AUTHENTICATED
U.S. GOVERNMENT
INFORMATION
GPO

S. HRG. 111–50

CARBON CAPTURE AND SEQUESTRATION

HEARING

BEFORE THE

COMMITTEE ON ENERGY AND NATURAL RESOURCES UNITED STATES SENATE

ONE HUNDRED ELEVENTH CONGRESS

FIRST SESSION

TO

RECEIVE TESTIMONY ON S. 1013, THE DEPARTMENT OF ENERGY CARBON CAPTURE AND SEQUESTRATION PROGRAM AMENDMENTS ACT OF 2009

MAY 14, 2009

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

U.S. GOVERNMENT PRINTING OFFICE

50–986 PDF WASHINGTON : 2009

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

COMMITTEE ON ENERGY AND NATURAL RESOURCES

JEFF BINGAMAN, New Mexico, *Chairman*

BYRON L. DORGAN, North Dakota
RON WYDEN, Oregon
TIM JOHNSON, South Dakota
MARY L. LANDRIEU, Louisiana
MARIA CANTWELL, Washington
ROBERT MENENDEZ, New Jersey
BLANCHE L. LINCOLN, Arkansas
BERNARD SANDERS, Vermont
EVAN BAYH, Indiana
DEBBIE STABENOW, Michigan
MARK UDALL, Colorado
JEANNE SHAHEEN, New Hampshire

LISA MURKOWSKI, Alaska
RICHARD BURR, North Carolina
JOHN BARRASSO, Wyoming
SAM BROWNBACK, Kansas
JAMES E. RISCH, Idaho
JOHN McCAIN, Arizona
ROBERT F. BENNETT, Utah
JIM BUNNING, Kentucky
JEFF SESSIONS, Alabama
BOB CORKER, Tennessee

ROBERT M. SIMON, *Staff Director*
SAM E. FOWLER, *Chief Counsel*
MCKIE CAMPBELL, *Republican Staff Director*
KAREN K. BILLUPS, *Republican Chief Counsel*

CONTENTS

STATEMENTS

	Page
Anderson, A. Scott, Senior Policy Advisor, Environmental Defense Fund, Austin, TX	38
Barrasso, Hon. John, U.S. Senator From Wyoming	2
Batten, Kit, Ph.D., Science Advisor, Office of the Deputy Secretary, Department of the Interior	9
Bingaman, Hon. Jeff, U.S. Senator From New Mexico	1
Der, Victor K., Acting Assistant Secretary, Office of Fossil Energy, Department of Energy	3
Freudenthal, Hon. Dave, Governor, State of Wyoming, Cheyenne, WY	53
Lubnau, Thomas E., II, State Representative From Wyoming, House District 31, Gillette, WY	14
Moor, Karl, Vice President & Associate General Counsel, Southern Company, Atlanta, GA	32
Murkowski, Hon. Lisa, U.S. Senator From Alaska	2
Tombari, John, Vice President, Schlumberger Carbon Services, Houston, TX	30
Trabucchi, Chiara, Principal, Industrial Economics, Inc., Cambridge, MA	43

APPENDIX

Responses to additional questions	55

CARBON CAPTURE AND SEQUESTRATION

THURSDAY, MAY 14, 2009

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

The committee met, pursuant to notice, at 3 p.m. in room SD–366, Dirksen Senate Office Building, Hon. Senator Jeff Bingaman, chairman, presiding.

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

The CHAIRMAN. Ok. Let me ask everyone to please be seated. I welcome everyone here. We have a distinguished group of witnesses here.

This is to consider S. 1013 which is the Department of Energy Carbon Capture and Sequestration Program Amendments Act of 2009. Senator Barrasso and I introduced this bill along with Senators Dorgan, Tester, Bayh, Landrieu, Casey, Voinovich, Udall and Conrad. It establishes a national indemnity program through the Department of Energy for up to ten commercial scale, carbon capture and sequestration projects.

Based on the input from industrial and environmental NGO and other organizations it's been made clear to me that there is a real need to for liability treatments and adequate project financing for early mover projects. The creation of an indemnity program for these large scale, early mover projects is an important, necessary step to building confidence for project developers as well as the public. S. 1013 sets qualifying criteria that will help to ensure that these critical early mover projects will be conducted safely while addressing the growing concern of reducing greenhouse gas emissions from industrial facilities such as coal and natural gas, hard utilities, cement plants, refineries, other carbon intensive industrial processes.

This legislation also maps out a clear framework for closing down a geological storage site. It's essential to consider the issue of safe, long term storage of carbon dioxide. It's also critical to take the steps necessary for site stewardship during the injection phase directly following closure and for long term, preventative maintenance of the geologic storage site.

A science based monitoring and verification is required after the injection of carbon dioxide ends to ensure that the carbon dioxide remains safely in place throughout the life of the project and well beyond the closure phase. This topic of reducing greenhouse gases, particularly carbon dioxide emissions remains of great concern to

me and to all members of the 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.

I'd like to thank each of our witnesses who've come to testify as to the merits of the legislation. Also the administration witnesses as well as Tom Lubnau, who is here representing the State of Wyoming. The efforts that he and the Governor, Governor Freudenthal, have undertaken in their State legislature to rapidly move forward with commercial carbon sequestration projects in Wyoming serves as a model for other States to look at as well as a model for us to look at as we undertake here in the Senate the deployment of such a promising greenhouse gas reducing technology.

Let me call on Senator Murkowski for any statement she would have. Then if Senator Barrasso had any statement I would call on him too, since he's prime co-sponsor on the bill. But you go right ahead, Senator Murkowski.

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

Senator MURKOWSKI. Thank you, Mr. Chairman. I want to thank the witnesses for joining us this afternoon. I think we all recognize that the advancement of carbon sequestration technology is a very important task. I think we all recognize the role that coal has played in the development of our country as we look to our energy sources and the value that it holds not only in the past tense, but moving forward.

We've authorized many programs at DOE to advance carbon sequestration technologies between FutureGen, the Clean Coal Power Initiative, the Regional Partnerships. There's about $4.1 billion sitting at DOE waiting to be spent. But I think we all recognize that it's not always just about money.

Sometimes there are other matters to be addressed. Certainly the responsibility for carbon sequestrationsites over the long term is one of those issues that is on the list. The bill before us would place that responsibility squarely on the shoulders of the Federal Government for a number of demonstration projects.

This would be a bold decision. But it also raises a number of questions. I would hope that some of those questions can be addressed before we mark up this bill.

I'm very supportive of carbon sequestration. I believe that we must continue to aggressively advance the technology. But I want to make sure that we go about that task in the most effective way and responsible way so that the technology can continue to evolve as quickly as we would like it to do.

So I look forward to hearing from our witnesses on this very important subject today. Thank you.

The CHAIRMAN. Senator Barrasso, did you wish to make an opening statement?

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

Senator BARRASSO. Just briefly, Mr. Chairman. Thank you for allowing me to co-sponsor this important piece of legislation with

you. Like you I want to make sure that we make American energy as clean as we can, as fast as we can and do it in a way that doesn't increase costs for American families.

It's especially a privilege to have with us today Representative Tom Lubnau. Tom and I served together in the Wyoming legislature. Tom and I have held town meetings together in his home community in Gillette, Wyoming which is the coal capital of the world.

It is also Mike Enzi's, Senator Enzi's hometown. Mike was mayor of that community. We know how important all the energy sources are. Coal is a very important part of the energy needs of this Nation.

Tom has taken a significant leadership role, Mr. Chairman, in the Wyoming legislature with our carbon sequestration legislation. It has been a bipartisan effort. The Governor has been very involved. Tom has been involved and significant commitment on the part of the entire State because we know how important this is for the energy security of our Nation.

So thank you, Mr. Chairman. Welcome to Representative Lubnau.

The CHAIRMAN. Thank you again for co-sponsoring this bill with us.

Let me introduce this first panel.

Dr. Victor Der is the Acting Assistant Secretary in the Office of Fossil Energy in the Department of Energy. Thank you very much for being here.

Dr. Kit Batten is Science Advisor with the Office of the Deputy Secretary in the Department of Interior. Thank you for being here.

As Senator Barrasso indicated Representative Tom Lubnau, Thomas Lubnau is a State Representative from Wyoming from House District 31 in Gillette, Wyoming.

So thank you all for being here. If each of you could take 5 or 6 minutes and give us your views on this legislation and pros and cons and suggested changes. We would appreciate it.

STATEMENT OF VICTOR K. DER, ACTING ASSISTANT SECRETARY, OFFICE OF FOSSIL ENERGY, DEPARTMENT OF ENERGY

Mr. DER. I thank you, Mr. Chairman and members of the committee. I appreciate this opportunity to discuss the Department of Energy's research efforts in carbon capture and storage and hope that this information will be helpful to the committee as you consider ways to address liability issues associated with CCS.

Our fossil fuels resources, specifically coal, represent a tremendous and strategic national asset. Based upon current rates of consumption, the United States probably has sufficient coal to meet its needs for the next century. Making use of this domestic asset in a responsible manner will help the United States meet its energy requirements, minimize environmental impacts, positively contribute to national security and compete in the global marketplace.

Our focus must be therefore to develop deployable advanced technologies necessary to achieve near zero emissions from coal use including CCS. The Department remains a leader in the development of advanced technologies that have helped reduce pollution emis-

sions and have increased power plant efficiencies. In fact nearly 75 percent of the coal power plants in the United States employs technologies with roots in the DOE's program for advanced coal.

These technological successes coupled with substantial funding from the Recovery Act and our fiscal year 2010 budget request will help us accelerate the advances and innovations needed to meet the challenges of CO_2 reduction. To accomplish this goal our advanced coal program is focused on three important areas:

- Technologies for affordable CO_2 capture,
- Establishing a scientific and technical basis for safe and effective storage of CO_2, and
- Substantially improving the efficiency and reliability of fossil energy systems.

All 3 of these areas are important as we work to make CCS technologies deployable and cost effective.

We have a good start in this direction. Years of research and demonstration experience have resulted in new concepts including the conversion of coal into cleaner, versatile gases that can be used to generate power or produce fuels. Additionally our research continues to explore emerging approaches to clean power generation that hold great promise for integration with coal based or combined coal and biomass energy plants for CCS. To that end, we are working on CCS enabling and transformational technologies including advanced gasification combined cycle, advanced hydrogen turbines, advanced materials for ultra high efficiency plants, supersonic compression and revolutionary concepts for CO_2 capture.

With regard to storage we continue to implement large scale CCS demonstration efforts under the sequestration partnerships and the Clean Coal Power Initiative programs. For instance, DOE helped fund the development of the Nation's first large scale injection and storage site in Decatur, Illinois, which will hold one million metric tons of carbon. We also continue to conduct analyses of the CO_2 geological storage capability including a just released study of potential storage capability beneath Federal lands.

This study builds upon prior studies and data from the DOE and the United States Geological Survey. Early estimates from this study indicate that based on our current levels of CO_2 emissions these formations have the potential capacity to hold about 60 years worth of CO_2. So we are moving forward with valuable CCS R&D analysis.

But the success of our programs will ultimately be judged by the extent to which emerging, cost effective technologies are deployed and more importantly that we get it right. Successful implementation of an economically viable national CCS system depends on having developed a national set of workable, enabling policies. Such policies can help establish definitive standards, practices and procedures, encourage technology development and investment and address liability issues related to carbon capture and storage.

Whatever structure is created it must encompass the input of a broad range of stakeholders in the decision process. DOE has made great strides toward the goal of effective deployable CCS systems in a 2020 to 2025 timeframe. With continued leadership and support from the administration and the Congress, the Department

can move forward with development of new technologies and policies to meet the requirements of a safe, secure and clean energy future.

Again, Mr. Chairman, thank you for the opportunity to testify here today. With that I welcome any questions the committee may have. Thank you.

[The prepared statement of Mr. Der follows:]

PREPARED STATEMENT OF VICTOR K. DER, ACTING ASSISTANT SECRETARY, OFFICE OF FOSSIL ENERGY, DEPARTMENT OF ENERGY

Thank you, Mr. Chairman and members of the Committee. I appreciate this opportunity to provide testimony on the United States Department of Energy's (DOE's) research efforts in carbon capture and storage. The Department of Energy has not had an opportunity to fully analyze S. 1013, and therefore, cannot take a position on the bill at this time.

INTRODUCTION

Fossil fuel resources represent a tremendous national asset. An abundance of fossil fuels in North America has contributed to our Nation's economic prosperity. Based upon current rates of consumption, the United States probably has sufficient coal to meet its need for the next century. Making use of this domestic asset in a responsible manner will help the United States to meet its energy requirements, minimize detrimental environmental impacts, positively contribute to national security, and compete in the global marketplace.

Fossil fuels will play a critical role in our Nation's future energy strategy. By developing technologies to mitigate the release of carbon dioxide (CO_2) into the atmosphere, we can continue to use our extensive domestic coal resource while reducing the impacts on climate change. Carbon capture and storage (CCS) can play a central role in fossil fuels remaining a viable energy source for our Nation. CCS is the primary pathway DOE is pursuing to allow continued use of fossil fuels in a carbon-constrained future.

Through fossil energy funding under the American Recovery and Reinvestment Act and annual appropriations, DOE's Coal Program is working to accelerate the development and industry deployment of CCS to meet future energy needs.

The remainder of my testimony will highlight CCS activities that are underway in the Coal Program.

COAL PROGRAM

DOE provides a national leadership role in the development of advanced coal technologies. DOE Office of Fossil Energy's Coal Program has returned substantial benefits to consumers and taxpayers across a broad range of innovative technologies that are now in use throughout the world. For example, DOE and the private sector responded to the challenge of dramatically reducing the emissions of particulate, sulfur, nitrogen oxide, and mercury from coal-based energy systems with the development of technologies that enable coal-based power plants to meet environmental controls and limits placed on these pollutants. These technological innovations have resulted in significant environmental benefits: reducing pollutant emissions, reducing water use, minimizing wastewater discharge, and reducing solid wastes. DOE research and demonstration capabilities are well suited to address new challenges associated with the reduction of greenhouse gas emissions as a climate change mitigation strategy.

The Coal Program—administered by DOE's Office of Fossil Energy and implemented by the National Energy Technology Laboratory—is designed to address climate concerns of coal usage by developing a portfolio of revolutionary advanced carbon capture and storage technologies that will be economically feasible for deployment by industry. In partnership with the private sector, efforts are focused on maximizing efficiency and performance, while minimizing the costs of these new technologies. In recent years, the program has been restructured to focus on CCS. The program pursues the following two major strategies:

1) capturing carbon dioxide; and
2) storing it in geologic formations.

Capturing and storing carbon dioxide and improving the fuel-to-energy efficiency of CCS will help address pollutant emissions reduction, water usage, and carbon

emissions on a per unit of electricity basis. These plans strive to achieve dramatic reductions in emissions and ensure that current and future fossil energy plants will meet all emerging requirements for a safe and secure energy future.

Coal research has resulted in important insights regarding future innovations. New engineering concepts have been developed to convert coal into gases that can be cleaned and then used to generate power or produce fuels. New approaches to clean power generation are emerging that hold promise for integration with coal-based or combined coal and biomass energy plants. Technologies for achieving CCS are stretching beyond basic research, defining pathways in which greenhouse gas emissions can be permanently diverted from the atmosphere. With these building blocks, a new breed of coal plant can be created—one that generates power and produces high-value energy with much less environmental impact. DOE's work includes a focus on high priority CCS enabling technologies, such as advanced integrated gasification combined cycle, advanced hydrogen turbines, carbon capture, and fuel cells. These research areas provide the supporting technology base for all CCS development.

CARBON CAPTURE & STORAGE INNOVATIONS

As part of our Coal Program, we are addressing the key technology challenges that confront the wide-scale industrial deployment of CCS through industry/government cooperative research on cost-effective capture technologies; monitoring, verification, and accounting technologies to assess permanence of storage; permitting issues; liability issues; public outreach; and infrastructure needs. As an example, today's commercially available CCS technologies will add around 80 percent to the cost of electricity for a new pulverized coal plant, and around 35 percent to the cost of electricity for a new advanced gasification-based plant.[1] The program is aggressively pursuing developments to reduce these costs to less than a 10 percent increase in the cost of electricity for new gasification-based energy plants, and less than a 30 percent increase in the cost of electricity for pulverized coal energy plants.[2]

The existing research program has been performing CCS field tests for many years, where the seven Regional Carbon Sequestration Partnerships are drilling wells in potential storage locations and injecting small quantities of CO_2 to validate the potential of key storage locations throughout the country. Substantial progress has occurred in the area of monitoring, verification, and accounting of CO_2 storage with the development and refinement of technologies to better understand storage stability, permanence, and the characteristics of CO_2 migration.

Research is also focused on developing technology options that dramatically lower the cost of capturing CO_2 from fossil fuel energy plants. This research can be categorized into three pathways: post-combustion, pre-combustion, and oxy-combustion. Post-combustion refers to capturing CO_2 from the stack gas after a fuel has been combusted in air. Pre-combustion refers to a process where a hydrocarbon fuel is gasified to form a synthetic mixture of hydrogen and carbon dioxide, and CO_2 is captured from the synthesis gas before it is combusted. Oxy-combustion is an approach where a hydrocarbon fuel is combusted in pure or nearly pure oxygen rather than air, which produces a mixture of CO_2 and water that can easily be separated to produce pure CO_2. This research is exploring a wide range of approaches: membranes; oxy-combustion concepts; solid sorbents; CO_2 hydrates; and advanced gas/liquid scrubbing technologies. These efforts cover not only improvements to state-of-the-art technologies but also development of several revolutionary concepts, such as metal organic frameworks, ionic liquids, and enzyme-based systems, in conjunction with basic research in these areas now being conducted by the DOE's Office of Science.

A central piece of our CCS research is DOE's field test program, which is being implemented through the Regional Carbon Sequestration Partnerships. DOE's field test program reflects the geographic differences in fossil fuel use and potential storage sites across the United States and targets the use of regional approaches in addressing CCS. It encompasses field tests representative of approximately 97 percent of coal-fired and industrial CO_2 emissions, about 96 percent of the total U. S. land mass, and essentially all the geologic storage sites in the country that can potentially be available for carbon sequestration. The field tests are conducted through partnerships comprised of state agencies, universities, and private companies, with

[1] Cost and Performance Baseline for Fossil Energy Plants, Volume 1: Bituminous Coal and Natural Gas to Electricity, U.S. Department of Energy/National Energy Technology Laboratory, DOE/NETL-2007/1281, Final Report, May 2007.

[2] The goal for pulverized coal is under development.

the goal of developing the knowledge base and infrastructure for the wide-scale deployment of CCS technologies. The Regional Partnerships represent more than 350 unique organizations in 42 States, three Native American Indian Nations, and four Canadian Provinces. It is important to note that the non-Federal cost share for the field test program is greater than 35 percent, which is a key indicator of industry and other partner interest that will lead to the success of this program. Each partnership is focused on a specific region of the country with similar characteristics relating to CCS opportunities.

DOE is addressing key infrastructure issues related to permitting, pore space (underground reservoir) ownership, site access, liability, public outreach, and education. DOE works closely with the Environmental Protection Agency (EPA) and others in developing CCS regulation strategies, which will provide additional certainty for future CCS deployments.

Over the course of these research initiatives, DOE will jointly develop Best Practice Manuals on topics such as site characterization, site construction, operations, monitoring, mitigation, closure, and long-term stewardship. These Manuals, which will be developed in conjunction with DOE's Office of Science and the U.S. Geological Survey, will serve as guidelines for a future geologic sequestration industry in their regions, and help transfer the lessons to all regional stakeholders.

DEMONSTRATIONS AT COMMERCIAL-SCALE

The success of the Coal Program will ultimately be judged by the extent to which emerging technologies are deployed in domestic and international marketplaces. Both technical and financial challenges associated with the deployment of new advanced coal technologies must be overcome in order to be capable of achieving success in the marketplace. Commercial-scale demonstrations help the industry understand and overcome start-up issues and component integration issues associated with the implementation of a new technology and systems, and gain the early learning commercial experience necessary to reduce risk and secure private financing and investment for subsequent plants.

DOE is implementing large-scale projects through the Regional Partnerships and CCS demonstrations including the most recent round of the Clean Coal Power Initiative (CCPI). The Development Phase (Phase III) of the Regional Partnerships is focused on large-scale field tests of geologic carbon sequestration on the order of 1 million metric tons of CO_2 per year, and addresses the liability, regulatory, permitting, and infrastructure needs of these projects. The Partnerships have brought an enormous amount of capability and experience together to work on the challenge of infrastructure development. CCPI is primarily focused on component and subsystem testing at commercial scale to gain operational integration experience. The CCPI Round 3 solicitation specifically targets advanced coal-based systems and subsystems that capture or separate CO_2 for sequestration or for beneficial use, and is also open to any coal-based advanced carbon capture technologies that result in co-benefits with respect to efficiency, environmental, or economic improvements.

THE AMERICAN RECOVERY AND REINVESTMENT ACT

The American Recovery and Reinvestment Act (Recovery Act) appropriates $3.4 billion for "Fossil Energy Research and Development." These Recovery Act funds will help fund activities targeted at expanding and accelerating the commercial deployment of CCS technology to provide a key thrust to the Coal Program to accelerate, by many years, the advances needed for future plants with CCS.

The Conference Report accompanying the Recovery Act identifies the following major initiatives that will complement and accelerate efforts in the Coal Program:

Maintain Fossil Energy R&D Program: $1 billion to be used to conduct fossil energy research and development programs.

Additional Funds for the CCPI Round 3: $800 million to be used to augment funding for the CCPI Round 3 competition.

New CCS Initiative for Industrial Applications: $1.52 billion to be used for a competitive solicitation for a range of industrial carbon capture and energy efficiency improvement projects, including a small allocation for innovative concepts for beneficial CO_2 reuse.

Expand Geologic Site Characterization: $50 million to be used for site characterization activities in geologic formations. DOE expects to require projects to complement and build upon the existing characterization base created by the Regional Partnerships, looking at broadening the range and extent of geologic basins that have been studied to date.

Initiate a Geologic Sequestration Training and Research Grant Program: $20 million for geologic sequestration training and research grants. This program

will emphasize advancing educational opportunities across a broad range of colleges and universities.

These Recovery Act investments will also be complemented by the Carbon Sequestration research efforts of the baseline Fossil Energy R&D program. In particular, the efforts of the Regional Carbon Sequestration Partnerships highlighted earlier, can be viewed as another form of federal partnership in infrastructure investment. These Partnerships efforts, spanning our Nation and parts of Canada, will aid in understanding all the critical aspects that would be needed to support wide-scale deployment of CCS technology, taking into consideration the regional differences in geology, infrastructure development needs, and industrial activity that can affect the deployment of carbon sequestration technologies. The Partnerships have also supported studies by the Interstate Oil and Gas Compact Commission (IOGCC) that have resulted in the recent development of a model for a regulatory framework to support CCS deployment.[3]

Just recently, under DOE's sponsorship, the Southeast Regional Carbon Sequestration Partnership (SECARB), in partnership with the IOGCC, began a new study, to evaluate the legal and regulatory feasibility of developing a pipeline infrastructure in the U.S. specifically dedicated to the transport and storage of CO_2. The primary objective of the study is to identify barriers and opportunities associated with the wide-spread construction of pipelines for the transport of CO_2 for the purposes of carbon sequestration, enhanced oil recovery and other commercial purposes. A CO_2 Pipeline Task Force[4] will be formed as part of this 18-month activity to leverage the combined expertise of the oil and gas community to create guidance documents that encompass regulatory, legal, environmental, and educational aspects. A particular focus will be to incorporate the federal entities having key roles in these matters such as the Federal Energy Regulatory Commission, various elements of the Department of Transportation, and the Bureau of Land Management as part of the study.

CONCLUSIONS

In order to shift to a low-CO_2 emission energy future in the U.S., we must create an economically viable national CCS system. This can only occur in parallel with the development of a national set of definitive policies and incentives that encourage technology development and reward investments in and capital formation around improved carbon performance.

CCS requires a systems approach that includes not only site evaluation, characterization and selection, but must also address rules for liability throughout a project's short-, medium-, and long-term life. Nation-wide industrial CCS deployment will also require an infrastructure for CO_2 transportation and storage and the development of an agreed upon set of measurement, validation and accounting standards, practices, and procedures. Finally, whatever structure is created must encompass the input of a broad range of stakeholders in the decision process on proposed projects (developers, regulators, financiers, insurers, project operators, policymakers, and the affected public).

Today, nearly three out of every four coal-burning power plants in this country are equipped with technologies that can trace their roots back to the Department's Coal Program. These efforts helped accelerate production of cost-effective compliance options to address legacy environmental issues associated with coal use. Clean coal and CCS technologies will likely play a critical role in mitigating CO_2 emissions under potential future carbon stabilization scenarios. DOE's program is ensuring that enabling technologies will be available. The United States must continue to show leadership in technology development and future deployment to bring economic rewards and new business opportunities both here and abroad.

I applaud the efforts of this Committee and its Members for taking a leadership role in addressing these timely and significant issues. I would be happy to respond to any questions members of the committee may have.

The CHAIRMAN. Thank you very much, Dr. Der.

Dr. Batten, go right ahead.

---

[3] Storage of Carbon Dioxide in Geologic Structures, A Legal and Regulatory Guide for States and Provinces, September 25, 2007

[4] A project "kick-off" meeting for the Task Force is expected to occur at the IOGCC Mid-Year Meeting scheduled for May 11-13, 2009 in Anchorage, Alaska and plans for a review of their final report to occur at the IOGCC Mid-Year Meeting scheduled for May 23-25, 2010 in Lexington, Kentucky.

STATEMENT OF KIT BATTEN, PH.D., SCIENCE ADVISOR, OFFICE OF THE DEPUTY SECRETARY, DEPARTMENT OF THE INTERIOR

Ms. BATTEN. Thank you, Mr. Chairman, members of the committee. Thank you for the opportunity to testify for the Department of the Interior on S. 1013. I will also discuss the Department's forthcoming report on a framework for geologic carbon sequestration on public lands.

I am Kit Batten, Science Advisor in the Office of the Deputy Secretary of the Interior. This position was created at the beginning of this administration because Secretary Salazar strongly feels that our future both as a Department and a Nation is inextricably linked to our understanding through science of the world around us. I ask that my entire testimony be included in the record and I, excuse me. I am accompanied today by Tim Spivak of the Bureau of Land Management who will be glad to answer any questions related to the draft report.

The challenges of addressing CO_2 accumulation in the atmosphere are significant. S. 1013 calls for the Secretary of Energy to carry out a program to demonstrate the commercial application of integrated systems for long term geological CO_2 storage. The legislation addresses key issues such as long term liability, monitoring and stewardship.

The Department of the Interior supports the goals of S. 1013 and we look forward to working together to resolve legal and policy questions as we learn more about the technologies and geologic information.

The Department supports the need for a large scale carbon storage program and the need for liability treatments.

The Department also supports the requirement of science based monitoring and verification of the injected CO_2 throughout the life of a project to beyond the closure phase.

Drawing upon its long history with injecting CO_2 into geologic formations, the Department could offer a significant value to these efforts. For example, enhanced oil recovery taking place on lands managed by the Bureau of Land Management is a CO_2 injection technique to allow recovery of energy resources from older oil and gas fields. This technique provides valuable data and information that will facilitate future efforts to effectively capture and sequester CO_2 in geologic formations.

The BLM's existing administrative and regulatory framework will help facilitate future carbon sequestration demonstration projects and potentially leasing. In addition to experience in administering a large scale mineral leasing program, the BLM has the realty experience for issuing rights of way that could help serve the needs for CO_2 pipelines on public lands. The United States Geological Survey also plays an important role in recommending geologic criteria that could be incorporated into a set of best practices for geologic site selection for sequestering CO_2. The USGS has released a new assessment methodology for evaluation of carbon storage which helps to identify the best places to use geologic CO_2 sequestration.

