is to assess the carbon sequestration potential in the U.S. and to develop a national Carbon Sequestration Geographic Information System (GIS) and Relational Database covering the entire U.S.

An independent panel, consisting of individuals with relevant expertise and representing a variety of stakeholder organizations, will be convened to provide a technical review of the methodology. Upon completion of the review, the methodology will be published and available for public use. The subsequent national assessment called for by EISA would need to compete among other administration priorities for funding.

In addition, Section 714 of the EISA directs the Department to develop a framework for geological sequestration on public land and report back to this committee, as well as the House committee on Natural Resources, by December 2008.

This effort, coordinated among several agencies within the Department, is anticipated to result in recommendations relating to:

- criteria for identifying candidate geological sequestration sites in several specific types of geological settings;
- a proposed regulatory framework for the leasing of public land or an interest in public land for the long-term geological sequestration of carbon dioxide;
- a procedure for ensuring any geological carbon sequestration activities on public land provide for public review and protect the quality of natural and cultural resources;
- if appropriate, additional legislation that may be required to ensure that public land management and leasing laws are adequate to accommodate the long-term geological sequestration of carbon dioxide; and
- if appropriate, additional legislation that may be required to clarify the appropriate framework for issuing rights-of-way for carbon dioxide pipelines on public land.

The report will also describe the status of Federal leasehold or Federal mineral estate liability issues related to the release of carbon dioxide stored underground in public land, including any relevant experience from enhanced oil recovery using carbon dioxide on public lands.

The report will, in addition, identify issues specific to the issuance of pipeline rights-of-way on public land and legal and regulatory issues specific to carbon dioxide sequestration on land in cases in which title to mineral resources is held by the United States, but title to the surface estate is not.

This effort will be undertaken in coordination with the Environmental Protection Agency, the Department of Energy, and other appropriate agencies.

CONCLUSION

It is clear that addressing the challenge of reducing atmospheric carbon dioxide and understanding the effect of global climate change is a complex issue with many interrelated components. The assessment activities called for in the recently passed Energy Independence and Security Act of 2007 should ultimately increase the information base upon which decision makers will rely as they deal with these issues, and the assessments called for in these bills would duplicate those already mandated. In addition to addressing the challenges presented by carbon dioxide, we should also recognize that this commodity presents certain opportunities for future knowledge and utilization. As a leasable commodity, our experience demonstrates that there is a demand and a value attributable to this resource. As we examine undeveloped oil and gas reservoirs, we should consider the potential benefits of accessible sequestered carbon dioxide. It is clear that the discussion on this subject will continue and the Department stands ready to assist Congress as it examines these challenges and opportunities. Thank you for the opportunity to present this testimony. I am pleased to answer questions you and other Members of the committee might have.

The CHAIRMAN [presiding]: Thank you very much. Mr. Slutz, go right ahead.

STATEMENT OF JAMES SLUTZ, ACTING PRINCIPAL DEPUTY ASSISTANT SECRETARY, OFFICE OF FOSSIL ENERGY, DEPARTMENT OF ENERGY

Mr. SLUTZ. Ok. Mr. Chairman, members of the committee, it is my pleasure to appear before you today to discuss Senate bills 2323 and 2144. I currently serve as the Acting Principle Deputy Assistant Secretary for Fossil Energy.

Balancing the economic value of fossil fuels with the environmental concerns associated with fossil fuel use is a difficult challenge. Carbon capture and storage technologies provide a key strategy for reconciling energy and environmental concerns. DOE has assumed a leadership role in the development of carbon capture and storage technologies and in fact the United States, I would argue, is the global leader in this area. Through its carbon sequestration program DOE is developing the technologies through which geologic carbon sequestration could become an effective and economically viable option for reducing CO₂ emissions.

Since DOE first investigation into carbon sequestration began in 1997 with a budget of one million dollars, DOE has spent a total of 483 million through fiscal year 2008. Our fiscal year 2009 budget request of 148 million is a powerful sign of the continuing importance of this technology to our energy and environmental future. I might add that fiscal year 2009 we had a 30 million dollar increase over our 2008 request.

A recent report completed by the National Petroleum Council which was a comprehensive landmark study requested by the Secretary of Energy titled, "Facing the Hard Truths About Energy". The NPC's purpose of this report was to increase understanding

about the scale and significance of the energy industries activities and to produce sound, balanced strategies to meet today's challenges and benefit future generations. In the section of the report dealing with carbon management, the NPC recommended and I quote, "The United States must develop the legal and regulatory framework to enable carbon capture and sequestration and as policymakers consider options to reduce CO₂ emissions provide an effective global framework for carbon management." DOE is doing precisely that as a few examples more fully described in my submitted testimony illustrate.

DOE is working to increase the cost effectiveness of carbon capture technologies and to prove the viability of a long term geologic and terrestrial CO₂ storage. DOE's regional carbon sequestration partnerships are co-funding field tests for large scale CCS demonstrations. DOE is working closely with the Environmental Protection Agencies and the states through organizations such as the Interstate Oil and Gas Compact Commission to establish a standardized regulatory framework for CO₂ storage in deep geologic formations.

In December 2007, DOE participated in EPA's first workshop in preparation for a proposed rule for large scale injection of CO₂. Fortunately the United States has a large number of geologic formations amenable to CO₂ storage. In fact according to the 2006 carbon sequestration atlas of the United States and Canada, aggregate CO₂ sink capacity is estimated to hold several hundred years of total domestic U.S. emissions.

The U.S. Government, DOE and other agencies of the 50 States, several Canadian provinces, private industry, environmentalists and the scientists and the engineers have expended great effort, invested heavily and made remarkable progress over the last decade in understanding and preparing for an energy and environmental future in which carbon sequestration technology will play an integral role. DOE believes regarding the specific bills being considered, DOE does have some specific positions. DOE believes that the research and development and demonstration projects prescribed in Sections 3, 4 and 6 of Senate Bill 2323 are duplicative of our R&D demonstrations underway in our existing program.

We also believe that Section 5ive which requires interagency task force duplicates the task force the EPA has underway. Section 6 of the proposed legislation would shift lead responsibility for part of the Department's R&D program from Fossil Energy to the Office of Science. DOE opposes this provision.

Senate Bill 2144 would require a feasibility study related to the construction and operation of pipelines and carbon dioxide sequestration facilities and for other purposes. DOE supports this legislation.

There are many questions and I think it's useful to consider the scale of CO₂ issues and CO₂ management. Building the infrastructure required to capture and store the CO₂ emitted by energy producing activities requires serious, long term commitment on the part of government and industry and the public. As an example, in the United States all the CO₂ from existing coal fired electric generation alone would total, if liquefied, would total 50 million barrels per day. That's two and a half times the volume of oil handled

daily in the United States. Again I mention that just to scale the challenge and illustrates the urgency of moving forward with some of these issues.

Mr. Chairman, thank you for the opportunity to testify today. I'd be happy to answer any questions.

[The prepared statement of Mr. Slutz follows:]

PREPARED STATEMENT OF JAMES SLUTZ, ACTING PRINCIPAL DEPUTY ASSISTANT
SECRETARY, OFFICE OF FOSSIL ENERGY, DEPARTMENT OF ENERGY

Mr. Chairman, members of the committee, it is a pleasure for me to appear before you today to discuss Senate bills 2323 and 2144.

I intend, first, to survey The Department of Energy's (DOE) overall Carbon Sequestration Research and Development program, our goals and our progress to date. I will then describe DOE's collaboration with the Environmental Protection Agency (EPA) in carbon capture and storage.

Complete knowledge of all these efforts already underway should be of interest as the Senate bills under consideration go forward.

CARBON SEQUESTRATION AND FOSSIL FUELS

The availability of affordable energy is a bedrock component of economic growth. The use of fossil fuels, however, can result in the release of emissions with impacts on the environment. Of growing significance are emissions of carbon dioxide (CO₂) which contribute to global climate change.

Balancing the economic value of fossil fuels with the environmental concerns associated with fossil fuel use is a difficult challenge. Carbon capture and storage technologies provide a key strategy for reconciling energy and environmental concerns. Geologic sequestration—the capture, transportation to an injection site, and long-term storage in a variety of suitable geologic formations—is one of the pathways that DOE is pursuing to allow the continued use of fossil fuels while reducing CO₂ emissions.

DOE has assumed a leadership role in the development of carbon capture and storage technologies. Through its Carbon Sequestration Program—managed within DOE's Office of Fossil Energy and implemented by the National Energy Technology Laboratory (NETL)—DOE is developing technologies through which geologic carbon sequestration could potentially become an effective and economically viable option for reducing CO₂ emissions. The Carbon Sequestration Program works in concert with other programs within the Office of Fossil Energy that are developing the complementary technologies that are integral to coal-fueled power generation with carbon capture: Advanced Integrated Gasification Combined Cycle, Advanced Turbines, Fuels, Fuel Cells, and Advanced Research. Successful research and development could enable carbon control technologies to overcome various technical and economic barriers in order to produce cost-effective CO₂ capture and enable wide-spread deployment of these technologies.

DOE'S CARBON SEQUESTRATION PROGRAM

Since DOE's first investigation into carbon sequestration began in 1997 with a budget of \$1 million, DOE has spent approximately \$483 million through Fiscal Year 2008 (twelve year cumulative total) on further research and development, a powerful sign of the importance of this technology to our energy and environmental future.

The Carbon Sequestration Program, with a Fiscal Year 2008 budget of \$119 million, encompasses two main elements of technology development for geologic sequestration: Core R&D and Validation and Deployment. The Core R&D element addresses several focus areas for laboratory technology development that can then be validated and deployed in the field. Lessons learned from the field tests are fed back to the Core R&D element to guide future research and development. Through its Integrated Gasification Combined Cycle, Fuels, Sequestration, and Advanced Research programs, DOE is investigating a wide variety of separation techniques, including gas phase separation and adsorption, as well as hybrid processes, such as adsorption/membrane systems. Current efforts cover not only improvements to state-of-the-art technologies but also the development of several revolutionary concepts, such as metal organic frameworks, ionic liquids, and enzyme based systems. The ultimate goal is to drive down the energy penalty associated with capture so

that geologic sequestration can be done with only a moderate increase in the cost of electricity.

REGIONAL CARBON SEQUESTRATION PARTNERSHIPS

One of the key questions regarding geologic sequestration is the ability to store CO₂ in underground formations with long-term stability (permanence); this requires monitoring and verification of the fate of the CO₂, to ensure that the science is sound and ultimately gains public acceptance. DOE's NETL, with the Regional Carbon Sequestration Partnerships (RCSPs) are developing and validating technology, and national infrastructure needed to implement geologic sequestration in different regions of the Nation.

The RCSPs are evaluating numerous geologic sequestration approaches in order to determine those best suited for specific regions of the country. They are also helping develop a framework to validate and deploy the most promising technologies for geologic sequestration.

A THREE-PHASE APPROACH

NETL's three-phased approach began with a Characterization Phase in 2003 that focused on characterizing regional opportunities for carbon capture and storage, and identifying regional CO₂ sources and storage formations. The Characterization Phase was completed in 2005 and led into the current Validation Phase, which focuses on field tests to validate the efficacy of geologic sequestration technologies in a variety of storage sites throughout the U.S. Using the extensive data and information gathered during the Characterization Phase, NETL identified the most promising opportunities for carbon storage in their regions and commenced geologic field tests. In addition, NETL is verifying regional geologic sequestration capacities initiated in the first phase, satisfying project permitting requirements, and conducting public outreach and education activities.

The third phase, or Deployment Phase, for large-volume testing is intended to demonstrate the feasibility of CO₂ capture, transportation, injection, and storage at a scale comparable to future commercial deployments. DOE has in recent months awarded funds to initiate five large-volume demonstration projects. Depending on the results of a scientific needs assessment being conducted in FY 2008 and the ability of additional project proposals to meet those needs, additional large-scale projects may be initiated. In October, 2007, DOE announced awards totaling \$318 million for two projects with the Plains Carbon Dioxide Reduction Partnership, and one project each with the Southeast Regional Carbon Sequestration Partnership and Southwest Regional Partnership for Carbon Sequestration. In December, DOE announced a \$66.7 million award for a project with the Midwest Geological Sequestration Consortium.

The geologic structures to be tested during these large-volume storage tests will serve as potential candidate sites for the future deployment of technologies demonstrated in FutureGen and the Clean Coal Power Initiative, which plans to complete a solicitation for carbon capture technologies at commercial scale in 2008.

The NETL, with the RCSPs and the National Carbon Sequestration Database and Geographical Information System (NATCARB), has created a methodology to determine the capacity for CO₂ storage in the United States and Canada and an Atlas from data generated by the RCSPs and other databases, including the United States Geological Survey's (USGS) National Coal Resources Data System, USGS National Water Information System Database, and EROS Database. Based on data displayed in the *2006 Carbon Sequestration Atlas of the United States and Canada*, the aggregate CO₂ sink capacity—including saline formations, unmixable coal seams, and oil and natural gas formations—is estimated to hold several hundred years of total domestic U.S. emissions.

MOVING TOWARD COMMERCIAL DEPLOYMENT

Carbon capture and storage can play an important role in mitigating carbon dioxide emissions under potential future stabilization scenarios. The United States has a large capacity of geologic formations amenable to CO₂ storage. DOE's Carbon Sequestration Program will continue to help move geologic sequestration technology toward readiness for commercial deployment.

EPA'S ROLE IN THE DEPLOYMENT OF CARBON CAPTURE AND STORAGE TECHNOLOGY

Complementing DOE's carbon capture and R&D research program is the EPA program for ensuring that underground injection of CO₂ is conducted in a manner that is protective of underground sources of drinking water (USDWs) in accordance with

section 1421(d)(2) of the Safe Drinking Water Act (SDWA). EPA is initiating work to develop proposed regulations to ensure consistency in permitting commercial scale geologic sequestration projects. It plans to propose regulations in the summer of 2008. EPA is also responsible for reviewing and commenting on environmental impacts statements under the National Environmental Policy Act (NEPA).

As DOE moves forward with its R&D program and geological storage projects, EPA is focused on: evaluating risks to human health and the environment; providing guidance on permitting CO₂ injection wells for pilot-scale projects; identifying technical and regulatory issues associated with field tests and commercial projects; and developing an appropriate management framework for permitting.

DOE-sponsored and industry-sponsored research will help develop data and tools to address these issues. It is anticipated that EPA will aggregate and analyze the information generated from those efforts and initiate new research where there are gaps.

DOE has also sponsored a five-year, two-phase study by the Interstate Oil and Gas Compact Commission (IOGCC), which is reported on in the publication a Model CO₂ Storage Statute and Model Rules and Regulations. The report provides industry perspective on development of regulations governing the storage of CO₂ in geologic media and an explanation of those regulatory components. EPA will consider these and other viewpoints in its regulatory development process.

PROGRAM COORDINATION

EPA coordinated with DOE in the preparation of its research plan, and is working closely with DOE, state regulators and other stakeholders on all geological storage activities so as to leverage resources, clarify key questions and data gaps, and ensure that work is complementary and not duplicative.

EPA and DOE, for example, hold quarterly coordination meetings (at both the staff and managerial level) to share progress and discuss key issues.

EPA, in coordination with DOE, organized a series of technical workshops in 2007 to help define future research needs. The workshops were focused on technical issues that need to be addressed in order to design, operate, and permit CO₂ injection wells. Attendees included EPA and state regulators, DOE project managers, and DOE-funded researchers.

In addition, EPA has and will continue to be involved in major DOE/NETL activities such as the National Conferences on Carbon Sequestration and the Regional Partnership Annual Review Meetings.

S. 2323: CARBON CAPTURE AND STORAGE TECHNOLOGY ACT OF 2007

The U.S. Government, DOE and other agencies, the 50 states, several Canadian provinces, private industry, environmentalists, and scientists and engineers have expended great efforts, invested heavily and made remarkable progress over the last decade in understanding and preparing for an energy and environmental future in which carbon sequestration technology will play an integral role.

The Administration strongly supports research and development of carbon capture and storage technology as a solution to reduce carbon dioxide emissions and address global climate change. The Administration is currently performing the research and development needed to successfully develop this technology. DOE has numerous initiatives looking at decreasing the cost of carbon dioxide capture and proving the permanence of carbon dioxide storage in geologic formations and has success with its current structure. DOE believes that the research, development and demonstration projects prescribed in Sections 3, 4 and 6 of Senate Bill 2323 are generally duplicative of the R&D and demonstrations underway in our existing program. DOE is currently evaluating some of details of this bill within the context of its existing program, such as the use of competitive grants to fund commercial demonstration of carbon dioxide sequestration and the number of projects needed.

Section 5 of this bill would require an interagency task force to develop regulations for the capture and storage of carbon dioxide. This task force was officially established last year, and is chaired by EPA, with considerable support from DOE. Therefore, we believe that this section of the bill is also redundant.

For the past 10 years, DOE's Sequestration Program within the Office of Fossil Energy has funded research in areas of carbon dioxide capture, storage, monitoring, mitigation, and verification (MMV), breakthrough concepts, and infrastructure development through its Regional Partnership Initiative. NETL is researching the most suitable technologies, informing regulatory development, and evaluating infrastructure needs for carbon capture, storage, and sequestration in different areas of the country. The RCSPs are conducting much of these efforts, and include 41 states and over 350 distinct organizations working together for the most cost-effective solu-

tions. Additionally, the Clean Coal Power Initiative and FutureGen are providing the demonstration platform for testing larger carbon dioxide capture methods at power plants. These activities are currently providing the plan forward and should continue along their current path to produce the best results at the earliest time so that this technology can be an important option to cost-effectively reduce greenhouse gas emissions.

S. 2144: CARBON DIOXIDE PIPELINE STUDY ACT OF 2007

This bill would require the Secretary of Energy, in consultation with the Federal Energy Regulatory Commission, the Secretary of Transportation, the Administrator of the EPA, and the Secretary of the Interior to conduct a feasibility study relating to the construction and operation of pipelines and carbon dioxide sequestration facilities, and for other purposes. It also requires that the Secretary provide this report to Congress no later than 180 days after the enactment of this bill. DOE supports this legislation and notes that, although it is the study lead, it will work closely with the other agencies in conducting this study, and in particular with DOT's Pipeline and Hazardous Materials Safety Administration (PHMSA), which will have a leading role in evaluating plans for construction and operation of pipelines for carbon dioxide. Mr. Chairman, and members of the committee, this completes my prepared statement. I would be happy to answer any questions you may have at this time.

The CHAIRMAN. Thank you all very much. There are a lot of questions, obviously. One of the questions that occurs to me is what we are talking about when we talk about permanent CO₂ storage. I know Senator Kerry referred to permanent CO₂ storage.

Mr. Grumbles, I was not here during your testimony. I had to step out, but is this an issue? Is EPA planning to clearly define the required length of storage time for CO₂ in the regulatory work that you're working on these days?

Mr. GRUMBLES. Senator, I know we will certainly address that issue. That is one of the key areas, long term liability, financial responsibility and duration of requirements. So we do intend to seek comment on questions such as those about the duration and also on the responsibility, financial responsibility requirements.

Currently much of the UIC program, Underground Injection Control Program, has in place for other types of injections of fluids, financial responsibility requirements that last typically 30 years. So one of the questions that is very much going to be at the forefront of our debate and discussion is duration. How long of a period to ensure that there's monitoring and responsibility, financial responsibility.

The CHAIRMAN. Let me ask you, Chairman Kellier, what road do you see FERC as appropriately performing here? Is FERC the appropriate entity to regulate transportation rates? Is that something that you think is clearly FERC's responsibility?

Mr. KELLIHER. I think we could regulate the rate. There are three really existing models on how to regulate pipeline transportation either of energy resources or CO₂. In two of the three existing models FERC does set the transportation. In the other one the rate is—can be set by the Surface Transportation Board upon complaint. Otherwise it's set through a contract between parties. But FERC certainly has set the rate for oil and gas pipelines for decades.

The CHAIRMAN. Let me ask you, Mr. Allred, if you could just elaborate a little bit on what responsibility you would see in your agency for the site selection on Federal lands to the extent that someone were to determine that they wanted to pursue a carbon storage sequestration project on Federal lands. How far are you

from having in place a regulatory framework that would tell them how to proceed?

Mr. ALLRED. Mr. Chairman, members of the committee, I think that at this point in time we would have the basic rules that we could use in a sequestration project. There will be lots of questions as we go forward. One of the things that we have thought about are some demonstration projects that would, associated with enhanced oil recovery, help us answer some of those questions.

But I think the leasing rules and the Mineral Leasing Act and the laws that we have with regard to the management of Federal lands provide us the basics that we would need. That does not mean that as we go forward there won't need to be enhanced and changed.

The CHAIRMAN. All right. Let me go ahead and call on the next Senator on this.

Senator Barrasso.

Senator BARRASSO. Thank you very much, Mr. Chairman, and I want to first commend Senators Coleman and Senator Kerry for bringing this legislation before us today. The carbon capture, transmission and sequestration are enormously important to the people of Wyoming. Mr. Allred made some comments about that.

Wyoming produces about 38 percent of our Nation's coal. This coal provides a substantial portion of America with affordable electricity. Wyoming holds promising geologic formations for coal sequestration. Wyoming has experience in safely moving carbon dioxide and effectively using it for our enhanced oil recovery. Since emissions are not always located near appropriate geologic voids, carbon dioxide may need to be transported through States like Wyoming.

So I think we need some additional research to inform us on these issues. Congress and State Legislatures must fully explore any gaps in the existing legal and regulatory frameworks. The Wyoming Legislature is doing that when it meets next week in Cheyenne for this session.

I concur with Senator Coleman and Kerry on the urgency of this problem—and certainly in light of the current climate change debate and the potential of Congress imposing a price on carbon in one form or another. I am hearing a lot about this around the State of Wyoming. I'm hearing it from workers, from consumers, and also from industry.

Many of my constituents are increasingly concerned that the Federal Government will impose a cap on carbon before we've developed the appropriate legal and regulatory framework to address carbon dioxide. They're concerned that Congress is going to act on those issues before we act on the technology. So I applaud what Senators Coleman and Kerry are trying to do.

If anything I'm going to be pushing to do more research and more analysis, find more certainty for markets and to delve deeper into the important areas such as liability of CO₂ as it's transported and stored and some of the things that we've heard from the Honorable Edwards and to accomplish all of this in a shorter period of time. I'm distressed when I hear it's going to take till the year 2011 before regulations can be written. I want to thank the Chairman for calling this meeting.

I do have a question or two for Mr. Slutz. It really has to do a little bit with something along this line but a little different and that's the Future Gen issue from the Department of Energy. We talk about public/private partnerships, and when private entities put up money and make decisions, business decisions, that they want to have confidence that they're going to have a good partner in the U.S. Government. With this change for Future Gen, I think that confidence is eroding.

My question is how can we make sure that commitments by the Federal Government are really commitments that the private enterprises can depend upon and rely on?

Mr. SLUTZ. Thank you, Senator. You know and the, I should say the Future Gen decision that was announced yesterday was a very challenging and difficult decision. But part of that commitment is a partnership and you have to have both—there's the Federal Government and the industry partners. Both of those have to have agreements that they can work through and when a project doubles in cost it's a time to sit down and rework those agreements. In the details of that it was decided that the current agreement was not in the best interest of the American people and there were—the requirements that would have been in place to go forward would have put that project at risk.

So this issue is very, very important, too important not to allow that not to be successful. The decision was made by the Department to—with a new direction. Not a lack of commitment to Future Gen or a lack of commitment to furthering research and furthering demonstrating the technology of carbon capture and storage on a full commercial scale project, but doing it a way, I think, that the market could really act and it would be very market based commercial type plans that would be where the success would be very likely. That was the foundation for that decision is to make sure we have a successful outcome.

Senator BARRASSO. Mr. Chairman, as a member of both the Energy committee as well as the Environment and Public Works committee we're looking at using all the sources of energy, but doing it in an appropriate way for our environment. We don't want to put the cart before the horse too far. We want to make sure that we're working in unison to try to get things going on developmentally and educationally in a way that would help folks and help our environment, but also make sure that we have all the energy that we need. Thank you, Mr. Chairman.

The CHAIRMAN. Thank you very much.

Senator TESTER.

Senator TESTER. Thank you, Mr. Chairman. I want to thank Senator Barrasso for his comments. I want to dovetail on to them initially. Mr. Slutz, what's the level of urgency in the DOE as far as carbon capture and storage?

Mr. SLUTZ. It's the very critical to much of our research programs. A majority of clean coal is about how do we increase efficiency, reduce emissions or actually have carbon capture and storage. I think one of the urgencies that's communicating if you look at part of this decision on Future Gen and to communicate the importance that the Administration places on our clean coal research program.

We released our budget numbers early this year and showed a very significant increase in coal research which shows how we want to move this faster.

Senator TESTER. Coal research based on carbon capture?

Mr. SLUTZ. Based on carbon capture and storage.

Senator TESTER. How close are we to having a large scale carbon capture technology available?

Mr. SLUTZ. The technology exists. The issue is the cost of the technology and the costs that it would—

Senator TESTER. How close are we to having to having affordable large scale carbon capture technology?

Mr. SLUTZ. First let me, the technology exists. One of the advantages of this Future Gen approach is to actually get a commercial power plant in operation. We're looking at a date of 2015 that it could be operational on this because we don't know all of the costs. We only now can speculate and estimate the costs, but having actual real data on commercial scale, commercial operating power plants will be hugely beneficial in making those advancements in the future.

Senator TESTER. Ok. I just tell you I echo Senator Barrasso's comments. We have to have the technology. That technology is critically important. Everybody blames the price of food on corn ethanol. There's also a worldwide drought. That probably has more to do than any kind of renewable energy policy we put out of here.

I attribute a lot of that to worldwide global warming. I think that if we lead, and we lead in a way that's there's urgency, we can have our eggs and eat it too, as Senator Coleman said. That is that we can develop technology we can sell to other countries and we can clean it up on a worldwide basis. But there has to be a level of urgency. Because if there's not a level of urgency, we'll develop the technology and it will be too late.

I've got a question for Mr. Grumbles from the EPA. You talked about under any proposed regulation, and I'm reading from your written statement, currently under development that geological site characterizations to ensure that wells are sited in suitable areas to limit potential for migration and injected formation fluids into underground drinking water. Now I know you're with the drinking water area of the EPA, but what about leeching into the atmosphere? Isn't that also considered insuitable sites?

Mr. GRUMBLES. It's a very important issue that is part of our discussions with the Air Office. It's part of our discussions with all the stakeholders so far and all the national workshops and research forums we've had. We want to look at the environmental risks but from the standpoint of the Safe Drinking Water Act.

Senator TESTER. Ok.

Mr. GRUMBLES. We will be focusing on protection of underground sources of drinking.

Senator TESTER. I appreciate that. But so what you're saying here only as it applies to drinking water, but somebody's got to be looking at leeching of the atmosphere because that's another significant problem.

