

**CARBON CAPTURE AND SEQUESTRATION
LEGISLATION**

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

SECOND SESSION

TO

RECEIVE TESTIMONY ON CARBON CAPTURE AND SEQUESTRATION LEGISLATION, INCLUDING S. 1856, S. 1134, AND OTHER DRAFT LEGISLATIVE TEXT

APRIL 20, 2010



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CONTENTS

STATEMENTS

	Page
Barrasso, Hon. John, U.S. Senator From Wyoming	5
Bingaman, Hon. Jeff, U.S. Senator From New Mexico	1
Brownstein, Mark S., Deputy Director, Energy Program, Environmental Defense Fund	40
Casey, Hon. Robert P., Jr., U.S. Senator From Pennsylvania	2
Castle, Anne, Assistant Secretary for Water and Science, Department of the Interior	13
Hilton, Robert, on Behalf of Ms. MacNaughton, CB, Senior Vice President, Power and Environmental Policies, Alstom Power	29
House, Kurt Zenz, Ph.D., President, C12 Energy Research Fellow, MIT	43
Markowsky, James, Assistant Secretary for Fossil Energy, Department of Energy	6
Murkowski, Hon. Lisa, U.S. Senator From Alaska	4
Vann, Adam S., Legislative Attorney, American Law Division, Congressional Research Service	47
Yamagata, Ben, Executive Director, Coal Utilization Research Council	33

APPENDIX

Responses to additional questions	63
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CARBON CAPTURE AND SEQUESTRATION LEGISLATION

TUESDAY, APRIL 20, 2010

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

The committee met, pursuant to notice, at 10:03 a.m. in room SD-366, Dirksen Senate Office Building, Hon. Jeff Bingaman, chairman, presiding.

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

The CHAIRMAN. OK, why don't we go ahead?

Welcome everyone today. I thank the witnesses who are testifying before the committee on these bills. This is a hearing on S. 1856 and S. 1134, as well as a legislative discussion draft proposed by Senators Rockefeller and Voinovich.

These bills each focus on important issues associated with the deployment of commercial carbon dioxide capture and storage, CCS technologies. S. 1856 focuses on the issue of pore space ownership in the subsurface below Federal lands. S. 1134 focuses more broadly on CCS research, development, and demonstration related generally to clean coal power generation. The draft legislation aims to accelerate the commercial viability of CCS technologies and methods by supporting commercial-scale demonstrations of integrated CCS technology projects.

The topic of reducing greenhouse gases, particularly carbon dioxide emissions, remains of great concern to this committee and to myself. Carbon capture and storage holds promise as one means that can be used to mitigate global climate change, while still allowing the use of fossil fuels at electricity-generating plants and industrial facilities.

With discussions centered on coal use in a carbon-constrained world, integrated carbon capture and storage systems may present the most immediate solution for continued use of coal and other carbon-intensive fuels while not contributing further to carbon dioxide emissions and global warming.

Last May, I introduced S. 1013. That was legislation that focused on reducing some of the uncertainty for CCS project developers by providing an indemnity program for the first 10 early mover commercial-scale CCS projects. We had a hearing in this committee that received testimony not just on that bill, but also on the issues that are being discussed today, particularly on pore space ownership.

S. 1013 did make it through the committee process. It is now part of the larger energy bill that we have reported from this committee. However, much work still needs to be done to scale up CCS technologies to meet the level of carbon reductions that are needed to mitigate the effects of climate change.

Earlier this year, President Obama announced he would begin charting a path toward a cleaner future for coal use by initiating the Interagency Task Force on Carbon Capture and Storage. The task force, which is co-chaired by one of our witnesses today—Dr. Markowsky from the Department of Energy—is working to develop a plan to overcome the barriers to widespread cost-effective deployment of CCS within 10 years.

We look forward to hearing more about what that task force has identified as challenges for CCS deployment, also to how we, as members of this committee, can work with the administration to address and overcome some of those challenges.

I would like to begin by welcoming the original bill sponsors who have come to speak to us today. Senator Casey is here to speak on the issue of S. 1134, and Senator Barrasso, who is, of course, a valued member of this committee, will introduce his and talk about his bill, S. 1856.

So, Senator Casey, why don't you go ahead and tell us anything we need to know about your proposed legislation?

Senator CASEY. Thank you very much, Chairman Bingaman and Ranking Member—

The CHAIRMAN. Excuse me, I'm sorry. Senator Murkowski needs to give an opening statement here before we call on you.

Senator MURKOWSKI. Mr. Chairman, I respect the fact that we have conflicting schedules. So if Senator Casey needs to move to another committee hearing this morning, I would certainly be happy to defer my opening to allow you to give yours, if you would like.

**STATEMENT OF HON. ROBERT P. CASEY JR., U.S. SENATOR
FROM PENNSYLVANIA**

Senator CASEY. Thank you very much. Chairman and Ranking Member Murkowski, I appreciate the courtesy.

Senators Barrasso, Bunning, and Burr as well, thank you for this opportunity.

I wanted to talk briefly—and it will be brief, I know we have other witnesses here—about the bill that I introduced, S. 1134, the Responsible Use of Coal Act of 2009.

The bill provides the Department of Energy's National Energy Technology Laboratory with the funding needed to accelerate research, development, and demonstration and, ultimately, the deployment of carbon capture and storage technology and other critical advanced coal power generation technology needed to respond to climate change. Further, the bill would position the United States as the world leader in CCS technology development and export, creating the potential for thousands of new clean energy jobs.

Climate change is one of the most complex and challenging imperatives that our Nation and even the world has ever faced. We need to move forward in crafting legislation that will reduce green-

house gas emissions, encourage the use of renewable power, and create clean energy jobs.

As we move forward, we must do so in a manner that will ensure our energy security and protect our industries from so-called “carbon leakage” and help get our economy back on track and enable us to continue to benefit from our most abundant, affordable energy resource, and that is coal. Today, coal provides over half of the Nation’s electricity. It helps keep American homes, businesses, factories, airports, schools, and hospitals humming and creates millions of good-paying jobs across all sectors of the economy.

Further, much of the world depends upon coal. Large economies like China and India are increasingly relying upon coal to power them into the 21st century.

While the use of coal in the United States has more than tripled since 1970, emissions of sulfur dioxide, nitrogen oxide, and particulate matter from power plants have been dramatically reduced, reduced, as the power industry deploys technologies for capturing these pollutants. This illustrates how advanced technology has allowed coal to remain a critical component of the Nation’s energy strategy in the face of ever-increasing environmental requirements.

However, the continued use of coal in the United States and abroad is facing its toughest challenge ever. That is how to use this abundant resource without having a negative impact on our climate.

Coal combustion is the largest source of CO₂ emissions, both domestically and globally. Therefore, the technology needs to be developed that can cost effectively capture and store or reuse the CO₂ emitted by the coal-fired plants and large industrial sources of greenhouse gases. My bill, S. 1134 supports the continued research, development, and demonstration of CCS technology being carried out by the Department of Energy’s National Energy Technology Laboratory.