The Secretary of the Interior will be submitting a report to Congress containing a recommended framework for geological seques-

tration on public lands in the near future. The Department, in coordination with BLM, USGS, EPA and DOE examined criteria for identifying candidate geological sequestrationsites. This draft report describes Federal liability issues related to the release of CO_2 underground.

A few key findings include:

At this early stage in the development of CO_2 storage technologies many unknown factors may impact the development of a regulatory framework.

Carbon sequestration may conflict with other land uses such as oil and gas or geothermal fields or with drinking water.

The framework must recognize the long term liability of sequestering CO_2 and the required commitment for stewardship of facilities over an extended period of time.

Geological carbon sequestration on split estate lands presents other complications due to ownership issues of pore space. Limitations may need to be placed on surface and subsurface uses to ensure integrity of storage. Addressing the challenge of reducing atmospheric CO_2 and understanding the effect of global climate change will be a lengthy and complex challenge.

The Department stands ready to assist Congress as it examines these challenges and opportunities. Thank you for the opportunity to testify today. I will be happy to answer any questions. Thank you.

[The prepared statement of Ms. Batten follows:]

PREPARED STATEMENT OF KIT BATTEN, PH.D., SCIENCE ADVISOR, OFFICE OF THE DEPUTY SECRETARY, DEPARTMENT OF THE INTERIOR

INTRODUCTION

Mr. Chairman and Members of the Committee, thank you for the opportunity to be here today to discuss S. 1013, the Department of Energy Carbon Capture and Sequestration Program Amendments Act of 2009. I also will discuss the forthcoming Department of the Interior Report to Congress: Framework for Geological Carbon Sequestration on Public Land, created in compliance with section 714 of the Energy Independence and Security Act of 2007 (EISA).

I am Kit Batten, Science Advisor in the Office of the Deputy Secretary of the Department of the Interior. This position was created at the beginning of this administration because Secretary Salazar strongly feels that our future—as a Department and as a nation—is inextricably linked to our understanding, through science, of the world around us.

S. 1013 calls for the Secretary of Energy to carry out a program to demonstrate the commercial application of integrated systems for long-term geological storage of carbon dioxide. The Department of the Interior has not had an opportunity to fully analyze S. 1013, and therefore, cannot take a position on the bill at this time. However, the Department supports the need for large-scale demonstrations to address key questions surrounding long-term carbon storage. Additionally, the Department supports the requirement of science-based monitoring and verification of the injected carbon dioxide plume throughout the life of the project to beyond the closure phase. The Department, through our on-the-ground land managers and scientists, believes we could offer a significant value added to these efforts.

THE ROLE OF THE BUREAU OF LAND MANAGEMENT AND THE U.S. GEOLOGICAL SURVEY

As the Nation's largest land manager, the Bureau of Land Management (BLM) is entrusted with the multiple-use management of 258 million acres of land, and administers 700 million acres of sub-surface mineral estate of which the surface owners are Federal agencies, states, or private entities. Of the 1.2 billion acres inventoried by the U.S. Geological Survey (USGS) in its National Oil and Gas Assessment, 279 million acres are under Federal management. The Department diligently executes our responsibilities to make these resources available in an environ-

mentally-sound manner. Within the framework of a transparent public process, we carefully consider habitat, groundwater, air and other resources; mitigate impacts through best management practices, stipulations and conditions of approval; and balance development with other uses across the landscape.

All of these considerations remain consistent as the Department contemplates our role in the use of public lands to sequester carbon.

CHALLENGES OF ADDRESSING GEOLOGIC CARBON STORAGE

The challenges of addressing carbon dioxide accumulation in the atmosphere are significant. A variety of strategies are being investigated to reduce emissions and remove carbon dioxide from the atmosphere. Such strategies include the facilitated capture and storage of carbon dioxide through sequestration using plants, or by physical capture from major sources and injection into geologic formations.

The Department of the Interior has a long history with injecting carbon dioxide into geologic formations. Carbon dioxide injection techniques have useful practical applications in processes known as enhanced oil recovery (EOR), which currently take place on some public lands managed by the BLM. These processes allow the recovery of additional energy resources from older oil and gas fields.

EOR's use of carbon dioxide injection will continue to yield valuable data and information that will facilitate future efforts to effectively capture and sequester carbon dioxide in geologic formations found on public lands. A critical issue for evaluation of storage capacity is the integrity and effectiveness of formations for sealing carbon dioxide underground, thereby preventing its release into underground sources of drinking water, mineral resources, or the atmosphere. Current EOR efforts will enhance our understanding of these types of critical scientific and geologic issues. The Department expects that new information on these issues will continue to be generated from activities on BLM-managed lands. As such, we anticipate the need for the BLM to play a leadership role in collaborating with other Federal agencies, tribes, states, the private sector, and public interest groups as we move forward in addressing legal and policy issues that arise during development.

CARBON CAPTURE AND SEQUESTRATION (CCS)

The current atmospheric carbon dioxide concentration is approximately 380 parts per million and rising at a rate of approximately 2 parts per million 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, the global storage capacity of geologic formations may be able to accommodate most of the captured carbon dioxide. However, the extent to which this storage capacity is economically viable depends on the price of carbon. 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 subsurface rocks involves injection of carbon dioxide into the pore space of permeable rock units. 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.

CARBON CAPTURE AND SEQUESTRATION (CCS)—DOI'S MANAGEMENT ROLE

The BLM's existing administrative and regulatory framework will help facilitate future carbon sequestration demonstration projects and potentially, leasing geologic storage capacity. In addition to experience in administering a large-scale mineral leasing program, the agency has the realty expertise and an existing framework for issuing rights-of-way on public land that could serve future needs for carbon dioxide pipelines across public lands. Other programmatic and land management expertise, such as the BLM's experience in evaluation of potential environmental impacts of projects, will facilitate this effort. In addition, the USGS will also play an important role in recommending geologic criteria that could be incorporated into a set of "best practices" for geologic site selection.

The USGS released to the public and interested parties a new probabilistic assessment methodology for evaluation of carbon dioxide storage. Use of the methodology can help us identify the best places in the country to use geologic carbon sequestration and is an important step in understanding how much carbon dioxide can be stored underground.

A number of challenges will need to be addressed moving forward, and we must make use of current information to inform future discussions. For example, the Department has the results of research at international non-EOR sites at which large quantities of CO_2 have been injected for as long as 12 years. These sites have operated safely and shown no sign of leakage. We believe that the DOI land managers and scientists who are on the ground have expertise to offer on monitoring carbon sequestration and we would like to work with the Committee to facilitate interagency coordination.

ENERGY INDEPENDENCE AND SECURITY ACT CARBON CAPTURE PROVISIONS

Relating to section 711 of the Energy Independence and Security Act (EISA; Public Law 110-140), the USGS, as mentioned above, recently completed a draft methodology to assess geologic CO_2 storage resources with input from DOE, EPA, state geological surveys, and others. Currently, the USGS is in the process of assembling review comments and expert evaluations of the methodology so that it can be finalized. The USGS plans to apply this methodology in a national assessment of geologic storage resources in depleted oil and gas fields and saline formations. The initial stages of this assessment are funded in the President's Budget for Fiscal Year 2010.

Section 713 of EISA directs the BLM to maintain records on, and an inventory of, the quantity of carbon dioxide stored within Federal mineral leaseholds. The BLM is currently implementing the carbon capture and storage provisions of the EISA and is nearing completion of an initial inventory of carbon dioxide stored within Federal lands up to the end of Fiscal Year 2008 and will update this inventory annually.

FRAMEWORK FOR GEOLOGICAL CARBON SEQUESTRATION ON PUBLIC LANDS REPORT

Section 714 of the EISA directs the Secretary of the Interior to submit a report to Congress containing a recommended framework for geological sequestration on public lands. This report is expected to be released in the near future. Through the BLM, in coordination with the USGS, the Environmental Protection Agency, the Department of Energy, and other appropriate agencies, the Department examined criteria for identifying candidate geological sequestration sites in several specific types of geological settings. Additionally, the BLM reviewed the Interstate Oil and Gas Compact Commission's model regulations for carbon capture and sequestration to determine if they are applicable to public lands or could serve as a model for the requirements contained in Section 714 of EISA.

In reviewing these model regulations, the BLM considered the following criteria and objectives:

- 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 of 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 also will 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. In addition, the report will 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 split-estate lands, where title to mineral resources is held by the United States, but title to the surface estate is not.

REGULATORY ISSUES

At this early stage in the development of carbon dioxide storage technologies, especially in the absence of large-scale demonstration projects of more than 1 million tons of carbon dioxide per year, many unknown factors may impact the development of a regulatory framework and best management practices.

A proposed regulatory framework must recognize carbon dioxide as a commodity, resource, contaminant, waste and pollutant. Any regulatory or management regime adopted for CO_2 should accommodate all these realities. For instance, the geologic sequestration of CO_2 should distinguish between the sequestration of pure CO_2 and CO_2 mixed with other gases such as hydrogen sulfide, carbon monoxide, methane, and oxides of nitrogen and sulfur. These impurities have the potential to impact the economics, technical feasibility, location preferences, land use planning requirements, environmental impact mitigation, multiple-resource conflict potential, and regulatory oversight of geologic CO_2 sequestration. In this regard, DOI recognizes that the EPA has issued a proposed rule regarding carbon sequestration and storage and intends to coordinate as necessary as the EPA rule is finalized.

Carbon sequestration may potentially conflict with other land uses including existing and future mines, oil and gas fields, coal resources, geothermal fields, and drinking water sources. In addition to the existing geophysical and scientific barriers to commercial carbon sequestration, a proposed statutory and regulatory framework must recognize the long-term liability of any permitting decision to sequester CO_2 and the required commitment for stewardship of facilities over an extended period of time. The scope of liability and term of stewardship will be among the longest ever attempted, lasting up to hundreds of years or more. Relevant experiences from enhanced oil recovery using carbon dioxide on public lands can assist in examining this issue.

Lastly, geological carbon sequestration on split estate lands or lands where the surface is managed by other Federal agencies presents other complications due to ownership issues of pore space and limitations that may need to be placed on surface and subsurface uses to ensure integrity of storage.

S. 1013

S. 1013 directs the Secretary of Energy to carry out a program to demonstrate commercial application of integrated systems for long-term geological storage of carbon dioxide. The goal of this carbon storage program is to provide financial and technical assistance of up to 10 large-scale carbon dioxide storage projects.

The Department of the Interior supports DOE's work in conducting large-scale carbon storage demonstrations. Additionally, we support efforts to ensure science-based monitoring and verification of the injected carbon dioxide plume throughout the life of a project to beyond the closure phase. It must be recognized that effective risk management of any geologic sequestration decisionmaking and regulation of consequent activity is limited by the current state of the art of scientific assessment, monitoring, measurement, verification, and mitigation of any potential undesirable consequences occurring on or beneath the surface of the land. Additional investment in ongoing scientific and engineering research will be essential as geological sequestration is a rather new option to reduce greenhouse gas emissions.

Currently, the Department is reviewing the legislation in greater detail and we look forward to working with the Committee on these issues in the future.

CONCLUSION

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 EISA should ultimately increase the information base upon which decision makers will rely as they deal with these issues. 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.

S. 1013 addresses key issues—long-term liability, monitoring, and stewardship—that must be resolved in any regulatory framework for carbon sequestration. The Department supports the goals of S. 1013 but has not had time to fully analyze the bill and establish a position on specific provisions. We look forward to working together to resolve outstanding legal and policy questions as we continue to learn more about the technologies and geologic information necessary in moving forward with a carbon sequestration program.

Thank you for the opportunity to present this testimony. I am pleased to answer questions you and other Members of the subcommittee might have.

The CHAIRMAN. Thank you very much.

Representative Lubnau, go right ahead.

STATEMENT OF HON. THOMAS E. LUBNAU, II, STATE REPRESENTATIVE FROM WYOMING, HOUSE DISTRICT 31, GILLETTE, WY

Mr. LUBNAU. Thank you, Mr. Chairman and members of the committee and to my old friend, Senator Barrasso who is often times a co-sponsor of bills with me in the Wyoming legislature. It's a pleasure to work with you again.

I bring you greetings from the State of Wyoming where we applaud this effort. We have had a bipartisan effort for about 2 years working on this. Wyoming quietly and without incidence, supplies about 10 percent of the Nation's total energy.

Wyoming supplies annually about 10.01 quadrillion BTUs of energy to the United States. To put that into perspective that's more than Saudi Arabia, Venezuela, Nigeria and Iraq combined supply to the United States. Primarily those resources are coal resources, but they're very, very important to the State of Wyoming.

Wyoming has a tradition and a history of trying to be ahead of the curve and doing things the right way. An example, it wasn't too long ago that one of my predecessors was here testifying about Wyoming's Mine Reclamation Act which ultimately served as the pattern for the Federal Surface Mine Reclamation Acts, SMCRA. For the past 2 years we've been working to develop the legal infrastructure to make geologic sequestration possible.

Frankly we fought some really difficult political battles. But in the end I think we've got a legislative product upon which the State of Wyoming can be proud. I'd like to share some of our political experience so that the United States doesn't have to travel the same dead end roads that we traveled to get to where we are now.

Wyoming has established a comprehensive legal framework for carbon sequestration. The first question we answered was who owns the right? In Wyoming on fee land we adopted the American rule which is the majority rule that says that the pore space is owned by the surface owner.

Our philosophy in creating the legislation was, as we all know, property rights are a bundle of sticks that everybody left the legislative session with the same bundle of sticks that they came into the legislative session with. So that there wasn't a property grab going on. Because when you have the property grab, you create a lot of political opposition. So that was an important goal.

We confirmed that the mineral estate is dominant over the servient surface estate and the pore space estate. We left split estate issues to a matter of contract between the parties because we thought that people could deal with their own property rights better than government officials sitting in a legislative chamber in Cheyenne. We established a comprehensive regulatory and permitting process so that those questions were answered.

We established liability with the injector. So that that cost shifted to the ultimate consumer. We set up a unitization process to protect correlative rights and to allow a process to bring in recalcitrant folks who wanted to stop development.

In looking at this bill, I'm impressed. I had to think long and hard about things that I might do differently. This bill encourages development.

It addresses one of the great barriers to deployment because we don't have a structure in place. If we ultimately impose carbon caps, one of two things is going to happen because we're so dependent on coal. Either the carbon caps are going to fail or we're going to lose the source of about 50 percent of our energy because if you look at the timeframes for deployment of the other energy sources, it just doesn't happen.

So two things need to happen for carbon sequestration to be developed. We need to define ownership of the pore space under Federal lands because the States can't do that. We need to set forth some sort of process for liability. Those things this legislation does.

What I would do differently with this bill.

I'd more clearly define the process. When does the indemnification commitment occur? I can't tell from reading this legislation when that happens.

I think that you need to decide as a policy matter whether you define enhanced oil recovery in the process or out of the process. Right now there's a process in Wyoming, ongoing, currently where 40 million tons of carbon dioxide is being injected under the ground at the famous Depot Dome oil field.

I'd demand more specifics onsite characterization because nobody has ever done this before. We only have one chance to do it right.

I'd implement a process for removing the inept or unscrupulous operator. I don't see that in the legislation. If your commitment happens at the beginning of the project you've got a long period of time where you're married to that operator, I think under this legislation.

I'd proceed prudently and carefully to allow generational advancements.

I wouldn't nationalize the pore space or aquifers because I think that buys litigation chances to form and decreases the motivation for people to proceed with these projects.

Thank you. I'd stand for any questions.

[The prepared statement of Mr. Lubnau follows:]

PREPARED STATEMENT OF THOMAS E. LUBNAU, II, STATE REPRESENTATIVE FROM WYOMING, HOUSE DISTRICT 31, GILLETTE, WY

Mr. Chairman, Members of the Committee:

Thank you for the opportunity to share my thoughts on Carbon Capture and Sequestration (CCS). Creation of a legal infrastructure to make carbon capture and sequestration possible is a key component in domestic security, economic recovery and environmental protection.

I come to you, today, from Campbell County, Wyoming, where we supply the raw materials to generate 30% of the nations electricity, and 10% of the nations total energy. Annually, Wyoming generates 10.01 Quadrillion BTU's of energy. That is more energy than Saudi Arabia, Venezuela, Nigeria and Iraq, combined.[1] The bulk of that energy is produced in the form of coal, but Wyoming also contributes significant oil, natural gas and uranium to the national energy picture.

As you know, a secure energy source is one of the keys to domestic security. The security of the Wyoming resources are best illustrated by the fact few people know that less than 50,000 people, working quietly and efficiently, produce ten percent of the nation's energy supply, every hour of every day of every year.

The energy is produced in the U.S. for consumption in the U.S. Dollars are not being spent overseas to support entities and governments who's motivations are not necessarily aligned with the interests of the United States.

[1] Source: Ron Surdam, State Geologist, State of Wyoming Geological Survey, A Prospective on the Geologic Sequestration of Carbon Dioxide in Wyoming.

About two years ago, the Wyoming legislature sensed a change in the political tide in the country. We anticipated that no matter which party won the presidential election, the policies of the United States Government were going to be "greener" than the policies of the past three decades. Working together in a bipartisan manner, the Governor's Office worked with legislative leadership to craft the legal infrastructure necessary to operate geologic carbon capture and sequestration sites inside the State of Wyoming. As a result, the State of Wyoming has put in place the most comprehensive package of legislation in the country to establish the legal framework for geologic sequestration activities.

We felt carbon caps or other regulation of carbon dioxide emissions are adopted by this country, the tools should already be in place to meet the requirements of such legislation. Without both the legal and technical infrastructure in place to take the steps to reduce carbon dioxide emissions, such legislation is doomed to failure. While the State of Wyoming would never mandate carbon dioxide caps, we felt we should take the lead in establishing a paradigm for the geologic sequestration of carbon dioxide.

Wyoming's approach has been to anticipate what questions the large finance houses might ask prior to financing a large-scale carbon sequestration project, and to answer those questions. As a result, we have passed 5 pieces of legislation establishing the legal framework for CCS development in Wyoming. At this point, there are a few pieces of legislation at the state level needed to round out the package (finalizing the form of financial assurances and risk assessment), and, as I see it, two things that need to happen at the federal level to make geologic sequestration activities possible (addressing the issue of long term liability and determining the ownership of pore space on federal properties).

Creating the legal infrastructure necessary for the geologic sequestration of carbon dioxide in Wyoming took more than two years to and thousands of hours of work to establish. The five bills the Wyoming legislature passed to create the legal framework were pore space, permitting and regulation, we really mean it, you inject it, you own it, and pore space unitization.

PORE SPACE

The first bill Wyoming passed was entitled "Pore Space." With that bill, we tried to answer the question, who owns the rights to authorize geologic sequestration activities under the surface of the land. Our underlying philosophy was that everyone who came into the legislative session with property rights, left the legislative session with the same property rights with which they arrived. In other words, as any first year law student knows, property rights are a bundle of sticks. Our goal was that everyone who showed up with a bundle of sticks, left the legislative session with the same sticks in their bundle.

We determined that the majority rule in the United States was the American Rule, which said that the surface owner owns the voids—or as we later came to know—pore space under the surface. That determination makes sense, when you think the process all the way through. One of the first cases dealing with subsurface rights was a case about a salt mine. Salt had been mined out of the subsurface, except for a few salt pillars that were necessary to keep the roofs of the caverns from collapsing. After all the salt that could be mined, was mined, the empty salt mine was going to be converted to deep storage.

The question was who owns the rights to the deep storage?

The law in the United States, which we adopted from old England, says that the mineral owner has the right to use so much of the surface and subsurface as is necessary to extract the minerals. Since the salt miners were no longer extracting minerals, the court reasoned the salt miners did not have the right to use the voids for storage.

Wyoming codified that rule. We adopted a bill, known as HB89, which codified ownership of pore space on fee lands in Wyoming.[2] In that bill, we confirmed that the surface owns the pore space. We declared that unless specifically severed, transfers of the surface included transfers of the pore space. We confirmed the mineral estate was dominant over the servient surface estate, we required a specific description of the pore space to be included in the instrument of grant, or the instrument was void, and we required, in the instrument of transfer, that the instrument specifically describe the rights of use of the surface by the pore space owner in the instrument, or no rights to utilization of the surface were transferred.[3]

[2] HB 89 is now codified as W.S. §34-1-152.

[3] We confirmed the mineral estate was dominant over the severed pore space estate in a HB 58, the "we really mean it bill."

In so doing, we created some interesting political coalitions. The Agriculture industry was generally happy because they were the owners of the pore space. Their ownership of an asset was confirmed. They had control over what happened on the surface of their ranches. The mineral industry was sort of happy, or maybe agnostic, because their rights to extract the minerals were confirmed. The environmental movement in Wyoming found itself in an interesting dichotomy. Wyoming was taking the lead in establishing a framework for the carbon-friendly utilization of coal. On one hand, they found themselves applauding the infrastructure we were creating. On the other hand, they were sad that we were making the continued utilization of coal possible.

PERMITTING AND REGULATION

In the early 1970's, Wyoming passed the strictest mining reclamation law in the country. We tried to learn from the experience of our sister states, who had been overcome with mining related environmental problems. As a result, we passed the Wyoming Mine Reclamation Act. That law formed the pattern for the United State Surface Mine Reclamation Act.

We are proud of our tradition of environmental protection in Wyoming. We love our State, our unique wide open spaces and beautiful environment. As much as we love our friends from the Federal Government, we think we do a pretty good job of taking care of our environment.

Carbon sequestration activities are regulated under the Clean Water Act. Presently, the carbon sequestration wells are regulated as Class V experimental wells, or in the case of enhanced oil recovery, Class II wells. The EPA has proposed regulations which will create a new class of wells, Class IV carbon sequestration wells. Those regulations are slated to be finalized somewhere in the summer of 2011.

The State of Wyoming found that the Underground Injection Control (UIC) program was inadequate, in many respects, in protecting the environment, and in assuring that carbon sequestration activities were conducted in a responsible, ethical and safe manner. As a result, the Wyoming State Legislature passed HB 90, now codified as W.S. §35-11-313. That statute creates a comprehensive permitting and regulatory scheme which regulates, from cradle to grave, carbon sequestration activities. The legislation, and the concomitant regulations which are forthcoming, create a paradigm in which the carbon sequestration operator must operate safely and according to law.

The essential provisions of the regulation include a general prohibition against carbon sequestration activities in the State of Wyoming unless permitted in accordance with this chapter.

Enhanced oil recovery activities ("EOR") are exempted from the Act, because they are governed, and have been governed for the past 40 years by the Wyoming Oil and Gas Conservation Commission. During the last 40 years, enhanced oil recovery activities have been conducted in the State of Wyoming without incident. One of the weaknesses of the legislation pending in front of this committee is there is no a distinction between EOR activities and geologic sequestration of carbon dioxide for pure geologic sequestration purposes. Currently in Wyoming, there is an Enhanced Oil Recovery project in which, ultimately, 40 million tons of CO_2 will be injected and sequestered underground. If the intent of this committee is to finance those types of projects, then the legislation is fine. If not, then the legislation may need modification.

In order to obtain a Wyoming permit for geologic sequestration of carbon dioxide, one must describe the geology, including i) geochemistry, structure and faulting, fracturing and seals, stratigraphy and lithology including petrophysical attributes; ii) a characterization of the injection zone and aquifers above and below the injection zone which may be affected, including the applicable pressure and fluid chemistry data to describe the projected effects of injection activities; iii) the identification of other drill holes and operating wells that exist within and adjacent to the proposed sequestration site; iv) an assessment of the impact to fluid resources, the subsurface structures and the surface of land that might reasonably be expected to be impacted and the measures required to mitigate such impacts; v) plans for environmental surveillance and excursion detection, prevention and control programs; vi) site and facilities descriptions, including documentation sufficient to demonstrate the applicant has all legal rights to sequester carbon dioxide and associated constituents into the proposed geologic sequestration site; vii) proof the wells are deigned to the minimum standards set forth by the Wyoming Oil and Gas Conservation Commission; viii) a plan for periodic integrity testing of all wells; ix) a monitoring plan to assess the migration of injected carbon dioxide; x) proof of financial assurances; xi) a detailed plan for post-closure monitoring; xii) proof of notice to sur-

face owners, mineral claimants, mineral owners, lessees and others of record of the subsurface interest; xiii) a requirement that any excursions are immediately reported; xiv) a procedure for terminating the permit if excursions cannot be controlled; and, xv) such other conditions or requirements as the department of environmental quality deems necessary to carry out the purposes of this section.

Given that the United States Government is accepting long term liability for carbon sequestration activities under this legislation, my suggestion is at a minimum, insure that such a permitting process is in place in each of the states where geologic sequestration activities are to occur. I would not recommend federal preemption of state's rights in this area. If the voters of a state do not want geologic sequestration activities conducted with the borders of their state, and the elected representatives of that state are unwilling to establish a permitting process, and if the consumers of power are willing to pay the increased costs of industrial applications which do not utilize geologic sequestration, then I believe it is not the obligation of the United States Government to force such activities to occur within the borders of those states.

The legislation pending in front of this committee does not take into account the existence of comprehensive, and in many cases, stricter state requirements for Carbon Sequestration activities. I would suggest the legislation be amended to include the possibility that the several states can regulate geologic sequestration activities. I would also suggest, as is contained in the UIC program, that the states take a primacy role in regulating these pilot CCS programs so long as they meet the minimum standards set forth by the United States government.

Whether by regulations, or by legislation, I would urge this body to include the minimum standards for permitting set forth in the Wyoming legislation. Frankly, at this stage, no one knows, in great detail, how to sequester carbon dioxide in large quantities. We only have one chance to do this right. We must proceed cautiously and with measured steps, rather than rushing headlong into carbon sequestration activities.

For example, there is much discussion in the scientific community regarding pressurization of formations. When one injects supercritical carbon dioxide into a formation that is already full of a brine solution, pressures in that formation build. The fluid dynamics mean that something is going to change. When CCS was initially contemplated, those fluid dynamics had not been fully explored. The Wyoming State Geologist has not modeled those fluid dynamics. His suggestion, to preserve homeostasis in the formation is, for every gallon of carbon dioxide that is injected into the formation, a gallon of brine is drawn out and purified. The waste is reinjected back into to the formation it came from with the carbon dioxide, trace minerals are stripped out and marketed, and the water from the saline formation is purified and used for domestic or agricultural water supply purposes. Now, that is a proposal on the table. We have not thought all of the ramifications completely through. But, you can see the science is dynamic. With dynamic science, we must proceed prudently and cautiously.

YOU INJECT IT, YOU OWN IT

Wyoming has taken the policy position that it does not make sense for the 550,000 citizens of the State of Wyoming to take liability for injected carbon dioxide, when, by and large, the ultimate consumers of the power generated from Wyoming resources are from out of state. Given that position, the Wyoming State Legislature passed HB 58, which will become law on July 1, 2009. That bill creates a rebuttal presumption that if a person injects carbon dioxide, that person owns it for all purposes, including liabilities of such ownership. This position is one from which Wyoming can retreat, but it can never return to this position, once the position has been abandoned. Our belief is the risks of the project are allocated, through the rate base, back to the user of the power. If the federal government provides indemnification, then all the better. In that way, a paradigm is created in which the injector owns the liabilities, but if certain conditions are met, the federal government will assume those liabilities, and the rebuttal presumption included in the statute will be overcome, and the liability will be assumed by the United States of America.

One consideration might be that carbon dioxide, in and of itself, is a valuable commodity. If the United States government is taking the liability for the asset, consideration should be given for taking the value of the asset as well—either in the legislation, or in the agreements authorized by the legislation.

UNITIZATION

Wyoming passed HB 80, which will become law on July 1, 2009, provides for the exercise of Wyoming's police power to protect "corresponding rights." The statute is

based upon oil and gas unitization principles. In much the same way there are oil and gas units formed under state law as well as federal law, I anticipate both federal and state carbon sequestration units. The exercise of the police power is justified to protect the rights of all pore space owners in the unit, and to not waste valuable pore space.

Under Wyoming's unitization concept, 80% of the owners of the pore space consent to the unitization, 20% of nonconsenting landowners can be brought into the unit.