Mr. GRUMBLES. Monitoring of these sites it's very important to have post closure monitoring of sites as it is with existing UIC programs.

Senator TESTER. Ok.

Mr. GRUMBLES. Monitoring can get into releases, surface releases as well.

Senator TESTER. Good. Mr. Allred, I have a question that kind of dovetails on the chairman's question. It deals with storage and with the plume that will be created with CO₂ storage. I don't care where you put it. That plume may affect not only Federal lands but also private lands and private lands where there's Federal minerals underneath them.

What do you recommend, or do you have a recommendation to deal with the liability as it applies to the plume and potential exposure there. Keeping in mind that, we put it under the ground, somebody may decide to drill a hole and let it out, that might happen on private lands. So how do you deal with that issue?

Mr. ALLRED. Mr. Chairman, Senator Tester, I—as I look at the Federal land question and I look at most of my background as you probably know is not in government. I look at how do you implement projects or how do you cause things to occur. To me one of the most important things that we need to look at is, first, to keep regulation as simple as it can be because if it is complicated, I think that that will deter people and organizations and financial resources from being applied to this.

Second, there's a big learning curve on this. The more that we can use existing legal frameworks to assure that we don't have unintended consequences or that we provide the ownership and responsibility for these the better off we'll be. I think that our oil and gas laws, both the Federal Government's and the State's, perhaps provide some of that mechanism. Particularly on Federal lands we think that through our leasing requirements and steps that we take to assure that oil and gas is properly handled and that the United States receives its proper royalty from that.

If you use the reverse of that, we think that those same processes or same legal applications can work on Federal grounds. I think one of the things you really have to consider is who owns that carbon dioxide because if you decide that then you probably have gone a long way to decide about liability and responsibility. If they are on Federal lands or Federal resources we're either going to have an agreement with the lessee to store their carbon dioxide or there will be decisions that that will become a Federal resource where there's Federal ownership and before that agreement is ever entered into there will be some assurances as to how safe it is to have it where it is.

Senator TESTER. I've run out of time, but the other question is what happens if it starts on Federal land and moves into private land? I don't want you to answer that because there are other people that have questions but that is a concern.

The CHAIRMAN. Senator Corker.

Senator CORKER. Actually I think that is a great question. This is an area that I guess I'm somewhat skeptical about just because, for a long, long time we've been pumping carbon in the air and we figure out here recently that's a problem. I don't know if we've done enough work to see what kind of problems will exist underground pumping tremendous amounts of carbon in.

But I'd love for you to answer Senator Tester's question because it seems to me that we do get into a lot of mineral rights issues, and storage rights issues. Storage can end up taking place under somebody's land and they might want to drill for something else. I mean it does seem to me there are a lot of complications that exist. So please answer Senator Tester's question.

Mr. ALLRED. Mr. Chairman, Senator Corker, to the best that I can, I will. But one of the advantages we have with depleted oil or even operating oil reservoirs is there's a tremendous amount of information about that reservoir with regard to its extent and characteristics. That's a source of data that we don't have perhaps in places that we might seek to sequester where we have not had that oil or gas experience.

Not in all cases will we be 100 percent sure. That's going to be a, I'm mean, there's got to be a concern about that because we may not. But remember why the oil and gas is there. It was captured because there was some structure that kept it there. What will be a bigger question probably is what have we done to make it not suitable because obviously we've drilled holes. That is an issue that can be dealt with fairly easily although it might be expensive.

The second question is when you enhance oil recovery, you do a thing called fracking and you fracture some of the area in order to have oil flow into a well more easily. That will be a real question as to how that fracking has affected those reservoirs and their integrity. That is something that we'll have to understand.

Senator CORKER. So is it envisioned that if a property, private property owner has an area underneath them where oil has been recovered and now there's a cavern there or someplace just to store carbon that that person would actually be paid for carbon to be stored under their land?

Mr. ALLRED. Mr. Chairman, Senator, if you were to follow the oil and gas laws and that's a big if, I think.

Senator CORKER. Right.

Mr. ALLRED. That has to be decided on non-Federal lands. I would assume that there would have to be a lease like an oil lease so you could use that. But I think that's one of the big questions about how do you regulate. I think the question on Federal land may be more clear than on private lands.

Senator CORKER. Yes, I would guess so. I actually think that as we get into this, while I agree with others there should be a tremendous sense of urgency, I think there are so many complications that exist around this that I can see how it might take several years to work out this whole process of rulemaking even though we'd like to see it happen more quickly.

In the area of drinking water itself it seems to me that water is becoming more and more of an issue even in a State like Tennessee. Talk to us about some of the hazards that exist, that you can envision existing storing carbon adjacent to water supplies and those types of things.

Mr. GRUMBLES. Senator we have extensive experience as was already mentioned with the Class two UIC program under the Safe Drinking Water Act injecting carbon dioxide for enhanced oil and gas recovery. But one of the key areas of focus for us, as we work to issue a regulation ensuring there are safeguards for the long

term storage and sequestration of carbon dioxide, is to reduce the likelihood of migration of that CO₂ into underground sources of drinking water. That it can lead to different types of pollution problems.

I would say one of the areas we're looking at as potential risks to aquifers, potential sources of drinking water, because we recognize that in some areas—data we have indicates that by 2013 at least 36 States in this country will experience some form of water shortage. That's not just in drought stricken areas. It's a combination of growth and population and development or drought.

So for us as we're going through this analysis, of CO₂ storage, we want to make sure that it doesn't migrate, that it stays in place. The experience to date is that it is a very promising technology. That it does stay in place for very long periods of time if the geologic siting is done properly, the well construction is done properly and it's monitored. So it is very promising in not producing or posing a significant risk to underground sources of drinking water.

Senator CORKER. Mr. Chairman, thank you for the time. At some point I hope we'll gain an understanding as to the practicality of this. I think that a lot of times we move in a direction and it sounds utopic to move there and there's a lot of political momentum.

I have to tell you that this still, to me, and I'm not an oil drilling State, seems like a fairly impractical thing to do on a mass scale. I can see in geographic locations that might be good, but thank you so much for this hearing.

The CHAIRMAN. Senator Dorgan.

Senator DORGAN. Mr. Chairman, thank you very much. In North Dakota we have the only coal gasification plant that was ever completed and it exists now as a technological marvel in terms of its production. It produces synthetic natural gas from lignite coal. It also is, I think, the world's largest demonstration of CO₂ capture and it captures 50 percent of the CO₂ from the coal gasification plant. It puts it in a pipe and pipes it to Canada to the oil wells in Alberta and they use it for enhanced oil recovery.

So there is a capture process with respect to coal gasification. I suspect if we're taking a look at what's happening in the oil wells up in Canada we can get a sense of some leeching issues and other issues about is this sequestration for the long term and so on. But I want to ask this question. This is such an important area. Fifty percent of our electricity comes from coal. We're not going to have a future without using coal. I mean our future's going to include the use of coal. The question is how do we use coal.

We're going to be able to use coal if we can effectively unlock the mysteries of capturing carbon and sequestering carbon. How do we do that? I'm chairing the appropriations side on the subcommittee on appropriations that funds a lot of this. Here's the way it looks to me.

We've got carbon sequestration R&D projects. We've put 120 million into that. We have regional organization. So we got 120 million dollars in our area. It's called PECORE. But 120 million dollars was for carbon sequestration R&D. 70 million dollars for the clean coal power projects. 75 million dollars was put in this year for Future Gen, now I saw your announcement yesterday about that, six

billion dollars for loan guarantees for coal projects that will demonstrate these technologies.

So we have all of these things happening. You know, it reminds me kind of a circus with a bunch of rings. The question is who brings it all to the center ring? Who brings it to center stage to decide how all of this works together because we're in a big hurry? The fact is we need to get to center stage soon with technologies we know will work. So, Mr. Slutz, who down there at the Energy Department is bringing these five or six projects or areas of funding together to accomplish what we want to accomplish?

Mr. SLUTZ. It is, Senator. We do manage these programs as an integrated approach even though it may not look like it all the time, but we do. In fact I will use an example in answering some of the questions about what's this going to do in the subsurface. That's why we have those—that carbon sequestration program with the seven partnerships and we have four large scale projects underway. Three more will be finalized and ready to announce later this spring.

Those—the four that are announced are each there in the site characterization doing those detailed geologic assessments. They will when they, a little after that assessment is done and assuming the assessment all proves out, they are scheduled—will inject at least a million metric tons a year of CO₂. They'll be monitored extensively. It's to get that information, that detailed information, that then working with our partners at EPA and the other agencies can use to develop what's the best rules.

One side on that this CO₂ is not in some big cavern. It's in the pore space of rock. I think that's an important piece and I'm sorry to end—

Senator DORGAN. You know, last year I called down because what was happening inside the department is the Department of Science was over here and others were over here and the money wasn't being released to the partnerships. So I don't know that both hands were communicating so well. They finally got the money but there is an urgency about this.

Someone just gave me this core sample. This is sandstone and this is where you would invest CO₂. The question is does it stay there? What are the conditions under which it stays there?

You know, the science is very sophisticated, very important and my great concern is we're moving very quickly on this issue of climate change and our understanding that we have to take immediately no regret steps to deal with it and perhaps more aggressive steps. But that doesn't mean that this country's going to be able to have the kind of energy supply that it wants and needs without using our most abundant resource and that is coal. So, when I mentioned five or six programs I don't know that you have this all laced up real tight down there. I hope so.

Because just for example the last six billion dollars we put in which would be loan guarantees. I don't know how you intend to use those. I don't know the announcement you made yesterday. I don't know what that means in terms of the several larger projects rather than one in Future Gen. I don't know how that relates to the regional partnerships.

So, I hope you can continue to give us as much information as possible about how all these things come together and lace up something that gets us to a conclusion. Because we can—you know one of the things about the government is it just studies things forever. That's really interesting but not very effective. At some point you have to have coordinated studies that get the results you need in order to move forward and achieve the goals you have.

Mr. SLUTZ. Let me answer that as I think it requires a little more of an answer that we can provide outside in subsequent to the hearing. But it is coordinated even as we work through our budget process. In looking we've done climate overlays that look at things like where can we spend the money to get different benefits at different times from the various programs within DOE. Not just fossil, but energy efficiency and all those are layered together to see how would we address, how would the overall DOE research budget address climate change?

Then as you then work within the programs, for instance the fossil energy, we have the core coal R&D that's going to move these advance technologies. The CCPI program that gets those technology pieces out into a demo environment. The Future Gen project that is a full scale powered plant with CCS and then you mentioned you get these proved up in demo. You still have to get them deployed into the marketplace and that's where loan guarantees come into play.

So it is a program that works together. I would be happy to follow up with a little more detail on how that meshes up a little bit. [The information follows:]

Attached is a graphic* that outlines the activities of the Office of Fossil Energy's Carbon Sequestration Program and the relationship of those activities to basic research carried out under DOE's Office of Science. Carbon Sequestration and Storage is one of six areas highlighted in the FY 2009 DOE budget request for enhanced coordination between basic and applied research and development. Coordination of activities between the DOE programs is carried out through program manager-level working groups.

Senator DORGAN. My time has expired. I want to thank all the witnesses today. I have to go to another hearing as well, but I appreciate very much your testimony.

The CHAIRMAN. Thank you.

Senator Murkowski.

Senator MURKOWSKI. Thank you, Mr. Chairman. Thank you for the testimony here this afternoon. I want to follow on a little bit to Senator Dorgan's comments and those made by Senator Barrasso about the Future Gen project and the decision coming out of DOE and more specifically to the signal that is sent.

Again you had a pretty ambitious private/public partnership there. A lot of time, a lot of money goes into it and then I understand what you were saying, Mr. Slutz about having to re-evaluate and do the cost. But in terms of signals sent, it is not a very encouraging signal sent from the Department of Energy about one of these proposals that we're looking to firmly establish that the technology has worked and we're making it happen right here.

Ms. Edwards, I want to ask you a question about just the logistics of how these CO₂ pipelines would work. If we were to go to full

*The graph has been retained in committee file.

CCS for all powers I would imagine we're going to have to expand this pipeline network, not only the numbers of pipelines, but the lengths of the pipelines that we're talking about. The question is, as you are pumping the CO₂ further distance and in larger volumes, does this cause any problems? You kind of spoke to the safety aspect of the process, but recognizing that it's going to be more, higher volumes going farther distances, does that do anything to us?

Ms. EDWARDS. Again these are the sorts of risks that we regularly manage in transportation. So I would think that the—we have a regulatory framework in place that's ready for CO₂ pipelines however they were configured. They may be short. They may be longer and with more capacity. So I would say that the——

Senator MURKOWSKI. But it does cause the pipe to age more quickly?

Ms. EDWARDS. You know again it would and that would be part of the requirements or if it did it would be part of the requirements. You know the operator understands the risks and does the monitoring. Of course it's very consequence phased depending on where the segments run and what is the exposure.

Senator MURKOWSKI. So do we not know yet?

Ms. EDWARDS. This is material that does not have the same types of, you know, certainly environmental risks or even risks of life and property as other materials that are moved by pipeline. So we, yes, you know those questions—the technology is mature for pipelines. So I would say that the core significant issues having to do with pipeline transportation are not technical but more economic in terms of siting and investment.

Senator MURKOWSKI. Let me ask you this, Commissioner Kelliher, about the siting you mentioned in your opinion that the State siting seem to be working relatively well if you have an increase again in this pipeline network. With the siting issues, does it become more complicated with an increased capacity there in terms of the siting? Is it something that at some point you might say that the Federal preemption is the way to go? Is this something to be evaluated later?

Mr. KELLIHER. I think looking at what Congress did on gas pipeline siting. It started off with state siting and at some point it failed. In the views of Congress they concluded that state siting had failed. But it was after the failure was demonstrated. Then Congress came in and changed the law. Exclusive and preemptive siting was the rule.

The State siting has worked for CO₂ pipelines up to this point. But the network is much smaller than the oil and gas pipeline networks. The CO₂ pipeline network is about 3,900 miles. The natural gas pipeline network is about 300,000 miles and the oil pipeline network is about 200,000 miles. Last year actually was a very big year for gas pipeline additions and we added about 2,700 miles last year alone on gas pipelines.

So it really relates to if this is the path the country goes down how big of a CO₂ pipeline network are we going to need and how quickly are we going to need it? There are varying estimates on how big of a network we might need.

Senator MURKOWSKI. So at some point in time you may have to evaluate this preemption issue. I would certainly think there would be state consultation if that is the route you would go. I want to ask you a question a little bit off topic, but since you're here, Commissioner Kelliher I'd like to ask you about this MOU that I understand this is regarding ocean energy projects.

You know I've been following this and trying to see some progress with this. There's been some competing Federal jurisdiction out there, FERC, saying anything within three miles MMS is looking at those projects located on the outer continental shelf. Can you give me a status very, very quickly as to what is happening with that MOU?

Mr. KELLIHER. The quick status is that in my view it is final. In my view we're prepared to sign, but the MOU cannot be effective with only one agency signature.

Senator MURKOWSKI. Can we expect the other agency signatures shortly? What is the status on that?

Mr. KELLIHER. I would have to defer to Secretary Allred on that.

Senator MURKOWSKI. Secretary, can you give me an update on where you are on your end?

Mr. ALLRED. Senator Murkowski, as you are aware we had negotiated an agreement. I think it's one that was generally acceptable to both of us. We were asked by this committee not to proceed with that in light of and until there were certain decisions that I assume the committee chose to make with regard to the energy legislation.

One of the things that's happened in the intervening period of time is that our regulations for alternative energy offshore are now about ready to be released. While I don't anticipate that that would make a significant change in how we and FERC deal together it's probably premature for us to do that in light of the fact that these regulations will go out for public comment. If the regulations themselves don't deal, and there are some that do deal with some of the issues in the memorandum of understanding, it would be my intent that we would modify that agreement so that it will be specific to the items that we might have yet uncovered in those rules and regulations.

Senator MURKOWSKI. You're not giving me any indication in terms of timing on this then.

Mr. ALLRED. I would anticipate that the rules and regulations will be out for draft review within the next 2 months.

Senator MURKOWSKI. We certainly—an awful lot of people that are hoping that this gets resolved very quickly and we're very optimistic when this MOU was announced. So, I'd like to think that we're going to see that sooner than later. My time is up, but perhaps I can have a little follow up after this with you if it's possible to do that. Thank you, Mr. Chairman.

Mr. KELLIHER. Just 30 seconds or so, Mr. Chairman, thank you. I just want to emphasize how important it is that we clarify the respective roles of the two agencies. Actually I don't see that there's conflict between the MMS role and the FERC role. I actually think they're complementary. It's just that the two agencies actually have never worked together on projects. We haven't seen ocean projects in the outer continental shelf before that are FERC jurisdictional.

So from the developers point of view there's tremendous uncertainty. I think perpetuating that uncertainty is forestalling exactly what we need now on ocean energy demonstration projects. We need to demonstrate these technologies and the uncertainty means we probably won't see development of ocean hydro projects. So I think we do need to clarify the respective roles to the agencies.

Senator MURKOWSKI. Mr. Chairman, if there's anything that we on this committee can do to help encourage that along I think it would be very, very beneficial for all. Thank you.

The CHAIRMAN. Thank you very much.

Senator Menendez.

Senator MENENDEZ. Thank you, Mr. Chairman. I appreciate your leadership here on the committee on this particular issue. It seems to me that we need action that matches the sense of urgency that we are feeling on climate change.

We've heard testimony here and elsewhere that China is building a coal fired plant every week. It seems to me if we have any hope of lowering greenhouse gas emissions and avoiding catastrophic climate change we need to act quickly and effectively. But it also seems to me if we want technologies like carbon capture and sequestration to flourish in the near future it would appear to me that we need to pass a cap and trade bill as soon as possible because when carbon emissions have a price attached to them well the coal powered industry will act quickly by investing their own money and not just relying on Federal research.

I was listening to Senator Dorgan's numbers as he was putting them out there and other numbers that we've heard projected. We're talking about an enormous amount of money. I think there's a good part of who participates in this process because while we need to act quickly, I think we also need to act wisely.

The issue I'd like to pursue with this panel to some degree is I think maybe one of the most important issues in the question of the regulatory regime and that's the question of who pays to oversee and regulate this new effort. I mean I look at Future Gen which some of us have believed is has always been Never Gen. I look at the statement made by the Deputy Energy Secretary, Clay Sell, who said among the reasons why they were dropping and this was just as in December the Department was listing this as the centerpiece of their strategy for clean coal technologies. One of the major reasons is that the price had risen to 1.8 billion dollars.

That I think goes to the very heart of the question of who participates in this process in paying toward it. You know we have had 150 years of electric power and fossil fuel that has, yes, it has lit up America, but it's also caused some significant environmental damage along the way and a lot of public health concerns including acid rain, mercury poisoning, asthma attacks, ozone depletion, particulate matter pollution, just to name a few. There are no apologies, no apologies for any of this.

Instead now when the industry is under threat they want the American taxpayers to save them. I think it has it backward. I'm wondering whether one of the views that we should have is that in fact an industry that is mature and immensely profitable shouldn't be significantly in the forefront of the concept of polluter pays for example is one.

So my question that I wanted to throw open to the panel is if we're likely to have to ensure CO₂ stays in the ground for 100 years or more who's going to ensure. Who's going to pay for that process of making sure that we have the pipelines, that we have the monitoring, that we in essence are going to ensure that something, that we're going to pursue that course on is going to be one that is not born specifically by the American taxpayer. Do we view this being born by the American taxpayer? You don't all have to jump to answer the question.

Mr. GRUMBLES. Just from an EPA perspective we understand that is one of the key questions and as we're moving forward on the regulatory piece that relates to safeguards for underground sources of drinking water. As I mentioned earlier the financial responsibility question for not only the closure, but the post closure and monitoring is one that we're going to be getting comments from the public on in the rulemaking process. Outside of the rule-making process, we have an established workgroup with DOE and with States.

A key question on that is also the important role of the States in this effort. From the Safe Drinking Water Act standpoint, the UIC program, 35 States have been delegated the authority to run the program and many States are very interested in carbon sequestration, the new frontier. We're going to be working with States on that question of liability.

EPA continues to embrace the polluter pays principle. When it comes to government oversight and management that's going to be one of the key issues; post closure monitoring and financial responsibility.

Senator MENENDEZ. Many of us find the EPA weakening the provisions of polluter pays by virtue of the fact that Superfund is a perfect example of how we have not met that standard. But my question is to the rest of you. You know we're talking about an enormous outlay of pipelines, of the sequestration caverns which we will put this in, the monitoring for the leaking and just the technology. Isn't there a participation of some significant degree by the industry or do we see the American taxpayer putting this all out there and ultimately not having a very robust, to say the least, participation by the industry at the end of the day.

Mr. Slutz.

Mr. SLUTZ. We really how this has developed just like the rest of the infrastructure of this country will be by the private sector and the market and in the case of DOE technologies the idea is to create these technologies so the market can pick them up. One of the issues with reference to the Future Gen project that was 74 percent U.S. Government funded and 26 percent industry. The revised approach that we have come out with while we're still we have a request for information. We're seeking feedback, but would likely the way this comes out would reverse that percentage and have a much larger private sector share in a power plant than it would be much more commercially oriented. So it is built into that.

I would add one more thing as we deal with issues of carbon. One of the challenges which I know all of you are aware of is how do you develop the technology. How do you implement them with-

out dramatically increasing the price of energy because as you say that will then impact our economy and impact citizens.

Senator MENENDEZ. Mr. Chairman I know my time is over, but, you know, I find it interesting just two notes here for future reference. Powers affect the price of energy, of course it's important. But by the same token if the government is funding overwhelmingly all of this effort and then the monitoring, that is the taxpayer too. They may not see it in their energy bill, but they're seeing it out of their money in enormous fashion, No. 1.

No. 2, I find it interesting we had a hearing on a different matter, Mr. Chairman on the Banking committee where the whole issue is what are we doing to try and help people of this country having the American dream not become the American nightmare. A lot of those who say don't get engaged. You know, let the market work its forces.

If we're not going to solve the problem for people who ultimately may be losing their homes was the centerpiece of the American dream, then I'm not so sure the American taxpayer can be called upon to solve the problems for the coal industry, be responsible, overwhelmingly for the problems of the coal industry in trying to meet the challenges of the future. I think there has to be some symmetry at the end of the day as to what's our views in terms of responsibility. But, thank you, Mr. Chairman. I appreciate the opportunity.

The CHAIRMAN. Thank you very much. We have another panel right after this. Let me ask if Senator Corker has any final question to put to this panel?

Senator CORKER. Mr. Chairman, thank you and Senator Menendez, I agree with you. I think this is what we need to get away from is any subsidizing. We ought to figure out the true cost of energy and I hope it will be industry funded.

We're all going to be looking at bills. Senator Bingaman has a very thoughtful bill. There's other bills regarding cap and trade. Regardless of whether the money is there from the private sector to put carbon in the ground or not, the first thing we all have to be comfortable with is it is safe to do that. I mean can we, are we really solving a problem? Are we not having other unintended problems occur?

I'm just wondering if you all could give us a guess, if you will. We got a lot of departments that work on this. It's kind of a cluster making everything happen sequentially. Do you all have any idea when we're going to know for real, in a way that we can really pump some significant resources toward this from this from the private sector, when we're really going to know when it is safe and we have the regulations in place? It would be helpful to us.

We're going to have to be dealing with credits and allowances and all those kinds of things. Just to have an idea of when you think on a mass basis we will be able to do that? I would just love a number.

Mr. GRUMBLES. From an EPA standpoint the key part of answering that question is getting in place the safeguards up front. We believe that there's very minimal risk associated with carbon sequestration if you do have the proper geologic siting and well construction and monitoring and post closure monitoring. We're learn-

ing a lot by the work that is going on around the world in some of the demonstration sites. So we're optimistic about this promising, but still unproven technology.

IPCC basically has said it's very promising from their perspective. They say that carbon dioxide could be trapped for millions of years in appropriate geologic formations are likely to retain over 99 percent of the injected CO₂ over 1,000 years. So it is a question of when you go from the smaller and experimental demonstration sites to the larger commercial scale sites. Will you have the basic safeguards in place to ensure the proper siting and monitoring and measuring? If so, then we're very optimistic about the safety of this long term storage.

Senator CORKER. That seems vague to me.

The CHAIRMAN. Does anybody else want to respond?

Mr. SLUTZ. I will respond. We can get some more information with some of the dates from our—we have a carbon sequestration research road map that lays out certain milestone dates. Rather than throw them out and be incorrect. But we can show some of those things.

One of the challenges is we have a greatly differing and varying geology in this country. That's why we have these seven partnerships to try to get information in different regions, different types of geology. One of the challenges we don't always know, you know, it's research. You don't know exactly what you're going to find. But I think we can put together some information that will show you some of the key milestones on where we're trying to get with our research program and our portfolio to help understand that.

I don't know if it will, it won't give you that specific date, a year or something. But it'll show you the various milestones that we're getting over the next 5 to 8 years.

[The information referred to follows:]

Following is the response to information (milestones/dates) as to when a system will be in place that assures the safety of carbon sequestration and a regulatory framework to allow ongoing mass storage of CO₂.

DOE agrees with the testimony presented by the Environmental Protection Agency (EPA) on January 31, 2008, which stated as follows:

In March 2007, EPA issued technical guidance to help State and EPA Regional managers in processing permit applications for geological sequestration (GS) demonstration projects under the general UIC regulations.

Under the SDWA [Safe Drinking Water Act], EPA develops minimum requirements for state UIC [Underground Injection Control] programs. States may develop their own regulations for injection wells in their State. These requirements must be at least as stringent as the federal requirements (and may be more stringent). Annually, billions of gallons of fluids are injected underground through wells authorized under State and Federal UIC Programs. This includes approximately 35 million tons of carbon dioxide that are injected for the purposes of enhancing oil and gas recovery. EPA's proposed regulations will build on the UIC Program's many years of experience in safely injecting fluids, including carbon dioxide, into the subsurface.

The proposed regulation, currently in development under an accelerated schedule, will take into account the EPA's existing UIC program requirements. Key components of the proposed regulation will include requirements related to: (1) geologic site characterization to ensure that wells are sited in suitable areas to limit the potential for migration of injected and formation fluids into an underground source of drinking water; (2) well integrity testing and monitoring to ensure that the wells perform as designed; and, (4) well closure, post-closure care, and financial responsibility to ensure proper plugging and abandonment of the injection well. We will also discuss long-term liability and seek further comment on this issue as part of the proposed rulemaking.

The CHAIRMAN. Anyone else?

Mr. Allred.

Mr. ALLRED. Mr. Chairman, Senator Corker. Just a point that I think that there is already a lot of information that is available that would show that it can be done. I think we have to be more deliberate about how that information is collected, but as Mr. Slutz indicated, they have projects where in excess of a million tons of CO₂ have been injected. We have a number of places where over a million tons a year has been injected for enhanced oil recovery.