Just quick highlights of the bill. First of all, the bill would promote the continued large-scale commercial demonstration and, ultimately, the deployment of the most promising integrated CCS systems.

Second, the bill would promote the continued research and development of advanced pre-combustion, oxy-combustion, and post combustion CO₂ capture technology and geological storage concepts in order to drive down costs, increase performance, and foster innovation. It is critical that in addition to the commercial demonstration of current CCS technology, we continue to develop and advance new CCS ideas and concepts through a robust research and development program in order to continue to lower the cost of CO₂ capture and storage.

Next, the bill will promote the continued research and development of other coal power generation technologies, including gasification, combustion turbines, fuel cell, and hydrogen production.

Next, the bill will promote the export of U.S. CCS technology to those countries such as China and India, which rely upon coal as their dominant energy source, ensuring that the United States is the leader in developing and exporting clean coal technologies and taking advantage of thousands of new clean energy jobs such as this industry would create.

I should point out that a critical outcome of the implementation of this bill will be the data necessary to support the creation of a framework to address the liability and long-term stewardship of commercial geological CO₂ storage operations. Such a framework was introduced last year by Senator Enzi and I in the Carbon Storage Stewardship Trust Fund Act of 2009.

Let me close by saying that I applaud the work of this committee and your committee's efforts in particular to recognize the important role that coal plays in driving our economic engine every day. I look forward to working with you to move forward legislation that will accelerate the research, development, demonstration, and deployment of CCS and advanced coal technology.

I appreciate this opportunity, and I appreciate the willingness of the ranking member to allow me to jump ahead of the line. It doesn't happen very often in Washington, but we are grateful.

Thank you, Mr. Chairman.

The CHAIRMAN. All right. Thank you very much for your statement. Unless any member has a question, we will allow you to get on to your other responsibilities.

Senator Murkowski, why don't you go ahead with any statement you have?

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

Senator MURKOWSKI. Thank you, Mr. Chairman.

I am pleased to be able to provide that opportunity to Senator Casey, and I look forward to Senator Barrasso speaking to his legislation as well.

Mr. Chairman, you mentioned in your opening comments our bipartisan energy bill that we moved through this committee sometime ago. I have stated before that I would like to see us take this up, debate it on the floor, and move it to the President.

But hearings like this remind us that there is always more that we can do in this committee and to provide an opportunity to hear from agencies and stakeholders about the progress that we have made. I think we will be getting some of that this morning.

I think CCS is a perfect example. Its applications are broad, including enhanced oil recovery, cement mixtures, or merely underground injections for the sake of climate. It can be applied to a number of fossil feedstocks, but of course, coal-fired projects appear to be the most promising to start with.

Carbon sequestration is the newest entrant into how we mark the difference between regular coal and clean coal. Over the years I think that that definition of clean coal, how we define it, has shifted and perhaps dramatically. Where once it meant that particulate sulfur dioxide, mercury, and other emissions had been reduced, it now means we must separate and sequester the carbon building blocks of the fuel itself. It makes sense to ask more of a fuel that is already so cheap, so abundant, particularly in light of what we are seeing with our changing climate.

Our recent experience has shown what a complicated endeavor carbon sequestration can be and the need for the responsible policies to promote it. Attempts to deploy this technology have raised

questions about everything from liability and infrastructure to chemical reactions and ownership of pore space.

We have made strides in many of these areas, but hopefully, today's hearings will help us advance just a little bit further. Ultimately, it is my hope that coal can be used not just more cleanly, but more broadly as well. We have some great opportunities through gasification for expanding the application of this abundant domestic resource to make America more secure from an energy standpoint.

We know that Senator Dorgan is well aware of these opportunities, as his State hosts the only facility to convert coal into synthetic natural gas there in North Dakota. That project makes a number of valuable commodities and sequesters much of its carbon dioxide emissions through the enhanced oil recovery.

In my State, we have a project that is being looked at by Cook Inlet Region, Inc. This is looking at avoiding the need to mine coal seams altogether with a technology called in situ gasification. This process could provide synthetic gas to power a 100-megawatt generating plant, bring a whole new supply of electricity to the region for economic development, and we are very intrigued about the prospects.

So the goalposts are moving for coal, but I think that we can keep up with it. I am glad to see both the Interior and Energy Departments here this morning. These contributions from your departments are essential if we are going to succeed in making the best possible use of our domestic coal reserves.

Whether it is coal and carbon sequestration, rare earths or green technologies, or nuclear power and a stable supply of uranium, it is essential that agencies coordinate so that their policies do not conflict with one another. So I am also glad that we are going to have a second panel this morning of experts and stakeholders about the progress that can be made in advancing carbon sequestration as quickly as possible.

Again, I would like to thank the sponsors of the legislation that we will have here before us this morning, and I just appreciate their good work in moving this forward.

Thank you, Mr. Chairman.

The CHAIRMAN. Thank you.

Senator Barrasso, do you want to give us a short introduction as to your legislation, and then we will go to the witnesses?

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

Senator BARRASSO. Thank you very much, Mr. Chairman.

I welcome the witnesses. As we have heard from Senator Casey and Senator Murkowski, coal is an essential part of America's energy future. Right now, half of the electricity in the United States comes from coal.

Coal is affordable, abundant, and reliable. Most importantly, coal is an American energy resource, and America cannot afford to leave stranded its most abundant, commercially viable energy resource.

Coal creates American jobs. It generates revenues for Federal, State, and local governments, and it enhances America's energy security.

So to make commercial-scale carbon sequestration a reality, we must provide the legal and the regulatory framework to do so. We must address the long-term liability. I want to thank Chairman Bingaman for his leadership on the liability issue. I am an original co-sponsor of the chairman's bill.

I introduced legislation clarifying pore space ownership under the Federal surface estate. Determining pore space ownership is a key aspect of creating the legal framework that is needed for carbon sequestration.

Addressing these questions is essential to ensuring the long-term viability of coal. That is why I have introduced S. 1856, the Federal pore space ownership legislation, which essentially defines pore space as the subsurface space of any size that can be used to store carbon dioxide or other substances. It clarifies that the Federal Government owns the pore space below Federal land.

So, with that, Mr. Chairman, I want to thank the witnesses. I look forward to their testimony and have some questions after that.

The CHAIRMAN. Thank you very much.

Our first panel here, as I have mentioned, is made up of 2 officials—Jim Markowsky, who is the Assistant Secretary of Fossil Energy in the Department of Energy, and Ann Castle, who is the Assistant Secretary for Water and Science in the Department of the Interior. We appreciate both of them being here.

Dr. Markowsky, why don't you start, and we will hear from you. Then, Anne Castle, we will hear from you.

**STATEMENT OF JAMES MARKOWSKY, ASSISTANT SECRETARY
FOR FOSSIL ENERGY, DEPARTMENT OF ENERGY**

Mr. MARKOWSKY. Thank you, and good morning, Mr. Chairman and members of the committee.