The unitization concept is much more palatable than eminent domain to pore space owners who's pore space is involuntarily included in the unit, because the pore space owner has the right under the unitization concept to participate in the income stream from the unit for the life of the unit, rather than being compensated for the value of the pore space taken at the outset of the carbon sequestration project. Additionally, the pore space owner, through the administration of the Wyoming Oil and Gas Conservation Commission has the right to object or otherwise have input into the operation of the unit.

The unitization concept allocates "economic benefits" throughout the life of the unit, to all parcels of the unit in and equitable fashion.

THE LAST TWO STEPS AT THE FEDERAL LEVEL

Wyoming has created as much legal infrastructure for carbon sequestration as it can, alone. There will be fine tuning of this state legislation for years, but the basic legal infrastructure is there. Two things need to happen to make carbon sequestration possible on a large scale. The first issue is addressed by S. 1013. Since this process is unknown, and the liabilities are unknown, and since the carbon dioxide will be under the surface of the earth for geologic time, long term liability needs to be allocated. This bill does exactly that. Insurance vendors have created a product for the short term liability, but no project will proceed until the long term liabilities have been addressed.

The second decision that needs to happen is for the federal government to determine the ownership of pore space under federal surface and federal minerals. While the several states can determine fee property ownership, unless the federal government makes its determination regarding federal lands, no project will proceed. States cannot preempt the federal government's ownership of its property, and so that determination will be key to the development of carbon sequestration projects, particularly in the west.

COMMENTS REGARDING THIS BILL

I commend the sponsors of this bill for bringing forward thinking legislation which takes a significant step toward proving carbon sequestration technologies. At the root of every successful economy is cheap and available energy. In order to spur economic recovery and to capitalize on the strengths of this country, we need to focus on the assets we have, instead of becoming dependent upon the assets of other countries. This technology will allow the country to develop its assets in a way that is both economically sound and environmentally friendly.

This bill is a great step in the right direction. Frankly, I had to think long and hard about things that I might do differently were I in this committee's position.

Some considerations on the language of this bill are as follows:

1. This body should make a determination as to whether or not enhanced oil recovery activities will be included as projects which qualify for this legislation.

2. Either by regulation, or by the language of the bill, consideration should be given to many of the factors included in the Wyoming model permitting scheme. I would suggest minimum permitting requirements. Factors which might be included in section 963(e) are:

i) a characterization of the injection zone and aquifers above and below the injection zone which may be affected, including the applicable pressure and fluid chemistry data to describe the projected effects of injection activities;

ii) an assessment of the impact to fluid resources, the subsurface structures and the surface of land that might reasonably be expected to be impacted and the measures required to mitigate such impacts,

iii) plans for environmental surveillance and excursion detection, prevention and control programs

iv) a requirement that any excursions are immediately reported,

v) a procedure for terminating the or substituting the operator of the geologic sequestration facility if certain operating parameters are not met. I do not believe that termination of indemnification obligations will encourage fi-

nancing, but there should be some sort of process by which incompetent or unscrupulous operators can be removed, and others substituted in their stead if operations are not being conducted as required.

3. The following concept was first put forth by David Victor from Stanford University. He urges that we do not proceed with too much haste in development of these projects. We need to insure development is done in a logical fashion, and that we do not force all of the projects to be built at the same time. Instead, we allow the projects to proceed successively, and that we are allowed to learn from the mistakes from others, rather that charging headlong into the process all at once. While the situation may be perceived as critical, we need to proceed carefully and prudently. We need to account for unexpected consequences of large scale geologic sequestration, which has never been accomplished before at scale, and to work through the process logically and safely.

4. I urge you to not force a cookie cutter approach on the entire country. Instead, I would defer to the collective wisdom of each of the states. Let each of the states serve as a laboratory for the United States as a whole. The good ideas will rise to the surface.

5. I have heard proposals, primarily in the halls of academia, to nationalize aquifers and pores space, and to impose a common scheme for carbon sequestration on the entire country. I would urge you not to take this approach. Our strength is in our diversity. Rather than an inbred single thought system, I would urge this technology be allowed to develop in broad and varied ways. The strength in the competition and diversity of ideas will allow us all to benefit by the best process and product available. If we do it the cookie cutter way, there is no motivation to cut costs, compete and provide the highest quality, lowest cost product.

CONCLUSION

Should carbon caps become a reality, the technology for carbon sequestration needs to be in place. The United States has vast coal resources, and to write them off without developing clean coal technologies is, to my way of thinking, short sighted and will have serious economic consequences to the country. This legislation is a giant step forward, and I wholly support it.

Thank you for the honor and opportunity to share my thoughts with this committee.

The CHAIRMAN. Thank you all very much for your testimony. Let me particularly thank you, Representative Lubnau. You've obviously spent a great deal of time on this subject. We can learn from your insights.

Dr. Batten, let me ask you. One of the things we did in the 2007 bill we passed was to request policy recommendations be provided to the Congress for carbon capture and storage development on public lands. As far as I can tell there are no policy recommendations in the report that you've done I was wondering is there any prospect that we could receive some recommendations of that sort prior to marking up this bill?

Ms. BATTEN. Thank you, Mr. Chairman. We are working on a report that the first draft of which was prepared in December 2008. However because of the change of administration it's been held up a bit.

It's currently under review. We are expecting to issue it to you very soon. The report asserts that the BLM has adequate statutory and regulatory authority to issue leases and permits for geologic carbon sequestration activities on public lands with the possible exception of the establishment of trust funds to manage the long term, post closure phase of sequestrationsites. The report recommends that research be undertaken in a number of areas to address the many unknowns related to carbon dioxide sequestration so that proper mitigating measures to protect the environment can be included in the land use authorizations.

It discusses existing law and the authority under that law that provides for potential CO_2 policy development. But it also identifies gaps. So we look forward to sharing that final report with you.

The CHAIRMAN. Ok. Let me ask if after looking at this proposed legislation that we've introduced as S. 1013. Do you believe that the role of the Department of Interior with regard to carbon capture and storage on public lands is adequately defined in the bill in order for us to proceed with this liability program that we've proposed or do you think we need to make some changes?

Have you been able to reach a conclusion on that?

Ms. BATTEN. We are still reviewing S. 1013 at the Department of the Interior. So what I'd like to do is to get back to you soon with some greater clarification on that question.

The CHAIRMAN. That would be great if you could do that.

Ms. BATTEN. Absolutely.

The CHAIRMAN. Also on page 8 of the report that you've referred to this section 714 report. It stated that many authorities currently exist to address CCS needs such as for managing pipelines, roads and infrastructure and various other issues. It goes on to state that existing authorities are not likely to address all of the unique issues that carbon sequestration presents.

Could you also get back to us and elaborate a bit more on any gaps that you think exist in current authority that we ought to try to fill?

Ms. BATTEN. Absolutely, Senator. Thank you.

The CHAIRMAN. Mr. Lubnau, Representative Lubnau, it's clear of course that Wyoming is the national leader in this area of developing CCS law that enables this technology to continue to progress to full scale deployment. Let me ask about unitization. I don't think you discussed that in your oral testimony.

But I gather you've got a provision in your law that makes an 80/20 split on unitization. Can you describe that? How you arrived at that? What opposition you encountered to the unitization provisions that you put in your law?

Mr. LUBNAU. Certainly. Thank you, Mr. Chairman. We do have an 80/20 unitization bill. Surprisingly it went through with little opposition. I think there were out of 90 members in the Wyoming legislature, 2 no votes in both Houses.

Here's why. There are two options for bringing in recalcitrant owners. There's unitization. Then there's eminent domain.

I challenge anybody right now to determine what the value of pore space two miles under the surface is. I mean, you just can't make that determination. It could either be a lot or it could be nothing depending on what the market bears.

So for eminent domain purposes you get one payment, up front. As a surface owner you don't have a property right anymore. So what the unitization bill did was it changed that so that you're entitled to a portion of the economic benefits as determined by the Wyoming Oil and Gas Commission and by the market over the life of the project. So instead of losing the property right forever, there's payment over the life of the project.

Additionally if there's the unscrupulous or inept operator, you can petition in front of the Oil and Gas Commission. Have some say in the way that the unit is operated. So for land owners that

was a more palatable method of including folks than the eminent domain was because you lose absolute control.

For the mineral industry they were just happy to have a process where none existed. If you look at Wyoming's Constitution there's enumerated a series of things for which you can condemn private property. The only thing that comes close is sanitary purposes, roads, mines. But there's nothing in Wyoming.

So it was unconstitutional in Wyoming. So we were faced with the choice of nothing or unitization. That's where the unitization came from.

As we've thought through it. We think that's a better use of our scarce asset and scarce resource because we can allocate equitably through our unitization process. I think we've tried to parallel. I mean starting a new industry entirely from scratch and using your imagination is hard.

We've tried to use as many parallels to oil and gas as we can because that's something we know. We have the case law and the infrastructure legally there. So I think it also provides an option to the Federal Government as well to set up a Federal unitization statute not unlike the oil and gas Federal unitization statutes we have.

The CHAIRMAN. Thank you very much.

Senator Murkowski.

Senator MURKOWSKI. Thank you, Mr. Chairman. I apologize that I had to slip out and miss the oral testimony of you, Dr. Der and Dr. Batten. Let me ask a question about just who assumes ownership and liability for the injected CO_2 in competing for the FutureGen site selection.

Both the State of Illinois and the State of Texas passed State laws to assume that liability and to assume ownership of the injected CO_2. What's the administration's opinion on this, and Representative, I'll also ask you your opinion on the role of the States in terms of the long term stewardship of the CCS sites as compared to the Federal role that we see outlined in the legislation that's been drafted. I'll ask each of you.

Dr. Batten, do you want to go first? Thank you.

Ms. BATTEN. Sure. Thank you, Senator. I don't believe—we've done a lot of research on the issue of the various components of the liability question that we need to consider both short term liability, long term liability, looking at the various CO_2 is not necessarily always the same thing.

We need to be looking at CO_2 as a commodity, as a resource, as a waste product, as a pollutant, etcetera. So there are many different ways to consider CO_2 and so when coming up with liability recommendations we need to consider all of those different definitions. In terms of exactly who should assume liability, we have not come out with a position on that yet, but we're looking forward to working with you on providing as much information as we can in terms of the Department's role in this and moving forward.

Senator MURKOWSKI. Dr. Der, anything further from the administration perspective?

Mr. DER. I want to echo what Dr. Batten has said. I think that currently the administration will probably go through some interagency reviews on the processes and to try to address those various

concerns and natures of CO_2 relative to liability on the Federal part.

Senator MURKOWSKI. What about your opinion on State verses Federal ownership?

Mr. LUBNAU. Thank you, Senator. Our State has taken a position and actually passed a bill that says if you inject it, you own it. So the injector owns it.

Here's why. If the injector owns the liability they pass it through their charges to the power plant who passes it through their charges and their rate base to the ultimate consumer of the electricity. It didn't make sense to us for the 550,000 people of the State of Wyoming, who are not the ultimate consumers of the power, to pay for those liabilities and assume those liabilities for our children and grandchildren. So ultimately I think that that liability should be best borne by the consumer of the power so that we don't build in an artificial, economic incentive one way or another.

I think that this bill is structured much the same way. Although backed with the full faith and credit of the United States. Because the United States provides indemnity, but they charge back to the injector the present value of those liability premiums which gets passed on through the rate base to the consumer so that the consumer pays. I think that that's appropriately where it should be.

Senator MURKOWSKI. Dr. Der, the Department has struggled with calculating the risk profile of loan guarantees for clean energy projects. Potential liabilities associated with carbon sequestration are probably even less certain. Is the Department comfortable with calculating—maybe comfortable is not the best word—calculating the fees that will be necessary to cover the potential liabilities required by this.

Have you given any thought about how you even begin the task of calculating that liability?

Mr. DER. To be honest with you I don't think we have because the——

Senator MURKOWSKI. How difficult do you imagine it will be?

Mr. DER. I think it will be very difficult because of the assessment of the risk and how you value that risk. We talk about bringing things to present value. It takes, I think, in my opinion some very sophisticated economic models and also risk models associated with this and long term storage liability.

That being said, I think there are probably some models that we could draw upon to see what has been done in the past, not only in the United States and overseas. Other models that have been put into place for long term liability and see how those yielded the results. The worst thing we want to do is to create a situation of unintended consequences both from the government's part and on the public's part.

Senator MURKOWSKI. In the 2007 energy bill there were 7 CCS demonstration projects, and this legislation provides for an additional 10 more. So you've got, well, my notes here say 19 demonstration projects. I guess that also includes FutureGen, representing another and then CCPI, presumably, at least another.

So we're talking about 19 demonstration projects. Is this about the right number? Is it too high or is it too low in terms of the

number of demonstration projects that will be necessary to prove out the viability of carbon capture and sequestration?

Mr. DER. We have seven partnerships. But I believe that there are 9 projects as part of that partnership and these 10. I think that's how you got your number on 19.

Senator MURKOWSKI. Yes.

Mr. DER. It actually depends on the nature of the integration of the source and the sink. We had different geologic formations. We have different types of sources.

What we really need to do is sit down and look at the matrix of what is covered and what needs to be covered so that there's confidence in these various sources and sinks to move forward to say that there are commonalities that we can draw upon for an amount of the projects. But there are some specific aspects of each project that we need to be able to characterize. So an additional ten is at least the minimum that we would need to take a look at.

Senator MURKOWSKI. An additional 10 on top of the 19.

Mr. DER. On top of what we had, yes.

Senator MURKOWSKI. Now, wait. I'm not clear. Indicated by this bill?

Mr. DER. As indicated by this bill.

Senator MURKOWSKI. Yes.

Mr. DER. An additional 10 would be very helpful in trying to increase the knowledge base.

Senator MURKOWSKI. Great. Thank you, Mr. Chairman.

The CHAIRMAN. Thank you.

Senator Dorgan.

Senator DORGAN. Mr. Chairman, I've been at an Appropriations mark up on the Omnibus. So I have not been here for the testimony. But this is a really important area and appreciate the hearing.

I will not ask questions because I've not heard the witnesses' testimony. Thank you very much.

The CHAIRMAN. Senator Barrasso.

Senator BARRASSO. Thank you, Mr. Chairman. Representative Lubnau, a couple things about pore space ownership. You mentioned in your testimony the need for determination of pore space ownership under Federal surface, Federal minerals.

You know we come from a State where half of the surface area is owned by the Federal Government. Two-thirds of the minerals under the ground is owned by the Federal Government, so where we have a State like Wyoming and a number of States where there is a significant amount of Federal ownership of the land, what are the ramifications of leaving the Federal pore space ownership unaddressed?

How important is it that we make sure that we address this thing fully?

Mr. LUBNAU. Thank you, Senator. If you don't make the determination as to who owns the pore space under Federal lands or around, whether it's the surface owner or the mineral owner, these projects won't proceed because you can't make the determination. You don't know who to ask.

You've got conflicting property rights. In a sixth of our State we've got fee surface over Federal minerals. So who do you ask?

In Wyoming we say that the surface on onerous the pore space. We've adopted the American rule which is generally the case law in the country. So Wyoming's law says that the pore space owner would be the surface owner.

If you make the determination here that the mineral owner owns it then you've got a conflict of laws. Of course, you have priority. But you can't know until you all make that determination one way or another.

I'd urge you to adopt the American rule.

No. 1 for consistency sake.

No. 2 because it avoids grabbing sticks from one bundle and moving it to somebody else's bundle. Because under the law it makes the most sense. A mineral owner should own the right to extract minerals on that much of the surface and subsurface as is necessary to extract minerals.

I don't think in the definition of a mineral right that through any kind of constructed oil other than to recover oil and gas or other kind of minerals you have the right to inject anything because you're putting something back in instead of taking something out. That's clearly under the case law surface owner right, I think.

Senator BARRASSO. So based on what you're saying it's very critical then that we make sure that we must address pore space ownership on Federal land.

Mr. LUBNAU. Yes, Senator.

Senator BARRASSO. Then for the States, 11 or so that have more than 40 percent owned by the Federal Government, what are the implications if we don't adequately go ahead and address that ownership of the pore space in those States?

Mr. LUBNAU. Senator, I don't think that these projects go forward because of just the sheer scale. I mean what you're talking about here is millions—I mean, right now it's a million tons of carbon dioxide. But if these projects go forward, Wyoming supplies 400 million tons of coal a year, if you do the chemical reaction—if you do the chemistry that turns into about 800 million tons of carbon dioxide a year.

So you compress that down to a liquid. You stick it down into the formation. There are some problems with the formation in that it pressurizes the formation.

So that the latest philosophy we have in Wyoming is for every gallon of compressed carbon dioxide you put in, you pull out a gallon of saline, purify it, put the non-disposable stuff back down into the formation it came from and sell the water, so that you don't over pressurize the formation. Those are a lot of philosophies that you have to work with to get this done. But if you don't have a Federal partnership you can't do it on fee land alone and without the determination of ownership it doesn't get done.

Senator BARRASSO. Could we then go to that question of the water? You said for every gallon of the liquid carbon dioxide you putting down you're getting a gallon of water purified. Get rid of the saline and then you have the water. Then you said sell it.

Talk about a little bit about the proposals for Federal ownership of the deep saline aquifers. What are your thoughts on that?

Mr. LUBNAU. A couple of things. No. 1, I think we're too far down the road for the government to do it without it being a taking. Those saline aquifers, for many years, have been used.

We've been doing carbon sequestration for many years, just not at scale. We call it either enhanced oil recovery or acid gas injection depending on where you put it. If it's in to the deep saline aquifer, it's acid gas injection.

We do it under Class II and I think Class I UIC permits. So, but it's not at scale. So there is a valuable asset and has been for a long time.

Now that the pore space ownership has been determined under fee lab. There are people who are creating leases and leasing their pore space already. So there is a value there. So that's a taking.

The second thing I would say about nationalizing the aquifers is that those aquifers are valuable particularly in the West where we're short of water. As technology and energy and demand for water becomes greater and greater and greater, those saline aquifers become more and more valuable to those States that already have that water. Taking that water, I think, is bad public policy.

Then the last thing I would say is that if you nationalize aquifers you nationalize the pore space because they are the same thing, essentially. So you discourage development. Even though the Federal Government would say that they own the pore space.

The surface owner who doesn't have any say in the game and doesn't have any income motivation to develop the pore space does everything in their power to stop that development. Prohibits access to surface monitoring facilities, litigates for years and years and years to keep the project out. There's a whole series of things that I think nationalization of the aquifers is just generally bad public policy.

Senator BARRASSO. Thank you, Representative Lubnau. Thank you, Mr. Chairman.

The CHAIRMAN. Thank you very much.

Senator Corker.

Senator CORKER. Thank you, Mr. Chairman. Another great hearing. I want to thank the witnesses.

I realize that we've been using carbon for enhanced oil recovery for years and many other things. I know that sometimes I use the term when donkeys fly. I don't mean that using CO_2, sequestering CO_2 is not something that can be done. I realize we are doing that today and have for years to benefit oil recovery and other ways.

I guess what I have trouble imagining and I could see why Wyoming is the center of this activity today. We just had a transmission siting hearing talking about a bill. So as I think about us trying to capture and sequester carbon, all carbon, that's generated through coal produced energy or any other way. I think about the myriad of pipelines throughout our country, the right of ways, the pumps that I understand need to exist, at least every 100 miles or maybe more.

Is this a reality to think about on a commercial scale our country looking at pumping CO_2 throughout our country using it where we can for oil recovery in other cases just sequestering it and getting rid of it? Is this a when donkeys fly type of thing or is this reality?

Representative Lubnau, you seem to be the most knowledgeable person here regarding that.

Mr. LUBNAU. Senator, that's—I'll be honest. That's a tough question for me to answer. I come to you from the State that produces—I come to you from the county that produces the most carbon of any county anywhere in the world.

But that's not true. My county isn't the largest emitter of carbon in the State of Wyoming, Yellowstone Park is.

Senator CORKER. During certain seasons. Some seasons not, but some seasons yes.

Can you imagine these pipelines running throughout our country and us pumping carbon throughout the country on a scale that makes any sense? Are we just all doing this to make coal to those who oppose coal, seem like something that's doable under a cap and trade scheme and will make sense? Just tell me. I mean are we smoking something or is——

[Laughter.]

Mr. LUBNAU. Senator, we can do it. It will be expensive. I think that if you cap carbon, it has to be a reality because we don't have enough energy sources to do it otherwise.

Let me give you an example. Wind has been touted in my part of the country as a panacea. You know, we've got thousands and thousands of acres where sage brush doesn't grow because the wind blows so hard.

It's also prime sage grouse habitat. Sage grouse are endangered, well, I don't know whether they're—there's no endangerment finding. But it's a big debate. It shuts down the oil and gas industry in the spring when the sage grouse lek.

Sage grouse are notoriously stupid animals. That's the way they are. So they are preprogrammed that if there's something seven or ten feet tall, standing in the middle of the prairie, that's a raptor perch. They don't lek anywhere near it.

You put 100,000 acres of wind towers out in the middle of Wyoming prairie, you've now put 100,000 acres of what the sage grouse perceive to be raptor perches. So they don't lek. So now all of a sudden what's touted as a panacea becomes an endangered species hazard in the State of Wyoming.

So you've got a conflict between the Endangered Species Act and the clean energy that you want. So do we exempt wind from the Endangered Species Act. That doesn't make much sense.

So things that have been touted as a panacea have unintended consequences. What does that lead me to believe? That leads me to believe that we continue to need to burn coal.

If we don't burn coal we just shut off about 50 percent of the Nation's energy supply, primarily not on the West Coast and not on the East Coast, but in the Rocky Mountain West and the industrial Midwest. Those are the people that lose their power. So if you put caps on carbon we have to have something like this or we just cripple our economy.

One of 2 things is going to happen. Either the carbon caps aren't going to work or the economy is going to fall apart. I don't see any other option.

Senator CORKER. You know, I hope this is a solution. I think what I hear you saying is that in the interim since coal is an im-

portant part of our energy production we need to at least make believe that it can happen.

[Laughter.]

Senator CORKER. So is that until we figure out something? I mean, I again, I just have—I don't know who is going to own these pipelines. I don't know who is going to pay for these pipelines. I don't know who is going to monitor these pipelines.

But I have this vision of tremendous amounts of pipelines running throughout from every urban area of the country and every part of the country into these caverns that we have all these legal issues. I hope there's a solution because I'm one of those who understands the importance of coal.

So back to DOE. I actually sense that a better solution for us is going to be figuring out something to do with CO_2 molecules that is beneficial. I think all this other stuff, candidly, is a nice past time, but I think that scientists, our better solution, is for scientists to find something beneficial to do with CO_2 by breaking it down and turning it into something else.

I'm just wondering what DOE's thoughts are in that regard. Whether we feel like we're investing enough in research to sort of circumvent this thing that we are talking about that has lots of problems.

Mr. DER. I think we have looked at various ideas and basic sciences in the past and to look at ways to break up the carbon molecule. The issue there is that from a chemical bonding, the energy it takes to remove that is fairly high. There may be some revolutionary technologies out there that we don't currently know about that could be on the horizon that let us do that.

There are ideas about mineral carbonization, using the CO_2 to regenerate products. But in the end when you look at the volume of the CO_2 that's generated from coal plants, fossil plants and any other type of industrial processes, it is a large quantity. I don't see us being able to subtract this carbon storage issue out of the equation.

I could be wrong. But if I am wrong, I would be glad to be wrong if there was a way to make use of that carbon in such a way that it would be of a beneficiary use. We do support research in those areas from a science basis, from the technology basis.

Senator CORKER. But you do see us solving it because of the mass of CO_2 that's going to be generated and this being common. You do see us solving it by piping carbon throughout our country and putting it in the ground.

Mr. DER. I think I would rather defer to some of the industry folks that would be possibly coming up after. But I think it is a feasible thing. For example, in terms of gas pipeline transmission, we have over 300,000 miles of transmission of gas pipelines today. It seems to be able to be dealt with in terms of right of ways and the like.

It will be a challenge. It depends on how the transportation network is designed relative to where the source and the sink goes to, whether or not it's a local prospect of a short distance of the transport of the CO_2 to a storage site or whether or not there will be large common areas where we feed CO_2 into a common pipeline.

Those things need to be looked at. I probably would rather defer to industry to see what those best solutions might be.

Senator CORKER. Thank you.

The CHAIRMAN. Let me ask if Senator Barrasso or Senator Murkowski have additional questions. Senator Barrasso.

Senator BARRASSO. Just one, Mr. Chairman, if I could maybe to Representative Lubnau. The State of Wyoming and General Electric are engaged in a project. They're building a $100 million plant in Wyoming.

Isn't the idea to have a plant right at the location where you do sequester the carbon dioxide without having to go with all these hundreds of miles of pipeline. I mean, I thought that was the principle behind this is to try to put the facility where the coal is made into electricity at the same site where the carbon is sequestered. I think North Dakota has some similar intentions. Then ship the electricity with the transmission lines that we're working on through this legislation.

Mr. LUBNAU. Senator, I thought that was the philosophy too. The State of Wyoming has just announced that that plant is going to be in Cheyenne. The prime geologic place in Wyoming is the Rock Springs uplift which is 4,000 square kilometers bounded on four sides. The prediction is there's 465 years worth of carbon sequestration in that uplift.

There's a serious, as you know, there's the Jim Bridger Power Plant right in the middle there. That is the initial plan, just to locate them where there's point sources. Right now carbon dioxide is a valuable commodity. It's valuable for enhanced oil recovery. If we can get the carbon dioxide to the oil fields, it's a valuable commodity.

The problem is that the sheer volumes of carbon dioxide mean that pretty soon that market goes away. Then it becomes a waste product. So initially it's economical just to put them, well, at the power plants and the Powder River Basin so that you can rejuvenate the Powder River Basin oil fields.

They say that you can get about as much oil out of the oil field with the enhanced oil recovery techniques as you got during the first life of the oil fields. So out of Teapot Dome in the Salt Creek oil field, they think another 200 million barrels of oil by re-injecting the carbon dioxide that they're getting from the Exxon plant in western Wyoming.

Senator BARRASSO. Thank you, Mr. Chairman.

The CHAIRMAN. Thank you. I was given a note here. Allison indicated that in this American Recovery Act we put $100 million in toward beneficial re use of CO_2 at the Department of Energy.

That's in response to Senator Corker's concern about whether we're doing research in this. I do think we're trying to look at all options. I think that's the wise course.

It's been very useful testimony. Thank you all for being here. We have another excellent panel which I would call forward at this point.

Let me introduce our additional panel.

It's Mr. John Tombari, who is Vice President with Schlumberger Carbon Services in Houston.

Mr. Scott Anderson, who is Senior Policy Advisor with Environmental Defense in Austin, Texas.

Mr. Karl Moor, who is Vice President and Associate Counsel with the Southern Company in Atlanta.

Ms. Chiara Trabucchi, who is the Principal with Industrial Economics in Cambridge, Massachusetts.

Thank you all very much for being here. Again, I apologize for the somewhat delayed hearing. But I think we're still in good time.

Mr. Tombari, if you could take 5 or 6 minutes and give us a summary of the main points. Then we'll just go across the panel and hear from each of you. Then we'll have some questions.

Go right ahead.

STATEMENT OF JOHN TOMBARI, VICE PRESIDENT, SCHLUMBERGER CARBON SERVICES, HOUSTON, TX

Mr. TOMBARI. Mr. Chairman, members of the committee, thank you for having me here today. I'm here to tell you that the technology for the safe storage of CO_2 is ready. There is an industry waiting to develop. We need to start this now for the sake of future generations.

Now I've been with Schlumberger Carbon Services, Schlumberger, for the past 28 years. I spent the last 5 years dedicating my life to CO_2 storage. Schlumberger has been around for 80 years.

We've consistently spent in research. Last year we spent more than $800 million in research. We understand the subsurface of the earth. We understand its characteristics, the layers, the compartments. We understand how fluids can move in and out of the earth.