So I think there are a lot of those things which either are now being done or could be done. The purpose of those, at least the oil recovery projects, has not been sequestration, although there may have been a significant amount of sequestration occur. One of the things I think that we have the potential to do is to add a purpose to those, not to eliminate the other purpose, but add a purpose to those. Answer a lot of questions that you were just asking. I suspect that those answers will be with proper knowledge and proper consideration that we will be safe in can be done fairly quickly.

The CHAIRMAN. Thank you. Senator Lincoln, did you have questions of this panel?

Senator LINCOLN. No.

The CHAIRMAN. Let me thank all the witnesses of this panel and we will stay in touch with you and try to continue moving ahead on this set of issues.

Let me call the final panel forward. Lawrence Bengal who is with the Arkansas Oil and Gas Commission. Tracy Evans who is with Denbury Resources in Plano, Texas and Scott Anderson with Environmental Defense from Austin, Texas. Thank you all for coming.

Yes. Let me call on Senator Lincoln to make whatever introductions she would like of our witnesses here. I know one of these witnesses is from her home State. Blanche, go right ahead with whatever you would like to say.

Senator LINCOLN. Mr. Chairman, I apologize that I've been absent for the earlier part of the hearing. As most of us know it gets over scheduled way too much, but I certainly appreciate your leadership in this area. There's so much to be done and so much for us to learn without a doubt.

But it is my pleasure to introduce the Chairman of the Arkansas Oil and Gas Commission, Larry Bengal. Mr. Bengal has held positions as researcher with the Illinois State Geological Survey as a project manager for Geologic and Mining Engineering Consulting firm, engaged in projects throughout the United States and as an independent counseling or consulting petroleum geologists as manager of the Illinois Class II underground injection control program and as a supervisor of the Illinois Oil and Gas division. He is here today in his capacity as chairman of the IOGC carbon capture and geologic storage task force. We're certainly appreciative of all of what he has done.

I feel, like you, Larry, we appreciate you being here and appreciate all the both evidence and intelligence that you bring to the issue that we're dealing with here and grateful that you've joined us. We look forward to continuing to work with you as well. But we're very proud of him in Arkansas and his work in the oil and gas issues there and equally proud of his fine work with the CCGS

task force. So thank you, Mr. Chairman and thank you, Larry for being here and to all the panelists.

The CHAIRMAN. Alright. Thank you very much. Mr. Bengal, why don't you start and then Mr. Anderson and then Mr. Evans.

STATEMENT OF LAWRENCE E. BENGAL, DIRECTOR, ARKANSAS OIL AND GAS COMMISSION, LITTLE ROCK, AR

Mr. BENGAL. Good afternoon and thank you, Senator Lincoln for that gracious introduction.

Mr. Chairman, committee members, my name is Lawrence Bengal. I am the director of the Arkansas Oil and Gas Commission and I'm appearing here today in my capacity as chairman of the Interstate Oil and Gas Compact Commissions Task Force on Carbon Capture and Geologic Storage. I would like to share with the committee the experience and conclusions of the task force and offer brief comments on S. 2144 and S. 2323.

Funded by the U.S. Department of Energy through the National Energy Technology Laboratory, the task force has been engaged since 2003 in a two phase effort relating to the regulation of geologic storage of carbon. In phase one the task force undertook a thorough review of the technology of geologic storage. In phase two developed model regulations. A major conclusion of the task force in phase one was that the geologic storage of carbon dioxide or CO₂ was not something entirely new or mysterious, but the technological outgrowth of analogs with which the States already have regulatory experiences.

In phase two the task force has produced a clear and comprehensive model regulatory regime for the geologic storage of CO₂. Utilizing these model frameworks, States and provinces and indeed other nations can begin immediately the process of enacting legislation and promulgating rules and regulations enabling CO₂ geologic storage projects. In fact a number of States have already begun this process.

By 2010 I fully expect that at least 5, 10 or more States will have legal and regulatory systems in place. The EPA carbon storage regulations under the Safe Drinking Water Act and it's implementing underground injection control or UIC programs should also be in place within this timeframe. It is my expectation the State regulatory systems will work seamlessly like hand in glove with the regulations likely to emerge from the EPA regulatory development process. This is largely because of the role States play in the administration of UIC programs under EPA privacy authority.

As concerns SB, Senate bill 2323 the legal and regulatory framework proposed by the task force does not require in order for our program to work effectively any broader, overarching Federal regulation. Framework proposed by the IOGCC task force is comprehensive and contains many aspects that are solely a function of State law. Our expectation is that the combination of State and EPA UIC regulatory systems will produce a flexible, responsive, safe and environmentally sound regulatory framework for CO₂ geologic storage that will be more than adequate to get the first project planned and safely off the ground.

We would suggest that before we rush to create a potentially unnecessary Federal and regulatory framework that we observe how

this combined State and EPA administered storage framework functions. If a need for additional Federal regulatory authority manifests, it can be addressed at that time. As concerns SB 2144, I would only suggest that the departments and agencies designated in the bill to conduct the study be required to conduct it in close cooperation and consultation with the States which have much experience in this area.

Let me now turn to the diagram which you see before you which illustrates the cradle to grave regulatory model that was developed by the task force and this is what we recommended to States. There are three phases you can see. Although I do not have enough time at this stage to go over each of the phases, this will give you some idea of the breadth of the regulatory structure proposed by the IOGCC task force.

I would note however that only within the project areas indicated by the green box does it appear to the EPA has regulatory authority over the Safe Drinking Water Act. The other areas would be covered under State law.

Let me close by noting the obvious that public support for carbon storage as a strategy for mitigating the impact of global climate change will be crucial. It is important to educate the public about this technology including CO₂ long history of being transported, handled and used in a variety of applications. CO₂ is certainly no more, if not less, than the hazardous waste of natural gas and calling it such makes it very difficult for public acceptance of CO₂ storage.

It will also be vitally important to include the public in every step of the regulatory development process at the State and Federal levels. State laws will ensure public notice and participation and the State processes of both legislation and regulation development stages. Thank you for the opportunity to appear here today. If I can provide any information, please do not hesitate to ask. I would ask though that a copy of the full IOGCC task force be included in the record today.*

[The prepared statement of Mr. Bengal follows:]

PREPARED STATEMENT OF LAWRENCE E. BENGAL, DIRECTOR, ARKANSAS OIL AND GAS COMMISSION, LITTLE ROCK, AR

Good afternoon. My name is Lawrence Bengal. I am the Director of the Arkansas Oil and Gas Commission and I'm appearing here today in my capacity as Chairman of the Interstate Oil and Gas Compact Commission's Task Force on Carbon Capture and Geologic Storage (CCGS). The Task Force was comprised of representatives from IOGCC member state and provincial oil and gas agencies, U.S. Department of Energy sponsored Regional Carbon Sequestration Partnerships, the Association of American State Geologists, industry experts, as well as representatives from the U.S. Environmental Protection Agency (EPA), the U.S. Bureau of Land Management (BLM) and the environmental group, Environmental Defense, who attended as observers.

The member states of the Interstate Oil and Gas Compact Commission (IOGCC) produce more than 99% of the oil and natural gas produced onshore in the United States. Formed by Governors in 1935, the IOGCC is a congressionally ratified interstate compact. The organization, the nation's leading advocate for conservation and wise development of domestic petroleum resources, includes 30 member states, associate states, and 4 international affiliate provinces. The mission of the IOGCC is two-fold: to conserve our nation's oil and gas resources and to protect human health

*Document has been retained in committee files.

and the environment during the production process. Our current chairman is Governor Sarah Palin of Alaska.

I am here today to share with the committee the experience and conclusions of IOGCC's CCGS Task Force and to offer our comments on S. 2144, the "Carbon Dioxide Pipeline Study Act of 2007", and S. 2323, the "Carbon Capture and Storage Technology Act of 2007".

Funded by the U.S. Department of Energy (DOE) and its National Energy Technology Laboratory (NETL), the Task Force has been engaged since 2003 in a two-phase effort relating to the regulation of the geologic storage of carbon. In Phase I, the Task Force undertook a thorough review of the technology of geologic storage and in Phase II developed a model statute and model rules and regulations for the states and provinces to administer regulatory oversight of geologic storage of carbon dioxide (CO₂).

A major conclusion of the Task Force in Phase I was that the geologic storage of CO₂, in addition to conservation, is among the most immediate and viable strategies available for mitigating the release of CO₂ into the atmosphere. It was readily apparent to the Task Force that carbon storage was also not something entirely new and mysterious—but the technological outgrowth of four analogues. These four analogues, in the opinion of the Task Force, provide the technological and regulatory basis for storage of CO₂ in geologic media: 1) naturally occurring CO₂ contained in geologic reservoirs, including natural gas reservoirs; 2) the large number of projects where CO₂ has been injected into underground formations for Enhanced Oil Recovery (EOR) operations; 3) storage of natural gas in geologic reservoirs; and 4) injection of acid gas (a combination of H₂S and CO₂), into underground formations, with its long history of safe operations.

It was the opinion of the Task Force that given the jurisdiction, experience, and expertise of the states and provinces in the regulation of oil and natural gas production as well in regulating the analogues identified above, the states and provinces would not only be well able to regulate, but would be the most logical and experienced regulators of CO₂ geologic storage. Additionally and importantly, the oil and natural gas producing states and provinces are strategically and geologically well-situated for the geologic storage of CO₂. Regulations already exist in most oil and natural gas producing states and provinces covering many of the same issues that need to be addressed in the regulation of CO₂ geologic storage, and consequently serve as adaptable frameworks.

Given these Phase I conclusions, the Task Force, in Phase II, began work and in September of 2007 produced, for the first time, a clear and comprehensive model legal and regulatory regime for the geologic storage of CO₂. Utilizing these model regulatory frameworks, states and provinces, and indeed other nations, can begin immediately the process of developing and enacting legislation and promulgating rules and regulations enabling CO₂ geologic storage projects. California, New Mexico, North Dakota, Texas, and Wyoming are, among other states, in various stages of developing such a legal and regulatory framework.

I anticipate that by 2010 there will be at least 5–15 states, encompassing much of the country best suited for carbon geologic storage, with legal and regulatory systems in place for the regulation of geologic storage of CO₂. I would also anticipate that in this same general timeframe that EPA will likewise have in place regulations governing geologic storage of CO₂ under the Safe Drinking Water Act and the implementing Underground Injection Control (UIC) Program.

It is appropriate that I now briefly address how the IOGCC anticipates the EPA's CO₂ geologic storage regulations will interface with the regulatory systems being developed by the states. Given the incorporation of UIC-like regulatory requirements into the proposed IOGCC model regulatory frameworks, there is every reason to anticipate that the IOGCC and EPA frameworks will fit like hand in glove. This is largely because of the role that states play in the administration of UIC programs under EPA primacy authority.

In this regard, as you are no doubt aware, the EPA is in the process of developing regulations for geologic sequestration under the Safe Drinking Water Act with the goal of having draft regulations for public comment by the summer of 2008. The IOGCC at the invitation of EPA has two representatives, Berry "Nick" Tew of Alabama and myself, actively participating in the process as state co-regulators. States with primacy already play an integral role in administering the UIC program and under future rules governing geologic storage, are likely to do so again. Having representatives from states involved in the process helps insure compatibility between the state and federal components of geologic storage regulatory oversight.

What is clear to me, especially given my involvement with the current EPA workgroup, is that the state regulatory system for carbon storage proposed by the

I OGCC Task Force will in all likelihood work seamlessly with the regulations likely to emerge out of the EPA regulatory development process.

Having made this observation let me now offer brief comment on the two bills which are the subject of this hearing today.

The legal and regulatory framework proposed by the Task Force, which I will discuss in more detail subsequently, does not require, in order to work effectively, broader over-arching federal regulation such as that apparently contemplated by S. 2323. The Task Force strongly believed that what it was proposing was comprehensive and given the number of aspects that are solely functions of state and not federal law (for example ownership of storage rights and means for amalgamating those rights through some type of condemnation proceeding) that there was no need or in some respects even the possibility of a broader federal role. It is suggested that there will be ample time over the coming years to see how the state-administered CO₂ storage frameworks function in tandem with the EPA UIC storage regulations thereby alleviating the need to rush to create a potentially unnecessary federal regulatory framework at this time. If there is need for additional federal regulatory authority, it can be addressed legislatively then. I fully anticipate that what will exist during this interim period will be a flexible, responsive, and environmentally sound combination of state and EPA UIC regulatory systems, which will be more than adequate to get the first projects planned and off of the ground. Experience with these projects will show us rather quickly if weaknesses or problems with the existing frameworks manifest. We have absolutely no expectations at this time that they will.

As concerns S. 2144 and the requirement of a study of feasibility relating to construction and operation of pipelines and CO₂ sequestration facilities, I would note first that the Task Force's proposed legal and regulatory infrastructure encompasses construction and operation of CO₂ sequestration facilities. Second, I would suggest that given this, that the federal government departments and agencies designated in the bill to conduct the study at a minimum be required to conduct the study in close cooperation and consultation with states, including representatives of the I OGCC Task Force.

It is now appropriate to supply a little more detail about the legal and regulatory system which the I OGCC Task Force has proposed for the geologic storage of CO₂ and how, precisely, the proposed EPA regulatory system for CO₂ storage would likely fit into this system. This *diagram will be helpful:

The diagram represents the "cradle to grave" regulatory model which the Task Force has recommended to states. There are three phases.

1. Licensing including amalgamation of Storage Rights

The first phase is the licensing phase which includes the critical requirement that the project operator control the storage rights.

The Task Force concluded that as a part of the initial licensing of a storage project that the operator of the project must control the reservoir and associated pore space to be used for CO₂ storage. The operator would need to acquire these rights from the owners or assume those rights by means of eminent domain, unitization or some other vehicle that either exists in a state or would be created by the state uniquely for this purpose. This step is necessary because in the U.S., the right to use reservoirs and associated pore space is considered a private property right and must be acquired from the owner. It was the conclusion of a Task Force legal subgroup that in most U.S. states, for non EOR-related storage, the owner of these rights would likely be the owner of the surface estate. It may be prudent, however, depending upon the specific property right ownership framework in a given state, for an operator to also control the relevant subsurface mineral rights.

Additionally, as part of the initial licensing of a project the operator would be required to submit for State Regulatory Authority (SRA) approval, detailed engineering and geological data along with a CO₂ injection plan that includes a description of mechanisms of geologic confinement that would prevent horizontal or vertical migration of CO₂ beyond the proposed storage reservoir. The operator would also be required to submit for approval by the SRA a public health and safety and emergency response plan, worker safety plan, corrosion monitoring and prevention plan and a facility and storage reservoir leak detection and monitoring plan.

The rules also include requirements for an operational bond that would be sufficient to cover all operational aspects of the storage facility excluding wells which would be separately bonded.

Site licensing and amalgamation of storage rights is generally believed to be outside the scope of the current UIC Program, and given that regulatory involvement

* Document has been retained in committee files.

with property rights is a state issue, this phase is best addressed at the state level. In addition, given the likely competition for acceptable storage sites, it is in a state's interest to manage these sites to maximize storage capacity and resolve any operator conflicts over the right to use storage resources, thereby maximizing the state's best economic interest in providing storage sites for that state's generators.

2. *The Storage and Closure Phase*

In this second phase we are talking about the phase, following initial licensing, when the storage project is developed, operated, and closed. This includes a short time period following plugging of the wells during which time the project is monitored to ensure stability of the injected CO₂.

During the storage component of this phase the model rules specify the procedures for permitting and operating the project injection wells to safeguard life, health, property and the environment. The operator would be required to post individual well bonds sufficient to cover well plugging and abandonment, CO₂ injection and/or subsurface observation well remediation. The rules also specify design standards to ensure that injection wells are constructed to prevent the migration of CO₂ into other than the intended injection zone. Provisions in the rules also ensure that all project operational standards and plans submitted during the licensing phase would be adhered to and that the project and wells are operated in accordance with all required operating parameters and procedures. Quarterly and annual reports would be required throughout the operational life of the project. The rules also ensure that the wells are properly plugged and the site restored. The individual well bonds, maintained during the operational phase of the project would be released as the wells are plugged.

The closure component of this phase is defined as that period of time when the plugging of the injection wells has been completed and continuing for a defined period of time (10 years unless otherwise designated by the State Regulatory Authority) after injection activities cease and the injection wells are plugged. During this closure period, the operator of the storage site would be responsible for providing the required data to ensure the injected CO₂ has not migrated beyond the project boundaries and the injected CO₂ plume has been stabilized. During this time the operator is required to maintain an overall project operational bond.

This phase is primarily where EPA is developing proposed rules to ensure the operation and plugging of the wells are protective of the groundwater resources under the UIC Program.

3. *Long-Term "Care Taker" Phase (long-term monitoring and liability)*

The last phase is the Long Term or Post-Closure Period and is referred to as that period of time when the operator of the project is no longer the responsible party and the long-term "care taker" role is assumed by a government entity or government-administered entity. The major issue faced by the Task Force was how to deal with long-term monitoring and liability issues. The formula settled upon by the Task Force is the following:

At the conclusion of the Closure Period, the operational bond would be released and the regulatory liability for ensuring that the site remains a secure storage site would transfer to a trust fund administered by the state. During the Post-Closure Period, the financial resources necessary for the state or a state-contracted entity to engage in future monitoring, verification, and remediation activities would be provided by this state-administered trust fund.

The Task Force concluded that such a state-administered trust fund would be the most effective and responsive "care-taker" to provide the necessary oversight during the Post-Closure Period. The trust fund would be funded by an injection fee assessed to the site operator and calculated on a per-ton basis.

In summary, the EPA Regulations under the SDWA and the UIC Program primarily deal with the Storage and Closure Phase as illustrated by the green box in the diagram, for it is only in the project areas within that box that EPA has authority under the SDWA. In addition to EPA's mandate to protect drinking water under the SDWA, the IOGCC regulations cover other public health and safety issues that need to be a part of a comprehensive regulatory framework. As previously stated, almost all of the well operational standards proposed in the IOGCC model regulations are already UIC requirements of one form or another.

What I anticipate is that the proposed EPA regulations, whatever they end up being, will yield a set of uniform national standards, which superimposed on whatever state regulations may be in place will result in national consistency of application so as to ensure that drinking water resources are protected. Again as previously stated, given most states (those with primacy) already administer the existing UIC program, they will continue to do so, conforming their state regulations as they per-

tain to the geologic storage of carbon to the minimum standard set by the new EPA regulations.

Unless the EPA regulations end up being unnecessarily proscriptive and onerous, the systems should work together perfectly and as I've already stated, "seamlessly". Certainly this is the hope and current full expectation of the IOGCC.

I will note that with regard to federal lands (surface and/or mineral interests), that federal regulations emanating out of the BLM will undoubtedly be necessary. However, what emanates out of BLM would in all likelihood be more akin to what the states have done with regard to state and private lands rather than an overarching and broader national regulatory scheme.

Additionally, our model regulatory system does not address the regulatory issues involving CO₂ emissions trading and accreditation for the purpose of securing carbon credits. The Task Force concluded that the issue of CO₂ emissions trading and accreditation would likely best be addressed in the marketplace and/or at the federal government level and was beyond the scope of the Task Force's mandate. In any event, the Task Force strongly believes that development of any future CO₂ emissions trading and accreditation regulatory frameworks should utilize the experiences of the states.

As concerns long term "care taker" liability, what the Task Force has proposed will have to be addressed by each state and province as they develop their own framework. It remains to be seen if states will agree with the Task Force or propose something new. There may indeed be a need for a federal role here at some point in the future but it is suggested that federal action in this area await a clear need manifesting itself in the years ahead.

Additionally and very importantly, states and provinces are likely to continue to regard CO₂ geologic storage reservoirs as a valuable resource that should be managed using resource management frameworks, therefore avoiding the treatment of CO₂ storage as waste disposal. The Task Force strongly believes that treatment of CO₂ as a waste under waste management regulatory frameworks will diminish significantly the potential of carbon storage technology to meaningfully mitigate the impact of CO₂ emissions on the global climate. The energy consuming public and the industry which produces that energy share a common goal in coming up with a workable solution.

Let me close by noting the obvious—that public support for carbon storage as a strategy for mitigating the impact of global climate change will be crucial. It will be important to educate the public about this technology including CO₂'s long history of being transported, handled, and used in a variety of applications. It will also be vitally important to include the public in every step of the regulatory development process, state and federal. State open meeting laws will ensure public notice and participation in the state process at both legislation and regulation development stages.

Thank you for the opportunity to appear here today. If I can provide any additional information, please do not hesitate to ask.

The CHAIRMAN. We'll be glad to include that in the record. Thank you very much for your testimony.

Mr. Anderson.

STATEMENT OF SCOTT ANDERSON, ENVIRONMENTAL DEFENSE, AUSTIN, TX

Mr. ANDERSON. Thank you, Mr. Chairman. We're pleased to be here today as the committee considers how to create a regulatory framework regarding carbon capture and storage so that CCS can play a role in the fight against climate change. Climate change is the most significant environmental issue of our generation. The Senate is doing important work in this area. Cap and trade legislation if adopted would do a lot to commercialize CCS by creating a market value for voiding CO₂ emissions and considering the measures you have before you today it is vital work as well.

Without a sound regulatory framework uncertainty will prevail and the marketplace will not be able to move CCS forward in a significant way. Public acceptance will happen only if the public is confident that rigorous and credible regulatory oversight is in

place. The fact that Environmental Defense supports deployment of CCS does not mean that we are champions of coal.

We believe that business as usual for coal is over. Public opinion is shifting and conventional coal plants are being delayed or canceled at a rate unimaginable a year ago. People are increasingly recognizing that energy efficiency and renewables should play a leading role in energy and climate policy.

We're not champions of coal at Environmental Defense but we are realists. Coal will continue to be used for the foreseeable future and we believe that CCS can play a significant role in helping coal to reduce its greenhouse emissions. Even today in the absence of a full fledged private market it's possible where the economics arrive to begin deployment.

The Texas legislature passed a bill in 2007 that provided a severance tax incentive for oil producers who use CO₂ to produce oil and then sequester the carbon afterwards, defining permits as meaning 99 percent retention for 1,000 years or more. So at least in Texas the legislature has made a determination that CCS is ready for deployment now.

I'll turn now to Senate bill 2144 and section 5 of Senate bill 2323. Senator Coleman's Senate bill 2144 would require a feasibility study that we believe is sound. We endorse this measure.

Section 5 of Senator Kerry's bill would establish an interagency task force to develop regulations and we believe that with some modification this is worthy of passage as well. Section 5 has several notable strengths. It assures that the development of a regulatory framework will move forward expeditiously that includes the Departments of Energy and Interior in the process. It appropriately names the administrator of the EPA who has key responsibilities of the Safe Drinking Water Act to be chairman or chairperson of the task force.

Finally the legislation builds on existing regulatory authority on an incremental as needed bases. Subsection (a)(5) requires regulations to take into account the existing UIC program and then continues to provide additional requirements that regulations must satisfy. We believe such a step by step approach is prudent for first generation CCS rules. As the need for additional grants of jurisdiction or congressional guidance become apparent additional provisions can be enacted through supplemental legislation.

There are also several areas of Section 5 that we feel could be improved. I'll only touch verbally on one of those. We are confident that the bill is intended to accelerate adoption of carbon sequestration regulations, but EPA is already engaged in rulemaking and there's a risk that the bill can actually slow down adoption of the first set of regulations. We recommend adding a provision indicating that Congress does not intend to discourage rulemaking in the near term, but rather intends that regulations should reflect the interagency process spelled out in the bill. If EPA adopts rules based on existing procedures in the meantime in a rules developed pursuant to this bill would become the second generation of rules.

The final portion of my prepared testimony discusses the appropriate design of geologic sequestration regulations. We suggest that rules generally should be flexible and performance based and that they should adapt to evolving knowledge and best practices. At the

same time we say that it's not enough to be flexible, adaptive and performance based. It's essential that rules be grounded in a thorough scientific understanding of the risks involved and the rules assure that the risk will be managed properly. Some aspects of the rules such as site characterization and selection requirements will need to be relatively more prescriptive than others. With that I'll close. Thank you.

[The prepared statement of Mr. Anderson follows:]

PREPARED STATEMENT OF SCOTT ANDERSON, ENVIRONMENTAL DEFENSE, AUSTIN, TX

We appreciate the opportunity to speak to you today as the committee considers how to create a regulatory framework that will enable carbon capture and storage (CCS) to play a role in the fight against climate change. Climate change is the most important environmental issue of our generation and successful development and deployment of CCS is a critical path for taking coal, the world's most abundant but carbon-intensive fossil fuel, and accommodating it to a carbon-constrained future.

Environmental Defense is a national non-profit organization representing more than 500,000 members. Since 1967, we have linked science, economics and law to create innovative, equitable and cost-effective solutions to urgent environmental problems. My personal background includes more than 20 years representing independent oil and gas producers in Texas, and so I have some appreciation for many of the issues and concerns related to the underground storage of carbon dioxide.

The Senate is doing important work to address the threat of climate change. The single most important thing the Senate can do to commercialize CCS is to take quick action on cap and trade legislation, since such legislation would create a market value for avoiding carbon dioxide emissions. Given the right incentives, we believe that the market will be far more effective and efficient in discovering necessary technologies of all types, including CCS, than any suite of government mandates or subsidies, however well intentioned.

Consideration of regulatory measures such as those before you today is vital work as well. Without a sound regulatory framework to govern carbon capture, transportation and storage, uncertainty will prevail and the marketplace will not be able to achieve the kind of deep and sustained reductions necessary to avoid the worst consequences of greenhouse gas build-up. Similarly, public acceptance of CCS will happen only if the public is confident that rigorous and credible regulatory oversight is in place.

The fact that Environmental Defense supports the deployment of CCS does not mean that we are champions of coal. We believe that business as usual for coal is over. Public opinion is shifting and conventional coal plants are being delayed or canceled at a rate unimaginable even a year ago. In states like Texas, Florida, Oklahoma and Kansas, people are beginning to realize that it is environmentally irresponsible and fiscally imprudent to proceed with building new coal plants, absent a concrete plan to reduce and avoid CO₂ emissions. We are also pleased that people are increasingly recognizing that energy efficiency and renewables should play a leading role in energy and climate policy.

Although we are not champions of coal at Environmental Defense, we are realists. Coal will continue to be used for electricity production for the foreseeable future. Therefore the nation and the world need technologies that enable coal to be used in a manner that avoids significant greenhouse gas emissions. According to an IEA study released in 2006, CCS could rank, by 2050, second only to energy efficiency as a greenhouse gas control measure. The Intergovernmental Panel on Climate Change projects that CCS could, by 2100, contribute 15 to 55% of the greenhouse gas reductions needed to avert catastrophic climate change. Just last week in a proposed directive on CCS, the Commission of the European Communities noted that efficiency and renewables are the most sustainable supply options in the long run but that "we cannot reduce EU or world CO₂ emissions by 50% in 2050 if we do not also capture CO₂ from industrial installations and store it in geological formations."