I appreciate the opportunity to appear before you today. I will be addressing the congressional interest in CCS as demonstrated by bills introduced by Senators Casey, Barrasso, and the legislative action drafted by Senators Rockefeller and Voinovich.

As you consider these proposals and the issues they seek to address, I believe it would be beneficial to update you on the Office of Fossil Energy's program to advance CCS technology. Our CCS program is boosted by receiving \$3.4 billion for CCS through the Recovery Act. This is complemented by \$600 million from our CCPI program.

Our CCS program primarily focuses on coal now, which provides nearly half of the U.S. electric generation. But CCS will be required for both coal- and gas-fired systems to meet long-term CO₂ reduction goals. Our research is focused chiefly on the technical and economic challenges to commercially deploy CCS technologies for use in electric power generation and also industrial facilities.

We have 4 key areas in our coal program, and that is developing technologies for global competitive CO₂ capture; establish long-term basis for geological storage and CO₂ reuse; improve efficiency of both existing and new coal-based power plants, which directly reduces the CO₂ emissions and reduces the requirement for capture and storage and also reduces coal use; computer modeling and simulation from the molecular level to the integrated plant level, along with geological reservoir modeling.

Right now, we are pursuing large-scale demonstrations of the current first-generation CCS technologies. We are partnering with industry to build large-scale CCS demonstration facilities to gain invaluable experiences with integration of the CCS operations into power generation facilities and industrial plants by 2015.

We have 3 major programs. The first is our Clean Coal Power Initiative 3, which is a coal-based power generation for CCS with CO₂ storage and beneficial uses, such as EOR.

The next is our FutureGen program, and we have been working with our FutureGen Alliance and currently reviewing the continuation application for moving this project forward. We also have solicitations that we are reviewing for our industrial CCS program, and we are currently reviewing those applications with the intent of making final selections in June of this year.

From these programs, we anticipate having 8 to 10 large-scale CCS demonstration facilities operational in the 2015 timeframe. First-generation CCS costs are very high. Post combustion typically increases COE by—cost of electricity by 70 to 80 percent. Pre-combustion typically will increase that by 30 percent.

To drive down the costs of CCS, we are pursuing in parallel with the first-generation technology demonstrations, research and development to increase the power plant efficiency and develop advanced second-generation technologies. These include advanced carbon capture on retrofit of coal power plants, which will increase the efficiency and reduce the cost penalty by approximately one-third that of noncapture configurations.

Advanced gasification increases the efficiency advantage by 3 percentage points and, again, reduces the cost penalty by a third. Ultra supercritical steam cycle, where we are looking at temperatures of upwards of 1,300 degrees where currently we have 1,100 degrees, efficiency advantage of over 3 percentage points and, again, a cost reduction of approximately one-third of the penalty.

Oxy-combustion, we are looking at that also, where you are burning pulverized coal in an atmosphere of oxygen where the combustion products are primarily CO₂ with some water, and the cost penalty there is only a third to a quarter.

We envision a new round of advanced CCS demonstrations in the 2015 timeframe, which will position commercial deployment of advanced technologies in the post 2020 timeframe.

We are getting to the cost-effective deployment that will require broad-based public and private collaboration on investment. With regard to storage, we are pursuing carbon storage with our seven regional partnerships. We have made great progress. These partnerships are involved in 43 States with basically 50 stakeholders.

We have made great strides in capturing this, but there are some obstacles to commercial deployment. That is why the President in February this year initiated the Interagency Task Force on CCS, the first-ever Government-wide task force to develop a comprehensive Federal strategy to address the barriers to CCS and also achieve cost-effective deployment technologies within 10 years.

As you mentioned, Mr. Chairman, I serve as the co-chair with EPA. We are holding our first public meeting this month, this coming month.

We have had excellent cooperation. We are making great strides, and we envision having a report to the President in August of this year to overcome the barriers.

In conclusion, I would like to just say that we are moving forward with CCS, the critical aspect of this technology to ensure environmentally and commercial sound use of fossil fuels including coal. But a viable national CCS approach will be possible only with development of a national set of definitive policies and incentives that reward technology development and encourage investment in CCS.

I applaud the efforts of this committee and members for taking a leadership role in addressing these issues in a timely fashion. I also look forward to working with Congress to forge a pathway to a viable and effective implementation of CCS and ensure a sound, secure energy future.

With that, Mr. Chairman, I would be happy to answer any questions the committee might have.

[The prepared statement of Mr. Markowsky follows:]

STATEMENT OF JAMES MARKOWSKY, ASSISTANT SECRETARY FOR FOSSIL ENERGY,
DEPARTMENT OF ENERGY

ON S. 1856 AND S. 1134

Thank you Mr. Chairman and members of the Committee. I appreciate this opportunity to meet with you this morning to discuss carbon capture and storage (CCS) legislation before the Committee.

While this hearing is focused specifically on S. 1856, a bill to amend the Energy Policy Act of 2005 to clarify policies regarding ownership of pore space, introduced by Sen. John Barrasso (R-WY); S.1134, the Responsible Use of Coal Act of 2009, introduced by Senator Robert Casey (D-PA); and CCS legislative text drafted by Senators John D. Rockefeller (D-WV) and George V. Voinovich (D-OH), I would like to take this opportunity to provide an overview of the United States Department of Energy (DOE), Office of Fossil Energy's Clean Coal Research Program and how our Research, Development and Demonstration Program is directly relevant to the legislation being discussed at this hearing.

Interagency Task Force on Carbon Capture and Storage

Before I discuss the Office of Fossil Energy's Clean Coal Research Program, I would like to briefly mention the recently announced White House Task Force on Carbon Capture and Storage. On February 3, 2010, President Obama issued a Presidential Memorandum titled "A Comprehensive Federal Strategy on Carbon Capture and Storage." This memorandum establishes an Interagency Task Force on Carbon Capture and Storage, consisting of fourteen Executive Departments and Federal Agencies, which are tasked with developing a comprehensive and coordinated Federal strategy to speed the commercial development and deployment of clean coal technologies. The co-chairs of the Task Force are DOE and the Environmental Protection Agency (EPA).

The Task Force is charged with proposing a plan to overcome the barriers to the widespread, cost-effective deployment of CCS within 10 years, with a goal of bringing 5 to 10 commercial demonstration projects online by 2016. Ultimately comprehensive energy and climate legislation that puts a cap on carbon will provide the largest incentive for CCS because it will create stable, long-term, market-based incentives to channel private investment in low-carbon technologies. The Task Force plan will explore incentives for commercial CCS adoption and address any financial, economic, technological, legal, institutional, social, or other barriers to deployment. The Task Force will consider how best to coordinate existing administrative authorities and programs, including those that build international collaboration on CCS, as well as identify areas where additional administrative authority may be necessary. The co-chairs will report progress periodically to the President through the Chair of the Council on Environmental Quality.

As the Department's delegate and co-chair of this Task Force, I am diligently working with representatives of EPA to assemble the proposed plan within 180 days of the release of the Memorandum.