Based on our experience, the technology we've developed and the projects we've participated in, we're ready to start a business to own and operate CO_2 storage sites in saline formations. Now let me be clear. Saline formations are actually rocks that exist miles underneath the earth. They're filled with salt water. They're perfect places to put carbon dioxide for safe, long term storage.

Now before we move into this business. We do move cautiously because it's not something easy to do. It's difficult for us and it pushes the envelope of our technology.

So there's four things that we need to get started.

No. 1, is this whole technology won't just work anywhere. So site selection is critical. We have ourselves a very strict criteria for the types of saline formations where we would be willing to do this. So that's No. 1, site selection.

No. 2, obviously and it's been said before is we need to be able to get the rights to the pore space where the CO_2 will eventually evolve. We're hopeful that those issues will be resolved.

No. 3 is we believe there needs to be a very strong regulatory framework developed. We would be unwilling to participate in an industry that might not be properly regulated that might involve bad practices. We support and we're encouraged and we've been involved in the EPA's Class VI UIC regulatory work. We hope that proceeds.

No. 4, and what this act is here to address is the notion of long term stewardship. So we believe once again that if the site is selected properly and if good characterization work is done early with

good technology and before injection starts, that the operational period of injection, the 10, 20, 30 years when CO_2 is injected, this operational period is manageable. In fact we're willing to take the responsibility during this period of time and manage the challenges that will occur.

Now once you stop injecting the CO_2, the CO_2 will continue to move in the formation. But if you have selected your site well, and if you've used good practices, it will come to equilibrium in a predictable time, in a predictable place. So we still would be willing to take responsibility through that time period.

Now once the CO_2 comes into equilibrium however, in order for an industry to properly form the public will demand and they should demand that an entity like the Federal Government takes on the hundreds or perhaps thousands of years of long term stewardship of the CO_2. That's what this Act puts forward. It gives encouragement and hope and incentive for companies who had used good practices like Schlumberger to actually get into this business.

Thank you.

[The prepared statement of Mr. Tombari follows:]

PREPARED STATEMENT OF JOHN TOMBARI, VICE PRESIDENT, SCHLUMBERGER CARBON SERVICES, HOUSTON, TX

I would like to open by describing what Schlumberger Carbon Services does. This is particularly relevant since the proposed legislation will encourage companies such as ours to fill a necessary industry role. Schlumberger Carbon Services is a division of Schlumberger, the world's leading oilfield services company. Schlumberger was founded in 1926 and employs more than 82,000 people of over 140 nationalities working in approximately 80 countries. Schlumberger invented the first instruments which take measurements deep below the earth's surface and allow the understanding of the properties of the earth's layers.

Since its inception, Schlumberger has spent consistently and heavily inesearch and development. In 2008, Schlumberger's R&D expense was $819 Million USD. It is in large part due to these efforts that today we canee with great clarity into the depths of the earth and visualize its content. Miles beneath our feet we can identify features much like those we observe today on the earth's surface such as: rivers, beaches & reefs. These features moved from the surface to the depths of the earth over millions of years. Despite the alterations that took place over this time, we can maphem, evaluate them and follow them as if we were hiking through history. These technologies have been used by the oil gas industry for decades to find & produce hydrocarbons. As you might imagine they also have extreme relevance to the challenges of geologic carbon sequestration.

It is important that I point out, at this time, that Schlumberger does not and never will take equity or production sharing contracts in the oil and gas businesses.

I appear today however, on behalf of Schlumberger Carbon Services and my comments relate not to oil and gas but more specifically to the prospects for the development of a geologic carbon sequestration industry. I joined Schlumberger Carbon Services in 2005 having worked elsewhere in Schlumberger since 1981.

Schlumberger Carbon Services has been involved in carbon sequestration since the mid 1990s. In 2005 this became a business initiative with the intent of providing comprehensive geological sequestration solutions to major point source emitters of CO_2. Our technical expertise, project management capability and technology portfolio in Carbon Services are leveraged from Schlumberger's 80 year history. We draw from the existing skills and technologies used for safe hydrocarbon exploration, production and reservoir management and apply them to sequestration site exploration and operations including injection and monitoring of CO_2. Schlumberger Carbon Services plans to design, build and operate sequestration sites in a safe and environmentally friendly manner. We hope this can be a business opportunity in the near future. We have participated in almost all of the geologic carbon sequestration initiatives around the world and are a member of most related consortiums and partnerships including all seven of the DOE's Regional Carbon Sequestration Partnerships. We are also investing significantly in the conversion of existing oil and gas

technologies and the development of new technologies to fill gaps so that the entire lifecycle of a carbon sequestration project can be properly managed.

If carbon sequestration is to have an impact on the CO_2 concentrations in the atmosphere, we will need to inject billions of tons of CO_2 underground over the next 40 to 50 years and store them for very much longer. The sheer scale of the challenge is daunting, and the industry that will need to develop to achieve this will be massive. It will require many other companies similar in capability to Schlumberger. Hundreds of thousands of technical and non-technical jobs will be created, and it is not unthinkable that one day it will be a sector of a "clean-energy" industry that could itself reach the scale of today's oil and gas business.

Despite the enormous potential for the creation of a carbon sequestration industry and the hundreds of thousands of clean-energy jobs that could be created, progress today is slow, but this is not due to the readiness of technology. In my opinion and through our project experience, the needed technology is ready for safe and large-scale deployment. The risks involved have been thoroughly studied and documented. Financial mechanisms for large-scale demonstrations appear to be in place and are growing in availability. Regulatory frameworks are under development through the EPA and in the State legislatures. The final issue to be resolved is the question of who will handle the long-term stewardship of a sequestration site. Such stewardship will likely extend for hundreds of years and is beyond the likely lifespan of any corporation.

Government legislation and policy must protect the public's interests and the taxpayers' money by allowing for the long-term stewardship of what will be a diminishing risk. Further, legislation should mandate good project practices that will be a condition for achieving the desired handover. Companies who manage sequestration projects properly must be able to hand them over to the federal government once regulatory requirements have been met.

One suggestion we bring is to provide more clarity around the conditions under which the handover would occur. We believe that early projects such as the 10 covered by the legislation you are considering should be held to the highest of standards with the greatest possible protection afforded to the public. DOE estimates show enormous potential for sequestration sites throughout the United States so we can be highly selective for the first ten. Site selection should be heavily weighted by the simplicity of the geologic environment, and the minimization of geologic uncertainty. To evaluate this uncertainty, and to properly select sites, a minimum standard of site characterization and qualification should be set—with the use of the best available technologies encouraged. Without naming specific technologies, stewardship should only be an option for projects that use the best possible site characterization technologies available at the time of baseline site description and modeling—prior to injection.

In closing we are hopeful that the investments we are making may soon be put to use, and that the beginning of a new clean energy business may be around the corner.

The CHAIRMAN. Thank you very much.

Mr. Moor.

STATEMENT OF KARL MOOR, VICE PRESIDENT & ASSOCIATE GENERAL COUNSEL, SOUTHERN COMPANY, ATLANTA, GA

Mr. MOOR. Senator Bingaman, good to see you, sir.

The CHAIRMAN. Good to see you.

Mr. MOOR. Senator Corker. I am Karl Moor with the Southern Company. We have 42,000 mega watts of generated capacity. About half of that is coal fired. So we're amongst the hopeful.

We have found over time that the possibility of sequestering carbon into something that we had an obligation to study and pursue in every way possible. We were very encouraged by the introduction of S. 1013. We're here today to endorse the bill because we feel it is an important first step in the road to making sequestration a real possibility of the lives, our lives, our children's lives, our grandchildren's lives.

John's a very hard act to follow. When you think about Schlumberger, the type of company they are, their worldwide rep-

utation. They help give all of us confidence that with this kind of technological sophistication, this type of commitment and these kinds of resources that we can create an environment under which sequestration can be made to work.

It's a daunting task. I was impressed by our State representative of Wyoming. A great, articulate spokesman for a view that I think all of us hold which is 50 percent of the Nation's energy derives from this resource. Our most valuable, domestic resource of energy, long term obligation to make sure that it's available.

It's been the secret to economic growth in the Southeast and the Tennessee Valley. It is a driving force in our economy both through rail, of the infrastructure in and around power plants, all that comes with it. It's the thought that we would abandon this resource, leave it unused, leave it untapped. Deny it to our children and our grandchildren when we in turn had already received the benefit of it would seem to me to be a terrible waste of a potential that America holds.

So when we've looked at this issue we've tried to take the view that we've had these benefits. What do we do to ensure that our children enjoy these benefits as well? So today I would tell you that the Southern Company has taken this responsibility very seriously by pursuing, really, four things, really five things.

Let me characterize the four first.

On the technology side there are four things that we decided that we had to do.

First of all we had to do large scale sequestration projects to figure out if we knew how to do this where we could employ this technology. So we've been pursuing those.

We also had to learn whether or not we could do this from conventional coal fired power plants. So we have a number of projects underway under the sponsorship of DOE that we think will give us the experience to do that over time.

The other thing that we said that we needed were working partnership with DOE as an opportunity to work at the fundamental research basis to understand what the challenges will be, not just in the next 5 years, but in the next 50 years.

Then finally we thought on the large scale we had an opportunity and a requirement really to bring IGCC into fruition. So just recently Mississippi Power Company which is one of the operating companies of Southern Company, has announced that we're going to attempt to build, if the Public Service Commission approves it, a 582 mega watt IGCC facility in Kemper County, Mississippi with a 50 percent carbon capture potential.

The great news there is the happy coincidence between the EOR and carbon capture is a good one for the Southeast. Much like the story in Wyoming, we're hoping that we can enhance oil recovery even as we sequester carbon. From our experience and the experience that we've had from others, we've concluded that risk management is at the very heart of this enterprise that we have to exercise great care because we are talking about an intergenerational creation of risk.

We've worked with Scott Anderson and others in the environmental community diligently to communicate the idea that because we take on our stewardship obligation very seriously, because we

take that obligation very seriously, we want to see this policy unfold in a way that creates the maximum opportunity for its success. We've also over time concluded, as have been talked by the geologists in the industries in and around the oil and gas industry as well as through the Willfield Services, is that the declining risk curve is a big part of this.

We'd have embraced early in the work of Dr. Sally Benson of Stanford University who tells us that the tail is long but it narrows. So what we're hoping to do is, as with John and his company, take on early responsibility through a combination effect. We found over time that we can manage risk, slight risk with large negative consequences through products like insurance and mutualization.

We believe those keep the private sector first and foremost in the place where they're managing the risk and managing the resources that allow you to deal with small risk. That being said, you'd say well why then would you support S. 1013? The idea that the DOE should be involved in the indemnification process and take on a responsibility that private industry really should have.

Our answer that is straightforward. We're at an interesting moment in history. The demand for carbon capture and sequestration is great. The timeframe that we have to implement it is relatively short.

We find ourselves in a place where we need the experience, frankly, of large scale projects which we're committed to as well, to teach us what we need to know about risk management, about the engineering, about the science. Using that and the possibility that these projects will be backward funded using risk mechanisms that you'll hear about from Chiara. But we have the opportunity to combine all of the elements of both the research community and to borrow a phrase from Chiara, all three legs working together, the science and technology, the law and policy and public policy as well as the engineering.

If we do those things and we create an environment in which early running projects like those that we have planned are given the chance to enjoy the umbrella that DOE could provide then there's a greater chance that carbon capture and sequestration will be deployed. That was why we were excited to see the bill. That's why we wanted to congratulate the Chairman and all his co-sponsors on the fine work done.

It is a great product and a wonderful start for an enterprise that we, like John, believe needs to begin tomorrow.

[The prepared statement of Mr. Moor follows:]

PREPARED STATEMENT OF KARL MOOR, VICE PRESIDENT & ASSOCIATE GENERAL COUNSEL, SOUTHERN COMPANY, ATLANTA, GA

Chairman Bingaman, Ranking Member Murkowski, and members of the Committee, thank you for the opportunity to speak with you today about carbon capture and sequestration and, in particular, S. 1013, the Department of Energy Carbon Capture and Sequestration Program Amendments Act of 2009.

I am Karl Moor, Vice President & Associate General Counsel for Southern Company Services, and while my testimony is only on behalf of our Company today, I do serve as Chair of our industry's CCS task force through the Edison Electric Institute and as co-chair of the Carbon Sequestration Council, a multi-industry group working to further CCS.

Southern Company is a super-regional energy company serving customers in Alabama, Florida, Georgia, and Mississippi and is one of the largest generators of elec-

tricity in the United States with 42,000 megawatts of generating capacity. Over 21,000 megawatts of that capacity is coal-fired. Southern Company has a long history of cooperative work with the U.S. Department of Energy in development of technologies for the utility industry, including work on low NOx burners and selective catalytic reduction (SCR) systems for NOx emissions reductions, flue gas desulfurization (FGD) systems for sulfur oxide reductions, mercury control technologies to reduce mercury emissions, and various others.

Southern commends Senator Bingaman and the other sponsors of S. 1013 for taking this important first step in resolving some of the risk management questions surrounding carbon capture and storage. CCS is a critical element in the full portfolio of technologies and methods needed to address greenhouse gas emissions. Unresolved questions about risk have hampered the CCS demonstration projects that are the necessary predicates to the commercial deployment of this technology. The proposed bill is the beginning of our national conversation on how best to answer these questions, while appropriately balancing federal, state, commercial and industry roles and responsibilities. Southern appreciates this opportunity to comment on the bill and discuss its perspective on CCS risk management.

As we face a future with possible legislation and/or regulations that would limit emissions of greenhouse gases, including carbon dioxide (CO_2), we believe that coal must continue to play a role in the energy future of the country. It currently represents about fifty percent (50%) of the electricity generated in the nation and its ample (two hundred years at current usage rates) and relatively low-cost domestic supply means it must continue to play a role in our energy future. We believe, moreover, that coal can and must play a role in a carbon-constrained future. For that reason, Southern Company is committed to advancing the development and deployment of carbon CCS, in order to facilitate coal's fulfillment of this role.

As a charter member of the Department of Energy's (DOE) Southeast Regional Carbon Sequestration Partnership—or SECARB, Southern Company has both cofunded and directly participated in its activities, as well as served as a host site for a Phase II project injecting 3,000 tons of CO_2 into a saline reservoir at Plant Daniel, one of our power plants in southeast Mississippi. We are continuing to expand our work with SECARB through Phase III of its sequestration demonstration program. In this project, Southern Company will not only participate in sequestration activities but capture CO_2 at one of our coal-fired power plants as the source of CO_2 for the sequestration program. This proposed project would feature a 25 MW scale CO_2 capture plant at one of our power plants, built with the technology vendor Mitsubishi Heavy Industries (MHI). This capture process will supply approximately 125,000 tons per year for four (4) years for sequestration in a saline aquifer.

We have a further goal of developing a larger scale-up of this sequestration project that would feature injection of 1 million tons of CO_2 per year for at least 4 years into one of the many large capacity and safe saline reservoirs in the Gulf Coast Region. This project would include a 170 MWe CO_2 capture plant to supply the CO_2 for the proposed sequestration project. This project was submitted by Southern Company in response to both the Restructured FutureGen and Clean Coal Power Initiative (CCPI) Round 3 solicitations. Southern Company believes it is important to integrate CO_2 capture from electric generating facilities, transportation, and sequestration in our demonstration programs in an effort to accelerate the deployment of safe and cost efficient commercial-scale CCS, and that is why we welcome the introduction of the Department of Energy Carbon Capture and Sequestration Program Amendments Act of 2009.

While these two projects will focus on carbon capture technology for pulverized coal plants, we are also extremely active in developing carbon capture systems for the Integrated Gasification Combined Cycle (IGCC) power plant of the future. For IGCC, Southern Company's Mississippi Power has recently filed for a certificate of public convenience and necessity with the Mississippi Public Service Commission (MPSC) to build a 582-megawatt IGCC power plant in Kemper County, Mississippi using lignite and designed for fifty percent (50%) CO_2 capture. The captured CO_2 would be sequestered through enhanced oil recovery operations in Mississippi oil fields. This new power plant will be partially funded with DOE funds from CCPI Round 2 and with investment tax credits authorized by the Energy Policy Act of 2005.

Also in partnership with the DOE, Southern Company operates a research station in Wilsonville, Alabama, that has focused on developing advanced power generating technologies, including fundamental research and development (R&D) for coal gasification. It is now moving its focus towards fundamental R&D and scale-up of technologies to research the capture and separation of CO_2 from both conventional and IGCC coal plants.

You can see that Southern Company is working on all of the four technical areas we believe to be critically important for commercial deployment of carbon capture and sequestration: large scale sequestration pilot projects, CO_2 capture from conventional coal plants, IGCC with carbon capture, and fundamental R&D for next-generation technologies.

Southern Company is also engaged in advancing the legal and policy framework needed to move forward with CCS. We are a member of the Carbon Sequestration Council (CSC) that was formed to provide a forum for inter-industry communication around key issues related to CCS including policy, funding, and legal issues. CSC has developed and participated in coordinated, multi-stakeholder approaches for providing input to a number of processes, including;

- EPA's technical and rule development workshops leading to the Agency's proposed rule regarding geologic sequestration of carbon dioxide under the Safe Drinking Water Act;
- the development of recommendations by the Ground Water Protection Council; and
- the development of regulatory frameworks by a number of states. CSC has also convened and shared ideas with a broad range of interested stakeholders including environmental groups to further discuss issues and build consensus on key CCS matters.

Risk management is a significant CCS issue. From our experience and that of others, we are learning that appropriate site characterization and other risk management efforts mean that CCS projects can be done safely and effectively, but there is a need to minimize risk. During these early days of pilot projects—and even when CCS is widely deployed in the future—risk mitigation issues must be addressed in order to procure financing and insurance and to address public concerns about siting and the acquisition of property rights.

Southern Company believes there are four distinct areas of risk management that needs to be addressed to facilitate the demonstration and deployment of CCS:

1. Property (including pore space) ownership and issues of trespass—These issues have not been consistently addressed to date, making it difficult to move forward with both commercial scale sequestration as well as with demonstration-scale R&D projects. We believe that interested states and groups are pursuing solutions to these issues and that, over time, given economic incentives, porespace ownership and compensation issues will be addressed. There, however, may be a role for the federal government in encouraging resolution of these issues if a lag develops that would impede full and timely implementation of CCS.
2. Long-term maintenance and monitoring for closed sites—This includes responsibility for the routine inspection and repairs necessary to insure the long-term integrity of all equipment and wells at a closed injection site.
3. Environmental remediation—This includes the active or passive cleanup of environmental ecosystem damages that may be related to geologic sequestration, such as the impacts associated with CO_2 accumulations in groundwater or damages resulting from fluid movements resulting from the injection of CO_2.
4. General tort liability—This includes claims of damage to health, property, or to the environment, as embodied in the definition of liability found in S. 1013.

In thinking about risk, we generally agree with Dr. Sally M. Benson of the Energy Resources Engineering Department and Executive Director of the Global Climate and Energy Project at Stanford University, that the environmental risk profile of carbon dioxide storage declines over time.[1] Accordingly, we believe that the probability of high-risk events decreases as time passes after an injection site has closed.

Typically, Southern Company uses insurance—a combination of private insurance and industry mutual insurance—to manage risks in its operation, including long-term risks. We have experience with the approach of pooling the risks of very low probability negative events across many industry participants. We think that, likewise, this model will be appropriate for carbon sequestration, and therefore we are in favor of a risk management strategy for CCS that follows this combination approach. Encouragingly, insurance companies have started offering limited policies for CCS projects. These policies generally cover property damage for the first few decades of operation, but will not provide long term coverage. Additionally, these policies are annual policies that must be renewed every year.

[1] http://pangea.stanford.edu/research/bensonlab/presentations/Carbon-Dioxide-Capture-and-Storage-in-Deep-Geologic-Formations.pdf

Southern Company has categorized five phases of the typical CCS project timeline and the associated levels of risks for each.

- Pre-injection siting and permitting. This phase is unlikely to pose many risk issues, but the work done in this stage will be critically important in the design of a successful project with a minimal risk profile. Insurance providers must be intimately involved with the site selection and characterization in order to be able to underwrite the policies.
- Injection inception. The start of injection is a fairly high risk phase during the project. Gross failures of the geology for its intended purpose of containment could be revealed during startup. Risks arise from unexpected or unprecedented CO_2 movement and leakage, as well as unanticipated fluid movement. Southern Company has concluded that the risk management for the operator will likely be a combination of private and industry mutual insurance.
- Operations. The operations phase is also a high-risk time for the project. As the CO_2 continues to be injected, and despite the best site characterization possible, flaws in the containment may be revealed that could result in unprecedented CO_2 leaks and intrusion into drinking water. Again, Southern Company believes that a combination of private and industry mutual insurance would be the preferred risk mitigation tool.
- Closure and stabilization. The closure and stabilization phase includes the time after injection stops, when the risks of unintended CO_2 and fluid movement should decrease sharply as the CO_2 starts to stabilize and stop spreading. We would expect the risks to be handled by the same approach of private and industry mutual insurance, but with less expensive instruments that presumably would recognize the reduced risks of this phase.
- Long-term care. The long-term care phase begins once the site has stabilized and the CO_2 has stabilized in the storage reservoir. At this point, the risks come from decaying infrastructure and the residual risks of CO_2 movement and leakage or displaced formation fluids. Southern Company feels that the best approach for this phase is a third-party caretaker for the long-term maintenance of the wells and infrastructure. For commercial-scale deployment, however, we do not believe that this structure is the most efficient way to address the risk and remediation. We would prefer that the industry—those with the most CCS experience—be responsible for the risk and remediation instead of delegating this to a third-party. Southern has come to this conclusion after much careful consideration and review of existing mechanisms meant to address long-term risk in other aspects of our industry. We note, however, that other utilities do support the transfer of risk to a third-party, likely a governmental entity, to ensure appropriate monitoring and to undertake possible remediation of CCS projects in the long-term care phase. We are actively engaged in discussions about how best to apportion risk and responsibility with other interested parties.

In light of our preference for an insurance/mutualization approach to risk management, some might ask why we support DOE's involvement in risk management for pilot projects. Internally, we refer to this as the "first movers' paradox" or more simply the chicken and the egg. Anticipated climate legislation and/or regulation requires accelerating the development and deployment of commercial scale sequestration, but the private insurance and mutualization mechanisms are not developing as quickly as necessary for rapid sequestration deployment. The lack of an industry mutual and private insurance can hinder commercial scale sequestration and development initially by stifling demonstration-scale projects. As noted, the need for risk management mechanisms is greatest now, while other more desirable approaches are maturing. This paradox must be addressed before commercial scale sequestration can be deployed and play its necessary role in meeting carbon constraints. This is why Southern Company commends Senator Bingaman and his co-sponsors of S. 1013 for addressing these complicated but necessary issues for early movers of sequestration projects. We agree that the risk management approach taken by S. 1013 is a positive step for building confidence for project developers, state regulators, as well as the public.

In offering our support for S. 1013, we would respectfully note several ways in which it could be improved to further its laudable goals.

- Southern Company is concerned about the length of time between ceasing injection for a sequestration project and complying with the site closure requirements under section (e)(5). We support the need for science-based proof of site closure, but we also recognize that the demonstration that a CO_2 plume has reached equilibrium with the geologic formation that comprises its geologic stor-

age unit will vary by geological formation. If equilibrium, as it is used in section S. 1013, is not appropriately defined, it is possible equilibrium would not be demonstrated for an unjustifiably long time period. During this time period, the four requirements under section (f) could have already been demonstrated, rendering the consecutive ten year period unnecessary. We would like the opportunity to work through this issue internally and propose to the sponsors of S.1013 possible other approaches for demonstrating that a sequestration project complies with the site closure requirements.

- Southern Company supports the indemnity agreement included in S.1013, but would be more confident in the agreement if section (g)(2) was changed to "The Secretary shall agree. . ." Changing the wording from "may" to "shall" will guarantee that a recipient who complies with all the terms and conditions set forth in the bill will be provided indemnity.
- Regarding the financial protection that must be maintained under section (e)(7), Southern Company would suggest that the appropriate amount of required protection be defined as the maximum private insurance available in the market for the particular project. The Secretary of Energy would determine the maximum level of coverage available in the private insurance market.

In addition, we note that there are a few clarifications that would eliminate confusion and ensure that the electric power industry, the source of about forty percent (40%) of our national CO_2 emissions, can be best positioned to use S. 1013 to demonstrate CCS on integrated power plants. First, the bill needs to recognize that flue gas is not pure CO_2. Second, it may be appropriate to require that some of the ten projects are integrated power plants that capture and sequester CO_2. Finally, to ensure that the fees paid are available in the event that indemnification is needed, the funds should be deposited into a segregated account instead of the general Treasury.

Southern Company commends the Chairman and his co-sponsors of S. 1013, the Department of Energy Carbon Capture and Sequestration Program Amendments Act of 2009, for addressing some the vital issues that need to be addressed to further the development of commercial scale carbon sequestration. S. 1013 is an indispensable step in the carbon constrained future facing the United States. We look forward to working with the Committee and assisting in any way we can. Thank you for this opportunity to testify in support of S. 1013.

The CHAIRMAN. Thank you very much.

Mr. Anderson.

STATEMENT OF A. SCOTT ANDERSON, SENIOR POLICY ADVISOR, ENVIRONMENTAL DEFENSE FUND, AUSTIN, TX

Mr. ANDERSON. Yes. I'm Scott Anderson, Environmental Defense Fund. It's not very often that an Environmental Defense Fund finds itself in agreement with Southern Company. But I'm almost tempted to just endorse his statement and pass the mike to Chiara which I'm sure you guys would love me to do. But I think I will stick to my text.

We appreciate the opportunity to be here. We wanted to begin by stressing, as others have said, that as a technical matter, CCS is ready to begin deployment now. I'm not saying it's commercial. But it's ready to begin deployment.

All the necessary technologies exist. What's missing is market drivers to cause companies to put those pieces together. With experience, cost will come down and project development more routine. We believe that cap and trade legislation can and should be the chief market driver. The complementary measures such as you have here today are also important.

We applaud Chairman Bingaman as well as the co-sponsors for introducing this legislation. We're pleased, for example, that the bill helps clarify the difference between two issues that are in fact separate, but frequently confused.

The first issue is the need for a long term site maintenance after sequestration projects are successfully closed. Your big policy questions on that issue are who should perform that function. How should you define that function and how should you fund that function? So that's one issue.

The second of these 2 issues that's frequently confused is the need for project developers to manage the risk of liability for damages that result from their activities. It seems that you're key policy questions here include the relative roles of government and the private sector risk management tools. How the relationship between government and the private sector should change with time as the CCS industry matures.

The bill addresses both of these issues. It's a measured response to barriers faced by some early mover projects at a time when private sector insurance options are not fully developed. The bill helps project developers manage risk while guarding against so called moral hazard.

In other words the bill provides coverage for losses while creating what I would call underwriting standards, provisions such as essential requirements for rigorous geologic characterization that will encourage project operators to operate responsibly and not cut corners. In this regard and in other important respects detailed in my written statement, the bills approach to risk management is similar to the insurance model as well as other financial instruments that have evolved in the private sector. Moreover by establishing a program similar to models that exist in the marketplace and by restricting the program to a limited number of early projects, S. 1013 will encourage the development of market based solutions to the emerging CCS industries need to spread risk at a reasonable cost.

In the long run we believe a market based solution should be our goal. That model is healthier for taxpayers. It's a prop for people who might suffer damages and for the industry itself then would be a system where firms routinely depend on the government to absolve them from their problems.

Unlike the enhanced oil recovery industry, unlike the gas storage business and unlike the underground injection of hazardous waste business, the CCS business, the geologic sequestration business has not had time to develop the kind of instruments which make it possible for them to approach the business in the same way these other industries do. The EOR business, the gas storage business, the hazardous waste injection business, none of them have any special liability relief. Yet they have no problems attracting investment capital.

The only liability relief they have is the expiration of statutes of limitation. So just because someone is in an injection business of sending large volumes of CO_2 into the underground area, it doesn't automatically follow in our judgment that they need special reliability relief in the long run. Early project is different.