While different analysts come up with somewhat different scenarios, it is clear that coal is not going to disappear anytime soon and therefore effectively capturing and sequestering carbon dioxide emissions from coal can make a real difference in whether mankind will be able to solve climate change problems. We are fortunate that early sequestration projects, together with over 30 years of experience with injecting CO₂ into oilfields, have provided confidence that long-term sequestration in properly selected geologic formations is feasible.

In fact, even today, when large-scale commercialization of CCS is hampered by the absence of price signals that could be provided by a market in trading allowances, it is possible to begin deployment and start making real reductions in CO₂ emissions. McKinsey & Company's recent study, "Reducing U.S. Greenhouse Gas Emissions: How Much at What Cost?," provides a sense of the costs involved. My fellow panelist Tracy Evans of Denbury Resources can speak from direct experience about the feasibility of deploying CCS in the oilfield context.

SUMMARY OF COMMENTS ON S. 2144 AND S. 2323

I would like to cover several things this morning. I will touch briefly on S. 2144, which would require a study of the feasibility of constructing and operating carbon dioxide pipeline and sequestration facilities. I want to focus most of our remarks, however, on Section 5 of S. 2323, which would establish an interagency task force to develop regulations for CO₂ capture and storage. Our remarks on Section 5 will focus on regulations for geologic sequestration, rather than capture. Finally, we will offer comments on the appropriate design of sequestration regulations. We will mention why it is important for CO₂ storage regulations, especially in the early years, to be relatively performance-based rather than prescriptive and why it is important for the regulatory framework to adapt as knowledge improves.

We believe that it would be useful to adopt S. 2144, and Section 5 of S. 2323 if modified in several respects, as stand-alone measures. These measures would be most useful, however, if enacted as part of or in concert with comprehensive cap and trade legislation that would create a market value for avoiding CO₂ emissions and thereby encourage market participants to engage in the activities that these measures are intended to address.

S. 2144

Senator Coleman's S. 2144 would require the Secretary of Energy, in coordination with certain other agencies, to study the feasibility of constructing and operating carbon dioxide pipelines and sequestration facilities. We believe that the scope of the contemplated study is sound and that the study is likely to yield important information. Without prejudice to the possibility that others may have valuable suggestions on improving the scope of the study, we generally endorse this bill as proposed.

SECTION 5 OF S. 2323

Section 5 of Senator Kerry's S. 2323 would establish an Interagency Task Force "to develop regulations providing guidelines and practices for the capture and storage of carbon dioxide."

Section 5 has several notable strengths:

1. The most fundamental benefit of Section 5 lies in assuring that the development of a regulatory framework for CCS will move forward expeditiously. The intent is clearly that issuance of regulations should be accelerated, not delayed.

2. Including the Departments of Energy and Interior in the regulatory development process is worthwhile. DOE has significant expertise in carbon capture and sequestration that can benefit the rulemaking process. The Department of Interior's Geologic Survey also has significant expertise and is in a position to offer useful input.

3. The bill appropriately names the Administrator of the Environmental Protection Agency as the chair-person of the task force. This is appropriate given that EPA, in addition to having its own significant expertise in CCS, has responsibility under the Safe Drinking Water Act's Underground Injection Control Program to protect underground sources of drinking water from contaminants that might cause a violation of a national primary drinking water regulation or otherwise adversely affect the health of persons.

4. The legislation builds on existing regulatory authority on an incremental, as-needed basis, i.e. subsection (a)(5)(A) requires that the regulations "take into account existing underground injection control program requirements" and then provides additional requirements that regulations must satisfy in subsections (a)(5)(B)-(F). We believe it is prudent to take such a step-by-step approach to authorizing and overseeing the development of "first generation" rules for CCS. Both industry and regulators will "learn while doing" in the early years of this technology. For now, most observers (ourselves included) appear to find the Safe Drinking Water Act's Underground Injection Control Program to be generally adequate as a basis for initial federal regulations. As the need for additional

grants of jurisdiction and/or Congressional guidance becomes apparent, additional provisions can be enacted through supplemental legislation.

There are also several aspects of Section 5 where the committee has an opportunity to make improvements:

1. As noted above, subsection (a)(5)(B)-(F) builds on the Safe Drinking Water Act by requiring that carbon dioxide capture and storage regulations satisfy several objectives that are not part of the existing underground injection control program. However, in our judgment, two more requirements ought to be added. These are (to borrow language from the proposed Lieberman-Warner Climate Security Act): (a) a requirement to regulate the “long-term storage of carbon dioxide and avoiding, to the maximum extent practicable, any release of carbon dioxide into the atmosphere;” and (b) a requirement that the carbon dioxide storage regulations protect not just underground sources of drinking water and human health, but “the environment” as well. In order to fill these two gaps, we recommend borrowing the language just quoted from section 8001 of S. 2191.

2. We are confident that S. 2323 is intended to accelerate the adoption of carbon sequestration regulations (while at the same time broadening the regulatory development process beyond EPA). There is a risk, however, that the bill could actually slow down adoption of EPA’s first set of regulations, which the agency currently plans to propose in the Federal Register by this fall. Publication and adoption of rules in the near term would be likely to have a positive effect on the development of early CCS projects. It would be extremely unfortunate if passage of S. 2323 served to convince EPA to wait for the conclusion of the S. 2323 process before adopting the first set of regulations. Accordingly, we recommend that a provision be added to the bill indicating that Congress does not intend to discourage earlier CCS rulemaking but rather desires to make sure that regulations growing out of an interagency process are adopted in the near-term. If EPA adopts rules based on existing procedures in the meantime, the regulations developed pursuant to S. 2323 would become the second generation rules.

3. Subsection (a)(5)(C) requires carbon dioxide storage regulations to “address the potential appropriate transfer of liability to governmental entities.” We would prefer that any regulations transferring liability to governmental entities be postponed until after the task force report called for in Section 8004 of S. 2191. If such regulations are authorized sooner, however, we think additional guidance is desirable in order to assure that those who develop the regulations recognize that shifting liability to the taxpayers affects the taxpayers differently depending on whether or not monitoring has demonstrated that the storage project in question is performing as expected. The current proposal in Europe regarding the transfer of liability, released January 23 by the Commission of the European Communities, would transfer liability to the government only “if and when all available evidence indicates that the stored CO₂ will be completely contained for the indefinite future.” (Proposed Article 18, Proposal for a Directive of the European Parliament and of the Council on the Geological Storage of Carbon Dioxide). Perhaps that would be a good policy for the United States as well. It would protect the taxpayer and assure that project developers maintain an incentive to operate projects safely and effectively. At a minimum, however, we recommend that subsection (a)(5)(C) of Section 5 be amended so that those who draft regulations addressing liability will do so “taking into account whether or not particular projects have demonstrated a reasonable likelihood that virtually all the CO₂ stored will remain sequestered permanently.”

4. Subsection (a)(4) of Section 5 calls on the Interagency Task Force to consult with industry, legal and technical experts. We suggest that consultation be expanded to include experts from non-governmental public interest organizations.

APPROPRIATE DESIGN OF GEOLOGIC SEQUESTRATION REGULATIONS

Geologic sequestration of carbon dioxide is feasible under the right conditions. It has been successfully demonstrated in a number of field projects, including several large projects. The Intergovernmental Panel on Climate Change (IPCC) Special Report on Carbon Capture and Storage concluded in 2005 that the fraction of CO₂ retained in “appropriately selected and managed geological reservoirs” is likely to exceed 99% over 1000 years. The IPCC also concluded that the local health, safety and environmental risks of CCS are comparable to the risk of current activities such as natural gas storage, enhanced oil recovery and deep underground storage of acid gas if there is “appropriate site selection based on available subsurface information, a

monitoring programme to detect problems, a regulatory system and the appropriate use of remediation methods to stop or control CO₂ releases if they arise.”

While there is little doubt that geologic sequestration is feasible, and little doubt that successful projects are technically achievable today, knowledge and understanding are expected to increase dramatically as the technology begins to be deployed on a large scale. Current projects are highly customized. There are gaps in our knowledge and neither government nor industry have yet developed standard protocols for fundamental aspects of the process such as site characterization and monitoring. The IPCC Special Report projects that increasing knowledge and experience will “reduce uncertainties” and “facilitate decision-making.”

In other words, we know enough to get started but we can expect to experience a lot of “learning by doing.”

What are the implications of this for the regulatory system? We believe at least four recommendations are in order to account for the fact that increasing knowledge and experience will facilitate rational decision-making in different ways over time:

1. Lean toward a performance-based system. “Performance-based” regulations and “command-and-control” regulations do co-exist—they are two poles on a continuum;
2. Be reasonably flexible. Different projects will present different risks and uncertainties, and the uncertainty presented by a single project will tend to decline over time;
3. Require projects to employ an iterative process, informed by monitoring results and perhaps even by experience gained from other projects, in order to reduce uncertainty and drive improvements in site characterization, site suitability assessment, models, model inputs, field operations, the monitoring plan itself, and the remediation plan;
4. Write “adaptive” rules. Look for language that automatically accommodates evolving best practices. Also structure rules to make use of evolving knowledge at each particular site. Be willing to amend rules when needed to protect the environment, giving due regard to the fact that it generally is in the public interest for the regulatory framework to give the regulated community the certainty needed to make investment decisions.

At the same time, it is not enough for rules to be flexible, adaptive and performance-based. It is essential that rules be grounded in a thorough, scientific understanding of the risks involved and that rules assure that the risks will be managed properly. In order to accomplish this, some aspects of the rules (e.g. site characterization and site selection requirements) will need to be more prescriptive than others.

CONCLUSION

In a carbon-constrained world where market forces are harnessed to make sure that society’s carbon footprint is reduced in an economically rational fashion, Environmental Defense foresees a dramatically increased role for renewable energy and for energy efficiency. At the same time, since any complete transition away from fossil fuels is likely to take a very long time, we foresee a long-term need to deal with CO₂ emissions from coal-based facilities. The sooner we begin to deploy CCS technology on a large scale the better. We applaud you for working on measures to make this a reality.

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

STATEMENT OF RONALD T. EVANS, SENIOR VICE PRESIDENT, RESERVOIR ENGINEERING, DENBURY RESOURCES, INC., PLANO, TX

Mr. EVANS. Thank you Chairman Bingaman and members of the committee for the opportunity to share our views on the policy aspects of carbon capture and storage for CCS. As Denbury Senior Vice President I oversee all reservoir engineering, land, acquisitions and purchases of anthropogenic CO₂. Denbury’s primary focus is enhanced oil recovery utilizing CO₂.

We are currently the largest oil producer in the State of Mississippi and one of the largest injectors, if not the largest injector

of CO₂ in terms of volume in the United States. Since 1999 we have produced over 15 million barrels of oil from CO₂ flooding from ten active EOR projects in Mississippi and Louisiana. We are currently participating in several demonstration projects and DOE's regional carbon sequestration partnership program. I will briefly address what we at Denbury believe are the most important policy aspects of carbon capture and storage: cost, taxation and the question of pipeline access and the legislation before the committee today.

Cost. Perhaps the single largest obstacle to developing CCS beyond a limited number of projects currently in operation is the significant cost involved with carbon capture and storage. The cost of capture stem from variations in the quantity and the quality of the CO₂ produced by hydrocarbon combustion, gasification or other industrial processes. The cost to purchase the compressors and the power to generate the compression necessary to pressure the gas significantly to enter the pipeline or sequestration, the lower the percentage of CO₂ in the stream of gases and the greater amount of impurities in the streams the greater the cost of capture.

In addition most technologies capture CO₂ at a lower pressure than the pressure required to enter a typical CO₂ pipeline or to inject into a deep saline reservoir or EOR project. The cost of the compressors and the power necessary to drive them are significant. One example approximately seven dollars and fifty cents per ton or just over one third of the estimated total cost of 20 dollars per ton for carbon capture and storage from the least expensive sources when transported only moderate distances.

The costs of transportation are also significant. Installation costs for CO₂ pipelines have increased dramatically in recent years. From about 30,000 dollars per inch mile for Denbury's free State pipeline to an estimated 100,000 dollars per inch mile for Denbury's proposed green pipeline due to rising steel prices, rising energy prices and construction costs doubling our effective CO₂ pipeline transportation rate. Without some means of reducing the cost of carbon capture and storage infrastructure, significantly development, will likely remain stagnant.

Senate bill 2144 directs the Secretary of Energy to study technical and financing issues related to the construction and operation of CO₂ pipelines. While further studies should prove useful, Congress can act now to address carbon capture and storage costs. Congress should amend section 7704, the tax code to clarify that section (d)(1)(E) covers man made as opposed to just naturally occurring CO₂.

A substantial portion of all the CO₂, natural gas, oil and product pipelines in the United States are owned and operated by publicly traded partnerships under section 7704 whose lower cost of capital lowers the cost of development and transportation of natural resources. Because of the current uncertainty in section 7704 much of the existing CO₂ pipeline capacity cannot be used and new capacity may not get built to transport anthropogenic CO₂. The Senate Finance committee approved a clarification last June, but Congress failed to include it in the Energy Independence and Security Act. We strongly urge members of this committee to work with their colleagues to pass this clarifying amendment.

Pipeline access. The natural gas, oil and product pipeline systems today consist of hundreds of thousands of miles of pipelines with significant interconnects between individual pipeline systems. There also exists a huge retail market for oil and natural gas with a large number of users. This situation stands at market contrast to CO₂ pipelines. In addition to CO₂ not being explosive, flammable or poisonous there currently exists no large interconnected system nor are there reasonable prospects for development of a retail market for CO₂ with a large number of users.

Only a limited number of regional CO₂ shippers and users exist. CO₂ pipeline systems are only a tiny fraction of the size of the oil and gas network. CO₂ pipelines should be given room to grow before FERC like regulation, including regulating access, is contemplated.

To conclude the U.S. economy will continue to require massive amounts of energy well into the future and thus this country needs to use all of its resources to produce the energy it requires given economic and environmental realities. EOR is already playing an important role in this regard and can do so by far greater scale with the right policies. EOR is the only currently active, actual on the ground method for CO₂ injection and sequestration.

While we agree that the additional research and studies proposed in Senate bills 2144 and Senate bill 2323 are worthwhile. We do not believe there's a need for comprehensive Federal regulation as section five of Senate bill 2323 proposes. Congress should provide necessary incentives in mechanisms to foster the development of CCS allowing states to continue to oversee various aspects with which they already have significant experience. Thank you.

[The prepared statement of Mr. Evans follows:]

PREPARED STATEMENT OF RONALD T. EVANS, SENIOR VICE PRESIDENT, RESERVOIR ENGINEERING, DENBURY RESOURCES, PLANO, TX

Denbury Resources, Inc., ("Denbury") appreciates this opportunity to share with Members of the Senate committee on Energy and Natural Resources its views on policy aspects of carbon capture, transportation, and sequestration (hereinafter collectively referred to as "CCS"). As Senior Vice President, Reservoir Engineering for Denbury, I oversee all reservoir engineering, land functions and acquisition activities; am responsible for securing and contracting sources of anthropogenic CO₂; and coordinating our government relations. Denbury is currently the largest oil producer in the State of Mississippi and the one of the largest injectors of carbon dioxide ("CO₂") in terms of volume in the United States. Denbury's primary focus is enhanced oil recovery ("EOR") utilizing CO₂. At the present time we operate ten (10) active CO₂ enhanced oil projects, nine in the State of Mississippi and one in the State of Louisiana.

Denbury also owns the largest natural deposit of CO₂ east of the Mississippi River, called Jackson Dome in central Mississippi, which we extract and transport through approximately 350 miles of dedicated CO₂ pipelines for use in EOR. Denbury is also in the process of designing or constructing an additional 375 miles of CO₂ pipelines in order to expand our operations into additional fields throughout the Gulf Coast of the United States. Finally, the committee may be interested to know that Denbury is working with the federal Department of Energy and various research universities on several Phase II and Phase III demonstration projects in the Regional Carbon Sequestration Partnership Program. While our business model focuses primarily on the transportation and sequestration components of CCS, we also are very familiar with the capture component both in terms of (1) the compression demands of transportation and sequestration and (2) our enhanced oil operations, which recycle large volumes of CO₂ in order to recover additional volumes of oil. Given this background, Denbury is pleased to share its perspective on various policy aspects of CCS and the proposed legislation before the committee today.

A thorough understanding of both (1) the physical processes by which CO₂ is obtained, transported and injected for purposes of EOR and/or permanent storage, and (2) the economics that underlie existing and future EOR-related use of CO₂ is essential to any consideration of potential policy issues. The significant and varying costs associated with CCS—whether in conjunction with EOR or not—are perhaps the single largest obstacle to developing CCS infrastructure beyond the limited, discrete projects currently in operation. From Denbury's perspective, it is critical that any contemplated state or federal regulation not increase these costs and impede private sector development of the CCS infrastructure necessary to meet the demands of our energy hungry and potentially carbon-constrained world. As explained in greater detail below, the current regulatory structure surrounding CO₂ consists of state and federal provisions that cover discrete aspects of CCS. For instance, the over 3,500 miles of dedicated CO₂ pipelines currently in use were constructed and are operating under rules and guidelines for safety issued by the Department of Transportation's Office of Pipeline Safety; with pipeline siting issues significantly impacted by state eminent domain laws; and with CO₂ injection wells permitted and approved by individual state government divisions or departments of Underground Injection Control, utilizing the standards and policies issued by the Environmental Protection Agency. While this system may appear patch-work and noncomprehensive, the current structure is entirely appropriate, as CCS is very much still in its infancy. This predominantly state-law-based system should suffice for many years to come. Thus, Denbury supports the recommendations of the Interstate Oil and Gas Compact Commission's 2005 Regulatory Framework for States. With few exceptions, such as funding research and further study of the issues involved as both bills propose, and given the current system of regulations and natural physical and economic constraints likely to exist for years to come, federal policymakers might best further national energy and carbon capture goals by deferring broad legislation or regulation while CCS is in this nascent phase.

I. CAPTURE / COMPRESSION

In thinking about the policy aspects of CCS, it is useful to separate the various components of CCS and to identify what issues within each merit particular attention, distinguishing between EOR-related CCS and CCS in saline or other formations where appropriate. The starting point for any type of CCS is to capture the CO₂. Denbury currently obtains all of its CO₂ from its natural deposit at Jackson Dome. Certain existing and some evolving technologies allow CO₂ emitted from various manufacturing processes to be captured. The combustion or gasification of hydrocarbon-based fuels such as coal, petcoke or other hydrocarbons produces particularly large volumes of CO₂ at varying levels of quality and purity. As new capture-inclusive projects are constructed, Denbury plans to acquire thousands of metric tons of CO₂ each day for use in EOR.

Aside from the threshold questions of how to properly classify CO₂ and whether and to what extent to restrict emissions, from Denbury's perspective, the capture of CO₂ presents no policy issue. Rather, the capture component presents a significant economic issue: First, capture technology is expensive. The byproduct of hydrocarbon combustion or gasification is a stream of gases and other impurities that contains various quantities of CO₂. In order for CO₂ to be usable in EOR it must be injected in a relatively pure form. Similarly, CO₂ injected into deep saline reservoirs must be in a relatively pure form to maximize the storage space available to be filled with CO₂. Thus, a significant component of the capture cost is the cost to separate and purify the CO₂ to be injected. The lower the percentage of CO₂ in the stream of gases and the greater the amount of impurities in the stream the greater the cost of capture. Second, most technologies capture the CO₂ at a lower pressure than is required to either enter a typical CO₂ pipeline or to inject into a deep saline reservoir or EOR project. The costs of the compressors and the power necessary to drive them are significant—approximately \$7.50/ton of the estimated \$20/ton total cost¹ for CO₂ that is transported moderate distances. Therefore, the compression costs associated with CO₂ capture are slightly more than one-third (33%) of the total CCS cost for the least expensive sources of anthropogenic (man-made) CO₂. Additional compression costs are incurred to maintain pressure in pipelines and again when CO₂ is pressured up to sufficient level for EOR reservoir injection. In sum, without some means of reducing the cost of captured anthropogenic CO₂ significantly, infrastructure development will likely remain stagnant.

¹Total costs of CCS varies substantially by source of CO₂—to upwards of \$70/ton—and even across proposed gasification projects because of variances in each process. This figure represents an estimate of the lowest-cost industrial-sourced CO₂.

To address this issue, last year the Finance committee approved a tax credit for the capture and sequestration of CO₂ of \$10.00/ton in connection with EOR and \$20/ton for non-EOR projects for up to 75,000,000 tons sequestered. From Denbury's perspective, this would be sufficient to incentivize construction of additional pipelines from emission sites to geologic sequestration sites in connection with EOR activities. Unfortunately, this provision was not included in the energy legislation ultimately signed into law in December. We hope that Congress will address the issue of CCS costs in 2008, especially those associated with capture and compression, and note that proposed projects from gasification through to sequestration have the potential to create hundreds and perhaps thousands of jobs across the country. On this point, S. 2144 directs the Secretary of Energy to study technical and financing issues related to the construction and operation of CO₂ pipelines and sequestration facilities. While this will be helpful to policymakers, the legislation should also direct the Secretary to consider these same issues in relation to CO₂ capture, separation, purification and compression.

II. TRANSPORTATION

The most economical way to transport CO₂ is through pipelines at pressures in excess of 1100 psi so that the CO₂ is transported as a supercritical fluid (dense phase). At pressures in excess of 1100 psi and temperatures common for CO₂ pipelines, CO₂ is a supercritical fluid which means that the CO₂ has properties of both a liquid and a gas. Larger volumes of CO₂ can be transported through CO₂ pipelines in this dense phase than can be transported as a gas. Given the pressure requirements to maintain CO₂ in the dense phase, CO₂ pipelines are generally operated at pressures greater than 2,000 psi. This pressure is well in excess of the average operating pressure of a natural gas pipeline, though the material used to manufacture both types is the same.

A. Safety

CO₂ is not as dangerous to transport as some other gases, such as hydrogen and natural gas because it is not explosive, flammable or poisonous. The primary safety issue with transporting CO₂ is asphyxiation caused by a leak in a pipeline. Although there have been a few accidents, releases and leaks reported, none of the dozen leaks that occurred from 1986 to 2006 resulted in significant injury. The characteristics of anthropogenic CO₂ and natural CO₂ are essentially the same. Thus, whether natural CO₂ or anthropogenic CO₂ is being transported in a CO₂ pipeline for the purposes of being delivered to an enhanced oil recovery project or being delivered to a deep saline reservoir sequestration project is irrelevant to the safe construction and operation of a CO₂ pipeline. At the present time there exist over 3,500 miles of dedicated CO₂ pipelines, most of which have been transporting CO₂ for over 20 years—and some for over 30 years—with an excellent safety record. We do not see any evidence to suggest that the current regulatory framework that oversees construction and operation of CO₂ pipelines should be modified. To the extent that consideration of safe handling, transportation, and sequestration issues by the Department of Energy, as S. 2144 directs, will address any lingering misconceptions about the relative safety of dense phase CO₂, it will facilitate public understanding and acceptance of CO₂ pipelines and sequestration projects.

B. Siting

At the present time federal eminent domain authority does not extend to CO₂ pipelines. Several states have provided eminent domain authority to CO₂ pipeline owners to assist in getting CO₂ pipelines constructed. While this is helpful in constructing *intrastate* pipelines, individual state eminent domain powers may not extend to interstate pipelines that are just traversing through a state with no origin or terminus there. For this reason and due to the long distances across state lines that separate potential CO₂ emission capture sites from potential EOR locations, federal eminent domain authority may ultimately be required to develop a nationwide CO₂ pipeline infrastructure. In addition, some mechanism may be necessary to address the siting of pipelines and CCS generally on federal lands. S. 2144 directs the Secretary of Energy to study CO₂ pipeline siting issues, which should facilitate a thoughtful approach by policymakers.

C. Rates

Any contemplation of federal regulation of CO₂ transportation rates and pipelines similar to the regulations that currently exist for natural gas, oil or products pipelines is premature, as there is no interconnected system of CO₂ pipelines to which to apply any such regulation, nor prospects for development of one for many years, nor reasonable prospects for development of a "retail" market for CO₂ with large

numbers of “users” of the CO₂. At the present time there are very limited areas with existing CO₂ pipelines and limited industrial CO₂ emissions being captured (North Dakota Gasification). The vast majority of the existing CO₂ pipelines are transporting natural CO₂ from natural underground CO₂ production sources that are owned and operated by the CO₂ pipeline owner—generally for use in enhanced recovery projects also owned and operated by the CO₂ pipeline owner. In cases where the owner of the CO₂ pipeline has CO₂ production volumes in excess of its own EOR requirements, the excess CO₂ volumes are sold to EOR operators in other projects or to industrial gas suppliers. This limited number of regional CO₂ shippers and consumers stands in marked contrast to the numerous and geographically widespread producers and consumers of oil and natural gas products.

It would be a substantial mischaracterization to suggest that the U.S. has an integrated CO₂ pipeline system similar to the fully integrated natural gas, oil or hydrocarbon products pipeline systems which have their transportation rates regulated by the Federal Energy Regulatory Commission (“FERC”). The natural gas, oil and product pipeline systems today consist of hundreds of thousands of miles of pipelines with significant interconnects between individual pipeline systems to accommodate the transfer of natural gas, oil or products from one pipeline system to the other. In contrast, existing CO₂ pipeline systems are a tiny fraction of that size (3500 miles) and are not interconnected. (see Attachment No. 1) Several pipelines delivering CO₂ for enhanced oil recovery in the Permian basin of west Texas are interconnected at Denver City, where CO₂ can be transferred from one pipeline to another. The other CO₂ pipeline systems in Wyoming, North Dakota, Oklahoma, and Mississippi are not connected to the Permian basin pipeline system or to each other. Thus, today no national CO₂ pipeline system exists and no federal regulation to ensure access is necessary.

Natural gas, oil and hydrocarbon products pipelines were constructed in a similar manner to today’s CO₂ pipeline systems. Individual pipeline systems were developed to transport natural gas, oil or products from production sites to consumption sites in their infancy. Only after a significant period of time, were these individual systems eventually interconnected to allow the transfer from one pipeline system to the other. Although the Federal Power Commission and eventually the FERC was granted jurisdiction over the transportation rates for natural gas, oil and hydrocarbon products, the combination of regulating rates and requiring open access has only existed since 1985. Several decades passed between the time that individual pipelines were constructed and eventually interconnected to create an integrated intrastate pipeline system. CO₂ pipelines should also be given room to grow before FERC-like regulation is contemplated.