CLEAN COAL RESEARCH PROGRAM

The Office of Fossil Energy's (FE) Fossil Energy Research and Development Program creates public benefits by enhancing U.S. economic, environmental, and energy security. The program carries out three primary activities: (1) managing and performing energy-related research that reduces market barriers to the environmentally sound use of fossil fuels; (2) partnering with industry and others to advance fossil energy technologies toward commercialization; and (3) supporting the development of information and policy options that benefit the public.

The FE Clean Coal Research Program—administered by the Office of Clean Coal and implemented by the National Energy Technology Laboratory—supports DOE's overall mission to achieve national energy security in an economic and environmentally sound manner. In the Coal Program, there are four key priorities: 1) developing technologies for globally competitive carbon dioxide (CO₂) capture for power plants and industrial sources, 2) establishing the basis for long-term geologic storage and CO₂ reuse, 3) improving the efficiency of both existing and new coal-fired power generation plants, and 4) implementing computer modeling and simulation to accelerate the Research and Development (R&D) path from discovery to commercialization and reduce costs.

Currently, we are pursuing the demonstration of first generation carbon capture and storage technologies with existing and new power plants and industrial facilities using a range of capture technologies and storing CO₂ in a variety of geologic formations. The goal is to have five to ten large-scale demonstrations in operation by 2016. In parallel, to drive down the costs of CCS as a potential climate change mitigation technology, the FE Coal Program is pursuing R&D to increase base power plant efficiency and thereby reduce the amount of carbon dioxide that has to be captured and stored per unit of electricity generated. FE is developing a spectrum of technologies to evolve coal into a low-carbon energy source that is economically competitive in 2020 and beyond.

There are a number of technical and economic challenges that must be overcome before cost-effective CCS solutions can be implemented to address climate change. Funding from the American Recovery and Reinvestment Act (Recovery Act) is helping to address these challenges. The Recovery Act provided an additional \$3.4 billion for FE R&D to expand and accelerate the commercial deployment of CCS technology. The experience gained from both the capture and storage demonstrations funded by the Recovery Act will be a critical step toward achieving widespread, cost-effective deployment of CCS. In addition to the Recovery Act projects, the core research, development and demonstration activities that leverage public and private partnerships will support the goal of broad, cost-effective CCS deployment in the post-2020 timeframe.

Core Research and Development Activities

The Clean Coal Research Program is comprised of core research and development activities and major demonstration programs. The Program is further enhanced through the CCS activities authorized under the Recovery Act.

DOE provides a worldwide leadership role in the development of advanced coal technologies. We are moving aggressively to address new challenges associated with the reduction of greenhouse gas emissions as a climate change mitigation strategy. In partnership with the private sector, efforts are focused on maximizing efficiency and performance, while minimizing the costs of new CCS technologies. Improving the efficiency of CCS systems will help address pollutant emissions reduction, water usage, and carbon emissions. The Program strives to enable dramatic reductions in emissions and to improve technologies applicable to current and future fossil energy plants and industrial facilities so they can cost effectively meet emerging requirements for an economically secure and environmentally sound energy future.

The following CCS-enabling R&D activities support the development of technologies that can then be tested for commercial readiness in our demonstration programs. These R&D activities provide the supporting technology basis for all CCS development.

Carbon Sequestration—The Department's Sequestration program focuses on the key technology challenges that confront the wide-scale industrial deployment of CCS. These challenges are being addressed 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. Developing low-cost pre-combustion capture technologies and establishing the technical basis for carbon sequestration will lead to a decrease in the atmospheric release of CO₂, thus allowing us to

use our domestic fossil fuel resources responsibly by reducing their impacts on global climate change.

Essential to these objectives are the Regional Carbon Sequestration Partnerships (RCSP). The Partnerships are a central piece of our CCS research efforts that develop the knowledge base and infrastructure for the wide-scale deployment of geologic storage technologies. The Partnerships address key infrastructure issues related to permitting, pore space (underground reservoir) ownership, site access, liability, public outreach, and education. The Partnerships also conduct field tests across the United States to characterize the geographic differences in fossil fuel use, potential storage sites, and different regional approaches to addressing CCS. The Partnerships encompass all of the geologic storage sites in the country that are potentially available for carbon sequestration. The Regional Partnerships represent more than 350 unique organizations in 43 States, three Native American Indian Nations, and four Canadian Provinces.

Innovations for Existing Plants (IEP)—The IEP program develops low cost, efficient technologies to reduce CO₂ emissions from new and existing pulverized coal-fired power plants. The program focuses on advanced post-combustion ultra-supercritical steam cycle, oxy-combustion, and CO₂ compression technologies in direct response to the priority placed on addressing the existing and new coal-fired power plants. Dramatic cost and energy penalty reductions for carbon capture are essential for broad deployment of existing plant CCS retrofits, both domestically and in developing economies.

Advanced Integrated Gasification Combined Cycle (IGCC)—Advanced IGCC technology utilizes a pre-combustion pathway to convert coal or other carbon-containing feedstocks into synthesis gas, a mixture composed primarily of carbon monoxide and hydrogen used as fuel for power generation. We are developing advanced gasification technologies to meet the most stringent environmental regulations and to facilitate the efficient capture of CO₂ for subsequent sequestration. Gasification plants are complex systems that rely on a large number of interconnected processes and technologies. Advances in the current state-of-the-art, as well as development of novel approaches, are required to make these systems affordable and reliable for commercial deployment. The program continues to focus on developing the next generation technology in gasification systems related to fuel flexible gasifiers, coal feed systems, high temperature contaminant removal, revolutionary oxygen supply technology, and CO₂ capture technologies. Specifically, we are targeting improvement in IGCC that could yield up to a 5 percentage point efficiency gain while reducing the system cost. These added improvements are targeted toward allowing IGCC to be deployed as a competitive option in the post-2020 time frame by reducing the cost of future systems and improving their reliability.

Fuels—The Fuels program is focused on reducing technology barriers for the reliable, efficient and environmentally friendly conversion of coal to hydrogen for utilization in advanced IGCC systems. Efforts for hydrogen production focus on generation at the plant for large-scale, central power applications and exclude transportation. Activities include support for the bench-scale development of hydrogen separation technologies and components.

Fuel Cells—Fuel cell systems when coupled with coal gasification for large scale power generation hold great potential for leapfrog advances in efficiency. Fuel cells also produce very low emissions, are modular in nature, and can be scaled to almost any deployment size. The ultimate goal of the program is to develop large (>100 MW) fuel cell power systems that produce electric power from coal using integrated coal gasification and CO₂ separation processes that capture at least 90 percent of the CO₂ emissions. The program is driving to reduce the cost of fuel cell technology by an order of magnitude compared to current technology and enable low-cost fuel cells scalable to MW class ultra-clean systems with potential for up to 60 percent electrical efficiency for central power generation.