So as the industry matures and needed risk management tools develop we should evaluate what roles government in private industry should play. We should make use of the competitive market forces as much as possible. We should also remember that liability rules grounded in common law and in statutes serve an important

function in our society. These rules encourage people to act as their fellow citizens expect them to act. So we should tinker with them and only cautiously.

One other issue I'd like to touch on is that the bill proposes to give money to States for training regulators. I think that's an extremely important part of the bill. We're glad to see that. CCS regulation does raise a lot of novel issues that need to be approached in a sophisticated way. The State regulators could use that help.

While this bill may not be the right vehicle, it would also encourage the Senate to consider giving additional appropriations to the States for their actual permitting and enforcement work as well. The Ground Water Protection Council has estimated that in order for States to fully implement the pending CCS rule at EPA it will require some tens of millions of dollars of additional financing that they don't have unless the Federal Government gives it to them.

So thank you very much.

[The prepared statement of Mr. Anderson follows:]

PREPARED STATEMENT OF A. SCOTT ANDERSON, SENIOR POLICY ADVISOR, ENVIRONMENTAL DEFENSE FUND, AUSTIN, TX

Environmental Defense Fund (EDF) appreciates the opportunity to speak to you today as the Committee considers how to help early carbon capture and sequestration (CCS) projects conduct operations in a safe and effective manner and otherwise address risk management issues. Since 1967 EDF has linked science, economics and law to create innovative, equitable and cost-effective solutions to urgent environmental problems. We believe that successful deployment of geologic sequestration is a critical path for accommodating coal, the world's most abundant but carbon-intensive fossil fuel, to a carbon-constrained future.

Climate change is the most critical environmental issue of our generation. The chief action the Senate can take to address this problem is to adopt cap and trade legislation, which would create a market value for avoiding carbon dioxide emissions, and a market mechanism for achieving these needed reductions at the lowest cost across the economy. The simple fact is that CCS has not been commercially deployed because there is currently no commercial reason to deploy CCS. A cap on carbon will create the market for this technology.

As part of this national cap and trade legislation, EDF supports reasonable complementary measures to help accelerate CCS deployment. With SO percent of our nation's electricity coming from coal, it is critical to have technologies that enable significant CO_2 reductions from coal fired power plants.

Fortunately, as a technical matter, CCS is ready to begin deployment today. All of the necessary technologies exist. What is missing are the market drivers to cause companies to put the pieces together. With experience, costs will come down and project development more routine.

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 IPCC Special Report on Carbon Capture and Storage concluded in 2005 that the fraction of CO_2 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 CO_2 releases if they arise." The IPCC and others have also noted that the risk of leakage will tend to decrease with time.

The fact that EDF supports the deployment of CCS does not mean that we are champions of coal. We are pleased that people increasingly recognize that energy efficiency and renewable energy should play a leading role in energy and climate policy. As indicated by McKinsey and Company's U.S. Greenhouse Gas Abatement Mapping Initiative, there are many efficiency and renewable energy strategies that are cost-effective and can be pursued even before CCS is deployed on a widespread basis. CCS is an important part of the solution, but it is only a part.

SUMMARY OF COMMENTS ON S. 1013

EDF applauds Chairman Bingaman and the co-sponsors of S. 1013 (Senators Barrasso, Dorgan, Tester, Bayh, Landrieu, Casey and Voinovich) for introducing this legislation. The bill has a number of strengths. We are pleased, for example, that the bill helps clarify the difference between two issues that are in fact are separate but are frequently confused: (1) the need for long-term site maintenance after sequestration sites are successfully closed; and (2) the need for project developers to manage the risk of liability for damages that result from their activities. The bill addresses both issues. It is a measured response to barriers faced by some early mover projects at a time when private sector insurance options are not fully developed. The bill helps project developers manage risk while guarding against "moral hazard." In other words, the bill provides coverage for losses while creating what in essence are "underwriting standards"—provisions that will encourage project operators to operate responsibly and not cut corners. In this regard, and in other important respects that are detailed below, the bill's approach to risk management is similar to the insurance model that has developed over time in the private sector. Moreover, by establishing a program similar to models that exist in the marketplace and by restricting the program to a limited number of early projects, S. 1013 will encourage the development of market-based solutions to the emerging CCS industry's need to spread risk at a reasonable cost. In the long-run, we believe a market based solution for risk management should be our goal. This model is healthier for taxpayers, parties who may suffer damages, and the industry itself than would be a system where firms routinely depend on the government to absolve them of the consequences of their actions.

We will continue to analyze this legislation and discuss the issues raised with other stakeholders. We look forward to the opportunity to continue working with members of the committee to make recommendations and suggest changes should the need arise.

POST-CLOSURE INFRASTRUCTURE MAINTENANCE—AN APPROPRIATE GOVERNMENT FUNCTION

Properly closed sequestration sites will require stewardship for long time periods even though there is sound basis to believe that they present little risk. EDF supports the creation of a third-party entity, adequately funded by industry, to manage the maintenance of properly closed sequestration sites. Ultimately the function might be privatized, but it makes sense for the government to perform this role for early projects.

The bill extends DOE's post-closure stewardship obligations beyond simple infrastructure maintenance (plugging the occasional leaking well, conducting a low-intensity monitoring regime, etc.) to include "remediation activities to ensure the geological integrity of the site and prevent any endangerment of public safety." Given the nature of the program established by S. 1013 (one in which the government will indemnify eligible sites for damages that do not arise from gross negligence or intentional conduct), we believe this broad definition of stewardship is appropriate.

When long-term stewardship policies are crafted for future projects, however, we recommend that Congress re-consider the scope of any third-party stewardship program. Creation of a third-party entity for site maintenance is probably appropriate for both early projects and later projects, but the optimum funding method and/or duties of the stewardship entity are likely to be different once the marketplace has had time to develop robust insurance offerings and other risk mitigation tools. In the future it may be desirable to charge fees for long-term stewardship that differ based on a given operator's track record. Even where closed sites are concerned, it may not be desirable for all industry participants to pay for expensive remediation projects (as distinct from routine site infrastructure maintenance) where the problem is due to a single operator and statutes of limitation have not yet expired.

A MEASURED RESPONSE TO RISK MANAGEMENT

By limiting the number of projects eligible for the indemnity program, by basing fees for participation on the estimated risks relating to particular indemnification agreements, and by providing that projects are not eligible at all unless they meet certain criteria, the bill constitutes a measured response to an identified problem—the barriers that some early-stage CCS projects face due to the lack of fully-developed financial risk management tools in the marketplace.

Many people appear to take it as a forgone conclusion that indemnification or "liability relief" must be a permanent feature of the legal system governing carbon capture and sequestration. EDF is not convinced that any "liability relief" will be need-

ed for the industry in the long-run, although we do see some role for special rules and institutions for early projects.

There is no special "liability relief" for the enhanced oil recovery business or the underground injection of hazardous waste business. Natural gas storage operators are not shielded from liability. Firms in these industries face potential liability for their actions until normal statutes of limitation have run their course or the companies are relieved of liability through bankruptcy. Yet all three of these businesses inject material into geologic formations and appear to have little trouble attracting investment in the marketplace.

The emerging carbon capture and sequestration industry, on the other hand, has not had time to develop a robust approach to risk management regarding potential damages that might be caused by its actions. Banks and other sources of investment capital are still coming to terms with the nature of risk presented by CCS projects and with the steps that project operators can take to minimize risks. Private sector insurance products recently have become available for CCS projects, but it is not yet clear how well this privately available insurance will meet the needs of developers. It is not yet clear how rapidly the insurance industry will be able to develop expanded offerings should additional offerings be necessary or how much competition there will be to provide this sort of coverage. We believe it is likely that additional insurers will enter this market, and perhaps that the CCS industry itself will develop mutual insurance arrangements, but these options are not yet in place.

In this context, we support appropriate efforts to resolve regulatory and risk management bottlenecks to technology deployment. Since we will need to learn by doing, protections for early movers make sense as the technology begins to be deployed—provided proper safeguards are in place. However, as the industry matures and needed risk management tools develop, we should reevaluate what roles government and private industry can and should play.

MINIMIZING "MORAL HAZARD" IS ESSENTIAL

To privatize economic benefits while socializing the associated risks is not a policy that is likely to yield efficient results or encourage workmanlike behavior. Current liability rules, grounded in common law and statutes, serve an important purpose—encouraging people to act as their fellow citizens, their investors and competitors, and policymakers expect them to act.

S. 1013 clearly was drafted with these principles in mind. Damages arising from gross negligence or willful misconduct are excluded from coverage. In order to be eligible for indemnification, projects must meet a number of standards that can be thought of as underwriting standards. One key requirement is that project selection must be based on detailed geological information, which is absolutely essential if CCS is to become a widespread technology worthy of significant government and industry investment. Other important requirements include the bill's rigorous criteria for determining whether a site qualifies for site closure and participation in the long-term stewardship program. It is one thing to for taxpayers to assume management for a well-executed sequestration project, and something else entirely to relieve the risk of liability from an operator who has created a project that presents significant risks.

S. 1013 EMULATES THE PRIVATE SECTOR APPROACH TO LIABILITY RISK MANAGEMENT AND SETS THE STAGE FOR A PRIVATE SECTOR SOLUTION IN THE LONG-TERM

The programs established by S. 1013 would function much like private insurance and other financial market instruments: developers are free to apply or not to apply; risk management assistance is based on a contract; the program has what I would call "underwriting standards" designed to minimize risk; there are exclusions that ensure that the risks of certain types of damages are borne by the operator alone; risk is pooled and participants pay a fees commensurate with the risk profiles of their projects. (It is important to note, however, that fees based on discounting future costs to present values will not be commensurate with the risk if the fees are deposited into the Treasury as miscellaneous receipts, as is proposed by S. 1013 in its current form, rather than being invested in order to grow at a rate equal to the discount rate used to calculate the present value).

By establishing programs similar to risk management models that exist in the marketplace and by restricting the programs to a limited number of early projects, S. 1013 should encourage the development of market-based solutions to the emerging CCS industry's need to spread risk at a reasonable cost.

ASSISTING STATE REGULATORY AGENCIES

EDF is pleased that the bill establishes grants to state agencies for employee training purposes. CCS projects raise a number of new regulatory issues and federal assistance in helping to educate state agencies regarding these issues is important. Although this particular bill may not be the right vehicle, we encourage Congress also to go beyond training assistance and provide more financial assistance than is being provided currently for state permitting and enforcement activity. The Ground Water Protection Council has estimated that implementation of CCS rules under the Underground Injection Control program it will increase state regulatory costs by several tens of millions of dollars per year.

CONCLUSION

In conclusion, I would again like to commend the Chairman and the co-sponsors for bringing this measure forward. It is sound approach to an important policy challenge. We look forward to continuing to work with you on this matter in the future.

The CHAIRMAN. Thank you very much.

Ms. Trabucchi, thank you for being here.

STATEMENT OF CHIARA TRABUCCHI, PRINCIPAL, INDUSTRIAL ECONOMICS, INC., CAMBRIDGE, MA

Ms. TRABUCCHI. Thank you. Chairman Bingaman, members of the committee, thank you for introducing S. 1013 and for the invitation to testify at today's hearing.

I'm a principal with Industrial Economics Incorporated located in Cambridge, Massachusetts. My expertise relevant to this matter is in financial insurance and long term indemnity models. My remarks today focus on the financial insurance and indemnification framework proposed by the bill and specifically on the assessment, collection and use of fees for CCS developers.

Firms seeking investment capital to finance business ventures including CCS must demonstrate the ability to assume and manage risks inherent to the venture. By doing so the firm is able to assure investors whether private or public that the value of their investment will not erode. In fact, with time will gain value. In the case of CCS the very long time horizon and the use of taxpayer dollars demands a financial insurance structure that blends the strength of private and public risk sharing.

To be effective a financial insurance structure that implements a private/public risk sharing as that proposed in the bill should achieve four clear goals.

First, it should ensure funds are adequate when needed.

Second, it should ensure these funds are readily accessible when needed.

Third, it should establish minimum standards for companies that choose to self insure or for financial institutions managing funds or underwriting risk.

Fourth, it should ensure continuity of financial assurances when ownership of sites is transferred.

The long term indemnity model proposed in S. 1013 is a notable step forward in achieving these goals. Appropriately limits indemnification to certain types of damages. In my view if the intent of S. 1013 is to establish a financial assurance framework that insures sufficient resources are available to pay for long term stewardship at the time ownership of the demonstration projects is transferred then the following elements of the bill would benefit

from additional clarification and should not be left to interpretation.

First, in the section addressing collection of fees in the use of net present value analysis the amount of fees assessed and collected should be based on the net present value of probable damages arising from each demonstration project. Simply stated the amount of money collected from each CCS developer should clearly correlate to the amount of money that may need to be paid in the future once ownership of their specific site is transferred. The analytic tools exist to estimate dollar values for potential damages from CCS and are routinely used by experts in financial and natural resource economics.

Second, this section also should require the design of an adjustable fee structure whereby the CCS developer pays a risk adjusted, site specific fee that is reassessed as actual site specific monitoring, measuring and verification data become available.

Third, in the section addressing use of fees consistent with basing fees on a net present value analysis the fees collected should not be deposited in the Treasury and credited to miscellaneous receipts. Rather the fees should be set aside in a dedicated interest bearing trust fund similar to other financial assurance models legislated by Congress. Otherwise the fees collected may disappear into the Treasury resulting in an intergenerational transfer of costs to future taxpayers.

In my view clarifying the language of S. 1013, as I have suggested, will help to ensure the continuity of financial assurances for long term stewardship, offer a measure of financial certainty to the developers of CCS demonstration projects and send a positive signal to the private capital markets interested in investing in CCS technology.

My written testimony elaborates on these areas and highlights my views with respect to other elements of the financial assurance and indemnification structure proposed by S. 1013. Thank you.

[The prepared statement of Ms. Trabucchi follows:]

PREPARED STATEMENT OF CHIARA TRABUCCHI, PRINCIPAL, INDUSTRIAL ECONOMICS INC., CAMBRIDGE, MA

SUMMARY

Firms seeking investment capital to finance business ventures, including CCS, must demonstrate the ability to assume and manage risks inherent to the venture. By doing so, the firm is able to assure investors, whether private or public, that the value of their investment will not erode, and with time, will gain value.

In the case of CCS, the very long time horizon and the use of taxpayer dollars demands a financial assurance structure that adequately protects the private and public investor.

To be effective, a financial assurance structure that implements private—public risk sharing should achieve four clear goals: (1) Ensure funds are adequate, when needed; (2) Ensure these funds are readily accessible, when needed; (3) Establish minimum standards for financial institutions providing funds or underwriting risk; and (4) Ensure continuity of financial assurances, when ownership of sites is transferred.

The long-term indemnity model proposed in Senate Bill 1013 is a notable step forward in achieving these goals, and appropriately limits indemnification to certain types of damages.

However, if the intent of Senate Bill 1013 is to establish a financial assurance structure that ensures sufficient resources are available to pay for long-term stew-

ardship at the time ownership of the demonstration projects is transferred, then the following elements of the Bill would benefit from additional clarification:

1. In the section addressing Collection of Fees and the use of Net Present Value analysis, the amount of fees assessed and collected should be based on the Net Present Value of probable damages arising from each demonstration project. The analytic tools exist to estimate dollar values for potential damages and are routinely used by firms expert in financial and natural resource economics.
2. This section also should require the design of an adjustable fee structure, whereby the CCS developer pays a risk-adjusted, site-specific fee that is reassessed as actual site-specific monitoring, measuring and verification data become available.
3. In the section addressing Use of Fees, consistent with basing fees on Net Present Value analysis, the fees collected should not be deposited in the Treasury and credited to miscellaneous receipts. Rather, the fees should be set aside in a dedicated, interest-bearing Trust Fund similar to other financial assurance models legislated by Congress. Otherwise, the fees collected may disappear into the Treasury, resulting in an inter-generational cost to future taxpayers.
4. The same financial assurance provisions should exist regardless of whether the CCS demonstration project is sited on private lands, public lands or tribal lands.

In my view, clarifying the language of Senate Bill 1013 as I have suggested will help ensure continuity of financial assurances for long term stewardship.

INTRODUCTION

Thank you for the opportunity to testify in today's legislative hearing on Senate Bill 1013, Department of Energy Carbon Capture and Sequestration Program Amendments Act of 2009. I am a Principal with Industrial Economics Incorporated in Cambridge, Massachusetts. My expertise is in finance and economics, with specific focus on financial assurance frameworks and financial indemnity models. Founded in 1981, Industrial Economics is a privately-owned professional services firm expert in the areas of financial and natural resource economics. The clients of the firm span the public and private sectors.

The focus of my testimony is on the financial management and indemnification framework proposed by Senate Bill 1013. Below, I offer my overall assessment of Senate Bill 1013, I highlight areas of the Bill with which I agree, and offer suggestions for consideration by the Committee. These suggestions are based on the language proposed in Senate Bill 1013, and the Bill's intended objective of fostering early mover deployment of no more than 10 Carbon Capture and Sequestration (herinafter CCS) demonstration projects.

The sections that follow map to the provisions proposed by Senate Bill 1013. Where appropriate, I highlight elements of the proposed language that are well designed; and I offer suggestions where the language of Senate Bill 1013 might be clarified or improved.

OVERVIEW. THE IMPORTANCE OF FINANCIAL RESPONSIBILITY

Firms seeking investment capital to finance business ventures must demonstrate the ability to assume and manage risks inherent to the venture. By doing so, the firm is able to assure investors, whether private or public, that the value of their investment will not erode, and with time, will gain value. Financing CCS ventures requires a long-term capital horizon, and therefore investors are likely to have a low tolerance for risks. Under traditional financing models, investors require that risks be bounded, quantified and accounted for either directly as an expense, or indirectly through third-party financial instruments (letters of credit, surety bonds, insurance, to name a few).

The use of taxpayer dollars and the very long time horizon associated with CCS—one which may extend beyond the natural life of the corporate entity undertaking the demonstration project—demands a financial management solution that blends the strengths of private and public risk sharing. To be effective, a financial assurance structure that implements a private—public risk sharing should achieve four clear goals:

(1) Ensure funds are adequate, when needed;
(2) Ensure these funds are readily accessible, when needed;
(3) Establish minimum standards for financial institutions providing funds or underwriting risk; and

(4) Ensure continuity of financial assurances, when ownership of sites is transferred.

To the degree society wishes to reduce greenhouse gas emissions, and the portfolio of emission reduction technologies includes CCS, then an effective financial assurance and indemnification framework will balance the four above-listed goals with needed incentives to foster the safe deployment of a limited number of early mover, demonstration projects.

If modified as I suggest below, the design of the financial assurance framework and the implementation of private—public risk sharing as proposed in Senate Bill 1013 should accomplish these goals.

PROJECT SELECTION CRITERIA

The science-based criteria and provisions for project selection as proposed by Senate Bill 1013 are necessary but not sufficient to underpin the financial management structure defined in later sections of Senate Bill 1013. Additional provisions requiring the explicit evaluation of potential human health and environmental impacts from a financial perspective—deriving expected loss values with a clear understanding of the statistical range of possible outcomes—are needed for each proposed demonstration project.

The outputs of these evaluations will achieve two objectives.

First, they will help the implementing agency assess competitive bids for demonstration projects, and make an informed decision as to the potential financial risk posed by each demonstration project.

Second, they will provide an appropriate basis to calculate the amount of financial assurance that should be set aside by the individual CCS developer.

TERMS AND CONDITIONS (FINANCIAL ASSURANCE)

In my view, as proposed by Senate Bill 1013, the CCS developer should remain financially responsible for events that occur during the operating lifecycle of the CCS project, and for a defined period post-injection. Specifically, financial assurances should be secured and maintained by the developer of the CCS demonstration project until such time as title to the site is transferred and accepted by the implementing Federal agency. In this way, the Bill provides incentives for CCS developers to properly operate and maintain their sites, limiting the potential for future damages. Firms are more likely to undertake design and operating decisions that minimize environmental (and remediation) costs, if they are held financially accountable.

Further, maximum flexibility should be afforded to developers of the early mover demonstration projects in selecting the financial instruments that may be used, including but not limited to trust funds, letters of credit, surety bonds, insurance, and self-insurance through a corporate financial test or corporate guarantee, or any combination thereof. The array of acceptable financial instruments must ensure that funds are adequate if and when needed, and readily accessible to pay for delineated activities. For this reason, minimum standards are necessary for financial institutions securing funds or underwriting CCS risks.

INDEMNIFICATION AGREEMENTS

Exception for Gross Negligence and Intentional Misconduct

In my opinion, Senate Bill 1013 appropriately limits indemnification to certain types of damages. The exception provided in Senate Bill 1013 for gross negligence and intentional misconduct is important, particularly as it relates to fraud and misrepresentation of site (monitoring, measuring and verification) data. The importance of this exception can not be overemphasized, because these data likely will be used to underpin financial assurances and fee calculations.

Collection of Fees

I believe it is appropriate to assess and collect fees from the CCS developer to finance the cost of long-term stewardship. In my view, the language proposed by Senate Bill 1013 should be clarified to ensure that the amount of fees collected is not arbitrary or based on a fixed rate for all sites. Establishing a blanket fixed fee to be paid by all CCS developers regardless of their individual site characteristics, operational methods and potential for consequences results in an inefficient use of available resources which otherwise could be invested for productive economic purposes. From a financial perspective, establishing a fixed rate that is paid by all CCS developers results in some developers paying more, and others less, than their fair share, because of differences in site attributes. Further, without strong oversight re-

garding site selection and fund management, and a clear process by which the amount of fees collected are periodically evaluated against the risk profiles of pooled sites, there is no reason to believe that the amount of funds collected will map to the actual financial resources needed to address long-term care expenses and delimited compensatory damages.

If the intent of Senate Bill 1013 is to ensure a fee structure whereby the CCS developer pays a risk-adjusted, site-specific fee, then additional clarifying language in the section of the Bill that addresses the criteria for determining the amount of the fee to be collected is necessary. In my opinion, this fee should be based on the Net Present Value of the future expected losses for each individual demonstration project. Probable loss scenarios can be derived from each project's site characterization and risk assessment plans. These analyses provide an indication of 'how bad it could get' if an adverse event related to a CCS project were to occur, as well as a measure of the amount of damages that might be required for remediation and to compensate for harm or injury.

The use of Net Present Value analysis, as proposed in Senate Bill 1013, is accepted practice for funds management within the financial community. The analytic tools exist to estimate the expected range of dollar values for potential damages. Similar tools are used by: (1) firms, such as insurers, in the risk management industry; (2) firms in the financial sector; and (3) firms with expertise in human health and natural resource economics.

Additional clarifying language is warranted with respect to the timing of when such fees will be paid by the CCS developer. To ensure continuity of financial assurance during active site injection, postinjection, and through long-term stewardship, the amount of fees collected from the CCS developer should be established either as an up-front payment or as a payment over time during the operating lifecycle—the period of active injection—of the demonstration project. If the intent of Senate Bill 1013 is not to delay the collection of fees until the end of the project, when there is the danger that the CCS developer may not have the resources available to pay the fees, or until an event or claim arises, then the language of the Bill should clearly state this. Provisions should be made at the outset of the demonstration project for the possibility of future bankruptcy or financial distress of the developer of the CCS demonstration project.

As the provisions proposed by Senate Bill 1013 relate to a limited number of demonstration projects, and the public is assuming a measure of financial risk, the fees should be reassessed as information about the risk profiles become available. Practical reality should inform the application of financial theory. For example, if actual site monitoring, measuring and verification data demonstrate a declining risk profile and a reduced dollar value of future expected loss, the Net Present Value calculation underpinning the fee collection should be adjusted to reflect this situation, and the CCS developer should pay less in fees. Overfunding a long-term financial structure benefits neither the private sector nor the public sector. However, the inverse is also true—if monitoring, measuring and verification data suggest an increasing risk profile—the fees assessed should reflect the incremental increase in potential harm that may arise from the occurrence of an adverse event.

Establishing an adjustable fee structure that is based on the results of actual monitoring, measuring and verification data ensures that the CCS developer is rewarded for design and operating decisions that minimize future risk, and by extension future loss. Further, underpinning the financial management structure proposed by Senate Bill 1013 with an adjustable fee structure that reflects the evolution of site risks over time ensures that the financial instruments used for purposes of financial assurance can be scaled up or down in response to site-specific differences.

Analyses underpinning the Net Present Value calculation proposed by Senate Bill 1013, and the determination of how much to collect in fees, should be developed prior to entering into an indemnification agreement. These analyses should be transparent, identifying key assumptions regarding the timing of probable payments and an appropriate risk-adjusted discount rate. The public should know what it is financing, especially if there is the expectation that these fees will be passed through to end consumers in the form of increased energy rates. Further, to the degree other projects (beyond the early mover demonstration projects) come on-line, the data generated as part of these early mover efforts should inform the financial assurances and design of financial management strategies for long-term stewardship of subsequent projects.

USE OF FEES (NET PRESENT VALUE AND THE IMPORTANCE OF FUNDS MANAGEMENT)

In my view, Net Present Value analysis should be used to underpin the financial management framework proposed in Senate Bill 1013. However, Net Present Value analysis presumes that money set aside today will earn interest and gain value over time. Thus, the use of Net Present Value analysis is effective only if the money that is collected is set aside in a dedicated, interest-bearing account, and does not form part of the miscellaneous receipts of the general Treasury, as currently proposed by Senate Bill 1013. Clarifying language is warranted in the Bill if, in fact, the expectation is that fees collected from developers of CCS demonstration projects will be set aside in a dedicated account. In the absence of doing so, the fees collected may disappear into the Treasury, and result in an inter-generational transfer of costs to future tax payers, if claims are made in the future and the fees collected are not set aside and allowed to gain value.

Based on my experience with financial assurance frameworks, and other long-term indemnity models legislated by Congress, the fees collected from developers of CCS demonstration projects should be set aside in a dedicated, interest-bearing account that generates a rate of return at least equal to the rate of inflation. Specifically, the fees collected from CCS developers should be deposited in a dedicated fund defined by Senate Bill 1013 as a "Fund" or "Trust Fund" for purposes of paying claims and monitoring costs arising after transfer and acceptance of title of the CCS demonstration projects by the Federal government. Conforming legislation establishing the Fund under Title 26, Subtitle I, Chapter 98, subchapter A of the Internal Revenue Code is necessary.[1] Duty for managing investments collected and deposited in the Fund should be the purview of the Department of the Treasury. The portion of funds vested in the Fund that is not required to meet annual withdrawals should be invested in interest-bearing obligations of the United States.[2] Other long-term liability and federal indemnity models, including the Hazardous Substances Superfund,[3] the Oil Spill Liability Trust Fund,[4] and the Harbor Maintenance Trust Fund,[5] to name a few, adopt a similar investment strategy. Further, the Secretary of the Treasury should rely on the implementing agency, as established by Senate Bill 1013, to provide information on the annual funding needs of the program, either as it may relate to the payment of claims following acceptance of title to the CCS demonstration project, or for purposes of long-term monitoring activities.

Ensuring that the language of Senate Bill 1013 clearly articulates the intent of Congress in assessing, collecting and using fees from the developers of CCS demonstration projects will help to avoid future litigation over how much should have been collected in fees, how much was collected in fees, and what happened to the fees that were collected.

FEDERAL LAND

The same financial and legal provisions, with respect to financial assurances and indemnification, should exist regardless of whether the CCS demonstration project is sited on private lands, public lands or tribal lands. The failure to establish the same financial provisions for demonstration projects sited on public or tribal lands as for those sited on private lands may result in: (1) poor operating decisions and lack of appropriate site selection, because the project developer is not held financially accountable for its business decisions; and/or (2) provide an unintended subsidy or competitive market advantage to developers of demonstration projects on public or tribal lands.

TRAINING PROGRAM

To the degree authority for financial management or investment of fees collected under Senate Bill 1013 is transferred to a federal agency other than the Treasury Department, appropriate training programs in financial and economic analysis should be provided.

---

[1] See 26 U.S.C. 9501 through 26 U.S.C. 9510 for dedicated Trust Funds established by the federal government under the Internal Revenue Code.