D. Costs

The construction and installation of CO₂ pipelines is a capital intensive effort, the costs of which have increased in recent years for a variety of reasons, including rising steel prices, construction costs and energy prices. By way of example, Denbury’s 93 mile, 20 inch Freestate pipeline (see Attachment No. 2) completed in 2006 cost approximately \$30,000 per inch-mile, resulting in an effective transportation rate of approximately \$3.50/ton at full capacity. The initial 37 mile segment of Denbury’s 24 inch Delta pipeline was completed in 2007 at a cost of approximately \$55,000 per inch-mile. We estimate that our planned 314 mile, 24 inch Green Pipeline that will run from Donaldsonville, Louisiana to Hastings field in southeast Texas will cost approximately, \$100,000 per inch-mile resulting in an effective transportation rate of approximately \$7/ton at full capacity. While the length (pumping stations to maintain adequate pressure add an additional \$1 to \$2 per ton to transportation costs), route obstacles and type of terrain all added to the estimated cost of the Green pipeline, the fact remains that such endeavors, even under the best of circumstances are extremely costly and take years of careful planning. As stated above, S. 2144 directs the Secretary of Energy to study technical and financing issues related to the construction and operation of CO₂ pipelines. Such information should prove useful to policymakers seeking to understand the significant costs involved in developing the infrastructure of CCS. Also, any study of CO₂ pipeline financing issues will undoubtedly encounter the tax code impediment discussed in the next section.

E. Taxation

Today, a substantial portion of all CO₂, natural gas, oil and products pipelines in the U.S. are owned and operated by companies that are organized as Publicly Traded Partnerships commonly referred to as Master Limited Partnerships (“MLPs”), which through their lower cost of capital have been an important financing source for building these assets. Section 7704 of the tax code permits MLPs to be taxed

so that income and tax liabilities are passed through to the partners, even though the MLPs are large public entities, provided 90 percent or more of the MLP's gross income is derived from certain qualifying activities. These activities include exploration, development, processing and transportation of natural resources, including pipelines transporting gas, oil, or products thereof (see Sec. 7704(d)(1)(E)). While this provision covers the processing and pipelining of "natural" CO₂, it is unclear whether it covers anthropogenic CO₂. Because of this uncertainty, much of the existing CO₂ pipeline capacity (that owned by MLPs) cannot currently be used to transport anthropogenic CO₂ from emissions sites—at least not without significantly higher tax costs than other pipeline assets in the industry.

Last year, as part of its energy tax package, the Senate Finance committee adopted a modification to include industrial source CO₂ in the definition of qualifying income (see Sec. 817 of the Energy Enhancement and Investment Act of 2007, June 19, 2007). However, Congress ultimately failed to include that package of provisions in the Energy Independence and Security Act of 2007 (P.L. 110-140). Without this modification of the tax code, a substantial portion of the pipeline industry will most likely not contribute capital to the construction of the CO₂ pipeline infrastructure necessary to facilitate CCS through transportation of anthropogenic CO₂. We strongly urge Members of the Energy and Natural Resources committee to work with their colleagues on the Finance committee and the House Ways and Means committee to accomplish this important clarification.

III. INJECTION / SEQUESTRATION

Enhanced oil recovery utilizing CO₂ requires multiple injection wells throughout a unitized field or reservoir. CO₂ injection wells are permitted and approved by each State's division or department of Underground Injection Control utilizing the standards and policies issued by the EPA. CO₂ injection wells utilized in tertiary oil recovery (a.k.a. EOR) are permitted and approved as Class II Injection wells. Such wells have been in existence for over 30 years. The CO₂ sequestration commercial demonstration projects proposed in S. 2323 and enacted in the Energy Independence and Security Act of 2007 should yield additional helpful data on the ability of EOR and saline reservoirs to sequester CO₂.

In 2005, the Interstate Oil and Gas Compact Commission ("IOGCC") issued its recommendations concerning CO₂ injection wells in EOR and non-EOR applications. The IOGCC has recommended that future CO₂ regulation should build upon the primarily state-based regulatory framework already in place, due to states' decades of experience with CO₂ EOR, natural gas storage, and acid gas injection. We concur with their recommendation that for future CO₂ injections in EOR projects, the existing regulatory framework should not be modified. The IOGCC recommended that for non-EOR CO₂ injections, additional regulatory requirements may need to be considered since these types of applications may not have a defined period of injection as does EOR. We also concur with the IOGCC recommendation that CO₂ injection wells for non-EOR applications should be permitted and approved as a sub-class of Class II injection wells or a new classification but not permitted as Class I or V injection wells.

Generally, every CO₂ well drilled is required by state regulations to set and cement a surface casing string below the Underground Source of Drinking Water (USDW) depth to protect the fresh water and ground water intervals. Cement is required to be circulated back to the surface to insure that all potential zones above the USDW depth that contain freshwater are protected. Only after setting the surface casing are wells drilled to the depth required to produce oil and gas or to inject CO₂. Once the well reaches total depth an additional casing string is cemented in the well to provide additional protection to the freshwater intervals and to produce or inject through. We believe existing laws and regulations provide sufficient protection of the fresh water and ground water reservoirs from the injection of CO₂ in EOR operations or, for that matter, in deep saline reservoirs.

The potential for significant migration or leakage from an EOR operation is extremely remote due to the geological nature of oil and gas reservoirs and the existing mechanism that has trapped the oil or gas. At the present time oil and gas operators are required under their mineral leases and state regulations to properly plug and abandon wellbores within a reasonable period after oil and gas operations cease. Responsibility for re-plugging an improperly plugged well remains with the oil and gas operator for an extremely long period of time and, in practice, remains as long as the oil and gas operator is in existence. Such responsibility should be essentially the same for deep saline reservoir injection. However, the detailed geologic and engineering information required by states for EOR projects does not exist for saline reservoirs. Thus, information about deep saline reservoirs will have to be developed,

taking into account that CO₂, being less dense than saline water, will segregate due to gravitational forces and migrate to the highest subsurface position in the reservoir. As noted above, S. 2323 proposes, and the Energy Independence and Security Act of 2007 provided for, commercial demonstration projects, as well as a national CO₂ storage capacity assessment. These undertakings should yield important data currently lacking on saline reservoirs.

IV. CONCLUSION

The U.S. economy will continue to require massive amounts of energy well into the future and thus the country needs to use all of its resources to produce the energy it requires given economic and environmental realities. EOR is already playing an important role in this regard—taking a waste product and using it to increase domestic energy production—and can do so on a far greater scale, with little action required by federal policymakers. The most important step Congress can take at present is to amend Section 7704(d)(1)(E) of the tax code to make clear that anthropogenic CO₂ is included.

The two bills being considered by the committee today, S. 2144 and S. 2323, are clearly intended to provide meaningful vehicles to better understand the issues central to CCS and we commend the committee for focusing on them. While we agree that additional research and further study are worthwhile—as both bills propose—we do not believe there is a need for comprehensive federal regulation, as Section 5 of S. 2323 proposes. Of course, there are areas where federal oversight will likely be necessary, such as management of CO₂ on and under federal lands. For the most part, however, Congress should simply provide necessary incentives and mechanisms to foster the development of CCS, allowing states to continue to oversee various aspects with which they already have significant experience.

The CHAIRMAN. Thank you very much. Thank you all for your excellent testimony.

Let me start with you, Mr. Bengal. I think you make a point in your testimony which is fairly key to our consideration of this whole subject and that is that you say States and provinces are likely to continue to regard CO₂ geologic storage reservoirs as a valuable resource that should be managed using resource management frameworks therefore voiding the treatment of CO₂ storage as a waste disposal. I gather that what you have put together, your task force as you see it, deals with this not as a pollutant but rather as a resource that should be managed in that way. Could you clarify that for me?

Mr. BENGAL. The CO₂ in and of itself may be not the resource as much as the pore space you would be putting it into. Primarily there's only so many places that would be good for CO₂ storage. Not every State has good geologic sites and there's some States that you should not store CO₂ in because of the nature of the geology. It's just not safe and sound.

So there will be a competition for that pore space for those places where it is good that would be an economic benefit to a State who has that pore space to effectively manage that pore space. Ensure that No. 1, the maximum amount of CO₂ is put into that storage area so it's not wasted, the space is not wasted, to keep other entities from encroaching upon that area so it can be set aside just for a particular project. There's a question about drilling through that site. If you had an entire site permitted and set aside for any particular project the State would then ensure that there's no other penetration to the well bores to that site.

So what we're really talking about is we're looking at the management of the pore space where you put the CO₂ as basically the resource. The CO₂ placed in that resource management frameworks deal with that because we deal with natural gas storage maximizing pore space to store the natural gas. With oil and gas you

maximize recovery by managing the pore space much the same way here.

In a waste framework you're just looking at a place to inject something to get rid of it. You're not managing effectively what you're using and where it's going. So that's the way we want to look at it. It's more regulatory framework issue as opposed to the CO₂ itself.

The CHAIRMAN. Let me ask, with my very limited knowledge of this subject at this point, it seems to me that a big problem is that much of the production of CO₂ from power plants is not going to be particularly near the storage locations that we're going to try to store or sequester this CO₂ in. So we're going to be talking about quite a few pipelines that are transferring this CO₂ across several states. So there's going to be a Federal responsibility once you get an interstate pipeline.

What do you see? I know you have a thing here saying that broader, overarching Federal regulation that's like that contemplated in 2323 is not appropriate in your view. How do you see the Federal Government regulating that transportation if I'm right that the significant amount of interstate transportation is going to be required?

Mr. BENGAL. What we're referring to basically is the storage site itself and not the transportation system. That would be a Federal role. The pipelines and the infrastructure for that would remain a DOT role as it is or a FERC role.

We're basically talking about the regulation of the site, the licensing of the site, the long term storage and things like that is what we're referring to and the Federal regulations that would deal with that. With respect to the location and the cost of CO₂ from existing power plants, you're absolutely correct. The cost of right now to retrofit an existing power plant to concentrate the CO₂ from that emission stack and then transport it somewhere, a distance for storage which is many years off in the future for sure.

What we're looking at is initially, I think the first projects would be basically a plant built for that purpose at a storage site where you have minimal transportation. Those are the kinds of projects we need to get going on first and right away as opposed to planning for this massive retrofitting of all existing power plants and a massive pipeline system which we don't need to do first. We need to get some major projects going right now. The technology exists. The regulatory frameworks are in place right now to do that.

The CHAIRMAN. Senator Corker.

Senator CORKER. Yes, sir, Mr. Chairman. Thank you for your testimony, all of you. Mr. Anderson, you talked about how coal is going to be moving into a new era. I can't help but think, based on all the complications that center around either the cost of transport that Mr. Evans talked about and just the geographic differences that exist between where carbon is produced and where it's going to be stored, that really, unless there's huge allowances that are laid out for coal on the front end, that basically coal is going to go through a really, really tough period of time beginning in 2012 if a bill does pass regarding carbon cap and trade which I'm not saying is a plus or minus. I'm just making an observation. Do you have any comment on that? It just seems to me that the

price of coal, the cost of coal produced electricity is going to skyrocket in the beginning as some of these other more complicated things are worked out. I wonder if you have any comment in that regard.

Mr. ANDERSON. The studies that I'm familiar with project a very large role for coal based CCS in the future under regimes like this. The International Energy Agency for example has estimated that by 2050 that CCS could rank second only to energy efficiency as a contributor to solving global warming. There are other estimates that project a 15 percent to 55 percent contribution.

So while I think that business as usual is over for coal, I think coal has a very bright future.

Senator CORKER. That it has a bright future just at a different cost structure?

Mr. ANDERSON. Yes, sir.

Senator CORKER. Mr. Evans do you have any comments in that regard?

Mr. EVANS. The comments I have, Senator, would be that the actual cost of transportation when you look at it although it's one third of the cheapest sources, it becomes a much, much lower component of say from an existing coal fired power plant. It may be as low at 10 percent of that cost. So really the cost on conventional coal today is primarily in the capture side not the transportation.

As we develop sequestration in general with EOR the oil and gas companies can build pipelines to capture the CO₂ and transport to their oil fields. We can cover that cost of the transportation and the sequestration side. It's how much of the capture cost in addition to that are we able to cover.

Senator CORKER. What kind of commercial market for carbon other than for use in enhanced oil recovery do we see 15, 20 years out? What part of the carbon that will be produced can actually be used for other commercial uses other than enhanced oil recovery?

Mr. EVANS. If I do a comparison in Mississippi we produce almost 550 million cubic feet a day of CO₂. About 80 million cubic feet of that goes into industrial uses to make dry ice, freeze chickens, industrial uses of CO₂ so there you're looking at around 20 percent. That market has only been growing about two to 3 percent a year. So I don't know that there's going to be without significant discoveries of other uses for CO₂ much use of it other than EOR or permanent sequestration.

Senator CORKER. Mr. Chairman, thank you.

The CHAIRMAN. Thank you.

Senator Lincoln.

Senator LINCOLN. Thank you, Mr. Chairman. Again welcome gentlemen. We appreciate your expertise in working with us.

Mr. Bengal you mentioned some states have begun the process of beginning a legal and regulatory structure for carbon storage. What are some of those or who are some of those States?

Mr. BENGAL. California, New Mexico, Wyoming, North Dakota, Texas and several other States.

Senator LINCOLN. So there are a few.

Mr. BENGAL. Yes, they're working on legislation as well as rules to move CO₂ storage along in their States.

Senator LINCOLN. What was the other or whoever was on your task force? Was there other expertise there?

Mr. BENGAL. Yes. The task force consisted of actually of two task forces through phase one and phase two. But it was State oil and gas regulators from various oil and gas States, representatives from the various DOE partnerships, the Association of Professional or state geologists, State geologic surveys, representatives from DOE, EPA, BLM and Environmental Defense was an observer during the process of our rules development.

Senator LINCOLN. So you had quite a wide—

Mr. BENGAL. Yes. There were industry experts as well.

Senator LINCOLN. I don't know that you've gotten into this yet today and maybe I'm being redundant. I hope not. But you might explain to me the issue regarding storage rights.

Mr. BENGAL. Much like natural gas if you're going to store something underground like you do natural gas the pore space is owned by someone. It's mineral right. It's a property right and you can't just use that without the property rights authority to do so.

That has to be acquired and that's generally, probably akin to the natural gas storage industry where it belongs to the surface owner. So in order to store these amounts of CO₂ we're talking about even though you may have a very large area an operator will have to acquire the right to store it in that area. There was a question before where's the plume going to go? How are you going to manage the plume for future liability?

You're going to know that before you start because that operator is going to have to own and control the entire area where that plume will go. That's a very large undertaking to do to acquire those rights. So that will be worked out prior to injection what the ultimate static disposition of that plume will be because it will be owned and controlled by owning those property rights.

Senator LINCOLN. That seems like that would be quite the lengthy process. I know just with the Fayetteville shale drilling that is going on in Arkansas the mineral rights and property rights and how they've gone in there has taken quite a bit of time.

Mr. BENGAL. It will be in a natural gas storage setting. States do that through eminent domain condemnation proceedings. You get a certain percentage of the site locked up and then you would go to the State and condemn the rest to move that project forward.

Senator LINCOLN. In terms of the—maybe you can help explain a little better too, more detail, how you see the state framework working with the EPA framework? Is that kind of like a MOA or how do they do that?

Mr. BENGAL. Right now the UIC program, the Underground Injection Program, most states have the authority through privacy from the U.S. EPA to administer that program at the State level for the U.S. EPA in each state.

Senator LINCOLN. So they've already got that?

Mr. BENGAL. They've already got that. In a few States, a direct implementation State, the EPA does on its own. But for those States that do have privacy whatever EPA changes the regulations to be they're automatically incorporated into the State functions that exist and are ongoing now.

Senator LINCOLN. Is there something special about Federal land. Is there something that—does there need to be regulations of CO₂ storage specifically on Federal lands?

Mr. BENGAL. They probably will have to develop a similar type of framework for regulation that we would have on private lands within the States. The State would probably be involved in that. I don't see why it would have to be much different than what the States would do on private lands. The one benefit of Federal lands is you have one mineral owner or one surface owner for the entire project. You could actually site projects very succinctly and not have to deal with the property issue at all.

Senator LINCOLN. Last just about emissions trading or accreditation of storage projects for the purposes of securing the carbon credits. Does your proposed infrastructure cover that as well?

Mr. BENGAL. No. We do not do that. We dealt with just the technology and the legal framework for the storage itself. That's probably going to be worked out at the marketplace or be federally—under the cap and trade system and you'll have to figure that out. We will fit in whatever it is.

Senator LINCOLN. We're always grateful for any suggestions or models you might have already come up with.

Mr. BENGAL. Just don't do more than you have to.

Senator LINCOLN. Ok. Thank you, Mr. Chairman.

The CHAIRMAN. All right. I think that's the end of our questions, and thank this panel very much. This was very useful testimony and we think it is a useful hearing. Thank you.

[Whereupon, at 4:25 p.m. the hearing was adjourned.]

APPENDIXES

APPENDIX I

Responses to Additional Questions

RESPONSES OF SCOTT ANDERSON TO QUESTIONS FROM SENATOR BINGAMAN

Question 1. Many people have called for “permanent” storage in introduced legislation (e.g. all the introduced climate bills), but do not go so far as to define permanence. Can any one of you elaborate on a clear definition of “permanent CO₂ storage” as it relates to geologic storage?

Answer. We suggest using retention of at least 99% for at least 1000 years as the standard for “permanence.” The Intergovernmental Panel on Climate Change has indicated that it is feasible to meet such a standard in well-selected, well-managed sites.

Question 2. What is the appropriate amount of time that CO₂ should be stored in the subsurface, as means of mitigating CO₂ emissions? Will storage times of that magnitude be burdensome on CCS projects?

Answer. We are hopeful that a 1,000 year standard as suggested above will assure that any material leakage that takes place will occur well beyond the era of fossil fuels and therefore at a time when climate change due to emissions of greenhouse gases such as CO₂ is no longer an issue. We do not expect such a standard to be burdensome and in fact we expect that well-executed projects will have minimal leakage for even longer times. Studies at the Weyburn project, for example, indicate a 95% probability that 98.7 to 99.5% of the sequestered CO₂ will remain in the geosphere after 5,000 years and that there will be even less leakage as time goes on. The longer CO₂ is contained underground the more likely it is to stay contained due to mineralization, dissolution in formation water, and residual trapping in pore spaces. See Whittaker, S., White, D., Law, D., and Chlaturnyk, R., IEA GHG Weyburn CO₂ Monitoring & Storage Project Summary Report, Petroleum Technology Research Center, Regina, 273 (2004); Damen, K., Faaij, A., and Turkenburg, W., Health, Safety and Environmental Risks of Underground CO₂ Storage—Overview of Mechanisms and Current Knowledge (Springer 2006).

Question 3. Is there any amount of leakage that is acceptable? The IPCC suggests that storage should be on the order of 1000 years in a geologic formation, with less than 1% leakage of the volume of CO₂ that is injected over the life of the storage project. Is this a reasonable expectation? How can we enforce such a requirement?

Answer. Some have calculated that leakage rates as low as .01% per year, implying 90% retention over 1000 years, might be acceptable from the perspective of climate change policy. Hepple, R. and Benson, S., Implications of Surface Seepage on the Effectiveness of Geologic Storage of Carbon Dioxide as a Climate Change Mitigation Strategy, in Gale, J. and Kaya, Y. (eds), Sixth International Conference on Greenhouse Gas Control Technologies, vol. I, 261–266 (2003). We believe that the 99% for 1000 years standard is feasible and provides a better margin of safety.

In order to enforce such a requirement, it will be necessary to: (1) require that sequestration projects take place only at well-characterized, properly selected sites; (2) require project developers to define the containment system and explain why it is reasonable to expect the system to contain the appropriate amount of CO₂ for the appropriate time frame; (3) require the developer to model and project the fate of the CO₂ in the containment system; (4) require monitoring to confirm or modify the definition of the containment system and to confirm or modify the projections regarding the fate of CO₂ in the system; (5) require that operations be modified if monitoring indicates that a risk of unacceptable leakage is developing; and (6) re-

quire remediation where problems develop that cannot be adequately resolved through modification of operations.

Question 4. In your written testimony, you support the coordinated efforts of the EPA, DOE, and DOI that are specified in Senator Kerry's bill (S.2323). Would there be any additional agencies, organizations, or individuals who you feel should be involved in the interagency task force? (e.g. in the case of ultimate liability of storage sites the Department of Justice may need to be consulted, DOT & FERC for pipelines issues, etc.)

Answer. Yes, the Department of Justice, DOT and FERC could all have valuable roles to play.

Question 5. You also state in your testimony a need to specify "permanent" geologic storage. In your opinion and that of Environmental Defense, how would you define permanent storage?

Answer. Please see answer to question 1 above.

RESPONSES OF SCOTT ANDERSON TO QUESTIONS FROM SENATOR DORGAN

Question 1. I also think it's important that the general public have an understanding of how vastly important an issue this will be to our energy future. In your judgment, what will it take for the general population to better understand and support the approaches associated with carbon capture and storage?

Answer. Education is important in order to achieve public understanding and support. A sound, rigorous regulatory framework is also essential. In addition, the public is more likely to support CCS if it views the technology as only one tool among many for combating climate change, as opposed to viewing CCS as being in competition with renewables and energy efficiency.

Question 2. Coal and oil & gas are two different sectors that traditionally have little history of working together. Today, through enhanced oil recovery opportunities, we are seeing these partnerships beginning to take shape. What kind of new relationships and partnerships will have to be established in order to achieve larger scale carbon capture and storage projects? How can we build on these and other public and private sector relationships to expand this into an industry (regional or national)?

Answer. Putting a market value on carbon sequestration by passing cap and trade legislation is the single most important thing Congress can do in order to encourage these relationships. Once this is done, the market will be able to become the primary driver for answering questions about the types of relationships and partnerships that ought to arise.

RESPONSE OF SCOTT ANDERSON TO QUESTION FROM SENATOR MENENDEZ

Question 1. Mr. Anderson, I agree with your testimony that carbon capture and sequestration technology needs to be advanced and I agree with you that a cap and trade bill would be the best way to make sure this technology is developed quickly. But I also do not want us to lose focus on the fact that we need to eventually transform our economy from one based on fossil fuels to one based on renewables. I am curious about your views on what the balance between funding for CCS and renewable should be. For instance, the Administration is asking for more funding for research on the technology than they are asking for in solar research. Is this the correct balance in your opinion?

Answer. We support the proposed level of CCS funding because it seems proportionate to current RD&D needs. This funding level should not be permanent, however. Once these investments have been made, the investment incentive in the future will need to come from the price signal induced by cap and trade legislation. Publicly-funded research needs for renewable energy are likely to remain large for a longer period of time, and accordingly we hope that the balance between CCS investments and investments in solar and other renewable energy will improve as time goes on.

RESPONSES OF BENJAMIN H. GRUMBLES TO QUESTIONS FROM SENATOR BINGAMAN

Question 1. Many people have called for "permanent" storage in introduced legislation (e.g. all the introduced climate bills), but do not go so far as to define permanence. Can any one of you elaborate on a clear definition of "permanent CO₂ storage" as it relates to geologic storage?

Answer. There is currently not a precise definition of "permanent CO₂ storage." Effectiveness of geologic storage is contingent on CO₂ remaining stored underground for a long period of time. A desirable timeframe for geologic storage of CO₂ is on

the order of thousands of years or longer. However, effectively sequestering CO₂ for even a few hundred years could provide valuable flexibility in reducing CO₂ emissions and contribute to reducing the costs of mitigating climate change.

Accumulation of CO₂ in natural geologic formations has been underway as a natural process in the earth's upper crust for hundreds of millions of years. In most proposed carbon capture and storage (CCS) projects, the goal is to remove CO₂ from the atmosphere, and store it in the subsurface for significant periods. Thus, "permanent" means some long period of time that provides a reasonable assurance that the majority of the CO₂ will stay in place over a number of years (100's to 1,000's). Eventually, an increasing portion of CO₂ stored in the subsurface will be trapped through processes such as formation of minerals, and hydrodynamics with the result that this portion of the CO₂ would be sequestered at a geologic time scale of millions of years. As we gain knowledge from geologic storage projects, a more precise understanding of "permanent CO₂ storage" should emerge.

For the purposes of EPA's proposed rulemaking under the Underground Injection Control (UIC) program, we have not defined this term. However, CO₂ will be stored for long periods of time (e.g., centuries) and EPA's regulations will ensure that CO₂ storage is conducted in a manner that does not endanger underground sources of drinking water.

Question 2. What is the appropriate amount of time that CO₂ should be stored in the subsurface, as means of mitigating CO₂ emissions? Will storage times of that magnitude be burdensome on CCS projects?

Answer. DOE and others are conducting pilot scale geologic sequestration projects to help better understand these questions and others. CO₂ storage in geologic formations can mirror the timescale of oil and gas deposits in formations containing naturally occurring carbon dioxide gas. These formations have held these fluids for millions of years. A desirable timeframe for geologic storage of CO₂ is on the order of thousands of years or longer.

Demonstrating storage over these timeframes should not be overly burdensome. For well-selected, designed, constructed and managed geologic storage sites, the vast majority of CO₂ will gradually be immobilized by various trapping mechanisms and, in that case, could be retained for up to millions of years. Because of these mechanisms, storage could become more secure over longer timeframes (IPCC 2005).

Question 3. Is there any amount of leakage that is acceptable? The IPCC suggests that storage should be on the order of 1000 years in a geologic formation, with less than 1 % leakage of the volume of CO₂ that is injected over the life of the storage project. Is this a reasonable expectation? How can we enforce such a requirement?

Answer. EPA is currently deliberating on several of these issues as the Agency works to develop a regulatory proposal under the UIC program. EPA anticipates that some CCS projects will exhibit a certain amount of leakage within the subsurface, however, safeguards such as leak detection and monitoring will protect against leakage that endangers underground sources of drinking water. The Agency is considering requiring monitoring for leakage to the atmosphere as it is an indicator of potential leakage to or endangerment of underground sources of drinking water.

Question 4. In the context of the national regulations that you are developing for carbon storage, have/will you make a clear definition of the appropriate storage time for CO₂ in the subsurface? Will you be proposing acceptable leakage rates and be mandating a minimum storage time? If so, how will you enforce this regulation?

Answer. EPA is currently deliberating on these issues as it works to develop a proposed regulation.

Question 5. In the case of other "pollutant" storage, the EPA has mandated 10,000 years residence time for the pollutant (or waste product) in the geologic subsurface. Do you anticipate proposing this sort of mandatory time restriction? In the case of Yucca Mountain this has proved to be very burdensome in the permitting/regulatory process.

Answer. EPA is in the middle of a deliberative process as it develops its proposed regulations and is considering this, among many other issues.

Question 6. According to a study conducted by Argonne labs, there is a perception from state EPA employees that they are currently inadequately trained, underfunded, and understaffed for handling the existing UIC program. After you complete the new regulations that you have described in your written testimony, do you anticipate that the state and regional EPA offices will have enough manpower, fiscal resources, training, and expertise to effectively implement these new rules? Should new staffing be required? How will this be funded?

Answer. While CO₂ storage raises new technical considerations, EPA is committed to continuing to support regional and state regulators for the purposes of implementing the UIC program. Currently, EPA provides nearly \$11 million annually to

assist primacy states and EPA regions where states do not have primacy with UIC program implementation. EPA directly implements programs in 10 states and shares responsibility in 7. The FY 2009 President's Budget requests \$10.9 million for this work.