Advanced Turbines—The Advanced Turbine program consists of a portfolio of laboratory and field R&D projects focused on performance-improvement technologies with great potential for increasing efficiency and reducing emissions and costs in coal-based applications. Future gasification based power systems outfitted with CCS will require high efficiency hydrogen turbines. Hence, the current focus of the Advanced Turbine program is the combustion of pure hydrogen fuels in greater than 100 MW size gas turbines and the compression of large volumes of CO₂. The Advanced Turbines program aims to improve the firing temperature and throughput of the next generation of combustion turbines for coal-based integrated gasification combined cycle power systems that capture and sequester CO₂.

Advanced Research—The Advanced Research Program is a bridge between basic research and the development and deployment of innovative systems capable of creating highly efficient and environmentally benign electricity and power. The objec-

tive of the program is to support development of critical enabling components that provide cross cutting benefits across the entire coal research program. Example developments that are being pursued include high temperature materials for ultra-supercritical plants, enabling efficiency increases up to 3 percentage points for coal-fired plants, revolutionary sensors and controls, and advanced computing/visualization techniques. The Advanced Research Program will continue to push revolutionary advances in efficiency improvements, computational analyses and projects aimed at a greater understanding of the physical, chemical, and thermo-dynamic barriers that currently limit the use of coal and other fossil fuels.

Additionally in FY 2011, a multi-lab partnership will be initiated to develop a comprehensive, integrated suite of computational models for accelerating the development of carbon capture technologies. The scientific underpinnings of the suite of models will ensure that learning from successive generations of a technology or learning from even competing technologies is maximized. The simulation-based confidence will reduce the risk in incorporating multiple innovative technologies into a new plant design, thereby significantly reducing the development cycle required to move novel technologies to commercialization.

Demonstrations at Commercial-Scale

Program success will ultimately be judged by the deployment of emerging technologies into the marketplace. Both technical and financial challenges associated with the deployment of new advanced coal technologies must be overcome in order to achieve success in the marketplace. Commercial-scale demonstrations help the industry understand and overcome component integration and start-up performance issues, and by reducing technology and economic risk, improve the opportunity for private financing and investment for subsequent plants.

The Department is implementing large-scale CCS projects through the Large-Scale Sequestration Field Tests being performed by the Regional Partnerships; the Clean Coal Power Initiative (CCPI); and FutureGen.

Large-Scale Sequestration Field Tests—A central piece of our CCS research is DOE's field test program, which is being implemented through the Regional Carbon Sequestration Partnerships. This 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. The Partnerships encompass essentially all the geologic storage sites in the country that can potentially be available for carbon sequestration. 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 interests leading to the success of this program. Each partnership is focused on a specific region of the country with similar characteristics relating to CCS opportunities and needs.

The Development Phase (Phase III) of the Regional Partnerships is focused on large-scale field tests of geologic carbon sequestration up to 1 million metric tons of CO₂ 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.

In FY 2011, several of the nine large-scale RCSP CO₂ injection projects are scheduled to begin injecting CO₂ for large volume (1 million tons/year) geologic storage tests. Most of the large-scale field tests will have completed the first stage of the projects consisting of site selection and characterization, National Environmental Policy Act (NEPA) review, pre-injection monitoring, and permitting. One project will have concluded its injection of about 2 million tons of CO₂ and will be conducting post injection monitoring at the site. These large-volume injections are needed to demonstrate that the formations selected for storage have the capability and capacity to store CO₂ from coal-based energy systems and industrial facilities.

Clean Coal Power Initiative—The mission of the Clean Coal Power Initiative (CCPI) is to enable and accelerate the deployment of advanced carbon capture and storage (CCS) technologies to ensure clean, reliable, and affordable electricity for the United States. The CCPI is a cost-shared partnership between the government and industry to develop and demonstrate advanced coal-based power generation technologies at the commercial scale.

CCPI demonstrations address the reliability and affordability of the Nation's electricity supply from coal-based generation. CCPI demonstrations will meet technical requirements set forth in the Energy Policy Act of 2005. By enabling advanced technologies to overcome technical risks involved with scale-up and bringing them to the point of commercial readiness, CCPI accelerates the development of both advanced coal generation technologies and the integration of CCS with both new and existing generation technologies. The CCPI also facilitates the movement of technologies into

the market place that are emerging from the core research and development activities.

FutureGen—The FutureGen Project intends to conduct novel large-scale testing to accelerate the deployment of a set of integrated advanced coal gasification-based electric power production technologies linked with CCS. This project would be the first of its kind to store CO₂ in a deep saline geologic formation. The Department is currently reviewing the renewal application submitted by the FutureGen Alliance on March 19, 2010.

THE AMERICAN RECOVERY AND REINVESTMENT ACT
(RECOVERY ACT)

The primary goals of the FE Recovery Act Program are to:

- Demonstrate CCS technology to reduce greenhouse gas emissions from the electric power and industrial sectors of our economy.
- Become the world's leader in CCS science and technology.
- Implement projects to support economic recovery by creating new jobs in pursuit of a secure energy future.

Recovery Act projects will leverage federal funding, stimulate private sector investment, accelerate delivery of CCS technology, and demonstrate the integration of coal-based energy systems and industrial processes with capture and permanent storage of CO₂ in geologic formations. Recovery Act projects are logical extensions of several important, ongoing Clean Coal Research Program baseline activities.

The FE Recovery Act R&D Program is comprised of five components, with the following specific objectives:

- Expand and Extend Clean Coal Power Initiative Round 3 (Expand CCPI-3)—Accelerate integrated CCS demonstrations by expanding and extending the opportunity for several additional CCS electricity generation demonstrations for both new and existing plants under DOE's ongoing CCPI-3 competition.
- Industrial Carbon Capture and Storage—Expand DOE's focus of CCS on advanced coal power systems to industrial CCS applications.
- Geologic Sequestration Site Characterization—Accelerate the comprehensive characterization of large-volume geologic reservoirs, thus augmenting existing data under the Regional Carbon Sequestration Partnerships.
- Geologic Sequestration Training and Research—Develop the next generation of scientists and engineers by expanding ongoing training and research efforts conducted primarily through the University Coal Research and Historically Black Colleges and Universities programs.
- Carbon Capture and Storage—Provide a fully integrated, advanced coal gasification-based power plant with utility-scale CCS technology capable of safely and permanently storing 1million metric tons of CO₂ per year.