[2] 26 U.S.C. 9602

[3] See Comprehensive Environmental Response, Compensation, and Liability Act § 221, 42 U.S.C. 9631 (2007), Superfund Amendments and Reauthorization Act § 517, 42 U.S.C. 9601(11) (2006), 26 U.S.C. 9507 (Hazardous Substance Superfund).

[4] See Oil Pollution Act § 1001(11), 33 U.S.C. 2701(11) (2007). 26 U.S.C. 9509 (Oil Spill Liability Trust Fund).

[5] See Act of May 13, 1954 (commonly referred to as the "St. Lawrence Seaway Act") § 13(a), 33 U.S.C. 988(a). Water Resources Development Act § 210(a), 33 U.S.C. 2238(a) (2007). 26 U.S.C. 9505 (Harbor Maintenance Trust Fund).

CONCLUSION

The use of tax payer dollars and the very long time horizon associated with CCS—one which may extend beyond the natural life of the corporate entity undertaking the demonstration project—demands a financial assurance structure that blends the strengths of private and public financing and risk management tools. In my view, a financial assurance structure that successfully implements private—public risk sharing should achieve four clear goals:

(1) Ensure funds are adequate, when needed;
(2) Ensure these funds are readily accessible, when needed;
(3) Establish minimum standards for financial institutions providing funds or underwriting risk; and
(4) Ensure continuity of financial assurances, when ownership of sites is transferred.

To the degree society wishes to reduce greenhouse gas emissions, and the portfolio of emission reduction technologies includes CCS, then an effective financial assurance and indemnification framework will balance the above-listed goals with needed incentives to foster the safe deployment of a limited number of early mover, demonstration projects. The long-term indemnity model proposed in Senate Bill 1013 is a step forward in accomplishing this objective.

However, if the intent of Senate Bill 1013 is also to establish a financial assurance structure that ensures sufficient funds are available to pay for long-term stewardship at the time ownership of the demonstration projects is transferred, then the Bill would benefit from the modifications that I outline above. Finally, ensuring that the language of Senate Bill 1013 clearly articulates the intent of Congress in assessing, collecting and using fees from the developers of CCS demonstration projects will help to avoid future litigation.

The CHAIRMAN. Thank you very much. I think you all have provided very useful testimony. Let me just ask any of you that would want to respond.

One of the points Representative Lubnau made was that we need to be more specific about what we do with unscrupulous operators of CCS projects. Is that something that makes sense? Something we need to be addressing in more specific terms?

If so, what do we do if an operator of a CCS project goes belly up or leaves town or becomes untrustworthy. What should we put in legislation to solve that problem? Mr. Anderson, Mr. Moor, do either of you have a thought about that?

Mr. ANDERSON. We've thought a lot about it. My first part of my answer would be one of my final statements. Don't be quick to throw away the current liability system. That is something we have that encourages good behavior.

Don't be too quick to relieve people of liability on a permanent basis unless you've identified a genuine problem with capital formation and targeted a policy response to that. The insurance companies and the people who loan money to projects, invest in projects are a great ally on this. People who, in the private sector, are not likely to invest lots and lots of money unless they have some confidence, a lot of confidence in the quality of the operations.

Conversely to the extent of the investment community doesn't have confidence that an operator is going to be a good operator, that operator is going to have to pay more for its capital and that's a good thing.

The CHAIRMAN. Mr. Moor, did you have a thought?

Mr. MOOR. Yes, Mr. Chairman. I associate myself with Scott's remarks. We—this is, I think, why we've concentrated on the mutualization model. Because we believe that the mechanisms inherent in that kind of model can help guard against the rogue activity and reassessment of risk associated with either bad behavior

or a bad risk profile can be guarded against by using the forces of the markets.

We've had some concern about the use of trust funds where it would simply be as, I think we've called it, Joe's Crab Shack and CO_2 sequestration operation would simply show up and begin to pay the fee and say we're in who can stop us. Whereas in mutualization and insurance with insurance products, there's a certain level of guardianship of capital that should keep those kinds of operators out of the business.

Ms. TRABUCCHI. Can I actually offer something else?

The CHAIRMAN. Yes, please.

Ms. TRABUCCHI. I think it's extremely important as you consider this bill and in my view developers of CCS projects should remain fully financially responsible during the operating act of injection period of the project and for a defined period post injection. In so doing you're rendering them financially accountable for their actions. That will foster sound site selection, sound operating decisions because they're the ones who remain responsible.

So any thinking about loan term indemnity really should be about long term stewardship. It shouldn't take place during the operational period.

The CHAIRMAN. Ok. Let me call on Senator Corker for any questions he has.

Senator CORKER. Ok. Mr. Chairman, first of all these witnesses are outstanding. They're very concise and understand well. I thank each of you for your testimony.

While I have some concerns about the viability of CCS I want to thank you for offering this title. I strongly support us researching in this area and developing standards. I just have concerns about the viability.

But I realize coal is a very, very important part of what we do power production wise. I think we need to be numbers of things to figure out a way to solve this issue. But it's always nice to get an emperor check on all those involved as to its reality.

Let me just—as it relates to the Southern Company. When you—one of the reasons that you use coal is its abundance and in essence its lesser expense if you will, in delivering power. When you start to fathom all of the expenses required with capture, sequestration, pumping, insurance, all of those things, hiring Mr. Tombari's great firm to do this.

I mean at the end of the day does it make it all begin to look at nuclear and other kinds of things. Is it going to render coal basically—I mean is this a transitional issue that you see your company, in essence, moving away from coal in general and using CCS in the interim as a transitional way of dealing with it?

Mr. MOOR. Thank you, Senator Corker. I think there will be changes in generation mix. We're committed to programs that will increase our nuclear utilization. We're looking at two new, possible nuclear units in the Southeast. We know that TVA is likewise focused on that.

Our commitment to IGCC is in part a statement that we believe coal has to be a part of the mix. That is an approach that our CEO has taken across the board in saying we can't throw anything out. We've got to have it all.

We have a number of very valuable, very efficient, very well regulated from a pollutant standpoint. Relatively new coal fired facilities that need to be preserved. If we can retrofit them with technology there may be, as I said, two happy coincidences for us.

One, we've been blessed with some good geology in the southern part of the service territory that we have some saline aquifers that are probably as most people, and maybe John will back me up on this, are some of the most attractive real estate for doing sequestration projects. So that works I think in our favor.

The other thing is the Southeastern oil fields are in need of CO_2. There's a demand for it. Thus when we did the IGCC look at Mississippi we could look down the road and see that some of the oil companies were interested in our CO_2. So the combined economic benefit is attractive.

We're like TVA in this regard. We've seen this resource do amazing things for our region. Hydro and coal have made the Southeast.

The Southeast is a bastion of economic development in a country that desperately needs production and good jobs. To see that disappear and not fight the good fight for a fuel that has been so valuable and important for developing our region would seem to be, to us, the wrong thing to do. So we're going to continue to pursue it.

We're continuing to pursue these technological approaches and efforts like this because we believe that it has to be a combined effort. We are in essence sending a man to the moon through the CCS effort. We've got to do it together. It's got to be a collaborative effort with the environmental community and public citizenry. We're going to pursue it hard.

Senator CORKER. Would it be your sense that, for the sake of our country, not just a particular region, that we need to be working equally hard, if not harder toward recycling of nuclear fuel so that we have a carbon free way of producing power in this country. If you were going to weight our efforts toward CCS or toward recycling nuclear fuel and being serious about building 100 new nuclear plants in the next 20 years which would you weigh toward?

Mr. MOOR. Beyond my pay grade, I will confess first. But I would say focusing on the coal side of the equation that the regional nature of the resource, the tremendous capital required for the investments in both of those technologies mean that whatever steps forward we take they're likely to be expensive. The region will feel the economic impact, not just the close in region, but the neighboring region because we exchange power with TVA. We exchange power with other partners in the Southeast.

I think it's the decision of a lifetime. We're going to have to do it with a full and open process that let's everybody know what's about to happen. The Public Service Commissions have to understand that either one of these approaches is tremendously expensive.

They've got to understand why we're doing it and what's motivating us for the good of the environment. But also the real consequences in terms of cost and they will be significant.

Senator CORKER. Ms. Trabucchi, You talked about the availability of cash. Your quiet statement about Federal Government here and how things disappear.

[Laughter.]

Senator CORKER. But the availability of cash to pay claims is what you're talking about. Just give us a sense of the type of claims that one might envision in the way of damages. Mr. Tombari, if you have any thoughts since you're obviously an expert in this area.

But for those of us who might think about some of the lingering liabilities. I mean, I don't know what CO_2 does to the underground as it relates to formations. I don't know what some of the liabilities are. But could you site a couple of examples where we, as citizens, might want to recover from a company like Mr. Tombari, what would the damages be?

Ms. TRABUCCHI. Let me preface my remarks by saying that I'm not an attorney. So I wouldn't want to make a representation of what would be a legal claim. With that said, I could envision dollar damages that might involve natural resources, ground water contamination, aquifer contamination, endangered species perhaps.

I think that, and again I'm not a scientific expert or an engineering expert. So I can't comment on whether when CO_2 travels what might happen to that plume. But I think there are analyses that can be done that look at the different receptors which I think is part of what you're getting at with your question.

The transport mechanisms and if there should be an event how it would adversely impact those receptors through harm or injury. Then there are analyses that you can do to place a dollar value on that.

Senator CORKER. Mr. Tombari, any?

Mr. TOMBARI. Yes.

Senator CORKER. What is it that, in your great research and preparedness for this, what are the things that you worry about happening down the road? You want to pass the liability on after the CO_2 has kind of balanced itself. I didn't use the right terminology I know.

But what are the things in the interim that concern you as it relates to things that could go wrong?

Mr. TOMBARI. Talking about "down the road." I think it's important to realize that the challenges do drop off. The challenges are higher during the operational phase and the equilibrium.

But at the point in time when we're asking for stewardship there really is minimal expense left to do care and also absolute minimal challenges. So we don't anticipate anything dramatic being left at that point in time.

I'd also like to point out that once again we're talking about carbon dioxide which is something we breathe out. It's something that's in your soda pop. So that's my thoughts on that. Thank you.

Senator CORKER. So not very damaging.

Mr. TOMBARI. No.

Senator CORKER. Mr. Chairman, thank you and thank you all.

The CHAIRMAN. Thank you very much. Thank you all for being here. This is very useful testimony.

Let me particularly thank Allison Anderson who has worked so hard on this legislation. She's done a great job. We hope to take the suggestions we've heard here today and perhaps even make additional improvements.

Thank you again. That will conclude our hearing.

[Whereupon, at 4:28 p.m. the hearing was adjourned.]

[The following statement was received for the record.]

THE STATE OF WYOMING,
OFFICE OF THE GOVERNOR,
Cheyenne, WY, May 19, 2009.

Hon. JEFF BINGAMAN,
Chairman, Senate Energy and Natural Resources Committee, 304 Dirksen Office Building, Washington, DC.

DEAR SENATOR BINGAMAN, I am writing to lend my strong support to your bill, S.1013, "Department of Energy—Carbon Capture and Sequestration Program Amendments Act of 2009". I sincerely appreciate your solid leadership in moving this important legislation forward.

As we have discussed, the ability to sequester carbon dioxide (CO_2) is very important to Wyoming and the country. It is becoming a pre-condition to continued use of coal in the United States. For any number of reasons, not the least of which is national security, we should not turn our back on this vital indigenous energy resource.

In Wyoming, we will continue to work on all the issues surrounding CO_2sequestration. Our technical and research work is proceeding at a strong pace. We have identified several promising candidate geological formations to store CO_2. We have also established the legal framework for pore space ownership and created a regulatory regime to permit and safely manage CO_2 sequestration. However, the largest impediment to progress in Wyoming is the issue of long-term liability for the sequestered CO_2. This is why your effort is so critical.

Addressing liability for ten large scale injection projects is an elegant way to move forward in both scientific understanding of the sequestration process and creating the experience base for sound financial and regulatory assessment. If we are serious about CO_2 sequestration in the United States, we need to marry scientific understanding with rigorous financial analysis to establish the actual risk profile of CO_2 in the ground. This is the pathway to a rational and efficient long-teim insurance solution.

I believe you have struck exactly the right balance in the manner you have written the bill. Evidence of this is the bipartisan support represented by the co-sponsorship of this legislation by Wyoming Senator John Banasso.

Again, thank you for your leadership on this and other important energy issues that our Nation must address. Please know that I stand ready to support your efforts on this legislation.

Best regards,

DAVE FREUDENTHAL,
Governor.

APPENDIX

RESPONSES TO ADDITIONAL QUESTIONS

STATE OF WYOMING LEGISLATURE,
HOUSE DISTRICT 31,
May 19, 2009.

Hon. JEFF BINGAMAN,
U.S. Senate.

DEAR SENATOR BINGAMAN: Thank you for the opportunity to testify in front of the United States Senate regarding S. 1013. Upon my return to Wyoming, I told my wife I was impressed how knowledgeable, interested and well-informed the Senate Energy Committee is on issues related to energy and the environment. In consultation with Ian Shaw from the Wyoming Legislative Service Office, and Wyoming Rep. Mary Throne (D—Laramie County), I have prepared the following answers.

Question 1. I think that the point that you make concerning the termination or substitution of the storage site operator is a good idea when they are cited as being negligent in their duties. How would you go about finding and designating a new field operator should the need arise? Is this something that you have worked on at the state level in Wyoming?

Answer. Wyoming addresses this issue two ways: 1) through the permitting and regulatory process; and 2) through the unitization process. The United States Government has the ability to deal with the unscrupulous or inept operators in much the same way—given the appropriate regulatory framework. We found the Underground Injection Control (UIC) permitting process was inadequate for regulation of carbon sequestration in total. As a result, we passed a comprehensive permitting process for carbon sequestration. The EPA is in the process of drafting regulations for permitting of UIC carbon sequestration operations. We believe the permit requirements, and most importantly, the entity providing the financial assurances for the permit as an enforcement arm outside the government. In that way, the provider of financial assurances acts as a free-market enforcement arm of the state regulations.

However, as a fail-safe to the process we have created other alternatives. We can revoke the sequestration permit, and stop all activities. We have also provided for petition and removal of an operator pursuant to our unitization statutes. Any interested party (in the Scalia sense of interested) can petition the Wyoming Oil and Gas Conservation Commission for removal of the operator.

I would suggest for the purposes of this legislation, that the DOE be authorized, by regulation, to enter into agreements with operators for long term operations, for the requirements for adequate financial assurances, and require a replacement operator be provided by the entity requiring the adequate financial assurances. Those contractual arrangements will relieve the United States Government from some of the burdens associated with sequestration site enforcement.

Additionally, in the context of this legislation, it may be possible to provide a limited right of action for certain parties to petition for the removal of an operator, and the substitution of another qualified operator based upon a showing of a material breach of the agreements with the government. The key to the substitution of the operator revolves around the financial assurances demanded by the government at the outset. The more significant and iron-clad the financial assurances, the more likely the operator will comply with the requirements of the process.

In Wyoming, violation of the permit is also a crime. I do not know how, in the context of this particular piece of legislation, criminalizing permit violation conduct will occur, but it might be a consideration of the committee.

Question 2. In addressing unitization—what sorts of feedback did you receive in determining the 80%-20% ruling? Was there any opposition to the approach you used in your unitization law?

Answer. I would like to say there was something magical in the selection of the 80/20 numbers. Unfortunately, we took the Wyoming Oil and Gas Unitization Statutes, and modified them to make them fit with carbon sequestration activities. The existing percentages in the oil and gas statutes were 80/20. Since no one objected to the percentages, we kept them.

The only objection to the legislation was an argument by some environmental landowners, that by virtue of a unitization process, and granting the mineral owner dominance, we were giving the federal government more control over fee lands. Because the federal government owns so much of the pore space in Wyoming, it was perceived that the federal government would consent to unitization, take control of the unit, and overrun the surface owners in Wyoming.

Wyoming landowners, as I imagine is the experience in New Mexico, are feeling ever growing frustration at the impingement on their property rights by mineral owners and the public entities. Any time a perceived impingement occurs, we see objections at the legislative level. As a result, Wyoming's legislation is designed so the fee surface owner has the most control over their lands, and the activities in or on their lands as possible. I urge the United States Government to lean that way. We have found that by becoming partners with the fee surface owners, our public is more amenable to geologic sequestration activities, and actually, in some sectors of the state, we are beginning to see a building excitement at the development of an entirely new industry in Wyoming.

Thank you for the opportunity to address these questions. If you have any further questions, or you would like to discuss this matter further, please feel free to call. I am at your disposal.

Yours very truly,

TOM LUBNAU, II,
Wyoming State Representative.

RESPONSES OF KARL MOOR TO QUESTIONS FROM SENATOR BINGAMAN

Question 1. In your written testimony (pg 5—long term care) you stated that Southern Company feels that the best approach for this phase is a third-party caretaker for long-term maintenance of the wells and infrastructure. Yet in your following sentence you state that you don't feel a third-party contractor should handle the long term care in the commercial-scale deployment phase. Can you clarify what you mean by this?

Answer. At Southern Company, we try to make a clear distinction between two aspects of ownership of closed sequestration sites. The first is small in scope, strictly the maintenance and upkeep of the infrastructure at the sequestration sites—the wells, the access to the wells (roads, etc.), and any monitoring equipment. The second aspect is the responsibility for any trespass, damages, remediation, and any other claims resulting from the injected CO_2. Southern Company believes that transferring only the infrastructure maintenance to a third-party is an appropriate and realistic approach given the lack of commercial-scale CCS demonstrations and policy regulations. We understand that other approaches could be considered in the future, but the responsibility for any harm caused by the injected CO_2 should remain with the sequestration site operator/owner unless transferred by contract or other means. So, to be clear, in a commercial sequestration site, we propose that the well maintenance and any other infrastructure maintenance should be handled by a third-party, but the liability for trespass, damages, remediation, and any other harm remain with the injecting parties which may be Southern Company or a third-party who has assumed liability under negotiated arrangement.

Question 2. In the case of early mover projects, like those described in S.1013, the site operator stays involved until the site closure certification is issued by the secretary. It isn't until the site closure certification is issued that the government (or some government appointed entity) will step in and manages the sight. Is the view that is outlined in your testimony in conflict with the long-term care program stated in S.1013?

Answer. Yes, for early mover projects, Southern Company would prefer an earlier involvement of the Department of Energy in helping those projects to manage risks. At present, the DOE only provides financial support and basic science research in support of CCS technology development. Our desire is for S. 1013 to provide protection through DOE for early movers during the operational phase of the CCS project. Our experience in early CCS projects shows that the private insurance providers today do not have enough information and/or experience to offer policies to site operators that can adequately cover the potential damages caused by an unforeseen event. This is part of our "first movers paradox"—i.e., Southern Company is more

concerned with the risks during the project's injection and stabilization phases than the long-term risk management (although we do see it as a future obligation that will have to be managed). My reference to Dr. Sally Benson's work at Stanford University in my written testimony is at the heart of this matter. As can be seen in the figure provided below, a typical CCS project risk profile will increase as CO_2 is injected and continue to be at the highest levels during injection and for some time after that. In this view, the risk drops by almost half when time equal to about half of the injection period passes. The risk continues to drop as time proceeds.

We think this is consistent with many other views of the potential risks of sequestration, that geological failures that allow CO_2 to migrate outside of the desired confining zone would occur while injecting or shortly thereafter.

It is my opinion that the bill would be more helpful in allowing companies like Southern Company to proceed with these early mover projects if they have some assistance in risk management for the injection and stabilization phases of these first projects. This approach would encourage projects which, in turn, would allow companies, like Southern Company, to gather information and more operational experience. This information and experience could be used by private insurance companies, industry mutual associations, and other entities to underwrite risk management instruments (primarily insurance) for all phases of commercial projects. Therefore, I would ask you to consider moving the involvement of the Department of Energy for these early mover projects to the beginning of the injection of CO_2 phase, and not just after closure.

RESPONSES OF KARL MOOR TO QUESTIONS FROM SENATOR MURKOWSKI

THE ROLE OF STATES

It is my understanding that Southern Company is a member of the FutureGen alliance. In competing for the FutureGen site selection, both Illinois and Texas passed state laws to assume ownership of, and liability for, the injected CO_2.

Question 1. What is your opinion on the role of the states in terms of long-term stewardship of CCS sites, as compared to the federal role contemplated by S. 1013?

Answer. I would first point out that the amount of CO_2 being captured and sequestered from the proposed FutureGen plant would be limited to only about 1 million tons per year. This is the prototype first mover plant and was established as a test bed for research activities. Commercial CCS plants would sequester between 2 million and 5 million tons per year. It is not certain that these states would agree to the same role for multiple commercial projects.

For infrastructure maintenance, there is a clear model in states with oil and gas production to manage abandoned wells, mostly through oil and gas boards. These operations are supported by charges to oil and gas operators through trust funds. We view CCS as a direct extension and recommend such organizations also oversee the wells and infrastructure of a closed sequestration site.

As far as states accepting the responsibility for any trespass, damages, remediation, and any other harm, we would suggest that this is an issue where the states can independently decide if this is appropriate and necessary.

The one issue for CO_2 sequestration that is a state responsibility is in the determination of who owns the pore space where CO_2 will be injected (surface owner or mineral rights owner or the public). Some states have begun addressing this issue, but the ability of a sequestration operator to efficiently gain access to the right to inject the CO_2 underneath private property and the fair compensation to the rightful owner for that access is one of the most pressing issues for CCS. It would be helpful for Congress to consider incentives for individual states to make access to the pore space available and assign value to the use of that pore space. Beyond the issue of ownership is the need for condemnation similar to forced pooling which has been successfully applied in the development of oil and gas fields.

TIMING OF INDEMNIFICATION

S. 1013 is relatively ambiguous about the point at which the Secretary would make a decision on whether or not to indemnify the non-federal participant in a demonstration project.

Question 2a. Do you think this represents a potential difficulty in terms of negotiating participation in a federal demonstration project or is it not likely to represent a problem?

Answer. Southern Company does recognize this ambiguity and the likely point of indemnification to be a potential problem for early mover projects. Our preferred risk management approach for commercial projects, the use of private and industry mutual insurance, is still a future option. These entities need real data and experi-

ence with the activity in question to be able to underwrite insurance coverage. The normal course of development would be to grow slowly both the sequestration industry and the related insurance coverage over several decades to reach a commercial position. With a need to accelerate the development of CCS, we feel that there is a need to have some assistance on these early mover projects to handle the risk management as CO_2 starts to be injected and not just after the site is closed. At the same time, the experience from these sites will lead to information that will help the private and industry mutual insurance entities write the insurance coverage needed for companies to move forward with commercial projects. To speed the development process toward commercialization, we suggest that the Department of Energy indemnification begin with CO_2 injection for these early mover projects assuming standards are met

Question 2b. How would the absence of clarity on a Secretarial willingness to indemnify impact the non-federal participant's economic planning and decision-making associated with a large-scale (1 million tons plus, per year) demonstration project undertaken jointly with the federal government?

Answer. With the entire responsibility for damages, remediation, and any harm being left with the early mover project team, the lack of assistance from DOE and the inability to purchase adequate insurance coverage at reasonable cost will certainly slow down and delay these projects. As we move toward injections of one million tons per years, some type of reasonable risk management instruments (whether insurance or DOE indemnification) will be necessary for these projects to go forward. As I noted in my written testimony, changing section (g)(2) of S. 1013 to state "The Secretary shall agree . . . " instead of "may agree" will provide the necessary clarity on this issue.

OPTIONS FOR ADVANCING CARBON SEQUESTRATION

The debate on domestic policies related to global climate change is still very much underway.

Question 3. Absent a price on carbon, and in addition to the liability option that is under consideration in the context of S. 1013, what other measures should the Congress consider pursuing to expedite the development and deployment of carbon sequestration technologies?

Answer. Carbon capture and sequestration is one of many approaches to provide electricity in a carbon-constrained future. Southern Company believes that use of a suite of technologies will be necessary to preserve economic growth and stability while decreasing emissions of CO_2 to the atmosphere. Many economic models predict that electric generating companies, like Southern Company, would turn to natural gas combined cycle generating units in the near-term. This large-scale, nationwide switch from coal generation to natural gas generation would have many adverse consequences. Therefore, we believe coal needs to be competitive with natural gas but not overtaken by it because of cost concerns. As I state in my testimony, Southern Company believes that coal should and must remain part of the future generating options. Our work in CCS is not only to prove the viability of the technology, but also to improve the technology to make it more cost-effective. Southern Company has been very active with the Department of Energy in helping to develop and demonstrate technologies for emissions reductions from coal power plant. We believe that the nation has benefited greatly from our partnership with DOE and those with other utilities, vendors, and research organization.

Congress must continue to support and increase funding for CCS work that supports large-scale demonstrations and fundamental research and development for capture of CO_2 from coal power plants. So first, we would propose that Congress needs to help this technology and the technologies of the future be accelerated to protect the nation's economy and those industries and individuals that rely on natural gas. Southern Company supports the concept of a "wires charge" on electricity paid into a fund to be used to support these activities as well.

Secondly, we would encourage Congress to consider incentives to the many states to put into place "model" statues that would clarify the ownership of the pore space into which CO_2 would be injected. At the same time, these state statues must balance the need for compensation of the pore space owner with the ability of sequestration operators to gain access to these formations thousands of feet below the ground surface.

Finally, for sequestration, we would suggest that Congress address some of the ancillary issues associated with carbon sequestration. These include ensuring that any regulations of CO_2 injection be flexible especially including the purity of the CO_2 stream injected underground. The applicability of CERCLA and RCRA to injected CO_2 streams must be addressed. Obviously, the CO_2 purity and the applica-

bility of CERCLA and RCRA are linked together, making it more difficult to be flexible and protective at the same time.

RESPONSES OF JOHN TOMBARI TO QUESTIONS FROM SENATOR BINGAMAN

Question 1. Do you feel that we have technologies available today to adequately characterize a site for CCS and for long-term monitoring, while simultaneously reducing operating risks related to liability?

Answer. Yes, technology is available today to adequately characterize a site and for long term monitoring. Technology is also available for operational and verification monitoring. Use of all of these in combination by a skilled person/company is what leads to simultaneously reducing the operating risk related to liability.

Good site selection and detailed characterization (prior to injection) are the best ways to reduce operating risks related to liability. For the first ten projects, covered by this legislation, sites should be chosen that have the simplest characteristics and where the best characterization technologies can be deployed.

Storage operators will need a deep understanding of the technologies available as well as experience with deploying these technologies. Only through this understanding and experience will they be able to properly control overall quality, safety and environmental impact.

The best currently available technologies for characterizing the subsurface attributes of a site should be used and at a minimum include:

- High-resolution three dimensional (3-D) seismic over the area of review (technology available).
- Multiple wells with the following:

  i. Cores (rock samples) recovered from both the injection zone as well as the confining unit. (technology available)

  ii. Downhole fluid samples from the injection formation as well as from overlying aquifers brought to the surface at formation pressure. (technology available)

  iii. A comprehensive set of wireline logs including those that help evaluate: mineralogy, porosity, permeability, layering, fracture analysis, mechanical rock properties and seismic calibration. (technology available)

  iv. Formation pressure testing and fracture gradient testing (technology available)

- Integration of all the data into a single static shared-earth model and subsequently incorporated into a simulator for estimating how the CO_2 plume and pressure front may evolve over time. (technology available)
- Construction of a geomechanical earth model to guide the injection design and operations. This will help prevent damage to the confining layer. (technology available)
- An analysis of the basin water system to evaluate the impacts which might occur in overlying or surrounding formations and/or fresh water aquifers. (technology available)
- Re-entry or evaluation of old wells that may be poorly constructed and/or poorly plugged and might intersect the plume of CO_2. Included should be the use of tools with full radial cement and corrosion coverage and that can detect small channels in the cement (technology available.)

These views are based on the current state of technology. Because of the long term nature of these projects, technology will continue to evolve. Liability can only be based on the current state of technology.