We would note that the Clean Air Act Advisory committee's (CAAAC) Advanced Coal Technology Work Group, which recently issued its final report, developed a recommendation regarding this topic. Specifically, the Work Group recommended that EPA, working with other agencies, "sponsor education and training programs for regulators and other officials involved in the permitting and monitoring of carbon capture and sequestration projects" (more information is available at <http://www.epa.gov/air/caaac/coaltech.html>). EPA is currently preparing a more indepth evaluation of this issue in order to respond to CAAAC. The President's Budget requests a total of \$3.9 million for UIC regulatory work in FY 2009, which the Agency could partially target to help address the CAAAC recommendation.

RESPONSES OF BENJAMIN H. GRUMBLES TO QUESTION FROM SENATOR DORGAN

Question 1. It seems to me that we need to much more quickly begin establishing and defining the "rules of the road" when it comes to carbon management. As we begin to unlock the opportunities for capturing, moving and storing larger amounts of CO₂, it is fair to say that the federal government will likely play a greater role. It will be better if we begin to better define appropriate roles for local, state and federal government. What are the most critical near-term issues that your agency can address so that developers can begin demonstrating CCS projects?

Answer. EPA understands the importance of clearly defining roles and responsibilities. Under the Safe Drinking Water Act, EPA develops minimum requirements for state and tribal Underground Injection Control (UIC) programs. Primacy states may develop their own regulations for injection wells in their state. These requirements must be at least as stringent as the federal requirements (and may be more stringent).

EPA has been working closely with DOE over the past several years as they implemented their CCS research and development program. The Agency recognized the critical near-term issue associated with facilitating UIC permits for demonstration projects to ensure that projects are carried out in a manner that does not endanger underground sources of drinking water. To address this, in March 2007, EPA issued guidance on permitting experimental projects as Class V injection wells. EPA plans to propose regulations in the summer of 2008 to ensure consistency in permitting fullscale CO₂ geologic sequestration projects. Final regulations would be issued by 2011. As with our other regulations, when EPA publishes new federal regulations with specific criteria and standards for constructing, operating, and closing CO₂ wells, a primacy state would need to adopt these standards and classes of wells and seek approval from EPA. In the interim, states will be able to permit CO₂ wells under existing EPA regulations and guidance.

Question 2. Creating an infrastructure to capture, transport, store, and monitor CO₂ will take greater federal resources including staff, technology and other elements. Do you think your agency is well-equipped to begin to undertake this enormous challenge?

Answer. There are several federal agencies that will play a role in establishing a national program to carry out carbon dioxide capture and storage (CCS) on the scale that will be needed to address climate change. While EPA itself will not undertake infrastructure projects, the Agency is responsible for implementing environmental statutes and other programs that may affect deployment of CCS. EPA has been and continues to thoroughly examine its CCS-related statutory and programmatic responsibilities in order to prioritize Agency efforts.

Along those lines, establishing a regulatory framework for geologic sequestration (GS) under the UIC program is an integral step towards creating an enabling framework for CCS. EPA is committed to continuing to provide funding and resources for regional and state regulators for the purposes of implementing the UIC program. Currently, UIC programs receive nearly \$11 million annually to assist in implementing their programs.

The UIC Program has regulated over 800,000 injection wells for over 35 years. While the GS of CO₂ is a new technology that poses a unique set of risks to underground sources of drinking water and human health, EPA believes that GS can be a safe and effective tool when wells are properly sited, operated, monitored, and closed. We believe the UIC program provides an appropriate regulatory framework within which to manage the injection of CO₂ to ensure protection of underground sources of drinking water.

Question 3. Many of the introduced climate change bills have called for “permanent” storage, but do not go so far as to define “permanence.” Since the EPA may have a role in monitoring CO₂, does the agency have a clear definition of “permanent CO₂ storage” as it relates to geologic storage? Would there be any amount of leakage that is acceptable? What is reasonable? How can we enforce such a requirements?

Answer. Effectiveness of geologic storage is contingent on CO₂ remaining stored underground for a long period of time. A desirable timeframe for geologic storage of CO₂ is on the order of thousands of years or longer. However, effectively sequestering CO₂ for even a few hundred years could provide valuable flexibility in reducing CO₂ emissions and contribute to reducing the costs of mitigating climate change.

For the purposes of EPA’s proposed rulemaking under the UIC program, we have not yet defined this term. Generally, the CO₂ will need to be stored for long periods of time (e.g., centuries or millennia) in a manner that does not endanger underground sources of drinking water.

EPA is currently deliberating on several of these issues as the Agency works to develop a regulatory proposal under the UIC program. EPA anticipates that some CCS projects will exhibit a certain amount of leakage within the subsurface, however, safeguards such as leak detection and monitoring will protect against leakage that endangers underground sources of drinking water. The Agency is considering requiring monitoring for leakage to the atmosphere as it is an indicator of potential leakage to or endangerment of underground sources of drinking water.

Question 4. Could you elaborate more about how the EPA could work with state regulations to monitor CO₂? Would there be similarities to how you monitor the UIC program?

Answer. The Safe Drinking Water Act, 42 U.S.C. 300h-1, allows States to apply to EPA for primary enforcement responsibility to administer the UIC program; those States receiving such authority are referred to as “Primacy States.” For UIC Class I, II, IV and V wells, states must meet EPA’s federal minimum requirements for UIC programs, including minimum construction, operating, monitoring and testing, reporting, and closure requirements for well owners or operators. Where states do not seek this responsibility or fail to demonstrate that they meet EPA’s federal minimum requirements, EPA is required, by statute, to implement a UIC program for such States (42 U.S.C. 300h-1(c)). We expect that states who wish to implement a CCS program would be subject to similar requirements for primacy and would need to demonstrate that they meet EPA’s federal minimum requirements for CCS.

RESPONSE OF BENJAMIN H. GRUMBLES TO QUESTION FROM SENATOR MENENDEZ

Question 1. Mr. Grumbles, CCS technology does not necessarily address other environmental problems with coal fired power plants. Coal is a major source of air pollution, with coal-fired power plants spewing 59% of total U.S. sulfur dioxide pollution and 18% of total nitrogen oxides every year. Coal-fired power plants are also the largest polluter of toxic mercury pollution, the largest contributor of hazardous air toxics, and release about 50% of the nation’s particle pollution. In addition, mining coal itself can pollute groundwater and devastate landscapes. Do you agree that even with an effective carbon capture and sequestration program that other environmental harms from coal need to be addressed before CCS technology can truly usher in an era of “clean coal?”

Answer. EPA is committed to addressing environmental challenges associated with the use of coal, which is an abundant domestic energy source that is important to U.S. energy security. Under the Clean Air Act, EPA has made and will continue to make significant achievements in reducing major pollutants from coal fired power plants, including sulfur dioxide, nitrogen oxides, and mercury. Reductions in air pollution, since the 1990 Clean Air Act Amendments, have moved significantly further through policies such as the Clean Air Interstate Rule. The proposed rulemaking under the Underground Injection Control (UIC) Program is an important step towards ensuring protection of U.S. drinking water. EPA is also working under the Clean Water Act (CWA) with other Federal agencies, the States, and the coal mining industry to significantly reduce adverse impacts to the Nation’s waters from surface coal mining activities. We are using our CWA regulatory tools to ensure mining impacts to streams and wetlands are avoided wherever possible, and where impacts can not be avoided, we are requiring more effective mitigation and reclamation to offset these impacts.

RESPONSES OF RONALD T. EVANS TO QUESTIONS FROM SENATOR BINGAMAN

Question 1. Many people have called for “permanent” storage in introduced legislation (e.g. all the introduced climate bills), but do not go so far as to define permanence. Can any one of you elaborate on a clear definition of “permanent CO₂ storage” as it relates to geologic storage?

Answer. The only definition or measure of permanent storage of which I am aware is that set forth by the Intergovernmental Panel on Climate Change (IPCC) which states that storage should be on the order of 1,000 years in a geologic formation, with less than 1% leakage of the volume of CO₂ that is injected.

Question 2. What is the appropriate amount of time that CO₂ should be stored in the subsurface, as means of mitigating CO₂ emissions? Will storage times of that magnitude be burdensome on CCS projects?

Answer. I am not an expert on climate change and thus not in a position to recommend the appropriate length of time CO₂ should be stored underground to mitigate emissions.

Whether or not storage times will be burdensome on CCS projects—specifically on projects undertaken in conjunction with enhanced oil recovery, Denbury’s area of operations—will depend on the nature and scope of any post-injection monitoring requirements. Denbury currently monitors and verifies CO₂ volumes we inject in enhanced oil recovery projects in order to properly manage the project. When it is determined that all of the economically producible oil or gas has been recovered, the projects are generally abandoned by properly plugging the wells. However, to date, we have not sequestered any volumes of CO₂ for permanent storage and thus have no experience managing long-term monitoring requirements. Further, we are not aware of any companies, or governments for that matter, that have been in existence for 1,000 years. Thus, the 1,000 year period being suggested by the IPCC seems difficult to envision, much less manage, particularly without knowledge of what will be required to satisfy regulatory agencies overseeing CCS projects.

Question 3. Is there any amount of leakage that is acceptable? The IPCC suggests that storage should be on the order of 1000 years in a geologic formation, with less than 1% leakage of the volume of CO₂ that is injected over the life of the storage project. Is this a reasonable expectation? How can we enforce such a requirement?

Answer. I am not an expert on climate change and thus not in a position to recommend the amount of CO₂ leakage that is “acceptable.”

It is difficult to say whether 1% leakage of the volume of CO₂ that is injected over the life of the storage project is a reasonable expectation. Based on our experience, we believe that CO₂ injected into a geological reservoir during and following the successful completion of enhanced oil recovery will remain in the ground permanently without leakage, assuming the project is abandoned properly following the recovery of the oil or gas. Subsequent events such as improper cementing, the drilling of wells through the geologic reservoir seeking additional minerals, or subsurface seismic activities, could cause the trapping mechanism to be breached, leading to some leakage. These risks can be properly managed to reduce the potential for leakage, but it is impossible to assert a particular percentage amount of leakage that is reasonable to expect from CCS projects generally.

In the short run, to enforce any leakage limitation, credits for sequestration could be withdrawn or withheld proportionate to the amount of leakage from a particular site. The best way for the government to enforce such a limit over the long run would seem to be for the government to assume control over and/or responsibility for the stored CO₂.

Question 4. Is Denbury or other EOR companies concerned that the EPA regulatory effort may be too onerous or prescriptive? Do you think they should be the lead agency in developing regulations for CCS (at the State or Federal level)?

Answer. It is difficult for Denbury to assess the EPA’s regulatory effort until the EPA proposes rules for comment. Nonetheless, we are concerned about how the EPA will eventually classify CO₂ emissions, and subsequently, what requirements the EPA will propose concerning how to capture and store CO₂. CO₂ is not poisonous, explosive or flammable and has been vented for many years without incident. In addition, CO₂ is currently consumed by individuals, consumed by plants, and utilized in the refrigeration of food. Thus, classifying CO₂ as any sort of hazardous substance would be inconsistent with its safety and its current uses.

I am not certain whether EPA is the appropriate lead agency in developing regulations for CCS. As stated in my written hearing testimony, Denbury agrees with the recommendation of the Interstate Oil and Gas Compact Commission (IOGCC) that future CO₂ policies should build upon the state-based framework already in place, as this framework has provided an entirely safe development of infrastructure for EOR involving CO₂. Based on Assistant Administrator Grumbles’ testimony at

the hearing, the EPA plans to address the injection of CO₂ emissions for CCS in its proposed rules this coming summer. His testimony indicated EPA would be working with a variety of government agencies within the existing framework of the underground injection control regulations. We believe that in developing proposed regulations on Underground Injection Control specific to CCS, EPA should work closely with the Department of the Interior's Minerals Management Service, which has significant experience managing the nation's natural gas, oil and other mineral resources.

Question 5. Many industry professionals have indicated that for large scale CCS to take hold, government must help provide certainty by developing a legal and regulatory framework for the storage of CO₂. Besides resolving technological hurdles, what are the first steps that the government can take specific to legal, regulatory or social elements that will allow more CCS projects to go forward?

Answer. First, Congress should amend tax code Section 7704 to clarify that subsection (d)(1)(E) covers man-made, as opposed to just naturally occurring, CO₂. With the current legal uncertainty in Sec. 7704, much of the existing CO₂ pipeline capacity cannot be used—and new capacity may not get built—to transport anthropogenic CO₂. This action would not be providing a new incentive for CCS; it would simply remove existing legal ambiguity.

Second, as discussed in my written testimony, federal eminent domain authority may ultimately be required to develop a nationwide CO₂ pipeline infrastructure.

Third, we believe that the current regulatory structure is sufficient with respect to (a) CO₂ pipeline safety, overseen by the Office of Pipeline Safety in the U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration, (b) CO₂ pipeline access, which is not currently federally regulated and need not be, due to the small, regional, non-integrated nature of existing and planned CO₂ pipelines, and (c) protection of the fresh water and ground water reservoirs from the injection of CO₂, as provided in the Safe Drinking Water Act and by the EPA's Underground Injection Control Program.

Finally, we concur with the IOGCC's recommendation that future CO₂ regulation should build upon the primarily state-based regulatory framework already in place, due to the states' decades of experience with CO₂ EOR, natural gas storage, and acid gas injection.

RESPONSES OF RONALD T. EVANS TO QUESTIONS FROM SENATOR DORGAN

Question 1. I also think it's important that the general public have an understanding of how vastly important an issue this will be to our energy future. In your judgment, what will it take for the general population to better understand and support the approaches associated with carbon capture and storage?

Answer. For the general population to better understand and support CCS, it is important to educate and disseminate information about various approaches to CCS, such as EOR, through various forums and Congressional hearings similar to the one held by this committee. The general public and legislators need to be educated about the various costs, merits and limitations of various energy sources, including the costs of CCS, available to the country along with reasonable forecasts of the energy needs of this country.

Capturing and storing CO₂ from various sources is technically feasible today, can provide additional sources of energy through enhanced oil recovery, and assist in the reduction of greenhouse gases. The transportation and sequestration of CO₂ related to enhanced oil recovery has been safely demonstrated for over 30 years with no loss of life due to CO₂ leakage. Particularly important is the necessity to distinguish between the relative safety of CO₂ in comparison to the other materials transported via pipeline such as oil, natural gas, petroleum products and hydrogen. CO₂ is not poisonous, explosive or flammable and thus poses far less risk when transported.

Question 2. I have seen reports that indicate that over 200 billion barrels of oil may remain as residual oil in geologically complicated, partially-produced or in mature oil fields in the U. S. What can you tell me about the potential for oil recovery using CO₂ EOR (enhanced oil recovery) that is practiced today versus the potential for so called "next generation" EOR technologies?

Answer. The various technologies associated with EOR (e.g. water flooding, steam flooding, CO₂ flooding, polymer flooding, advanced well designs, etc.) have been used and developed over the past thirty years. The CO₂ flooding used by Denbury today is state of the art and the most efficient at recovering oil in the proper applications. Nonetheless, we continue to refine and improve EOR processes in an attempt to yield additional barrels of oil. Future technological advances will likely allow recovery of incremental volumes of oil, rather than result in a quantum leap or step change in amounts recoverable.

In general, less than 50% of the oil discovered in this country was or will ever be produced, and thus a significant volume of oil is still in the ground and unable to be recovered without some sort of additional investment. The U.S. Department of Energy commissioned a study of the potential amount of oil that could be recovered from CO₂ enhanced oil recovery. The results of this study, completed by Advanced Resources International in 2006, indicated that approximately 390 billion barrels of the 580 billion barrels of oil originally discovered will remain in the ground after primary and secondary methods are applied. Using current technologies it is technically possible to recover approximately 89 billion barrels via CO₂ enhanced oil recovery. These technically recoverable barrels are based on several assumptions within the report concerning CO₂ prices, oil prices and other variables. The report can be found at: http://www.fossil.energy.gov/programs/oilgas/eor/Ten_Basin-Oriented_CO2-EOR_Assessments.html

Question 3. Many industry professionals have indicated that for large scale CCS to take hold, federal and state governments must help provide certainty by developing a legal and regulatory framework for the storage of CO₂. Besides resolving technological hurdles, what are the first steps that the government can take specific to legal, regulatory or societal elements that will allow more CCS projects to go forward?

Answer. Please see my response to Senator Bingaman's question #5. In addition, the Coal Fuels and Industrial Gasification Demonstration and Development Act, S. 2149, which you introduced on October 4, 2007, includes the necessary clarification of Section 7704(d)(1)(E) to cover man-made CO₂ and Denbury commends your leadership on this issue.

Question 4. I believe that in the near term we need to find ways to create certainty for investors to deploy CCS projects. I introduced a bill called the Clean Energy Production Incentives Act (S. 1508) earlier this year that among other things includes a 10-year production tax credit for the storage of CO₂. Developers receive a higher credit for permanent storage and slightly lower credit for using enhanced oil recovery techniques. The bill also included accelerated depreciation and tax credit bonds for CO₂ capture and storage property. Can you talk more about the scale of incentives and how these incentives can accelerate development of large scale carbon capture and storage? Are the incentives adequate to incentivize near-term and long-term storage options?

Answer. I agree that we need to find ways to create certainty for investors to deploy CCS. The production tax credits and accelerated depreciation of pipelines proposed in the Clean Energy Production Incentives Act introduced by you are meaningful incentives to encourage the development of large scale CCS. The proposed level of incentives should be sufficient to encourage the capture of the lowest cost emissions currently and a significant number of proposed gasification projects. Our analysis of the costs to capture, transport and store the lowest cost emissions indicates total costs of approximately \$20/ton. Thus a \$20/ton tax credit should be meaningful to projects that will be required to sequester their emissions in deep saline reservoirs. The corresponding lower amount, \$10/ton for CO₂ sequestered in EOR projects, is sufficient to encourage the development of additional enhanced oil recovery projects using volumes of captured anthropogenic CO₂. These tax credits would encourage the development of CCS projects in the near term.

Technological solutions will have to be developed in coming years to decrease the costs of CCS for many additional existing sources of CO₂ emissions. The cost of CCS for many of these sources is up to \$70/ton and potentially higher. The current proposed production tax credits are not sufficient to encourage or incentivize the capture and storage of these emissions. Necessary technology will only be developed, and the costs of CCS driven down for these sources, by getting the lowest cost CCS projects up and operating. As the lowest cost emissions get captured and research and development progresses, we are convinced that technological and cost breakthroughs will occur. However, delay in incentivizing the lowest cost CCS projects will delay the overall timeframe of the technology development necessary to ultimately address the higher cost emissions.

RESPONSE OF RONALD T. EVANS TO QUESTION FROM SENATOR MENENDEZ

Question 1. You claim that government incentives are necessary to promote the use of man-made carbon dioxide in enhanced oil recovery [EOR] projects. I find this claim troubling on a number of levels. EOR was economically viable even back when we had cheap oil. Why isn't \$90 a barrel oil all the incentive needed? In fact, there are several existing projects which do in fact capture man-made carbon dioxide for use in EOR. The process is economically viable right now, without any government incentives. More importantly, using CO₂ to recover more oil won't stop global warm-

ing because we may be putting some CO₂ in the ground, but the extra oil we extract will lead to more emissions of CO₂ when that oil is used. Why should EOR operations get credit for reducing greenhouse gas emissions, when the process is probably a wash at best in terms of the reduction of net CO₂ reductions?

Answer. In my written testimony, I stated that “without some means of reducing the cost of capturing anthropogenic CO₂ significantly, infrastructure development will likely remain stagnant.” As explained therein, the cost of capturing and compressing anthropogenic CO₂ is significant. EOR can indeed absorb a portion of the capture and compression costs, but the percentage of the capture and compression costs that EOR can cover is dependent upon the level of oil prices. The total cost of CCS from different industrial sources varies widely from \$20/ton to over \$70/ton. EOR can cover the costs of transportation and sequestration, which have seen significant increases over the last few years, and cover a portion of the capture and compression cost. Unfortunately, even with oil at \$90 per barrel, EOR cannot cover 100% of the CCS costs for a significant number of current emitters.

Naturally occurring CO₂ is generally priced as a percentage of oil prices. Thus, when oil prices were low, CO₂ prices were reduced in order to keep projects economic, but at very low oil prices almost all of the projects were uneconomic. As prices have increased, the cost of naturally occurring CO₂ has also increased. In addition to increasing CO₂ costs, the capital costs associated with CO₂ facilities and well work have increased substantially and in some cases the costs have more than doubled.

The only significant use of man-made CO₂ in EOR at present is EnCana Corporation's use of CO₂ from the North Dakota Gasification Project, which was made possible with significant support from the Canadian government. The other anthropogenic sources of CO₂ currently captured and used in EOR in the United States, primarily in the Permian Basin of West Texas, are produced along with natural gas from underground reservoirs. The reason this CO₂ is available at a relatively low cost is because the CO₂ must be separated from the natural gas in order to sell the natural gas. This separation results in a relatively pure stream of CO₂ that then only has to be compressed and transported short distances to the oil field.

The reason EOR should qualify for whatever credit may eventually exist for reducing greenhouse gas emissions is straightforward: First, America will continue to rely on fossil fuels to meet a substantial portion of its energy needs for the foreseeable future and a molecule of CO₂ stored, whether in EOR or non-EOR sequestration, is a molecule that will not get vented to the atmosphere. Second, use of EOR to produce oil domestically avoids the significant emissions and potential spills associated with shipping oil from overseas. Third, according to a recent study of CO₂ storage in connection with EOR commissioned by the U.S. Department of Energy's National Energy Technology Laboratory, advances in technology could enable storage of 1.6 times as much CO₂ in oil reservoirs as the CO₂ content in the recovered oil. (See: http://www.netl.doe.gov/energy-analyses/pubs/Storing%20CO2%20w%20EOR_FINAL.pdf) At present, EOR is the only viable process that can accept and use productively large volumes of anthropogenic CO₂ that would otherwise be emitted.

In addition, EOR benefits U.S. energy security by producing additional volumes of oil in the United States and displacing the necessity for imports from foreign countries. The barrel of oil produced by U.S. workers in the U.S. is worth significantly more in terms of domestic investment, jobs and energy security than the value of an imported barrel of oil.

Keeping up with America's ever-growing demands for energy while reducing emissions of greenhouse gases will take an enormous effort across all fields of energy development, all manner of industry, and all levels of society. If the twin goals of energy independence and a cleaner environment are to have any hope of being achieved without significant reductions in our standard of living, the country cannot afford to ignore particular resources or technologies; the U.S. must utilize every means available to it. EOR is not the answer to all of America's energy and emissions challenges, but it is one of the only readily available alternatives that is working now and that can be broadly utilized in the near term if policymakers decide action is imperative.

RESPONSES OF KRISTA L. EDWARDS TO QUESTIONS FROM SENATOR BINGAMAN

Question 1. Many people have called for “permanent” storage in introduced legislation (e.g. all the introduced climate bills), but do not go so far as to define permanence. Can any one of you elaborate on a clear definition of “permanent CO₂ storage” as it relates to geologic storage?

Answer. I would respectfully defer to the U.S. Department of Energy and other agencies represented at the hearing. The U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA), through its two safety programs, prescribes and enforces standards for the design, testing, and maintenance of tanks, cylinders, and other containers used in the transportation and incidental storage of CO₂. But we do not regulate any aspect of the long-term, permanent, or geologic storage of CO₂ and, accordingly, have had no occasion to consider the requirements for permanent geologic CO₂ storage.

Question 2. What is the appropriate amount of time that CO₂ should be stored in the subsurface, as means of mitigating CO₂ emissions? Will storage times of that magnitude be burdensome on CCS projects?

Answer. I would respectfully defer to other agencies represented at the hearing. As I mentioned in response to an earlier question, PHMSA's oversight extends to hazardous materials transportation, including incidental storage, and we have had no occasion to consider the requirements for long-term geologic storage of hazardous materials.

Question 3. Is there any amount of leakage that is acceptable? The IPCC suggests that storage should be on the order of 1000 years in a geologic formation, with less than 1% leakage of the volume of CO₂ that is injected over the life of the storage project. Is this a reasonable expectation? How can we enforce such a requirement?

Answer. I would respectfully defer to the other agencies represented at the hearing. As mentioned in response to an earlier question, PHMSA has had no occasion to consider standards for permanent or long-term geologic storage.

Question 4. In your testimony you stated that CO₂ pipelines have a strong safety record. Does your agency do any sort of public outreach to convey this message to the general public?

Answer. Yes. PHMSA regularly posts safety-related data, including incident statistics, on our public website (<http://primis.phmsa.dot.gov/comm/reports/safety/PSI.html>). In addition, PHMSA has several program initiatives focused on safety-related public education and outreach. The agency's Community Assistance and Technical Services (CATS) program is devoted to enhancing public understanding about pipeline operations and risk controls through direct interaction with local officials and concerned citizens and the development and dissemination of training programs. CATS representatives working out of the agency's five regional offices participate directly in community meetings and public hearings related to existing or proposed pipelines. As experienced pipeline engineers, our CATS representatives are uniquely qualified to answer public questions and concerns about pipeline operations and oversight.

As part of a comprehensive approach to pipeline safety, PHMSA also requires pipeline operators to develop and implement system-specific public awareness programs targeting nearby communities. These programs are designed to enhance public understanding about pipeline risks and safety performance and to educate communities about the prevention, detection, and reporting of pipeline events. Together with our state partners, PHMSA reviews operators' public awareness programs and enforces requirements under which operators must periodically evaluate their programs' effectiveness in reaching targeted populations and satisfying information needs.

Building on these efforts, PHMSA's Pipelines and Informed Planning Alliance (PIPA) is bringing together a broad group of stakeholders (including industry, safety advocates, and state and local officials) to promote the development of risk-informed standards to guide land use and community planning. We launched PIPA in January of 2008 and have arranged working group meetings throughout the year, targeting a final report by January 2009.

Question 5. Do you envision PHMSA taking on an expanded regulatory role should the existing CO₂ pipeline network be expanded beyond its current geographic distribution? Are there any areas where CO₂ pipelines may be more challenging to site and regulate?

Answer. PHMSA's existing pipeline safety program has provided effective oversight of CO₂ pipelines since 1991 and will accommodate new CO₂ pipelines, however and wherever they are located. From the perspective of public safety and environmental protection, the CO₂ pipeline network can be expanded beyond its current geographic distribution using existing technologies and under existing safety standards and oversight arrangements.

Under PHMSA's current program, a limited number of states are certified to oversee hazardous liquid pipelines, including CO₂ pipelines. To the extent that new CO₂ pipelines are planned in other states, we will be prepared to work with state and local officials to address information requirements and, as appropriate, help states expand their program certifications to encompass CO₂ pipelines.

I would defer to other witnesses concerning the economic and regulatory challenges associated with siting of CO₂ pipelines.