To date, there have been over 90 projects awarded, including the following most recent announcements:

- On October 2, 2009, Secretary Chu announced the first round of funding from \$1.4 billion from the Recovery Act for the selection of projects that will capture CO₂ from industrial sources for storage or beneficial use. The first phase of these projects will include approximately \$21.6 million in Recovery Act funding and \$22.5 million in private funding for a total initial investment of about \$44.1 million. The remaining Recovery Act funding will be awarded to the most promising projects during a competitive phase two selection process.
- On November 6, 2009, DOE issued a cooperative agreement with Hydrogen Energy California LLC to build and demonstrate a hydrogen-powered electric generating facility, complete with CCS, in Kern County, California.
- On March 9, 2010, U.S. Secretary of Energy Steven Chu announced that a project with NRG Energy has been selected to receive up to \$154 million, including funding from the Recovery Act. The post-combustion capture and sequestration project will demonstrate advanced technology to reduce CO₂ emissions and will assist with enhanced oil recovery efforts from a nearby oil field.
- On March 12, 2010, DOE announced the award of a cooperative agreement to Summit Texas Clean Energy, LLC, for the Texas Clean Energy Project to design, build, and demonstrate an integrated gasification combined cycle electric generating facility, complete with co-production of high-value products and carbon capture and storage.
- On March 12, 2010, DOE announced the award of a cooperative agreement to American Electric Power for the Mountaineer Commercial-Scale CCS Project to

design, construct, and operate a system that will capture and store CO₂ at an existing coal-fired power plant.

INTERNATIONAL COLLABORATIONS

Recognizing that climate change is a global issue that requires a global response, DOE plays an active leadership role in an international initiative known as the Carbon Sequestration Leadership Forum (CSLF). The CSLF is a voluntary climate initiative of developed and developing nations that, collectively, account for 75 percent of all anthropogenic carbon dioxide emissions. It is currently comprised of 24 members, including 23 countries and the European Commission.

Formed in 2003, the CSLF marshals intellectual, technical, and financial resources from all parts of the world to support atmospheric stabilization of carbon dioxide concentrations, the long-term goal of the United Nations Framework Convention on Climate Change. Members are dedicated to collaboration and information sharing in developing, demonstrating, and fostering the worldwide deployment of multiple technologies for the capture and long-term geologic storage of carbon dioxide at low costs. Additionally, the CSLF is committed to establishing a companion foundation promoting legislative, regulatory, administrative, and institutional practices for safe, verifiable long-term storage.

In addition to the CSLF, the Department is currently cooperating with numerous countries through bilateral agreements and multilateral activities to identify areas of collaboration in promoting and developing clean fossil energy technologies internationally.

CONCLUSIONS

CCS technologies can play a key role as we transition to the clean energy economy of the future. However, cost-effective commercial deployment of CCS can only occur in parallel with the development of a national set of definitive policies that encourage technology development and reward investments in and capital formation around improved carbon performance. Passing comprehensive energy and climate legislation that puts a price on carbon will provide the long-term, market-based incentives to channel private investment into CCS and other low-carbon technologies. Time is of the essence. The Administration wants to see comprehensive legislation sent to the President this year.

Addressing the barriers to CCS deployment requires a systems-based approach that includes not only site evaluation, characterization and selection, but also rules for short-, medium-, and long-term liability. Market driven CCS deployment will also require infrastructure for CO₂ transportation and storage and the development of a uniform 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.

CCS and other clean coal technologies can play a critical role in mitigating CO₂ emissions under many potential future carbon stabilization scenarios. The DOE program has put us on a path toward ensuring that the enabling technologies will be available to effect broad CCS deployment within a decade. Continued U.S. leadership in technology development and future deployment is important to the cultivation of 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 from members of the Committee.

The CHAIRMAN. Thank you very much.

Ms. Castle, why don't you go right ahead, please?

STATEMENT OF ANNE CASTLE, ASSISTANT SECRETARY FOR WATER AND SCIENCE, DEPARTMENT OF THE INTERIOR

Ms. CASTLE. Mr. Chairman, Senator Murkowski, members of the committee, thank you for asking me to be here today to address S. 1856.

As you mentioned, Mr. Chairman, I am the Assistant Secretary for Water and Science at the Department of the Interior. With me is Tim Spisak from the Bureau of Land Management. Tim is the Deputy Assistant Director for Minerals and Realty Management.

Interior will defer to the Department of Energy on S. 1134, as that bill addresses activities within DOE's purview.

Under Secretary Salazar's leadership, the Department of the Interior has made addressing global climate change one of its highest priorities, and a key component of working on climate change is mitigating the impact of carbon dioxide through measures like geologic carbon sequestration in permeable rock pore spaces.

S. 1856 would ensure that the ownership of any subsurface pore space located below a Federal surface estate would be vested in the Federal Government. Interior supports the goal of this bill to clarify policies regarding ownership of pore space. We support having clear rules in place before, not after, disputes arise.

But we would like to discuss with the committee some concerns that we have related to pore space ownership, including what we think are very important liability concerns, where the Federal Government manages the subsurface mineral estate but does not own the surface, the split estate situation.

At the Department of the Interior, our land and water managers are already confronting the impact of climate change. Reduced snowpack is leading to decreased recharge of groundwater aquifers. We are seeing increased stress on surface water systems and public water supplies. We are seeing reduced river flows that impact temperature and depth and spawning environment for fish. Our scientists are also noting changes in the abundance and distribution of species, including changes to migration patterns.

Interior's land managers and scientists have on-the-ground expertise in areas that are critical to developing and managing carbon capture and storage. The department is sharing its expertise with our partner agencies as a contributor to the President's Task Force on Carbon Capture and Storage, and the task force, as Mr. Markowsky explained, is working on a coordinated Federal strategy to speed the commercial development of clean coal technology.

The Bureau of Land Management is entrusted with the multiple-use management of 253 million acres of surface land. But BLM also manages 700 million acres of subsurface mineral estate where the surface owners could be BLM, could be other Federal agencies like the Forest Service, sometimes the States, and sometimes the surface is in private ownership. That Federal mineral estate includes 57 million acres where the Feds own the minerals and the surface estate is privately owned.

BLM worked with other Federal agencies to submit a report to Congress last May that was required by the Energy Independence and Security Act, and it addressed a wide variety of issues related to geologic carbon sequestration. In addition to experience administering large-scale mineral leasing programs, BLM has the real estate expertise and an existing framework for issuing rights-of-way that could serve future needs for carbon dioxide pipelines on public lands.

We believe that BLM's existing authorities could facilitate future carbon sequestration demonstration projects, but we also think that a more explicit statutory authority would be desirable. Again, we would like to discuss this further with the committee.

The United States Geological Survey contributes to better scientific understanding of our natural resources, and as part of its

mission, USGS also conducts assessments of energy resources like oil and natural gas both in the U.S. and around the world. USGS is currently finalizing the methodology for a national assessment of carbon dioxide storage capacity in oil and gas reservoirs and saline formations. USGS is also going to play an important role in recommending geologic criteria that could be incorporated into a set of best practices for geologic site selection.

The Department of the Interior supports the goal of S. 1856 to provide certainty regarding the ownership of pore space. Connecting pore space to surface ownership is a codification of what has been called the “American rule.”

We do have concerns about the split estate situations that are not explicitly addressed in the bill. There are long-term liability questions that could arise if the private entity holding the surface rights sequesters carbon dioxide in the pore space but then is unable to manage the CO₂ properly.

CO₂ is a leasable mineral. The bill addresses the ownership of the storage space, but not necessarily what is in the storage space, what is stored there. So the department would like to work with this committee to address those issues.