While technology selection is important, the following human factors are equally, if not more, important for success:

- Properly trained people with prior reservoir management experience.
- Best available data integration processes
- Proper and demonstrated risk management processes

Question 2. Do you or your company feel that the impending Underground Injection Control (UIC) Program [under the Safe Drinking Water Act] rulemaking process being conducted by the EPA is rigorous enough for adequate site characterization of conversely overly stringent? Are there any changes that you/Schlumberger would recommend that would impact this legislation?

Answer. The impending UIC Program rulemaking process being conducted by the EPA is rigorous enough for adequate site characterization.

The EPA should diligently enforce the regulations pertaining to the evaluation of existing wellbores that may intersect the CO_2 plume, to minimize the potential for these wellbores to allow leakage. Similarly, the EPA should diligently enforce regulations on new well construction to provide for maximum safety and environmental protection.

Question 3. You did no mention the need for liability program(s)—do you or Schlumberger feel that a liability program is needed, in light of the long history that your company has had working in the subsurface? Are the liability concerns real? Are the "risks" for geological storage as great as project developers claim they are?

Answer. Yes, Risk management programs including programs to manage liability risks, are important. These concerns are real. Claims of risks by potential project developers will vary based on the level of experience they have had with subsurface practices and technologies beyond those of pilot geologic storage projects.

Included in the request for long-term stewardship for early projects is an implied request that once the site is transferred (subject to established acceptance criteria), the operator's liability exposure would end. Liability concerns also can be managed through:

- Proper attention by CO_2 generators and regulators to make sure that the site developer/operator is properly qualified, has a history of safe subsurface operational experience and has demonstrated an understanding of the best available technologies.
- Proper site selection and detailed site characterization prior to injection.
- Proper integrated monitoring that identifies CO_2 and pressure plume locations and tracks the integrity of the confining layer.
- The site developer/operator being responsible for both data integration and risk and performance management practices so that decisions are made using the best and most currently available information.
- Periodic reviews of monitoring results compared to predictions as well as reviews of the practices in use.
- Linking liability to the current state of technology at the time commitments were made

RESPONSES OF JOHN TOMBARI TO QUESTIONS FROM SENATOR MURKOWSKI

OPERATIONAL CHARACTERISTICS

Question 1. A typical car tire may be inflated to 40 or 50 pounds per square inch. In terms of hydraulic fracturing for oil and gas production, those activities take place at close to 8,000 pounds per square inch, but that pressure is ultimately released as the oil and gas is produced.

By way of a comparison, can you share with us what the likely pressures would be for CO_2 injections in a large-scale (1 million or more tons injected per year) CCS operation, how long that pressure would be sustained, and whatever other differences between sequestration activities and enhanced oil and gas recovery through hydraulic fracturing or carbon dioxide injections that you think we should be aware of?

Answer. To inject CO_2 into a storage formation, there is an existing pressure that must be overcome in order to introduce the CO_2. Once injection ceases, pressures will ultimately return to equilibrium. At the best of sites, this process will not require fracturing. Fracturing has been used by the oil and gas industry in specific circumstances to assist the movement of fluids in the rock. Fracturing requires overcoming both the existing downhole pressures and the additional pressure necessary to break the rock.

It is likely that the CO_2 will be injected above 1070 psi because above this pressure the CO_2 has a liquid-like density allowing for more CO_2 to be injected per volume of pore space. The pressure will dissipate with distance from the injection point and it will dissipate over time depending on the boundary conditions and hydrogeologic properties of the storage formation. The boundary and hydrogeologic characteristics will need to be studied and understood prior to the start of injection. Technologies to do this are available.

It is important to make CO_2 pressure measurements using sensors placed deep in wells adjacent to the formation we are trying to inject the CO_2 into. Sensors at the surface (near the wellheads or in the pipeline), though also important, are not adequate for this purpose.

While pressure will vary with depth and formation properties it can be controlled through proper injection design and maintained safely below pressures that might damage the confining layer.

Determining the pressure (fracture gradient) above which damage to the confining layer for a given site can occur, is one of the most important aspects of proper site characterization. The technologies for this are available. After characterization, constructing a proper geomechanical earth model using appropriate computer software enables managing pressure over time, and gives confidence that the pressure increases will not damage the confining layer

OPTIONS FOR ADVANCING CARBON SEQUESTRATION

Question 2. The debate on domestic policies related to global climate change is still very much underway.

Absent a price on carbon, and in addition to the liability option that is under consideration in the context of S. 1013, what other measures should the Congress consider pursuing to expedite the development and deployment of carbon sequestration technologies?

Answer. To expedite the development and deployment of carbon sequestration technologies, Congress should consider:

- Authorizing and funding the proper detailed characterization of many of the existing potential storage sites throughout the country. .This would permit:
  - —Greater confidence in the distribution of storage sites throughout the country and their proximity to large point sources of CO_2 emissions or to planned projects.
  - —Better planning for distribution systems and/or pipelines.
  - —Better development of storage related regulatory requirements.
- Having a single regulatory agency responsible for all CCS regulations to add consistency to and to streamline processes.
- Federal guidance toward developing harmonious State laws regarding property, access, trespass, and liability.
- Providing for the development of CCS training/degree/certification programs.

RESPONSE OF JOHN TOMBARI TO QUESTION FROM SENATOR STABENOW

Question 1. Mr. Tombari, thank you for your testimony. The Carbon Services business at Schlumberger is a reassuring example of how the fossil fuels industry is responding positively to the prospect of a carbon-constrained economy. It is excellent that your expertise in identifying and accessing geologic sites for hydrocarbon production can be used for carbon sequestration. Mr. Anderson commented that while today's legislation will be helpful for risk management carbon sequestration projects, he hopes that market based solutions can soon provide that risk management.

To what extent will this bill encourage the availability of such market-based solutions? How far away is that scenario?

Answer. Market-based solutions for risk management during the operational phase and equilibrium phases of a storage project exist and will develop further once a commercial industry develops. With respect to the long term risks (post closure): while the potential risks are well documented and low, given a properly selected and operated site, a statistical database allowing for quantitative risk analysis does not exist. It will take a long time to develop good statistics because of the lag between start up operations and site closure. Once operations begin commercially there will be improvement in the ability to estimate post closure risks. Until then, some Federal based assistance for risk management programs will help establish the industry.

The program fostered by this legislation will create a bridge to market-based liability solutions. As indicated in Mr. Anderson's testimony, the program establishes a model that resembles market sector mechanisms in several respects and limits the number of eligible projects. It signals market players to not expect the federal government to play the same role for later projects which should encourage the development of market-based solutions. We expect that the specific projects supported through this legislation, along with other projects worldwide, (executed during the same time period) will be sufficient to create that market.

RESPONSES OF JOHN TOMBARI TO QUESTIONS FROM SENATOR SHAHEEN

Question 1. In reading your testimony, I have been impressed to learn of Schlumberger's work in carbon sequestration since the mid 1990's. We often talk about the challenges associated with carbon capture and sequestration from our power sector, but it is good to know there are companies out there—like yours—which have been sequestering CO_2 for years for enhanced oil recovery (EOR).

What kind of liability protection has your company used for the CO_2 injection projects that it has been involved with?

Answer. Allow me to clarify that Schlumberger has never and will never take ownership or production sharing in an oil and gas field including one for CO_2-EOR. Our involvement over the decades of CO_2-EOR operations has been only as a service and/or technology provider. Schlumberger Carbon Services is focused on saline formation storage as opposed to CO_2-EOR. Saline formation storage is the most important asset that needs to be developed, given the volumes of CO_2 that will need to be stored in order to impact climate change.

We have not been an owner of CO_2-EOR sites and therefore have not needed liability protection. For the storage demonstration projects we have been involved in, we have not had to take ownership of the sites and therefore once again have not needed liability protection.

Question 2. Are these EOR projects Schlumberger has been working on capable of permanent CO_2 storage? Does your company, or do the projects you have been working on, need comprehensive liability coverage for an EOR project that goes into eventual permanent storage?

Answer. We have not been an owner of CO_2-EOR sites and we do not have access to all the data that would be necessary to evaluate whether or not these sites would be suitable for permanent CO_2 storage. Our focus is on saline formation storage.

Question 3. Do you think the liability protections contained in S. 1013 will help address the concerns that new entrants into the carbon capture and storage field might have?

Answer. Yes, the protections contained in S. 1013 will help address the concerns that new entrants into the carbon capture and storage field might have.

The CCS industry as a whole has yet to form, so all entrants will be new. Even with our extensive technological experience, we too would be new entrants. By addressing long term stewardship and liability issues, S. 1013 will allow early commercial projects to proceed while permanent approaches to risk management are developed.

RESPONSES OF JOHN TOMBARI TO QUESTIONS FROM SENATOR BUNNING

Question 1. What types of technologies need to be implemented for the maintenance of a large scale CCS demonstration project? Are these technologies readily available? If not, when will they be and what are the estimated costs?

Answer. Proper site selection and detailed site characterization (prior to injection) are needed. Technologies to do this are readily available and described above in question number 1 from Senator Bingaman. Monitoring technologies, remediation technologies and other technologies needed after injection for the maintenance of a large scale CCS demonstration project are also readily available yet will vary based on site characteristics. Storage operators will need a deep understanding of these technologies as well as experience deploying them in order to control overall quality, safety and environmental issues.

Storage costs over the life of a large scale project at an easy site onshore United States are estimated to be in the range of $5 to $10 per ton of CO_2. These costs will fluctuate with the demand for people and services. There will be a competitive demand for similar people and services from both the oil and gas industry and the CO_2 storage industry. These costs will also be impacted by what evolves with respect to how property rights are acquired and with what regulations will ultimately require as well as the availability of risk transfer mechanisms.

Question 2. What does the risk profile for saline aquifer storage look like?

Answer. The risk profile at a saline aquifer storage site can vary depending upon many factors including:

- The site selected and its complexity.
- The extent to which detailed site characterization was performed prior to injection
- The expertise and risk management processes of the storage operator
- The options available for risk mitigation at the site selected and/or the availability of alternate sites.
- The frequency with which the risk profile is evaluated and updated

Assuming a qualified site operator has performed all the necessary initial detailed site characterization prior to injection and has established the risk profile to be acceptable and manageable throughout the anticipated life of the project then the following is likely:

During active injection, risk may fluctuate a bit depending on the specific site and the operations being undertaken yet will generally decline. Once injection stops the

risk will decline more rapidly as the CO_2 comes near equilibrium. Near equilibrium, risk will become very small and ultimately negligible as CO_2 continues to dissolve into the water and/or mineralization takes place.

The entire risk profile can be continually and pro-actively re-evaluated over time as new data from monitoring and/or other sources become available. With proper risk management practices and options put in place for even the most unlikely of consequences, risks can be kept under an acceptable threshold over time. The most critical factor for doing this, especially for the early projects, will be the qualifications of the storage operator and the technologies they deploy. With proper practices and use of the right technology, the risk that will be left for a long term steward to manage should be extremely small.

RESPONSE OF CHIARA TRABUCCHI TO QUESTION FROM SENATOR BINGAMAN

Question 1. Can you summarize the main differences between the liability and indemnity approach that we used in this bill, S. 1013 and those of the Price-Anderson Act? Are there any advantages or disadvantages to the application of either approach to this emergent technology, CCS?

Answer. My discussions with scientists and engineers expert in Carbon Capture and Sequestration technology (hereinafter CCS) suggest that CCS is an important component of the portfolio of emission reduction technologies available today. Further, to the degree investment in CCS technology avoids stranding or abandoning existing productive assets and stimulates regional and national economic growth; then, I am persuaded that investing in a limited number of demonstration projects would be prudent.

The challenge is to design a financial risk management framework that balances incentives to advance the deployment of CCS technology with the potential for adverse site selection due to moral hazard.[1]

The stated preference to advance CCS technology is similar to the stated preference in 1957 to advance the atomic energy industry. Then and now, proponents have cited to the interest of general welfare and of common defense and security. Then and now, interested stakeholders have raised issues associated with protection of public goods, limit of liability (indemnification) for losses and financial protection.

Enacted in 1957 as an amendment to the Atomic Energy Act of 1954, the Price-Anderson Nuclear Industries Indemnity Act (Price-Anderson) partially indemnifies the nuclear industry from 'public liability' arising from an 'extraordinary nuclear' incident.[2] Specifically, the Act was designed to protect the public in the event of a nuclear incident by ensuring compensation for 'meritorious' claims.

Price-Anderson established provisions for a cooperative program of research and development to advance the deployment of new technology to meet stated societal preferences.[3] The conceptual framework underpinning the indemnification and limitation of liability provisions in Price-Anderson is based on three components:[4]

(1) Individual (Operator) Financing;
(2) Collective (Industry) Financing; and
(3) Federal (Public) Financing.

The advantage of the Price-Anderson model is that it establishes a uniform legal foundation that blends private-public risk sharing with the stated objective of advancing new technology.

The establishment of a cooperative program and the application of a conceptual framework that balances financial responsibility between the individual operator, the industry collective and the public present similar advantages in the context of CCS. However, in my opinion, the specific financial protection provisions established for the atomic energy sector under the Price-Anderson model are not appropriate for use in the CCS context.

---

[1] Moral hazard refers to the specific situation where the risks of an unplanned event increase, because the responsible party is (partially) insulated from being held fully liable for resulting harm. If CCS facilities are not held completely responsible for the consequences of their actions, arguably they will be less careful in their siting and operating decisions. Therefore, the incentives to capture, transport, site/characterize, and inject carbon dioxide in an environmentally sound and protective manner may be diminished. The potential for risk increases, because the chances of an unpredictable event occurring due to poor siting/operating decisions increase. See also Chiara Trabucchi and Lindene Patton, Storing Carbon: Options for Liability Risk Management, Financial Responsibility, 173 World Climate Change Rep. (BNA) (Sept. 2, 2008).

[2] 42 U.S.C. 2210

[3] 42 U.S.C. 2292

[4] 42 U.S.C. 2210

DIFFERENCES BETWEEN PRICE-ANDERSON AND S. 1013

Senate Bill 1013 adopts elements of the private-public risk sharing model first designed under Price-Anderson, but tailors the design of the model to fit the CCS context. Specifically, there are three key differences between Price-Anderson and S. 1013:

(1) Timing of Liability Relief
(2) Use of Site-Specific Risk Assessment
(3) Establishment of Limits on Public Liability

First, with respect to Timing of Liability Relief, the Price-Anderson model establishes liability relief and indemnification for incidents that occur during the active operating life of the licensee, once claims exceed established limits of liability. In contrast, as I understand, S.1013 holds the developer of the CCS demonstration project legally and financially responsible for events that occur during the operating lifecycle of the CCS project, and for a defined period post-injection.

That is, S. 1013 provides liability relief and indemnification after a certificate of closure is obtained and title is transferred. By limiting liability relief to after the operator has demonstrated that the CO_2 plume 'has come into equilibrium with the geologic formation,' S.1013 provides incentives for CCS developers to properly operate and maintain their sites, limiting the potential for future damages and public liability.

Second, with respect to Use of Site-Specific Risk Assessment, the Price-Anderson model establishes absolute, blanket dollar caps on coverage for the individual tier, and for the collective industry tier.[5] Under Price-Anderson, the level of financial protection required by each licensee, and therefore the public liability resulting after the individual and collective industry caps are reached, is not based on a site-by-site characterization of risk or potential for injury. Rather, Price-Anderson limits the amount of primary financial protection required by the licensee to the "amount of liability insurance available from private sources."[6]

Price-Anderson further states that for a subset of licensees the amount of primary financial protection shall be the "maximum amount available at reasonable cost or on reasonable terms from private sources."[7] If claims from an incident exceed the available premiums from private and pooled insurance, the Nuclear Regulatory Commission has the authority under Price-Anderson to indemnify the licensee from remaining liability in connection with the occurrence.

To the degree the private insurance markets are unwilling to underwrite long-term liability claims for CCS at this time—that is, the maximum amount of liability insurance available from private sources for long-term CCS stewardship is $0—then, under a 'Price-Anderson like' model, the public would bear 100 percent of the financial risk for long-term care until such time as insurance products become available. Providing for 100 percent risk absorption by the public eliminates the inherent benefit of a private-public risk sharing model, by introducing issues of moral hazard and shifting financial responsibility to the taxpayer. Essentially, public financing of this sort distorts or eliminates the impact of market forces in determining what is or is not a rational, risk-neutral business venture.

In my view, failing to hold the CCS developer financially responsible during the project's operating lifecycle and/or establishing arbitrary limits of liability that are not based on the Net Present Value of potential damages arising from each CCS demonstration project may increase the probability and frequency of long-term risk by eliminating financial incentives for sound operating behavior and site selection.[8]

As noted in my written testimony, Net Present Value analysis should be used to underpin the financial management framework proposed in S. 1013.[9] Further, as I understand, S. 1013 is designed to assess and collect fees from the CCS developer during the active life of the demonstration project, with the objective of using such fees to finance the cost of long-term stewardship after title is transferred. In return, the CCS developer is assured a measure of liability relief and indemnification. With this adaptation, and by virtue of holding the developer financially responsible during the period of injection, S. 1013 has the advantage of sharing the financial risks

[5] 42 U.S.C. 2210(b)
[6] 42 U.S.C. 2210
[7] 42 U.S.C. 2210
[8] As I noted in my written testimony, dated May 14, 2009, the analytic tools exist to estimate dollar values for potential damages arising from each CCS demonstration project. These tools are routinely used by firms expert in financial and natural resource economics.
[9] See Written Testimony before the Committee on Energy and Natural Resources. United States Senate. Hearing on Senate Bill 1013, Department of Energy Carbon Capture and Sequestration Program Amendments Act of 2009. May 14, 2009. pp 5-8.

associated with long-term care between the private and public sectors, and minimizing the potential for public liability.

Third, with respect to Establishment of Limits on Public Liability, the Price-Anderson model affords broad-scale indemnification and limitation of liability across multiple use patterns in the manner of one size fits all. In contrast, S. 1013 authorizes assistance for up to 10 demonstration projects with explicit provisions for project selection and financial protection. By doing so, S.1013 provides a measure of financial and regulatory certainty and sends a positive signal to the private capital markets, but limits the overall risk exposure to the public to a discrete number of sites with a discrete array of selection criteria.

SIMILARITIES BETWEEN PRICE-ANDERSON AND S. 1013

There are two elements of S. 1013 that appear to draw language directly from Price-Anderson. In my view, these provisions should not mirror Price-Anderson, but rather should be adapted to the CCS context. The two provisions include:

(1) Level of Indemnification
(2) Deposits to the United States General Treasury

First with respect to Level of Indemnification,

> Price-Anderson. Section 2210(c) Indemnification of licensees by Nuclear Regulatory Commission "The Commission shall . . . agree to indemnify and hold harmless the licensee and other persons indemnified, as their interest may appear, from public liability arising from nuclear incidents which is in excess of the level of financial protection required of the licensee."[10]
>
> S. 1013. Section (g)(2) Agreements "The Secretary may agree to indemnify and hold harmless the recipient of a cooperative agreement under this section from liability arising out of or resulting from a demonstration project in excess of the amount of liability covered by financial protection maintained by the recipient under subsection (e)(7)."

As noted above, Price-Anderson establishes an absolute dollar value for the level of financial protection required of the licensee, and further caps the aggregate indemnity for all persons indemnified in connection with each incident. The indemnification language under Section 2210(c) of Price-Anderson relies on these concomitant limits of liability, and thereby establishes a de facto dollar value for public liability arising from incidents that occur during the active operating life of the licensee.

As I understand, under S. 1013, the CCS developer remains legally and financially responsible for incidents that arise during the active life of the project, and until such time as the developer demonstrates plume equilibrium. If so, the language in Section (g)(2) of S. 1013 should not map to the provisions of Section (e)(7), which establish financial assurances until a certificate of closure is issued. Rather, the language in Section (g)(2) should map to the risk-adjusted, site-specific Net Present Value of future expected losses arising from each individual demonstration project. This change, which aligns the provisions in Section (g)(2) with the provisions related to the collection of fees in Section (g)(4), creates financial incentives for the CCS developer to establish site selection and operating criteria that will limit the 'net present value of payments,' and thereby reduce the potential for future damages and public liability.

Second, with respect to Deposits to the United States General Treasury,

> Price-Anderson. Section 2210(b)(4)(B) Amount and type of financial protection for licensees " . . . any funds appropriated under subparagraph (A)(i) shall be repaid to the general fund of the United States Treasury from amounts made available by standard deferred premium assessments, with interest at a rate determined by the Secretary of the Treasury . . . "[11]
>
> Section (g)(4)(C) Use of Fees "Fees collected under this paragraph shall be deposited in the Treasury and credited to miscellaneous receipts."

In the event funds available to pay valid claims in any year are insufficient, the Nuclear Regulatory Commission is authorized under Price-Anderson to request the Congress appropriate sufficient funds necessary to satisfy such payments. With few exceptions, funds appropriated for this purpose are to be repaid to the general fund

[10] 42 U.S.C. 2210(c)
[11] 42 U.S.C. 2210(b)(4)(B)

of the United States Treasury by the licensee. In the absence of doing so, the Commission may place liens against the property of, or revenues generated by, the licensee.[12] These provisions presume that the licensee is active and remains financially capable of generating income. That is, Price-Anderson establishes provisions for cost recovery ex poste.

In my view, the indemnification provisions of S. 1013 are predicated on the payment of funds into the Treasury today (or in the near term) with the expected use of funds deferred to a future period in time—after title to the CCS project has transferred, and the operator is no longer financially responsible pursuant to its indemnification agreement. That is, S. 1013 establishes provisions for cost recovery ex ante.

Unless the fees collected pursuant to S. 1013 are set aside in a dedicated, interest-bearing account, there is the risk that the funds collected will not match the anticipated use of funds in the future. A key implication of not setting the fees aside in an interest-bearing account is that this sequestration program likely would need to collect a larger amount of funds today to avoid under funding long-term care costs in the future.

In my view, there are advantages in applying elements of the provisions established under Subchapter VII, Decontamination and Decommissioning of the Price-Anderson Act to Section (g)(4)(C) of S. 1013. Specifically, Section 2297(g) of this Subchapter of Price-Anderson establishes a dedicated interest-bearing account, the Uranium Enrichment Decontamination and Decommissioning Fund, in the Treasury.[13] The Fund was established to finance decontamination, decommissioning and remedial action costs at covered facilities.

In my view, the adaptations discussed above, coupled with the modifications suggested in my written testimony, will help offer financial and legal certainty to the developers of CCS demonstration projects, ensure the continuity of financial assurances for long-term stewardship and send a positive signal to the private capital markets interested in investing in CCS technology. With these modifications, S. 1013 represents a notable step forward in providing the incentives necessary to capture, transport, site/characterize, and inject carbon dioxide in an economically efficient, environmentally sound and financially protective manner.

RESPONSE OF CHIARA TRABUCCHI TO QUESTION FROM SENATOR BUNNING

I believe that C.O.2 is not a waste product, but rather a commodity that will be sold on the marketplace for enhanced oil recovery and other uses. What can the government do to encourage this kind of use for carbon emissions?

Answer. The sale of carbon dioxide (CO_2) for Enhanced Oil Recovery (EOR) or other beneficial use is encouraged under various state statutes.[14] In my view, the beneficial use of CO_2 for purposes of FOR extends the production of domestic energy resources and avoids stranding or abandoning existing productive assets. To the degree society has a stated preference to reduce CO_2 emissions, and CO_2 for FOR represents a near-term opportunity to foster CCS technology, then incentives may be warranted, including:

(1) Incentives that promote joint business ventures between generators of CO_2 emissions and firms undertaking EOR projects.

(2) Opportunities for financial and technical assistance for EOR projects that demonstrate material beneficial use and permanent storage of CO_2.

(3) Incentives to foster the development of a pipeline infrastructure that bridges CO_2 processing plants and geographic areas with unrecovered oil deposits.

DISCUSSION

In oil fields where production by conventional drilling has dwindled, firms are able to extend the revenue generating potential of the site by injecting CO_2. The CO_2 is recycled over the life of the project to prolong production. By using existing well bores, the firm is able to increase production without incurring added capital expenses, thereby maximizing return on investment.

Depending on the time horizon over which risks and attendant financial consequences from these investments are likely to occur, the financial markets may offer short-, medium-, or long-term capital. In general, the shorter the term of the capital investment, the greater the market segment's tolerance for risk.

[12] 42 U.S.C. 2210(b)(3)

[13] 42 U.S.C. 2297(g)

[14] See Texas Natural Resource Code, Title 3, Oil & Gas, Subtitle D, Chapter 119

Financing CCS ventures associated with coal-fired power plants requires investors with a long-term capital horizon. Typically, these investors have a low risk tolerance for the unexpected and the unquantifiable. This segment of the financial market generally seeks risk sharing opportunities with market segments that demonstrate higher risk tolerance; for example, the oil and gas sector. In so doing, the institutional investor is best able to diversify its investment portfolio and hedge its overall risk exposure. Increased pressure facing coal-fired power plants to mitigate CO_2 emissions coupled with oil interests searching for supplies of CO_2 for EOR suggest market opportunities exist for mutually beneficial joint ventures.

Companies undertaking EOR projects with CO_2, either individually or as part of a joint venture, are likely to reap considerable returns on investment. However, these returns are predicated on up-front capital investments, including:

- Facilities for CO_2 Capture (e.g., natural gas or other),
- Pipelines,
- Compression equipment,
- Transportation,
- Distribution lines,
- Flow lines, and
- Injection wells.

Simply stated, the beneficial use of CO_2 for EOR is predicated on a pipeline infrastructure, whereby CO_2 is captured, compressed and shipped from a CO_2 (natural gas or other) processing plant, then shipped via pipelines to the oil fields.

To the degree society has a stated preference to reduce CO_2 emissions, and CO_2 for EOR represents a near-term opportunity to foster the design and deployment of CCS technology on a smaller, yet economically efficient scale, then:

(1) Incentives that promote joint business ventures between generators of CO_2 emissions and firms undertaking EOR projects may be warranted; and

(2) Similar opportunities for financial and technical assistance as those proffered to large-scale industrial sources under S.1013, including the opportunity to compete for a cooperative agreement under Section (d) of the Bill, may be warranted for FOR projects that demonstrate material beneficial use and permanent storage of CO_2.

(3) Incentives to foster the development of a pipeline infrastructure that bridges the processing plants with available CO_2 and the geographic areas with unrecovered oil deposits may be warranted;

RESPONSES OF A. SCOTT ANDERSON TO QUESTIONS FROM SENATOR BINGAMAN

Question 1. In Mr. Moor's testimony, he states that the financial protection required for the operational phases be set and defined as the "maximum private insurance available in the market". Do you think this is a necessary provision, seeing as how companies frequently self-insure their industrial operations? They also have other mechanisms for "insurance", such as mutual funds, bonding programs, and more.

Answer. Once CCS developers are able to manage the risks of liability exposure and other financial risks by relying on market mechanisms rather than government protection, a variety of alternatives will be available and the tools will by no means be limited to insurance. To some extent the various tools already exist today. It is only because some developers are unable or unwilling to self-insure, and because other risk management mechanisms for CCS are not fully developed, that it makes sense for government to serve as a back-stop for some early projects.

In a fully functioning market the decision on whether and how much insurance to purchase should be left to individual firms. We agree with Mr. Moor, however, that even a program for a limited number of early projects should not indemnify private parties for losses that could have been covered by private insurance. We would support defining "insurance" broadly to include similar types of private sector risk-sharing arrangements (bonds, letters of credit, etc.) acceptable to the Secretary. Requiring developers to obtain as much insurance as they reasonably can would protect taxpayers and create demand that encourages development of private sector offerings.

We recommend along with Mr. Moor that the statute give project developers an affirmative obligation to demonstrate that they have used their best efforts to obtain the maximum insurance coverage (broadly defined) available given the developer's individual circumstances. In addition, the statute should limit the government's financial exposure so that taxpayers will not pay for losses that could have been covered by such insurance.