RESPONSES OF KRISTA L. EDWARDS TO QUESTIONS FROM SENATOR DORGAN

Question 1. It seems to me that we need to much more quickly begin establishing and defining the “rules of the road” when it comes to carbon management. As we begin to unlock the opportunities for capturing, moving and storing larger amounts of CO₂, it is fair to say that the federal government will likely play a greater role. It will be better if we begin to better define appropriate roles for local, state and federal governments. What are the most critical near-term issues that your agency can address so that developers can begin demonstrating CCS projects?

Answer. PHMSA and our state partners currently oversee nearly 4,000 miles of CO₂ pipelines under established and effective standards for public safety and environmental protection. The same oversight arrangements and standards will govern new CO₂ pipelines, however and wherever they are configured and located. Accordingly, PHMSA foresees no significant challenges meeting its statutory responsibilities with respect to CCS projects involving pipeline transportation. We will be prepared to work with communities, prospective operators, and state pipeline safety programs to plan for the construction, operation, and oversight of new CO₂ pipelines.

Under our current program, a limited number of states are certified to oversee hazardous liquid pipelines, including CO₂ pipelines. To the extent that new CO₂ pipelines are planned in other states, we will be prepared to work with state and local officials to address information requirements and, as appropriate, help states expand their program certifications to encompass CO₂ pipelines.

Question 2. Creating an infrastructure to capture, transport, store and monitor CO₂ will take greater federal resources including staff, technology and other elements. Do you think your agency is well-equipped to begin undertaking this enormous challenge?

Answer. Yes. Having successfully overseen the operation of CO₂ pipelines since 1991, DOT is well-positioned to carry out its statutory responsibilities with respect to future CO₂ transportation. PHMSA’s existing pipeline safety programs and standards are established and effective, as reflected in accident trends generally and the strong safety record of the roughly 4,000 miles of CO₂ pipelines currently in operation. Since we introduced our Integrity Management program in 2000, the annual number of serious incidents involving hazardous liquid pipelines has reached historic lows, even as the size of the pipeline network has grown. Within these data, the safety record of CO₂ pipelines is especially strong, with no incidents involving death or serious injury since the inception of DOT oversight in 1991.

Together with our state partners, PHMSA currently oversees more than two million miles of natural gas and hazardous liquid pipelines, including pipelines carrying crude oil, refined products, highly volatile liquids, anhydrous ammonia and hydrogen, in addition to carbon dioxide. Because it is neither combustible, reactive, nor toxic, CO₂ is the least hazardous of the materials regulated under our pipeline safety program.

The Nation’s pipeline network is expanding, with numerous privately-financed pipeline construction projects currently underway and in the planning and permitting stages. Although I would defer to other members of the panel for more precise data and projections, we expect this growth to continue, without regard to any pipeline expansion associated with CCS projects.

In accordance with the Pipeline Inspection, Protection, Enforcement, and Safety Act of 2006 and our FY 2008 appropriations, PHMSA is in the process of increasing the numbers of federal inspection and enforcement personnel and increasing financial support for state pipeline safety programs. The President’s FY 2009 budget proposes further increases in staffing and state grants, addressing a variety of new oversight demands, including the construction of new and expanded energy pipelines and the use of existing pipelines for the transportation of new fuel products and blends.

PHMSA’s existing program can accommodate the expansion of CO₂ pipelines, without significant new challenges or resource requirements. The current CO₂ pipeline network accounts for roughly two percent of the hazardous liquid pipeline mileage under our jurisdiction (and less than 0.2 percent of the total pipeline mileage we oversee). Accordingly, even a significant expansion of the CO₂ pipeline network will only marginally increase the mileage under our jurisdiction and is unlikely to necessitate any changes in our standards and oversight arrangements. PHMSA is prepared to work with communities and prospective operators to plan for new CO₂ pipelines, and we will be prepared to oversee their construction and operation, just

as PHMSA is doing today in connection with the expanding network of natural gas, crude oil, and refined products pipelines.

As I mentioned in response to an earlier question, PHMSA anticipates that state pipeline safety programs may play a larger role in oversight of new CO₂ pipelines, depending on the location and configuration of the new lines. We will be prepared to provide financial and technical support to states interested in participating in oversight of CO₂ pipelines.

RESPONSES OF LAWRENCE E. BENGAL TO QUESTIONS FROM SENATOR BINGAMAN

Question 1. Many people have called for “permanent” storage in introduced legislation (e.g. all the introduced climate bills), but do not go so far as to define permanence. Can any one of you elaborate on a clear definition of “permanent CO₂ storage” as it relates to geologic storage?

Answer. Using the term “permanent” when referring to storage of carbon dioxide (CO₂) unnecessarily identifies CO₂ with the disposal of manmade “wastes”, which essentially remain the same in the subsurface, unlike CO₂. CO₂ is a “natural” gas that, in addition to being part of the air we breathe, can be found naturally in the subsurface throughout the world. Naturally stored CO₂ is part of the earth’s geologic processes. Injected CO₂ will likewise become part of the natural earth processes, mineralizing, going into solution and eventually reaching a stability as do natural CO₂, natural gas and crude oil reservoirs, in which CO₂, natural gas and oil are “stored” naturally for millennia.

It is important also to realize that it is primarily during the active injection phase that there is a risk of leakage into the atmosphere. These risks can be significantly reduced if not eliminated by injecting the CO₂ only into select geologically sound storage reservoirs and making certain through subsurface monitoring that the CO₂ during the active injection phase is being contained within the storage interval. Once the injection ceases and the injection facility is closed, the risks of migration from the reservoir decrease exponentially as the CO₂ incorporates with the reservoir environment. Should a leak be detected during the injection phase, remedial actions can be initiated to address the leak until the situation is mitigated. Although monitoring will continue during the post closure phase, it unlikely to reveal leakage that hadn’t been detected during and immediately after the active injection phase.

In summary, at the time a site is closed, the regulator would be expected to have a good understanding of how the CO₂ is behaving in the storage interval and a good deal of confidence that the injected CO₂ is likely to remain in that interval over the very long term. As I have discussed, however, the term “permanence” seems to be more applicable to the situation where a non-natural man-made substance is being emplaced into the earth. In this case, in a very real sense, CO₂ becomes part of the geologic environment into which it is emplaced. It is thus not so much “permanently” contained, as it is incorporated, albeit permanently, into the geologic system as are natural accumulations of oil and natural gas.

Question 2. What is the appropriate amount of time that CO₂ should be stored in the subsurface, as means of mitigating CO₂ emissions? Will storage times of that magnitude be burdensome on CCS projects?

Answer. The answer to the prior question basically answers this question as well. If all goes as anticipated in the storage of CO₂ in an appropriate geologic reservoir, where during the injection, closure and post-closure phases no leakage from the storage interval has been detected by monitoring, it can generally be assumed that the CO₂ has become integrated into the geology of the interval into which it has been emplaced. As previously discussed, there is no reason to anticipate post closure leakage (see also the answer to question #3), although monitoring will continue indefinitely. The IOGCC-proposed state administered trust fund, to which operation of the site would be transferred post closure, would be designed to be more than adequate to indefinitely monitor the site and take, should such be deemed necessary, any and all remedial actions. The specification of a “storage time” would not be a burden, but an expected part of the post closure regime. Of more importance would be the definition of “leakage” and the regulatory burden a strict “un-measurable” standard would impose on a CO₂ project (see next question).

Question 3. Is there any amount of leakage that is acceptable? The IPCC suggests that storage should be on the order of 1000 years in a geologic formation, with less than 1% leakage of the volume of CO₂ that is injected over the life of the storage project. Is this a reasonable expectation? How can we enforce such a requirement?

Answer. In answering this question it is important to be clear what we are trying to accomplish in regulation of the storage of CO₂. We begin with the assumption that first and foremost the reason we are geologically storing CO₂ in the first place

is in lieu of “storing” (releasing) this greenhouse gas in the atmosphere where it will contribute to global climate change.

There are three regulatory standards which will determine an acceptable amount of “leakage”: 1) carbon credits—the leakage threshold in this respect will likely be established by the governmental and or commercial entity which is ultimately established to award carbon credits for the underground storage of CO₂; 2) public health and safety—while there is a threshold of even minimal release into the atmosphere which could endanger public health and safety, catastrophic release from underground storage is almost inconceivable, and; 3) drinking water protection—this is the purpose of the regulations being developed by the U.S. Environmental Protection Agency (EPA), likely to be administered by states under delegated authority from EPA under its Underground Injection Control program. Presumably these regulations will establish this threshold, which is likely to be “no contamination”.

Having said this, it is very clear that the most important factor in assuring that stored CO₂ remains in the subsurface is to make certain that the geologic sites selected for the storage of CO₂ are optimal for that purpose and mirror the “storage” capabilities of naturally occurring oil and natural gas reservoirs. I therefore begin with the assumption and expectation that CO₂ will be stored in formations for which the geology indicates a very strong likelihood of long term containment which meet the thresholds of all three regulatory interests identified above. I further assume and fully expect that the regulatory framework which permits any such storage facility will contain layers of safeguards designed to prevent leakage. However, the purpose of subsurface monitoring is, first and foremost, to detect leakage in the subsurface (above the storage interval) well before the CO₂ reaches the surface and hence the atmosphere. However, even in the very unlikely event that monitoring reveals leakage and that leak is mitigated (mitigation options range from complete cessation of injection—including ultimately depressurizing of the storage interval until leakage is no longer occurring—to capture and re-injection of the leaking CO₂ all while still contained in the subsurface) I am assuming and expecting that any escaping CO₂ will be unlikely to reach the surface and hence the atmosphere.

Question 4. In your testimony you outline the operational bond requirements for the post-closure phase of the CCS project. Following site closure, the operational bond is released the regulatory liability is turned over to a trust fund administered by the state. Did the IOGCC consider a period of time whereby private insurance companies could manage these sites (post-closure)?

Answer. No. Based on the states’ long experience with financial assurances in the plugging of oil and gas wells and the administration of state administered abandoned oil and gas well programs, the IOGCC Task Force believed that the state-administered trust fund would offer the greatest flexibility post closure to monitor and “caretake” the facility in perpetuity. Private insurance would lack the flexibility and responsiveness to be able to immediately respond to potential contingencies. It would also require that a regulator adopt inflexible rules setting the parameters under which insurers would operate.

RESPONSES OF LAWRENCE E. BENGAL TO QUESTIONS FROM SENATOR DORGAN

Question 1. I also think it’s important that the general public have an understanding of how vastly important an issue this will be to our energy future. In your judgment, what will it take for the general population to better understand and support the approaches associated with carbon capture and storage?

Answer. I couldn’t agree more. I indicated in my testimony the importance of public support for this technology, but before the public can support this technology, they must understand and feel “comfortable” with the process. The U.S. Department of Energy has understood this and has required each of the Regional Carbon Sequestration Partnerships to have a strong public outreach component. It has also funded the Interstate Oil and Gas Compact Commission to widely distribute the findings of the Task Force’s work regarding geologic storage of CO₂. The most recent publication of the IOGCC entitled Road to a Greener Energy Future—CO₂ Storage: A Legal and Regulatory Guide for States is being circulated broadly and can be downloaded at the IOGCC website at (<http://www.iogcc.state.ok.us/PDFS/Road-to-a-Greener-Energy-Future.pdf>).

We also firmly believe that a key component of building public support is making absolutely certain that states in their process of creating the laws and regulations to govern this technology do so in a completely open and transparent manner. It is essential that all stakeholders be included in the process if the public is to have confidence in the technology. The public must understand that site selection will be a very important part of the regulatory process. Not every site will be suitable for storage. Only the sites most geologically suitable will be considered.

Also important will be how this issue is presented to the public. As I indicated in my testimony, the public needs to be informed about the long history of CO₂ transportation, handling and use in a great variety of applications. They need to understand that CO₂ is a substance that is part of the air we breathe and that storing it underground is not something entirely new and mysterious, but the technological outgrowths of things with which states already have regulatory experience, like oil and natural gas development, natural gas storage, and CO₂ injection for enhanced oil recovery. I believe it will be important that the public understand that the production of CO₂ is a consequence of the public's demand for and use of fossil energy and that it is arguably in the public's interest to actively participate along with industry in efforts to reduce CO₂ emissions through geologic storage.

Given the regulatory complexities of CO₂ storage including environmental protection, ownership and management of the pore space, maximization of storage capacity and long term liability, geologically stored CO₂ should be treated under resource management frameworks as opposed to waste disposal frameworks.

Regulating the storage of CO₂ under a waste management framework sidesteps the public's role in both the creation of CO₂ and its interest in the mitigation of its release into the atmosphere and places the burden solely on industry to rid itself of "waste" from which the public must be "protected". Such an approach lacking citizen buy-in with respect to responsibility for the problem as well as the solution could well doom geological storage to failure and diminish significantly the potential of geologic carbon storage to meaningfully mitigate the impact of CO₂ emissions on the global climate.

A resource management framework, as proposed by the Task Force, allows for the integration of these issues into a unified regulatory framework and proposes a "public sector-private sector partnership" to address the long-term liability, given that the release of CO₂ into the atmosphere is at least partially a societal problem and that the mitigation of that release is likewise at least partially a societal responsibility and clearly a societal benefit.

Question 2. Many industry professionals have indicated that for large scale CCS to take hold, federal and state governments must help provide certainty by developing a legal and regulatory framework for the storage of CO₂. Besides resolving technological hurdles, what are the first steps that the government can take specific to legal, regulatory or societal elements that will allow more CCS projects to go forward?

Answer. Echoing a point made above and in my testimony, the technology which will be used to store CO₂ underground is not something new, but a technological outgrowth of things with which states already have regulatory experience, like oil and natural gas development, natural gas storage, and CO₂ injection for enhanced oil recovery. What could kill this technology is regulatory uncertainty in such areas as long term liability. If the federal government imposes a Superfund model on storage, the technology is probably dead on arrival as a viable means of mitigating the impacts of climate change on the environment. If on the other hand investors and companies interested in undertaking the storage of CO₂ are reasonably assured that a long term regulatory system along the lines of that proposed by the IOGCC Task Force is adopted, then such an atmosphere will likely be much more conducive to rapid development of the technology.

OTHER ISSUES OF IMPORTANCE

The IOGCC team clearly understands that there are large numbers of underground sites with effectively no risk of leakage and other sites where CO₂ injection should not be permitted. States, working with Federal officials, need to develop a set of criteria by which the optimal sites are chosen first. Such things as properties of primary seals, the presence of secondary and tertiary seals clearly need to be considered in such a ranking.

Aggregation of sufficient mineral and/or storage rights will be a large obstacle for this activity in a large number of places within otherwise suitable areas for sequestration. Both Federal and State rules may need clarification and action to facilitate such aggregation activities.

Many areas with CO₂ emissions will be effectively unsuitable for sequestration. Pipelines moving CO₂ from such areas to suitable ones will therefore be necessary. State and Federal legislation could simplify this task. Adoption of an open-access status to those pipelines may be appropriate as well. Additionally, it appears that some sort of public assistance might prove a useful incentive to a private organization seeking to build a private pipeline. Incentives could come in the form of special tax treatment, access to eminent domain provisions, bonding assistance (similar to

the Wyoming or North Dakota Pipeline Authorities), or some private-public arrangement (with the public part designated as open access).

Avoidance of unnecessary and ominous “permanence” requirements is also essential.

The post closure transfer of responsibility to a governmental entity is considered a necessity. Qualifying a site as low risk and allowing a rapid transfer in a short post-closure period would be both appropriate and stimulating for early action.

Question 3. I believe that in the near term we need to find ways to create certainty for investors to deploy CCS projects. I introduced a bill called the Clean Energy Production Incentives Act (S. 1508) earlier this year that among other things includes a 10-year production tax credit for the storage of CO₂. Developers receive a higher credit for permanent storage and slightly lower credit for using enhanced oil recovery techniques. The bill also included accelerated depreciation and tax credit bonds for CO₂ capture and storage property. Can you talk more about the scale of incentives and how these incentives can accelerate development of large scale carbon capture and storage? Are the incentives adequate to incentivise near-term and long-term storage options?

Answer. Until government imposes a limitation on the amount of carbon that can be released into the atmosphere, presumably through adoption of a carbon tax or a cap and trade system, no additional incentives are likely to prove particularly efficacious. After that happens, all of the incentives noted in the question would be most beneficial indeed. I would caveat that I would question the rationale for disadvantaging enhanced oil recovery (EOR). Perhaps the solution is to frame any production tax credit so as to advantage the CO₂ capturing entity or the pipeline entity or both rather than the injector. That effectively makes the CO₂ less expensive thus encouraging the sequestration with expanded EOR projects.

Additionally, the biggest issue today is the cost of separating and compressing the CO₂ at the source so whatever can be done on that front will be money well invested.

RESPONSES OF JOSEPH T. KELLIHER TO QUESTIONS FROM SENATOR BINGAMAN

Question 1. Many people have called for “permanent” storage in introduced legislation (e.g. all the introduced climate bills), but do not go so far as to define permanence. Can any one of you elaborate on a clear definition of “permanent CO₂ storage” as it relates to geologic storage?

Answer. I note, as an initial matter, that the Commission has extensive expertise in the storage of natural gas in underground reservoirs. However, the storage of natural gas differs significantly from the “permanent” sequestration of CO₂. Natural gas storage is a dynamic process whereby gas is injected, stored and withdrawn with some regularity while the point of CO₂ sequestration is to “permanently” inject and sequester the CO₂ in the reservoir.

Permanent sequestration would appear to contemplate CO₂ remaining in place for the long term. “Permanent” sequestration may pose problems similar to those experienced by natural gas storage reservoirs which are not cycled (the process of injecting and withdrawing gas) on a regular basis. In the case of a natural gas storage field that does not experience sufficient cycling, and does not have well defined geologic boundaries, gas could migrate through the storage formation into other formations or, in the case of aquifer storage facilities, the gas eventually could dissolve into the water and the water eventually could fill the reservoir. If a natural gas storage reservoir is cycled, and the physical infrastructure (piping, casing, surface facilities) is maintained, there is no reason to believe that the storage field could not operate indefinitely.

Question 2. What is the appropriate amount of time that CO₂ should be stored in the subsurface, as means of mitigating CO₂ emissions? Will storage times of that magnitude be burdensome on CCS projects?

Answer. The Commission has no information regarding the amount of time that CO₂ needs to be sequestered to ameliorate the effects of climate change. However, a study by the Massachusetts Institute of Technology (MIT) titled, “The Future of Coal” states, at p. 44, “. . . it is very likely that the fraction of stored CO₂ will be greater than 99% over 100 years, and likely that the fraction of stored CO₂ will exceed 99% for 1000 years.” (footnote omitted).

Question 3. Is there any amount of leakage that is acceptable? The IPCC suggests that storage should be on the order of 1000 years in a geologic formation, with less than 1% leakage of the volume of CO₂ that is injected over the life of the storage project. Is this a reasonable expectation? How can we enforce such a requirement?

Answer. References to leaks in natural storage fields generally apply to leaks in the equipment at the storage field including well casings, piping, compressors, and other miscellaneous surface facilities, not the storage formation, per se. This lost and unaccounted-for gas varies by facility. Gas can also migrate through rock formations and this may be what the referenced IPCC report refers to. Natural gas storage operators drill and maintain observation wells to monitor the migration of natural gas out of the designated boundaries of their storage field. Migration out of designated storage boundaries could occur if the operator does not have a complete understanding of the geology of the storage location. This is not to suggest that the operator is at fault—despite advances in technology, it is still impossible to know exactly what lies beneath the earth's surface. However, migration can also occur as a result of improper operations or as a result of third party operations outside the boundaries of the storage field.

The MIT study referenced in the previous response addresses CO₂ storage leakage as follows:

- Importantly, CO₂ leakage risk is not uniform and it is believed that most CO₂ storage sites will work as planned. However, a small percentage of sites might have significant leakage rates, which may require substantial mitigation efforts or even abandonment. It is important to note that the occurrence of such sites does not negate the value of the effective sites. However, a premium must be paid in the form of due diligence in assessment to quantify and circumscribe these risks well. [p. 50] (footnote omitted).
- Even though most potential leaks will have no impact on health, safety, or the local environment, any leak will negate some of the benefits of sequestration. However, absolute containment is not necessary for effective mitigation. If the rate and volume of leakage are sufficiently low, the site will still meet its primary goal of sequestering CO₂. The leak would need to be counted as an emissions source as discussed further under liability. Small leakage risks should not present a barrier to deployment or reason to postpone an accelerated field-based RD&D program. This is particularly true of early projects, which will also provide substantial benefits of learning by doing and will provide insight into management and remediation of minor leaks. [p. 51] (footnotes omitted).

Question 4. In your testimony you mention three models for governing interstate pipelines. Are you prepared, as an agency, to implement any of these three models for pipeline management?

Answer. In my testimony, I referenced the oil pipeline model, where the states have siting authority, the Commission sets rates, and the Department of Transportation handles safety matters; the natural gas pipeline model, in which the Commission authorizes siting and sets rates, while the Department of Transportation handles post-construction safety; and the current carbon dioxide pipeline model, under which pipelines are sited under state law, and rates are set by the pipelines, subject to review by the Department of Transportation's Surface Transportation Board in the event a complaint is filed. Should Congress so require, the Commission could implement either of the first two models, while the third model would have no role for the Commission. However, as I said in my testimony, I would not recommend that Congress preempt the states or alter the Department Transportation's rate-making and safety roles by providing for exclusive and preemptive FERC siting of carbon dioxide pipelines, because the precondition that led Congress to such a course for siting natural gas pipelines—the failure of state siting—does not exist.

Question 5. While you state in your testimony that you feel the siting of CO₂ pipelines should stay in the jurisdiction of the state agencies—do you think that they are the appropriate entity to regulate transportation rates? This seems like it is well within the jurisdiction of FERC to regulate fair and equitable transportation costs.

Answer. As I mentioned in my written testimony, rates for carbon dioxide pipelines are currently set by the pipelines themselves, subject to the authority of the Department of Transportation's Surface Transportation Board to hold proceedings regarding the reasonableness of the rates, if a complaint is filed. While the Commission does possess ratemaking expertise, I have seen nothing to indicate that the current model is not functioning well. I do not recommend granting ratemaking authority over carbon dioxide pipelines to the individual states, because of the prospect of a patchwork of inconsistent rate regulation for an interstate pipeline network.

RESPONSES OF JOSEPH T. KELLIHER TO QUESTIONS FROM SENATOR DORGAN

Question 6. It seems to me that we need to much more quickly begin establishing and defining the “rules of the road” when it comes to carbon management. As we begin to unlock the opportunities for capturing, moving and storing larger amounts

of CO₂, it is fair to say that the federal government will likely play a greater role. It will be better if we begin to better define appropriate roles for local, state and federal government. What are the most critical near-term issues that your agency can address so that developers can begin demonstrating CCS projects?

Answer. Given that the Commission has no jurisdiction over carbon dioxide pipelines or sequestration facilities, I do not believe that there are issues that the Commission can address directly to speed the development of these projects. However, should Congress pass legislation such as S.2144, my staff and I would be pleased to work with other agencies to study the feasibility of carbon dioxide capture, transportation, and sequestration projects. As I said in my testimony, FERC can play a helpful role examining regulatory barriers and regulatory options relating to the construction and operation of carbon dioxide pipelines.

Question 7. Creating an infrastructure to capture, transport, store, and monitor CO₂ will take greater federal resources including staff, technology and other elements. Do you think your agency is well-equipped to begin undertake this enormous challenge?

Answer. Should Congress establish a role for the Commission in this area, I am confident that the Commission could carry it out. Depending on the nature of the responsibilities given to the Commission, and the extent of the CO₂ capture, pipeline and storage network, the Commission might need additional personnel resources were it assigned to regulate these activities.

Question 8. Your agency has experience siting and regulating interstate pipelines for natural gas and oil. I said earlier in my statement that building a new system for CCS transportation could be compared to building the Interstate Highway System. This means creating right-of-ways, landowner rights and liability issues and others. In terms of siting CO₂ pipelines and potentially moving CO₂ across state lines, which priorities should we as policy makers address in order to help CCS projects move forward?

Answer. Your question poses some of the key issues Congress would need to address if it chose to create a comprehensive federal regulatory regime for carbon dioxide pipelines. Among other things, Congress might want to consider what type of ratemaking regime (cost-based or market-based) would be appropriate; whether carbon dioxide pipelines should be common carriers; whether to grant the holders of authorization for carbon dioxide facilities the power of eminent domain; and whether there are specific environmental, economic, or other findings that the siting agency would be required to make in connection with authorizing such facilities.

RESPONSES OF JAMES SLUTZ TO QUESTIONS FROM SENATOR BINGAMAN

Question 1. Many people have called for “permanent” storage in introduced legislation (e.g. all the introduced climate bills), but do not go so far as to define permanence. Can any one of you elaborate on a clear definition of “permanent CO₂ storage” as it relates to geologic storage?

Answer. There is currently not a precise definition of “permanent CO₂ storage.” Effectiveness of geologic storage is contingent on CO₂ remaining stored underground for a long period of time. A desirable timeframe for geologic storage of CO₂ is on the order of thousands of years or longer. However, effectively sequestering CO₂ for even a few hundred years could provide valuable flexibility in reducing CO₂ emissions and contribute to reducing the costs of mitigating climate change.

Geologic storage of CO₂ has been underway as a natural process in the earth’s upper crust for hundreds of millions of years. At geologic time scales, CO₂ forms a natural part of the Carbon Cycle and is necessary for life. In most proposed carbon capture and storage (CCS) storage projects, the goal is to remove CO₂ from the atmospheric portion of the Carbon Cycle, and store it mainly in the subsurface for significant periods. Thus, “permanent” must mean no unacceptable change over some long period of time and should provide a reasonable assurance of indefinite storage of the majority of the carbon over a defined number of years (100’s to 1,000’s). Any leakage from the subsurface to the atmosphere could be mitigated, or the CO₂ could be recovered and stored elsewhere, if deemed necessary. Eventually, an increasing portion of CO₂ stored in the subsurface will be trapped through processes such as formation of minerals, and hydrodynamics with the result that this portion of the CO₂ would be sequestered at a geologic time scale of millions of years. As we gain knowledge from geologic storage projects, a more precise understanding of “permanent CO₂ storage” should emerge.

Question 2. What is the appropriate amount of time that CO₂ should be stored in the subsurface, as means of mitigating CO₂ emissions? Will storage times of that magnitude be burdensome on CCS projects?

Answer. DOE and others are conducting pilot scale geologic sequestration projects to help better understand these questions and others. CO₂ storage in geologic formations should mirror the timescale of oil and gas deposits in formations containing naturally occurring carbon dioxide gas. These formations have held these fluids for millions of years. A desirable timeframe for geologic storage of CO₂ is on the order of thousands of years or longer.

Demonstrating storage over these timeframes should not be overly burdensome. For well-selected, designed, constructed and managed geologic storage sites, the vast majority of CO₂ will gradually be immobilized by various trapping mechanisms and, in that case, could be retained for up to millions of years. Because of these mechanisms, storage could become more secure over longer timeframes (IPCC 2005).