Interior believes that carbon capture and sequestration can play a significant role in reducing the long-term effects of carbon emissions, and we would like to work with the committee on these critical efforts to mitigate the impact of climate change.

Thank you for asking for the department’s views, and I am available to answer your questions at the appropriate time.

[The prepared statement of Ms. Castle follows:]

PREPARED STATEMENT OF ANNE CASTLE, ASSISTANT SECRETARY FOR WATER AND SCIENCE, DEPARTMENT OF THE INTERIOR

ON S. 1856 AND S. 1134

Introduction

Mr. Chairman and Members of the Committee, thank you for the opportunity to discuss S. 1856, a bill to amend the Energy Policy Act of 2005 to clarify policies regarding the ownership of pore space, and S. 1134, the Responsible Use of Coal Act. The Department of the Interior defers to the Department of Energy on S. 1134 as the scope of the bill is limited to activities within the Department of Energy.

I am Anne Castle, the Department of the Interior’s Assistant Secretary for Water and Science. I am accompanied by Tim Spisak, the Bureau of Land Management (BLM) Deputy Assistant Director for Minerals and Realty Management. Under Secretary Salazar’s leadership, the Department of the Interior has made addressing global climate change among its highest priorities. A key component to addressing climate change is mitigating the impact of carbon dioxide through energy conservation, clean renewable energy, and measures such as geologic carbon sequestration into permeable rock pore spaces.

S. 1856 would ensure that the ownership of any subsurface pore space located below a Federal surface estate would be vested in the Federal Government. The Department of the Interior supports the goal of S. 1856 to clarify policies regarding ownership of pore space. We support having clear rules in place before, not after, disputes over property rights arise. However, we would like to discuss with the Committee concerns related to pore space ownership on split estate lands—including important liability concerns—where the Federal government manages the subsurface mineral estate but not the surface.

Background

Climate Change Impacts & the Department of the Interior

At the Department of the Interior, our land and water and wildlife managers are already confronting the impacts of climate change. Reduced snowpack is leading to decreased recharge of groundwater systems, increasing stress on surface water sup-

plies and public water systems, and reducing river flows that impact temperature, depth, and other characteristics of spawning environments for fish. Our Arctic parks and refuges are seeing some of the earliest impacts of climate change. Melting sea ice threatens marine mammals as well as coastal communities, and thawing permafrost can destabilize buildings, roads, and facilities—disrupting the structural basis of large regions of Interior-managed lands.

Our scientists are also noting changes in the abundance and distribution of species, including changes to migration patterns; the expansion of pests and invasive species; increased vulnerability to wildland fire and erosion; and an overall reduction in carrying capacity. Many of the iconic wildlife species that the Department manages from the Arctic to the Everglades will see their habitat threatened by global climate change.

To assure that our climate change adaptation strategies are grounded in sound science, Secretary Salazar has created a new climate change strategy for the Department through Secretarial Order #3289 (September 14, 2009): “Addressing the Impacts of Climate Change on America’s Water, Land and Other Natural and Cultural Resources.” This Order establishes a new Department-wide strategy to address climate change, with an emphasis on climate change science, adaptation, and mitigation.

This Order identifies geologic carbon sequestration as a key component in the Department’s climate change mitigation program—the Carbon Storage Project. The Order identifies the U.S. Geological Survey (USGS) as the lead agency in administering the Department’s Carbon Storage Project, and the USGS will work closely with the BLM and external partners to enhance carbon storage in geologic formations consistent with the Department’s responsibility to provide comprehensive, long-term stewardship of its resources.

The Role of the Bureau of Land Management & the U.S. Geological Survey

As the Nation’s largest land manager, the BLM is entrusted with the multiple-use management of 253 million acres of surface land. The agency also administers 700 million acres of sub-surface mineral estate of which the surface owners are Federal agencies, states, or private entities. This Federal mineral estate includes 57.2 million acres underlying a privately-owned surface (split estate). The USGS collects, monitors, analyzes, and provides scientific understanding about natural resource conditions, issues, and problems. As part of its mission, the USGS also conducts assessments of energy resources such as oil and natural gas of the United States and the world. Because of this expertise and experience, the USGS is conducting a national assessment of the carbon dioxide storage capacity in oil and gas reservoirs and saline formations. The USGS is currently finalizing the methodology for this national assessment.

The Department diligently executes its responsibilities to make our Nation’s energy resources available in an environmentally-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 its role in the use of the public lands to sequester carbon dioxide. Additionally, the Department’s bureaus have the expertise and experience needed to effectively implement carbon sequestration programs, from the identification of areas appropriate for storage to the deployment of leasing programs.

The BLM’s existing administrative and regulatory framework could facilitate future carbon sequestration demonstration projects. However, clearer statutory authority specific to carbon sequestration may be desirable in some areas in order to move more effectively in implementing commercial-scale storage on Federal lands. The Administration is currently reviewing these issues, including whether additional legislation is desirable, as part of the White House Task Force on Carbon Capture and Storage. Issues that we are currently discussing include the most appropriate mechanism for longer term storage of carbon dioxide (leasing, rights-of-way, or other methods), the nature and term of the agreements, and how other uses such as future energy and mineral extraction, other subsurface resources, and other surface uses that the BLM may authorize could affect longer term storage, and liability. We look forward to reporting back to the Committee on the results of the Task Force’s work in the near future.

In addition to experience in administering large-scale mineral leasing programs, the BLM 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 play an important role in recommending geologic criteria that could be incorporated into a set of “best practices” for geologic site selection.

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-Enhanced Oil Recovery (EOR) sites at which large quantities of carbon dioxide have been injected for as long as 12 years. These sites have operated safely and shown no sign of leakage. However, the carbon storage contemplated for the primary purposes of sequestration may be for longer terms and larger quantities. We believe that the DOI land managers and scientists who are on-the-ground have expertise to offer on monitoring carbon dioxide sequestration, and we are working with our partner agencies to share their expertise.

Carbon Capture & Sequestration (CCS)

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 United States is in deep saline formations.

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 data collected since 1959 by NOAA at the Mauna Loa observatory in Hawaii and 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 scientific and operational understanding of geologic storage capacity is needed to address these knowledge gaps.

Energy Security & Independence Act of 2007(EISA)/Pore Space Ownership

Section 714 of the EISA directed the Secretary of the Interior to submit a report to Congress containing a recommended framework for geological sequestration on public lands. Through the BLM, and in coordination with the USGS, the EPA, the DOE, and other appropriate agencies, the Department fulfilled this mandate with its May 13, 2009, report, Regulatory Framework for Geologic Carbon Sequestration on Public Land. This report addressed a wide variety of issues related to geologic carbon sequestration and helps inform our response to the legislation before the committee.

The report also included a discussion of pore space ownership. Section (6) of the report notes that Interior Board of Land Appeals (IBLA) rulings have recognized the “American Rule,” which holds that subsurface pore space is the property of the surface owner. Various state governments are considering legislation that would establish the “American Rule” as state law. Wyoming enacted such a law in 2008; Montana and North Dakota enacted similar legislation in 2009.