Question 2. Also, Mr. Moor and states concerns with the term "equilibrium" that if it is not more adequately defined it could drag out the closure period for "an unjustifiably long time period". Do you agree with this statement? Do you feel that the term is too restrictive? Do you consider the additional 10-year period to be redundant?

Answer. EDF agrees that a strict application of the term "equilibrium" (or the similar term "stabilization") could extend the closure period beyond the time necessary. Our understanding is that there are likely to be some cases where secure storage can be demonstrated, prior to equilibrium, even though the CO_2 plume will continue to migrate slowly for many decades or even centuries.

The attached letter, submitted to EPA on December 23, 2008 by a diverse group of stakeholders including EDF, the American Petroleum Institute and the Edison Electric Institute, recommends a set of closure standards that would not require equilibrium or stabilization to be expressly demonstrated in every case. The suggested standards are based on earlier work by the World Resources Institute and the Ground Water Protection Council. If EPA and other regulators adhere to these proposed closure standards in their entirety, we believe the standards will lead to appropriate decisions on whether and when to certify sites for closure. We ask that the letter be made a part of this record.

While EDF believes that in the future it will not be necessary to demonstrate stabilization in every case (we prefer the term "stabilization" to "equilibrium"), we do not oppose using the concept in a bill relating to early projects so long as the concept is not applied in an overly strict manner. Stabilization has an intuitive, common-sense appeal and requiring evidence related to stabilization may promote public acceptance of the emerging technology. Moreover, even as a technical matter, there is a sense in which a degree of stabilization is important. In order to be sure that the stabilization requirement is not overly strict, we suggest that the bill be amended to require a determination of whether the carbon dioxide plume has stabilized "to the degree necessary" to begin an assessment of whether closure standards have been satisfied.

With regard to the ten-year period, we do not view it as redundant. In fact, we do not view it as "additional" to the closure evaluation required by the bill. Instead, as we read the bill, the ten-year period is treated as an integral part of the closure assessment process. The bill's approach to closure evaluation appears to be based on the concept that assessment should occur over a minimum span of time and the concept that a project should have a "clean bill of health" throughout the period. The question in our mind is whether this is a reasonable approach.

EDF believes that sequestration projects can be regulated in the future without requiring post-injection monitoring for a fixed period of time. The important thing is to require that projects meet environmentally sound performance standards before the projects qualify for closure—regardless of how much or how little time it takes to meet the standards. Nevertheless, we do not oppose the idea of a fixed, minimum evaluation period as part of the oversight of early projects. Like the stabilization concept, this idea has an intuitive, common-sense appeal and may promote public acceptance of the emerging technology.

RESPONSES OF A. SCOTT ANDERSON TO QUESTIONS FROM SENATOR MURKOWSKI

OPTIONS FOR ADVANCING CARBON SEQUESTRATION

Question 3. The debate on domestic policies related to global climate change is still very much underway.

Absent a price on carbon, and in addition to the liability option that is under consideration in the context of S. 1013, what other measures should the Congress consider pursuing to expedite the development and deployment of carbon sequestration technologies?

Answer. EDF supports the additional measures proposed by USCAP in order to expedite the development and deployment of carbon sequestration technologies. See USCAP, A Blueprint for Legislative Action—Consensus Recommendations for U.S. Climate Protection Legislation (January 2009). The USCAP suggestions are part of a larger climate initiative and are not a stand-alone proposal. In the absence of cap and trade legislation, we believe that any additional Congressional funding for carbon capture and sequestrations should be relatively modest. Consensus Recommendations for U.S. Climate Protection Legislation

PURITY OF CARBON DIOXIDE

Question 4. In some instances, it is my understanding that the flue gas to be sequestered from coal-fired plants may not be 100% pure CO_2.

Is the Environmental Defense Fund concerned about substances other than CO_2 being injected underground?

Answer. We do not expect injected CO_2 streams to be 100% pure CO_2, although we do expect the CO_2 content of the injected stream to be 95% or greater in virtually all cases. It is important to remember that the scientific consensus supporting the feasibility of CO_2 sequestration relates to CO_2 sequestration, not to the sequestration of flue gas. CO_2 needs to be separated from the flue gas before it is injected. While these are our expectations, we are not advocating new quantitative requirements relating to CO_2 content or to the content of substances that might be mixed with the CO_2. We believe that other substances should be prohibited if they interfere with storage site operations or if they are not incidental to the capture process.

There are some special situations where injection of substances other than the CO_2 itself might lead to problems, but at this point we do not think that new grants of regulatory authority are necessary in this regard. If the "other" substances were to cause the injection stream to qualify as a hazardous waste under RCRA, the injection operation would and should become subject to RCRA jurisdiction. Similarly, if substances were to leak from a storage formation and trigger CERCLA liability, the operation would and should be subject to the requirements of that statute.

The theoretical applicability of RCRA or CERCLA may never arise in practice. But there is one issue relating to "other substances" that is almost certain to arise—how much hydrogen sulfide should be permitted in the CO_2 stream? For safety reasons, CO_2 pipelines currently impose very strict limits on hydrogen sulfide content. The limits vary from pipeline to pipeline. We understand that in some instances the CO_2 capture process could yield incidental traces of hydrogen sulfide that, while small, are in excess of the current specifications of some pipelines but within the specifications used by other pipelines. We believe that this is an issue that deserves the close attention of regulators and policymakers, but at this point we do not believe that any new regulatory authority is needed in order to deal with possible problems.

RESPONSE OF A. SCOTT ANDERSON TO QUESTION FROM SENATOR STABENOW

Question 1. While it is imperative to identify quality geological formations that will contain carbon with as little risk of leakage as possible, I would like to know more about other ecological and environmental risks that may be present. Mr. Moor of Southern Company mentioned in his written testimony the risks that injected carbon may pose to ground water. In a place such as Michigan where water is carefully monitored and protected, please tell me: what we need to do to ensure water quality while finding more opportunities for CCS?

- Has United States Geological Survey studied this issue?
- What have we learned from injecting carbon into old gas and oil wells?
- Are there adequate protections from the Safe Drinking Water Act? While EPA is not present here, is it already considering this?

Answer. These are large and important questions! Fortunately there are good reasons to expect that 99% or more of CO_2 sequestered in geologic formations will remain in place for 1000 years or more—if the sites are properly selected and properly managed. See, for example, the International Panel on Climate Change Special Report on Carbon Dioxide Capture and Storage (2005) and literature reviewed by EPA in Docket No. EPA-HQ-OW-2008-0390, Proposed Rule for Geologic Sequestration of Carbon Dioxide.

The importance of proper site selection and proper operations cannot be overemphasized—geologic sequestration is not something that can be done just anywhere and it requires sophisticated oversight by both the companies involved and regulators. EDF agrees with the International Panel on Climate Change and with the U.S. EPA that the necessary tools and expertise are available. As a technical matter, CCS is ready to begin deployment today.

I believe that one of the most important objectives in the oversight of geologic sequestration projects is assuring that formation fluids displaced by CO_2 injection are not driven out of the underground storage area and into an underground source of drinking water. Michigan will want to make sure that requirements include: (1) confining zones of sufficient quality and lateral extent to confine both displaced formation fluids and injected CO_2; (2) a definition of "zone of elevated pressure" that is designed to guard against either CO_2 or formation fluids being driven into a USDW; (3) modeling movement of both the CO_2 plume and formation fluids; (4) monitoring of ground water quality and any geochemical changes above the confining zone; (5) remedial response plans in the event problems appear to be developing; and (6) a prohibition against sequestering CO_2 above the lowermost source of drinking water

unless special rules are followed relating to assessing confining layers beneath the injection zone, monitoring, and conducting regional hydrogeologic studies. EPA has proposed requiring (1) though (5). In the case of (6), EPA has proposed an even stricter approach—a total prohibition on sequestration above the lowermost USDW.

The USGS is in the process of studying issues regarding geologic sequestration. For example, see DOI, Report to Congress: Framework for Geological Carbon Sequestration on Public Land (2009) (USGS, as well as EPA and DOE, contributed to this study). As time goes on we hope that USGS will be able to continue to make significant contributions to the deployment effort.

For over 30 years, the oil industry has injected without serious incident significant quantities of CO_2 in order to enhance petroleum production. Injections currently total about 35 million tons per year. In the process much has been learned about the behavior of CO_2 underground. The oil and gas industry has developed expertise in a number of other areas as well that are useful for geologic sequestration, e.g., various types of seismic imaging, techniques for calculating site-specific limits on injection pressures, and well construction techniques that are capable of preventing leakage from the injection zone back to the surface.

At this time we believe EPA's Safe Drinking Water Act authority is adequate to regulate geologic sequestration for purposes of protecting underground water quality.

RESPONSES OF VICTOR K. DER TO QUESTIONS FROM SENATOR MURKOWSKI

Question 1. Number of Projects—The 2007 Energy Bill authorized 7 CCS demonstration projects, FutureGen represents another, CCPI will presumably result in at least one, and S. 1013 would provide for 10 more. That represents, minimally, 19 demonstration projects.

Does the Department believe this number is too high, too low, or about right in terms of the number of demonstrations that will be required to prove the viability of carbon capture and sequestration technologies at a sufficiently diverse number of geological and geographical sites throughout the country?

Answer. The Department of Energy believes that in order to demonstrate the long term, safe storage of CO_2, projects covering a wide variety of geologies, formations, and reservoir types must be tested. We also need to demonstrate integrated carbon capture and storage (CCS) demonstrations with both current and evolving capture technologies. We believe that the 19 projects cited will provide a strong foundation to demonstrate the viability of CCS technologies, and would represent the minimum number of projects necessary to set the stage for early demonstration over the next few years.

Question 2. Quantifying Risk—It has proven somewhat difficult to calculate the risk profile of loan guarantees for clean energy projects (under Title XVII of the 2005 Energy Policy Act) that have a verifiable cost in terms of the amount of the individual loans to be guaranteed. The potential liabilities and attendant risk profiles associated with carbon sequestration demonstration projects are even less certain and include bodily injury, sickness, disease, death, loss of or damage to property, loss of use of property, and injury to or destruction or loss of natural resources (including fish, wildlife, and drinking water supplies) according to the legislative text of S. 1013,

Is the Department prepared to calculate the fees required by this bill (on page 8, line 21 of S.1013) to cover potential liabilities?

Have you given any preliminary thought to how you would go about that task?

What is the precedent for a calculation of this kind? Specifically, what are the relevant differences and similarities between the approach taken by 8.1013 and both the Price-Anderson indemnification program and that established by Public Law 85-804?

What are some examples of potentially suitable financial protections to be maintained (on page 6, line 6 of S. 1013) by the non-federal participants in any of the 10 demonstration projects authorized and does the Department have information (anecdotal, quantifiable or otherwise) that it can share on the availability, or lack thereof, of private insurance policies for carbon sequestration operations?

Answer. To answer your first question, no, DOE is not presently prepared to make these calculations.

DOE is still researching and identifying possible examples of financial protection applicable to CO_2 storage. However, it is notable that private insurance companies are starting to develop products to cover some of the risks associated with geologic injection and storage of CO_2.

Question 3. Existing Appropriations—There are now approximately $4.1 billion at DOE for projects related to carbon sequestration. For at least a portion of that money (that which is spent pursuant to the Section 702 authorization of the 2007 Energy Independence and Security Act), there is a statutory requirement that 1 million tons of CO_2 be injected per year or that a project be undertaken at a scale that demonstrates the ability to inject and sequester several million metric tons of industrial source carbon dioxide for a large number of years. S. 1013 would decrease that requirement for the existing Section 702 authorization and retain it for the newly (and potentially) authorized 10 projects in the bill.

Is it possible for DOE to spend the already appropriated $4.1 billion on projects that would inject 1 million tons of CO_2 annually without the option to indemnify the nonfederal participants?

Is it possible for DOE to spend the already appropriated $4.1 billion on projects that are undertaken at a scale that demonstrates the ability to inject and sequester several million metric tons of industrial source carbon dioxide for a large number of years without the option to indemnify the non-federal participants?

The day following the legislative hearing on S.1013, the Department announced funding for $2.4 billion in CGS projects. Did that funding include a minimum of 1 million tons of CO_2 injected annually as part of the eligibility criteria, or that the projects are undertaken at a scale that demonstrates the ability to inject and sequester several million metric tons of industrial source carbon dioxide for a large number of years?

Is the $1.52 billion associated with the "Industrial Carbon Capture and Storage" to be made available pursuant to the Section 702 authorization, or some other provision of law?

Answer. Regarding indemnification and spending per the appropriated funding, it is unknown at this time how the indemnification provision in S. 1013 will impact the number or quality of applications for the Industrial Carbon Capture and Storage (ICCS) program and Clean Coal Power Initiative (CCPI) Round 3, both authorized for funding by the American Recovery and Reinvestment Act of 2009 (Recovery Act). We expect that applicants may be willing to accept the risk and propose projects. The CO_2 capture and injection goals of the Department of Energy, however, are unaffected by the indemnification provision in S.1013.

The ICCS and CCPI programs, as authorized by the Recovery Act, are to demonstrate the integration of CO_2 capture and storage methodologies. The ICCS Funding Opportunity Announcement sets a target of I million tons CO_2 sequestered per plant per year by 2015. The amount of CO_2 sequestered will be one of the evaluation criterion. The CCPI has a requirement for a minimum of 300,000 tons of CO_2 per year.

Consistent with the conference language accompanying the Recovery Act, the $1.52 billion will be used for industrial carbon capture and storage authorized pursuit to Section 703 of the Energy Independence and Security Act and an allocation for beneficial use of CO_2.

Question 4. The Role of States—In competing for the FutureGen site selection, both Illinois and Texas passed state laws to assume ownership of and liability for, the injected CO_2.

What is the Administration's position on the role of the states in terms of long-term stewardship of CCS sites, as compared to the federal role contemplated by S. 1013?

Answer. Some states have passed laws to assume ownership and liability of the CO_2 for a particular project, while several others have passed or are looking to implement laws assigning ownership and liability to industry. The legal framework for carbon capture and storage will need to address liability, pore space ownership, and pertinent regulatory authority. The potential for wide variability in how states address these issues is great since some states have extensive experience in oil and gas production, some states have experience in regulatory permitting, while others have limited experience related to both. DOE and other Federal agencies are currently reviewing S.1013 regarding the state versus the Federal role in assuming liability for injected CO_2 after which recommendation to the Administration can be made.

RESPONSES OF VICTOR K. DER TO QUESTIONS FROM SENATOR SHAHEEN

Question 1. Much of DOE's work on clean coal has been on the technology development front, but it's good to hear you are also working on storage issues and sequestration issues for CCS. Many of the individual pieces of a CCS system are known—that is how to capture carbon at the combustion source, how to transport CO_2 and how to geologically sequester it. Yet the real challenge seems to be to com-

bine all of these different technologies into a working system. In your view, what kinds of time horizons are we looking at for the deployment of large-scale CCS projects in the utility sector?

Answer. The President's budget proposal for FY 2010 calls on Congress and stakeholders to work with the Administration toward the goal of reducing of our greenhouse gas emissions to a level that is about 14 percent below 2005 levels by 2020 and 83 percent below 2005 levels by 2050. Initiating commercial implementation of carbon capture and storage (CCS) in the 2020 timeframe is required to ensure that new plants can economically incorporate CCS and that CCS technology can be affordably applied to the existing coal-fired power plants so that they too can contribute towards the 2050 reduction target.

Question 2. In your testimony you state that "today's commercially available CCS technologies will add around 80 percent to the cost of electricity for a new pulverized coal plant." Is it fair to say that as CCS technologies ramp up, and we learn from some of the earlier "first-of a-kind' CCS facilities that these costs will come down? Do you have any sense of how long it will take for the price of these CCS facilities to come down?

Answer. The carbon capture and storage (CCS) technology research, development and demonstration effort is focused on achieving specific performance goals, including reducing the cost of capture technology, along a timeline that will result in marked improvements over today's technology. Experience from first-of-a-kind demonstrations should result in the ability to identify cost reductions, efficiency improvements, sustained reliability and other optimizations for follow-on plants with CCS. These integrated goals are applicable to both the existing fleet of coal-fired power plants as well as the new near-zero emission coal-fueled energy systems of the future. These goals are described in the FY2010 Congressional Budget Request:

- By 2012, validate pre-combustion capture technology(ies) that if integrated with an IGCC power plant, through a rigorous systems analysis, could show "near-zero" atmospheric emissions configurations at no more than 10 percent increase in the cost of electricity relative to 2003 technology baseline (pulverized coal).
- By 2013, complete bench-scale development of advanced post-and oxy-combustion capture technologies that are capable of 90 percent CO_2 capture at no more than a 35 percent increase in cost of electricity.
- By 2020, complete full-scale demonstration of advanced post-and oxy-combustion CO_2 capture technologies that can achieve 90 percent CO_2 capture at a target of less than a 35 percent increase in cost of energy.

It is difficult to make any definitive comments regarding the decrease in CCS technology costs with time. The economics and commercial viability of CCS implementation will depend on factors other than successful technology demonstration, such as, maintenance costs for the technology and changes in legislation regarding greenhouse gas emissions.

Question 3. Do we have any time horizons and costs of scale for other technologies, for example the development of nuclear power that we can compare CCS to?

Answer. We do not have credible methods for comparing the time horizons and costs of scale for nuclear power or other alternative technologies with carbon capture and storage (CCS).

Some CCS technology has the benefit of decades of experience from the oil and gas industry. For example, the oil and gas industry experience in exploration, drilling and enhanced oil recovery using CO_2 flooding has produced significant understanding of the storage of CO_2 as well as preliminary evidence of its permanence. Furthermore, the capture of CO_2 from a dilute combustion stream is somewhat analogous to the capture of SO,, and NO from these streams Lessons learned and technology developed in these related fields will help to advance CCS technology in a timely manner. Demonstrating the safe and effective long-term geologic storage aspects to the public will also be addressed as part of our program as we move forward with CCS.

RESPONSES OF VICTOR K. DER TO QUESTIONS FROM SENATOR BUNNING

Question 1. Mr. Der, as you know I am a proponent of coal-to-liquid fuels technology. I believe this promising technology paired with carbon capture can provide a domestic supply of diesel and jet fuel in an environmentally responsible manner. In the past I have introduced legislation to provide government incentives, in the form of tax credits and planning loans, for the first few coal-to-liquid facilities. Do you believe that coal-to-liquid facilities with carbon capture capability can help ac-

celerate the demonstration of stored C.O.2 in conjunction with enhanced oil recovery and saline aquifer storage?

Answer. A coal-to-liquids facility will act like any other industrial source of CO_2 and, when integrated with CCS technology, provide a stream of CO_2 that can be used to demonstrate CO_2 storage, such as in a saline aquifer, or used to commercial benefit, as in enhanced oil recovery. Additionally, DOE's National Energy Technology Laboratory's analyses have shown that a coal and biomass to liquids facility, using indirect liquefaction technology with carbon capture and storage (CCS) capability (e.g. enhanced oil recovery systems, saline aquifers), could produce liquid fuels that have over a 30 percent lower life cycle Greenhouse Gas (GHG) emissions than petroleum-derived diesel.

Question 2. Mr. Der, in your testimony you outline the funding that was provided to D.O. E for sequestration in the American Recovery and Reinvestment Act. Could you discuss your funding needs for these projects in the long term?

Answer. Funding in the American Recovery and Reinvestment Act of 2009 (Recovery Act) will allow us to accelerate the development of technology required to capture and store CO_2 by fully funding early carbon capture and storage (CCS) projects. The goal is to have advanced CCS technologies demonstrated by 2020, which would then allow CCS to be widely deployed. Recovery Act funding helps to achieve that goal by allowing us to accelerate research and development of applicable capture and storage technologies, while working to reduce their cost and speed their commercial potential. This would entail additional follow-on demonstration projects in the outyears that would incorporate improved, lower-cost CCS technologies resulting from our R&D program.

Question 3. What information and data do you hope to gain from the 7 regional partnerships demonstrations? When will this information become available?

Answer. The DOE Regional Carbon Sequestration Partnerships (RCSPs), located throughout the United States, have completed a significant amount of work on the characterization of their regions for opportunities to store CO_2 in different geologic formations. Each of the RCSPs has created a digital atlas for its region, which contains information on the sources of CO_2 and the storage capacity. The DOE has worked with all of the RCSPs to standardize their capacity assessment methodology and combine the regional data into one system called the National Carbon Sequestration Database and Geographic Information System (NATCARB), which is an interactive atlas and is available free, online, to the public. In addition to NATCARB, DOE has worked with the US. Geological Survey and others to develop and produce the Carbon Sequestration Atlases for North America. The results of these assessments have shown that there is enough capacity to store the emissions from major point sources in North America for hundred of years.

The RCSPs are also working on technical, regulatory and permitting issues during the operation of over 30 field projects in different geologic settings. The lessons learned are being documented by the partnerships to identify the technologies and protocols which would result in cost effective storage of CO_2 in deep geologic formations such as oil fields, coal seams, and saline formations. The DOE and the RCSPs are also working on a series of best practices manuals to consolidate these lessons learned for future stakeholders. The first of these manuals was released earlier this year and summarizes the best practices from the monitoring, verification, and accounting of geologically stored CO_2. Over the next year, the DOE and the RCSPs will work on additional best practices manuals for site characterization and selection, well construction, public outreach and education, simulation and risk assessment. These and other manuals will be developed and updated as the partnerships complete their large-scale field projects.

We understand that the knowledge and experience gained has also been useful to the U.S. Environmental Protection Agency as it develops regulations for geologic storage of CO_2.

RESPONSES OF KIT BATTEN TO QUESTIONS FROM SENATOR BINGAMAN

Question 1. Having reviewed S.1013, do you feel that the role of the DOI and CCS on public lands is adequately defined in the bill to proceed with the liability program that is proposed? If not, what would you recommend?

Answer. The authority in S. 1013 focuses on the role of the Department of Energy (DOE) in carrying out demonstration projects for the large-scale, commercial application of carbon capture and sequestration. In general, section 963A(g) of the bill allows the Secretary of Energy to provide indemnification to participants, and contains a definition of liability, an exception for gross negligence and intentional misconduct, and provisions for determining the fee to be paid by participants for indem-

nification and the use to which the fees collected must be put. In contrast, the Department of the Interior does not oversee the liability treatments of projects and participants under S. 1013, but instead is tasked with authorizing the siting of projects on federal land under its jurisdiction, consistent with all the applicable laws and management plans and subject to any terms and conditions the Secretary of the Interior deems necessary. In addition, the Department of the Interior is also given authority (at sec. 936A(e)(7)) to determine whether the financial protections, such as bonding, provided by the participant for a project are acceptable. While we defer to DOE as to the overall position on the liability provisions in general, we believe that the role of the Department of the Interior on public lands is adequately defined in the bill to proceed.

Question 2. The Section 714 (EISA of 2007) report states that many authorities currently exist to address CCS needs, such as for managing pipelines, roads, and infrastructure (and other issues). It goes on to state that existing authorities are not likely to address all the unique issues that carbon sequestration presents. Could you elaborate a bit more on what gaps exist in the existing authority that lawmakers need to address?

Answer. While existing authority is likely adequate for many carbon capture and sequestration needs, there are situations unique to the development and more widespread use of this technique, and some of these may require legislative action. These include, for example, not only the need for clear leasing authority and a mechanism to provide for the long-term stewardship of sequestration sites, but:

- clarification of how long-term carbon storage may affect other uses of the public lands, in particular the future extraction of other minerals;
- clarification of the ownership of subsurface pore spaces in split estate situations; and
- clarification of the ownership of sequestered CO2 and other gases, and the resulting liability for any environmental damage caused by the sequestered gas.

RESPONSE OF KIT BATTEN TO QUESTIONS FROM SENATOR MURKOWSKI

Question 1. In competing for the FutureGen site selection, both Illinois and Texas passed state laws to assume ownership of, and liability for, the injected CO_2.

What is the Administration's position on the role of the states in terms of long-term stewardship of CCS sites, as compared to the federal role contemplated by S. 1013?

Answer. The Department of the Interior's role in S. 1013 involves siting and other activities on the public lands that it manages. In this regard, the long timeframes envisioned for sequestration and the post-closure phase of facilities on public lands suggest that only the federal government will likely have the fiscal resources to manage the ongoing risk and offer the expectation of maintaining continuity of long-term stewardship across generations for these projects.

RESPONSE OF KIT BATTEN TO QUESTION FROM SENATOR STABENOW

Question 1. While it is imperative to identify quality geological formations that will contain carbon with as little risk of leakage as possible, I would like to know more about other ecological and environmental risks that may be present. Mr. Moor of Southern Company mentioned in his written testimony the risks that injected carbon may pose to ground water. In a place such as Michigan where water is carefully monitored and protected, please tell me: what we need to do to ensure water quality while finding more opportunities for CCS?

Has United States Geological Survey studied this issue?

What have we learned from injecting carbon into old gas and oil wells?

Are there adequate protections from the Safe Drinking Water Act? While EPA is not present here, is it already considering this?

Answer. While the U.S. Geological Survey has engaged in a number of studies evaluating geological and geochemical factors that improve understanding of processes occurring during geologic storage of CO_2, the potential risks associated with storage of large volumes of CO_2, and some potential environmental impacts of geologic sequestration, the focus of USGS evaluations of these risks is generally at the regional or basin scale. The evaluation and mitigation of the risks at the scale of individual site-specific injection projects is generally covered by the Environmental Protection Agency. The USGS has also collaborated with the Department of Energy on sequestration projects such as the DOE-lead Geo-SEQ program, a consortium of National Laboratories working on monitoring technologies and simulation codes for CO_2 storage; the DOE-sponsored Frio Brine project in Texas; and review of the ef-

forts by DOE to develop several large scale field projects throughout the United States.

However, there remains uncertainty with respect to the ability to sequester carbon dioxide in geologic reservoirs. Current outstanding research issues include:

- determining the capacity of seals to retain CO_2;
- characterizing, on a regional extent, the integrity of seals above potential storage systems;
- defining the potential for mobilization of trace metals and organic materials by CO_2 reactions with minerals or dissolution of organic components;
- determining the need for new or improved tools to sample formation waters for site evaluation and measurement, monitoring, and verification during storage and following site closure;
- improving prediction of the solubility of CO_2 in saline formations during and following injection;
- understanding the role of bacteria and other microorganisms in water-rock-CO_2 interactions relevant to sequestration; and
- characterizing and understanding where fresh water/saline formation boundaries occur in geologic basins throughout the United States.

The USGS is currently working on several of these issues.

The underground injection of CO_2 for purposes such as enhanced oil and gas recovery is a long-standing practice. However, CO_2 injection specifically for geologic sequestration involves different technical issues and potentially much larger volumes of CO_2 and larger scale projects than in the past. As noted above, research efforts to evaluate the technical aspects of geologic sequestration of CO_2 are currently underway.

Lastly, geologic sequestration of CO_2 through well injection meets the definition of "underground injection" in section 1421(d)(1) of the Safe Drinking Water Act (SDWA), and the EPA has authority for underground injection of CO_2 under the SDWA Underground Injection Control program, and EPA and states, territories, and tribes that have primacy for these programs act as co-regulators to protect such waters from any potential endangerment from underground injection of CO_2.

RESPONSE OF KIT BATTEN TO QUESTIONS FROM SENATOR BUNNING

Question 1. Do you believe that there needs to be some type of expedited process for NEPA reviews of demonstration projects on BLM lands? Or a NEPA waiver for approved projects? As you know, these reviews are often used as a delaying tactic by environmental groups.

Answer. The National Environmental Policy Act is intended to protect the public health and safety and environmental quality by ensuring transparency, accountability, and public involvement in federal actions and in the use of public funds. Given the complexity of the issues surrounding the development of these projects on public lands and the potential impacts of geologic carbon sequestration itself, it is important that applicable environmental reviews be carried out. These NEPA reviews will ultimately help the Department identify appropriate and specific areas for siting and development of carbon sequestration and capture projects.

We recognize that applicable NEPA reviews must be completed in an expeditious manor. Following an orderly process, and based on sound information, these reviews will provide us with a solid foundation on which to defend our decision-making.

○