Question 3. Is there any amount of leakage that is acceptable? The IPCC suggests that storage should be on the order of 1000 years in a geologic formation, with less than 1% leakage of the volume of CO₂ that is injected over the life of the storage project. Is this a reasonable expectation? How can we enforce such a requirement?

Answer. Yes, this is reasonable to expect. Ideally, of course, no leakage will occur and any leakage that does occur must be taken in the context of how much CO₂ must be sequestered to reach and maintain preferred atmospheric levels. Extensive monitoring and modeling will be implemented at each of DOE's large-scale field tests. This monitoring and modeling will occur before, during, and after the CO₂ is injected, for a period of approximately 10 years. This extensive monitoring will result in the opportunity to mitigate any potential leakage.

A natural analog is the million barrels of oil and gas deposits, as well as naturally occurring carbon dioxide gas, that has been trapped in underground geologic formations for millions of years. Furthermore, with proper construction and monitoring, there is a very high probability that the same geologic formations which trap oil and gas deposits and naturally occurring carbon dioxide gas will also help to prevent the significant leakage of carbon dioxide. Sites will need to be chosen carefully, and only the ones with the best geology and proper characterization should be selected for storage. I might add that the United States has a great deal of experience injecting and storing natural gas (in which gas is injected underground during the summer and then recovered to heat homes in the winter) and, though short-term, this experience will also prove useful in developing successful carbon sequestration technologies.

In all cases, best engineering practices will be developed and used when carbon dioxide is injected into geologic formations. The carbon dioxide in the formation is trapped in porous rock, like sandstone. Using a variety of tests and mapping activities should help to identify any fractures in the cap rock and other faults which then can be avoided.

In addition to extensive modeling to determine the potential fate of CO₂, proper site monitoring, measurement and verification (MMV) also can determine if the CO₂ is remaining in the formation. The oil and gas industry has extensive knowledge of monitoring for leaks of various gases from their wells and also for characterizing potential drilling sites for hydrocarbon recovery. This technology along with others being developed through research can be utilized for MMV to ensure that CO₂ leakage is not an issue. Enforcement via continuous monitoring technology may be implemented through a variety of potential regulatory or other legal frameworks that are currently under development.

Question 4. Is the DOE comfortable with the EPA leading the interagency task force described in S. 2323 or would you suggest another organization as the lead agency?

Answer. DOE is comfortable with the EPA leading the interagency task force described in S. 2323. Over the past several years, EPA has been coordinating with DOE. As DOE has developed a Carbon Sequestration Technology Roadmap for the development and deployment of this technology, EPA has been working to design an appropriate management framework for geologic sequestration. By engaging in DOE's R&D program early and working with stakeholders on all sides of this issue, EPA is well-positioned to help in the permitting of future carbon dioxide underground injection wells.

Question 5. As I understand it, one of the chief benefits of the FutureGen approach was that it would demonstrate an integrated design, optimized to maximize CO₂ capture and overall plant efficiency. How are you going to insure we receive this same benefit from a substantially smaller federal investment in a commercial facility?

Answer. The FutureGen program remains a vital component of the Administration's plan to make coal a part of a cleaner, more secure energy future for America. The Administration is restructuring the FutureGen program to accelerate commercial use of carbon capture and storage technology and expand the program from one

project to multiple demonstration projects. The 2009 budget request more than doubles funding for FutureGen, from \$74 million in 2008 to \$156 million in 2009.

Rather than investing in the total cost of an experimental facility integrated with carbon capture and storage, the revised FutureGen approach will invest in the carbon capture and storage portion of commercial power projects, capturing and sequestering at least double the amount annually compared to the FutureGen concept announced in 2003. This will limit taxpayer's financial exposure to only a portion of the incremental cost of the carbon capture and storage portion of the plant. Furthermore, this new approach will allow us to accelerate nearer-term technology deployment in the marketplace faster than the timetable for the previous approach. In order to be successful in competitive power markets (not to mention in the Department's competitive proposal evaluation process), the underlying power plant projects will still need to be efficient, competitive and environmentally sound. The original FutureGen approach was targeting a CO₂ capture and sequestration level of approximately 90 percent, and that level is also specified in the Request for Information for the re-structured FutureGen program.

Question 6. I have heard estimates that including large-scale carbon capture and sequestration on a typical power plant will increase costs by roughly a third. What assurance do you have that the amounts you propose to distribute under this program will be sufficient incentives to lead to commercial-scale demonstration of the technology? Will other federal incentives be available to the applicants, and are more necessary?

Answer. Approximately thirty commercial Integrated Gasification Combined Cycle (IGCC) projects are in various stages of planning, permitting and design across the Nation, which is evidence that a commercially viable basis for IGCC technology already exists. Some are stalled because of uncertainty regarding CO₂. Federal incentives, such as loan guarantees and tax credits, are awarded on a competitive basis and may also be available to some of these projects. Federal funding for FutureGen demonstration projects will help pay for the CCS part of some of these projects this provides additional incentives for such projects. Responses to FutureGen's Request for Information are due by March 3, 2008, and should provide further information on how to structure the FutureGen solicitation to provide sufficient incentives for demonstration projects. Nothing precludes FutureGen applicants from applying for other Federal incentives, such as loan guarantees or tax credits. We have considered the need for further incentives, but believe that none are necessary at this time.

Question 7. In recent months we have seen proposed commercial IGCC plants significantly delayed or cancelled. What assurance do you have that there will be sufficient commercial interest in building these plants to give us the demonstrations we need?

Answer. At the present time over 30 Integrated Gasification Combined Cycle (IGCC) power plants are in various proposal stages and major barriers to their deployment include the uncertainties regarding future CO₂ emissions regulations and the actual costs of constructing and operating IGCC-Carbon Capture and Storage (CCS) power plants. The restructured FutureGen is designed to help understand, address, and solve technical, siting, permitting, regulatory, and fiscal aspects of CCS deployment in various commercial settings. Through its Request for Information, DOE expects to identify the power producers who would consider participating in the revised FutureGen initiative.

Question 8. The 4 phase-3 large-scale CO₂ sequestration tests that have been awarded thus far are all expected to inject less than 1 million tons (approx 500,000) of CO₂ per year—will there be an effort to increase those amounts so that we can have information more in line with that FutureGen would have produced?

Answer. In addition to the four large-scale tests awarded to three of the Regional Carbon Sequestration Partnerships (RCSP) in October 2007, a fifth test was awarded in December 2007 to a fourth RCSP. Three of the tests (in the Alberta Basin, Lower Tuscaloosa Formation, and Entrada Formation) individually are expected to inject at least 1 million tons of CO₂ per year for at least one year. Two other tests (in the Williston Basin and Mount Simon Sandstone Formation) will inject greater than 1 million tons in total, though at a rate of less than 1 million tons of CO₂ per year. The injection rates will be at a scale that demonstrates the ability to inject and sequester several million metric tons for a large number of years. This operation at commercial-scale is as significant as that of higher injections of 1 MM tons per year. It is our intention to confirm the design of these injections, including the applicability of the injection scale proposed for the demonstrations to operations at commercial scale, in a March 2008 technical peer review.

Question 9. The competition for FutureGen between Texas and Illinois led both states to examine the policy framework that would be necessary for CO₂ sequestra-

tion. How will the new program create similar incentives for states in which the projects will be located? What can we do here to accelerate this deployment?

Answer. There are major technical and regulatory hurdles to overcome before coal with CCS can be commercially deployed, however it is in the best interest of states to adopt a posture that would help enable ultra-low emission integrated gasification combined cycle (IGCC) plants with CCS, like FutureGen, to provide stable power supplies at affordable prices.

FutureGen will provide early CCS demonstration experience in a commercial setting, which is aimed at accelerating deployment and advancing carbon capture policy. The revised approach would sequester at least double the amount of CO₂ than the previous approach, generate enough electricity per plant to power 400,000 households, and have the potential of demonstrating CCS in multiple states. FutureGen will help establish commercial feasibility and formulate a model that industry could use to deploy commercial-scale plants that each sequester at least one million metric tons of carbon dioxide annually.

RESPONSES OF JAMES SLUTZ TO QUESTIONS FROM SENATOR DORGAN

Question 1. It seems to me that we need to much more quickly begin establishing and defining the “rules of the road” when it comes to carbon management. As we begin to unlock the opportunities for capturing, moving and storing larger amounts of CO₂, it is fair to say that the federal government will likely play a greater role. It will be better if we begin to better define appropriate roles for local, state and federal government. What are the most critical near-term issues that your agency can address so that developers can begin demonstrating CCS projects?

Answer. The most critical near-term issues DOE can and is addressing through its research, development, and demonstration carbon capture and storage (CCS) program are the development of technology for CCS, which in turn will advance public acceptance of CCS as a technology for mitigating greenhouse gas emissions. Testing the storage of CO₂ in deep saline formations and depleted oil fields will enable representatives from industry, states, the U.S. Environmental Protection Agency, and others to learn from the field demonstration of site characterization, operations, and closure which will lead to the development of best management practices for all aspects of CCS projects. These field activities, which DOE is supporting on a cost-shared basis, are critical in the deployment of these technologies and will provide key information in the development of regulations and policies to support CCS. The near-term successes of the field activities will help to support demonstrations planned under the restructured FutureGen Program [at 1M tons CO₂/yr, FutureGen is about the same scale as the field tests].

Question 2. Creating an infrastructure to capture, transport, store, and monitor CO₂ will take greater federal resources including staff, technology and other elements. Do you think your agency is well-equipped to begin undertake this enormous challenge?

Answer. The DOE has a dedicated interdisciplinary team, working to develop and demonstrate technologies for carbon capture and storage (CCS) and provide support to other agencies in the development of regulatory structures for injection. Additionally, DOE works with other countries through the Regional Carbon Sequestration Partnerships (with over 350 entities involved) and the Carbon Sequestration Leadership Forum. DOE also has the ability to add resources from the nineteen national laboratories and enter into cooperative agreements with industry and other research institutions when necessary.

Question 3. DOE has been implementing the Carbon Sequestration Regional Partnership program to study carbon management in different regions of the country. Also, your agency has been working to identify storage sites for CO₂. I think this work is important and should continue to help us evaluate where the opportunities for CCS demonstrations could take place.

I do believe that we can find cleaner and more efficient ways to utilize our coal resources. However, we must do so in a way that does not jeopardize are ability to generate base load power. Your agency has several different areas working on different elements of carbon capture and storage.

Could you provide me with an explanation of how the Department of Energy is coordinating the different research, development, demonstration and deployment program areas working on CCS in order to deploy the technology more rapidly?

Answer. There are several elements of DOE’s Sequestration Program for carbon capture and storage (CCS). They include the R&D which fund basic and applied basic research for carbon storage and capture technologies. The projects funded through these R&D programs represent innovative approaches that can significantly reduce the cost and demonstrate the safety and effectiveness of CCS. The second

part of the program consists of large-scale CO₂ injection projects, which are designed to take the technologies developed in the R&D programs and deploy them in the field through programs like the Regional Carbon Sequestration Partnerships. This part of the program is also responsible for developing the infrastructure technologies and information, such as CCS best practices that could help form a basis for regulations, for CCS deployment through the involvement of representatives from industry, non-governmental organizations (NGOs), universities, and Federal and state partners. The final piece of the DOE CCS program will be implemented through the clean coal demonstration program (such as the Clean Coal Power Initiative and FutureGen demos), which will take the technologies developed from the R&D and large-scale injection projects and implement these in full-scale power plant demonstrations that include CCS. Early commercial deployment of plants with CCS can benefit from FutureGen demos and other deployment incentives. The Sequestration Program, which is managed by the Office of Fossil Energy, also coordinates with DOE's Office of Science to enhance the scientific learning and understanding in the field demonstration projects.

All of the projects awarded through these DOE programs are based on cooperative agreements with industry and/or research institutions. Therefore, the success of these programs depends upon the success of our partners and DOE's continued efforts to promote technology transfer.

DOE is also supporting working groups through other Federal agencies, non-governmental organizations (NGO), and industry that are working to develop regulations and liability frameworks, and to educate stakeholders about the benefits of CCS.

RESPONSES OF JAMES SLUTZ TO QUESTIONS FROM SENATOR LANDRIEU

Question 1. I learned that the Department of Energy has decided to alter course on its "FutureGen" project. In the Request for Information that you released yesterday, you describe that your new approach will target IGCC plants to demonstrate carbon capture and storage technology. In Louisiana, we have saline storage formations, and we have a 300 megawatt power plant coming online. At present, it will be fueled by Petroleum Coke, but it is not currently slated to be an IGCC plant. Will the Department keep an open mind about selecting plants that may not be IGCC equipped, but that are nonetheless capable of capturing and storing their carbon?

Answer. Yes, alternatives to Integrated Gasification Combined Cycle (IGCC) will be considered. The Request for Information does seek comments on whether the revised FutureGen approach should allow for advanced coal-based technology systems, other than IGCC, that would meet the stated performance requirements for FutureGen (e.g., approximately 90 percent CO₂ capture and storage, 0.04 lbs/million Btu SO₂ emissions, less than 0.05 lb/million Btu NO_x emissions, less than 0.005 lb/million Btu particulate matter emissions, and greater than 90 percent mercury removal).

Question 2. Additionally, your Request for Information states that the Department will contribute the incremental cost associated with adding CCS technology to the facilities power train. Would the DOE cover the costs associated with compressing and transporting the CO₂? Are these grants only intended to cover capital costs, or will they cover certain qualified operating costs as well?

Answer. DOE will contribute a portion of the incremental cost associated with adding CCS technology. Based in part on input obtained through the Request for Information, DOE will determine which incremental costs are eligible for cost-sharing, such as compressing and transporting the CO₂ and certain operating costs. The determination of which costs will be eligible for cost sharing, particularly for any equipment that might be shared between the power plant and CCS technology, will be articulated in the formal solicitation.

RESPONSES OF JAMES SLUTZ TO QUESTIONS FROM SENATOR CANTWELL

Question 1. The Energy Bill (Title VII, Section 702) passed in December directs the Department of Energy to conduct not less than 7 initial large-scale sequestration tests to study and validate commercial deployment of technologies for CO₂ capture and sequestration. Seven regional partnerships have been identified and are currently entering Phase III of their projects. I understand the Department has currently awarded 4 of the 7 partnerships with Phase III funding. What is your path forward to provide funding for the final three in 2008?

Answer. DOE has made awards for five large-scale tests to four of the Regional Carbon Sequestration Partnerships (RCSP) for Phase III Large Volume Sequestration Testing. Depending on the results of a scientific needs assessment being con-

ducted in FY 2008 and the ability of additional project proposals to meet those needs, additional projects may be awarded in FY 2008 or FY 2009. The remaining three Phase III projects are in the process of being evaluated. The evaluation process requires finalizing the technical scope of the project along with undertaking a scientific evaluation and cost analysis of the proposed projects to verify their appropriateness within the overall objectives of the Sequestration Program. Independent cost verification is being undertaken by DOE to ensure the project costs are adequate prior to award. Independent cost reviews of the projects that have received awards have been completed. An independent technical review will be conducted at the end of March 2008. This technical review, conducted by an internationally renowned group of experts, will compare the proposed test plans against the program needs and that required for proper scientific evaluation in order to develop an integrated portfolio of robust tests. DOE is conducting reviews and plans to evaluate award of the remaining RCSP Phase III Projects based on the results on the scientific evaluation. The estimated time-frame for evaluating the remaining awards is the summer of FY 2008. The Sequestration Program budget is available to fund these awards.

Question 2. Which partnership takes into consideration the geologic formations in the Pacific Northwest and what is the status of this project?

Answer. The Pacific Northwest is shared by two Regional Partnerships, the Big Sky Regional Partnership (Big Sky) and the West Coast Regional Carbon Sequestration Partnership (WESTCARB). The Big Sky Regional Partnership is currently evaluating basalt formations in the region. The West Coast Regional Carbon Sequestration Partnership in addition to the West Coast is responsible for working with the states in the Pacific Northwest to characterize the geology and terrestrial sinks in that region. The WESTCARB project has completed the initial characterization of saline reservoirs and coal seams which could be possible storage formations. The results of this characterization is available through the National Carbon Sequestration Database and Geographic Information System online Atlas at the following site: <http://www.natcarb.org> These Regional Partnerships are currently in Phase II, undertaking Field Validation Testing in the region, and are two of the awards that are in the process of evaluation for potential award under Phase III.

RESPONSE OF JAMES SLUTZ TO QUESTION FROM SENATOR MENENDEZ

Question 1. In April, in testimony before this committee, Thomas Shope, Acting Assistant Secretary for Fossil Energy at the Department of Energy, estimated that Carbon Capture and Sequestration technologies would become deployable and available in 2020 to 2025, but that wide deployment for most projects would not happen until 2045. Do you agree with this estimate? If so, won't this be too late if we are going to reduce our greenhouse gas emissions by 80% below 1990 levels by 2050?

Answer. Widespread deployment of Carbon Capture and Storage (CCS) depends on a variety of factors, including success of R&D to drive down the cost of safe CCS, particularly the cost of separating CO₂ from other gases and compressing it (to a supercritical fluid) for injection into geologic formations, and success of demonstration of CCS technologies so that the lowest cost technologies can be identified and commercialized in a timely manner.

The Administration believes that significant reductions in CO₂ can be made through investment in technology that will lead to a fundamental change in the way we produce electricity and power our vehicles. The President's 2009 budget request for research, development and demonstration of advanced clean coal technology, when combined with required private-sector contribution, will approach a total investment of nearly \$1 billion. With continued support, it could be possible to significantly advance the timing for full deployment of CCS technologies.

[Responses to the following questions were not received at the time the hearing went to press:]

QUESTIONS FOR STEPHEN ALLRED FROM SENATOR BINGAMAN

Question 1. Many people have called for "permanent" storage in introduced legislation (e.g. all the introduced climate bills), but do not go so far as to define permanence. Can any one of you elaborate on a clear definition of "permanent CO₂ storage" as it relates to geologic storage?

Question 2. What is the appropriate amount of time that CO₂ should be stored in the subsurface, as means of mitigating CO₂ emissions? Will storage times of that magnitude be burdensome on CCS projects?

Question 3. Is there any amount of leakage that is acceptable? The IPCC suggests that storage should be on the order of 1000 years in a geologic formation, with less than 1% leakage of the volume of CO₂ that is injected over the life of the storage project. Is this a reasonable expectation? How can we enforce such a requirement?

Question 4. In your testimony you mention that the Dept of Interior will have a critical role in determining how CO₂ is managed on public lands. One area your testimony did not discuss was the site selection criteria that will be necessary in choosing geologic formations suitable for storing CO₂. The USGS employs some of the world's leading geologic experts. In your opinion, would the USGS be a good organization to recommend a set of "best practices" for geologic site selection for CO₂ storage? By this I mean that they would not be regulators of the site selection, but instead recommend the technical requirements for safe, long-term geologic storage of CO₂.

QUESTIONS FOR STEPHEN ALLRED FROM SENATOR DORGAN

Question 1. It seems to me that we need to much more quickly begin establishing and defining the "rules of the road" when it comes to carbon management. As we begin to unlock the opportunities for capturing, moving and storing larger amounts of CO₂, it is fair to say that the federal government will likely play a greater role. It will be better if we begin to better define appropriate roles for local, state and federal government. What are the most critical near-term issues that your agency can address so that developers can begin demonstrating CCS projects?

Question 2. Creating an infrastructure to capture, transport, store, and monitor CO₂ will take greater federal resources including staff, technology and other elements. Do you think your agency is well-equipped to begin undertake this enormous challenge?

QUESTIONS FOR STEPHEN ALLRED FROM SENATOR SMITH

Question 1. I want to thank you for your response to my December 2007, letter concerning the pending Memorandum of Understanding between the Minerals Management Service (MMS) and the Federal Energy Regulatory Commission (FERC) regarding wave and current energy projects on the Federal Outer Continental Shelf (OCS). It is my understanding that this issue also came up at the Energy Committee on Thursday. I appreciate the actions taken by MMS, but I remain concerned that the potential for environmentally-friendly wave energy development will continue to be delayed on the OCS. Can you tell me when these proposed regulations, which have yet to be published for public comment, will be finalized? In the current draft of the agency rulemaking, do you address the issue of jurisdiction between MMS and FERC, which I understand would have been addressed in the MOU? If not, why can't MMS sign the MOU in order to provide regulatory certainty on agency jurisdiction now, and seek to amend the MOU if the final regulations require such a modification?

Question 2. You stated in your letter and at the Committee hearing that you had been asked by the Committee not to sign the MOU. It is my understanding that such a request was originally made when there was Senate-passed language in the 2007 energy bill that would have specified that FERC did not have jurisdiction over kinetic hydropower facilities located in the OCS. However, that language was not included in the final version of the bill, which is now P.L. 110-140. Can you tell me why, in the absence of this language, it wouldn't be helpful to those seeking to develop projects on the OCS to provide immediate clarity concerning the regulatory roles and responsibilities of the two agencies?

QUESTION FOR STEPHEN ALLRED FROM SENATOR WYDEN

In my State of Oregon and in the State of Washington, western coastal basins offer potential carbon sequestration opportunities. Promising basins include the Puget Trough, Tofina-Fuca Basin, West Olympic Basin, Whatcom Basin, and Willapa Hills Basin in Washington, and the Astoria-Nehalem Basin and Tyee-Umpqua Basin in Oregon.

Furthermore, Oregon is one of the states that is part of the Big Sky Carbon Sequestration Partnership (BSCSP). Their vision is to prepare its member organizations for a possible carbon-constrained economy and enable the region (Montana, Idaho, South Dakota, Wyoming, eastern Oregon and Washington, and adjacent areas in British Columbia and Alberta) to cleanly utilize its abundant fossil energy resources and sequestration sinks to support future energy demand and economic growth. The BSCSP will achieve this vision by demonstrating and validating the region's most promising sequestration technologies and creating the supporting infra-

structure required to deploy commercial scale carbon sequestration projects. BSCSP has the goal of developing an infrastructure to support and enable future carbon sequestration field tests and deployment throughout the BSCSP region.

This technology is extremely attractive in assisting to address climate change issues; assuring the environmental acceptability and safety of carbon dioxide (CO₂) storage in geologic formations and determining that CO₂ will not escape from geologic formations or contaminate drinking water supplies are major concerns. Much research is needed to better understand and characterize sequestration of CO₂ in geologic formations; I understand that researchers are building on the significant baseline of information and experience that exists.

Question 1. During the second panel discussion of the hearing, Mr. Allred of the Department of the Interior discussed issues pertaining to land leasing requirements and mineral rights, as well as carbon dioxide ownership and eminent domain. While this discussion was informative, no resolution was provided on the subject matter. Mr. Allred, can you provide details on how carbon capture, transport, and sequestration, as well as the creation of carbon dioxide transport pipelines will impact private land owners' property and mineral rights in Oregon? And what are the federal land right impacts of carbon capture, transport, and sequestration on public property such as national forests and those supervised by the Bureau of Land Management?

APPENDIX II

Additional Material Submitted for the Record

AMERICAN PUBLIC POWER ASSOCIATION,
Washington, DC, January 28, 2008.

Hon. JOHN KERRY,
U.S. Senate, 304 Russell Senate Office Building, Washington, DC.

DEAR SENATOR KERRY: I am writing to express the American Public Power Association's (APPA) support for Section V of your bill (S. 2323) that establishes an interagency task force to develop regulations providing guidelines and practices for the capture and storage of carbon dioxide.

As Congress continues to debate climate change, one of the most frequently discussed technologies is that of carbon capture and storage. While this may be a viable option to address climate change, there are major challenges that must be overcome, both technically and in public policy, before widespread commercial-scale carbon capture and storage can be achieved. APPA believes your bill is a step in the right direction to overcoming these challenges.

Again, thank you for your dedication and hard work on this matter and we look forward to working with you as your legislation moves forward.

Sincerely,

MARK CRISSON,
President & CEO.

STATEMENT OF ROBERT J. FINLEY, DIRECTOR, ENERGY AND EARTH RESOURCES
CENTER, CHAMPAIGN, IL, ON S. 2323

The Illinois State Geological Survey is one of the largest and most diverse state geological surveys in the United States. We have been researching carbon sequestration in the Illinois Basin of Illinois, southwestern Indiana, and western Kentucky since 2001. In 2003, we submitted a successful competitive proposal that began our work as a lead agency for a Department of Energy (DOE), Regional Carbon Sequestration Partnership. Phase I of that work was completed in 2005, and a Phase II program was awarded in 2005 that runs through 2009. Our Phase III large-scale sequestration test was awarded this past December and we will inject one million metric tonnes of carbon dioxide (CO₂) into a saline reservoir with the collaboration of the Archer Daniels Midland Company who is providing the site and the high-purity carbon dioxide for the test. Other tests we are conducting include injection into mature oil reservoirs and into coal seams to evaluate enhanced oil recovery and the ability of coal to adsorb CO₂. With these efforts we have established a program to address the major potential reservoirs for carbon sequestration, as have the six other Regional Carbon Sequestration Partnerships in their respective regions around the country. The existence of these efforts leads me directly to offer comments on S.2323.

Section 3 of this bill is essentially duplicative of the work that the DOE Regional Carbon Sequestration Partnerships are conducting as part of their Phase III efforts. The projects already planned and underway involve 1 million tonnes from a variety of commercial sources. For purposes of sequestration, and assessing the safety and effectiveness of the process of isolating CO₂ from the atmosphere, the Partnership tests are addressing the very issues this bill proposes to address. Given the urgency in developing responses to climate change, I cannot support initiating a new effort that duplicates work that is already in place with similar goals, volumes of CO₂, and geographic diversity.

I would also call your attention to Section 6. A significant amount of research has already been conducted or is now underway with respect to carbon capture by the Office of Fossil Energy within DOE. S.2323 seemingly does not provide for coordina-

tion between Office of Science and the Office of Fossil Energy with respect to the work that already has been accomplished. Thus, the potential for duplicative work again arises.

It is important that Section 7 of S.2323 recognizes the work on capacity assessment that has been completed and is now being updated by the DOE Office of Fossil Energy. The initial methodology is already undergoing modification and refinement. However, some of the work proposed in this section is likely to be duplicative and the required coordination provisions should be strengthened. Certainly, some detailed, recent assessments of the volumes of oil incrementally recoverable through CO₂ enhanced oil recovery have been made on a basin scale, published, and presented around the nation. With regard to the Geological Verification provision of Section 7, I would suggest that this element be dropped. The authorized funding will not cover any useful new drilling in its entirety while providing for the other aspects of this Section. It would be far more effective to focus on partnerships with existing drilling efforts in order to specifically cofund data collection (coring, advanced well logging, and similar) but not make any contributions to actual drilling expenditures or footage rates.

Senator Bingaman and Members, I appreciate the opportunity to submit these comments to the committee and would welcome any follow-up communications that may be useful to you.

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