S. 1856

The Department supports the concepts of S. 1856, which consists of two key provisions. The first, Section (1)(b), clarifies that the subsurface pore space is the property of the Federal Government in cases where the Federal Government is the surface landowner (codification of the “American Rule”). The second key provision, Section (1)(d), establishes the mineral estate as the dominant interest when in competition for priority with a pore space interest. Section 1(d) presents questions related to how mineral interests and those with interests in storing carbon dioxide in the pore space would intersect.

In following the American Rule, S. 1856 provides that the Federal government would own the pore space when it owns the surface interests. While not addressed in the bill, the American Rule would also hold that a private surface owner would own the pore space if the surface/subsurface estate is split between the private surface owner and the Federal mineral estate. In the case of approximately 57 million acres of land where the estate is split between a private surface owner and the Federal mineral estate, the private surface owner’s pore space interest could present long-term liability questions. We can foresee a situation where a private entity holding split estate surface rights sequesters carbon dioxide in the pore space but then finds itself in a position of not being able to manage the carbon dioxide or bear its

liability in perpetuity. It remains unclear who would be liable for the carbon dioxide in these situations. Questions also remain as to whether carbon dioxide, which is a leasable mineral when naturally occurring on Federal lands, could be considered part of the mineral estate when transported onsite, injected, and stored long-term. The Department would like to engage in discussions with the Committee concerning these issues.

Conclusion

The Department of the Interior believes that carbon capture and sequestration can play a significant role in reducing the long-term effects of carbon emissions. The Department of the Interior looks forward to continuing to work with the Committee on the critical work of mitigating the effects of climate change.

The CHAIRMAN. Thank you both very much.

Let me start. We will just do 5-minute rounds here. Let me just start with you on the issue you have been talking about, Ms. Castle. I gather from your testimony, you say that the bill provides the Federal Government would own the pore space when it owns the surface interest. I think that is pretty clear.

Then you go on to state that the fact that the bill does not make the Federal Government the owner of the pore space when it owns the mineral estate, as distinct from the surface estate. So I am not clear. Does the department have a position as to whether it wants to own the pore space in circumstances where it owns the mineral estate, but not the surface?

Ms. CASTLE. No, sir. I am sorry if our testimony was not clear on that point.

We do support the codification of the American rule, that connects the ownership of the pore space to the ownership of the surface estate. What we have concerns about is the situation where the Federal Government owns the mineral interest, but somebody else owns the surface and, therefore, owns the pore space.

The CHAIRMAN. Right.

Ms. CASTLE. Because of the concerns about long-term liability, if the surface owner isn't able to manage properly that sequestered CO₂. So that is the issue we would like to address. We are not suggesting that the pore space ownership should be associated with the mineral estate.

The CHAIRMAN. I guess I am just a little unclear. If I am a surface owner, and the Federal Government has retained the mineral estate, and I am being told now that I own the pore space below the surface, what legal right do I have with regard to that pore space if the Federal Government has retained the mineral estate and perhaps leased that out to someone else?

Ms. CASTLE. As I understand it, Senator, the bill would make the mineral estate dominant over the ownership of the pore space. But I think that you are raising good questions about the interaction between the owner of the surface, who is utilizing the pore space for sequestration, and the owner of the mineral interest.

As I mentioned, CO₂ is a leasable mineral. So once you put it in the ground, it is not clear who has the ownership to it, whether it is the surface owner or the mineral rights owner. So those are the kinds of things that we think could benefit from a dialog with the committee, with the benefit of the experience that BLM has had in these split estate situations.

The CHAIRMAN. So your view is we don't yet know whether we ought to codify the American rule, or we do know that we ought to codify the American rule? That is the part I am not clear on.

Ms. CASTLE. The department does support the codification of the American rule. The legislation, S. 1856, could benefit from additional clarification of those interactions in a split estate situation.

The CHAIRMAN. OK. I am not sure that I am still very clear on this. But let me ask you, Dr. Markowsky, one issue is these large-scale projects that you are standing up. I think you said you will have 8 to 10 of those by 2015—

Mr. MARKOWSKY. That is correct.

The CHAIRMAN [continuing]. In operation. That is one of the things that is a priority. You also, I gather here, have basic research going on with regard to carbon capture and storage. Could you just elaborate a little on what the Office of Science is doing in that area with regard to this basic research?

Mr. MARKOWSKY. Yes, thank you.

We are working closely with the Office of Science. What we identified actually last year, when we knew that we were going to have a high cost for the first-generation post combustion capture using the mean systems that are available now and chilled ammonia and the various types of means, we got together with the Office of Basic Science and started looking at advanced capture techniques.

This is advanced sorbents, solvents, and ionic type of fluids that could capture the CO₂ with very little energy and then be regenerated again with very little energy needed, which is the key thing. Because what you want to do is capture the CO₂, and then you are going to take that CO₂ outside the flow stream, and you are going to release it with either a pulse of energy or something and then recirculate the solution that is capturing the CO₂.

So we are working closely with them. They are doing research on various types of sorbents and solvents along with us, and the tie is that they know what our needs are, and we have a very tight timeframe. We are also working with ARPA-E, the other organization we have. They have solicitations out for advanced capture.

So, actually, we have got 3 entities within DOE that are focusing very heavily on advanced capture and post combustion treatment.

The CHAIRMAN. Thank you very much.

Senator Murkowski.

Senator MURKOWSKI. Thank you, Mr. Chairman.

Dr. Markowsky, I would like to ask you about the 2009 stimulus funds that DOE received. It is my understanding that there was \$3.4 billion that went for CCS, and it included funding for industrial applications, for R&D, a third round of Clean Coal Power Initiative selections. According to DOE's Web site, we have just less than a third of the money that has been awarded over the last 15 months, it is my understanding that just \$16 million, or about 0.5 percent, has actually been spent.

So my question to you this morning is what exactly is happening with these fossil energy accounts? What are the hold-ups? Is DOE on track to be spending these stimulus dollars? We, of course, had all hoped that these would be targeted, timely, and temporary. I mean, it doesn't look like anything is getting out the door.

Mr. MARKOWSKY. Thank you for that question, Senator Murkowski.

What we have is really large-scale demonstration projects in 3 areas with the CCPI program we have, with the industrial CCS, and also FutureGen. Initially, we sent out solicitations, and then we reviewed them, and we selected 4 programs under CCPI-3. We are right now down-selecting the programs under the industrial CCS solicitation, and we are also working with the FutureGen Alliance.

So we are positioned to make these awards and begin detailed engineering. The earlier work was very preliminary engineering, which we call "feed," which is a very, very low level of expenditures. But we are on track to obligate moneys in all 3 of those programs by September of this year. Then after we make the awards for detailed design and construction, we will have a ramp-up of expenditures, and then we are on target for the 2 major programs to have those expenditures completed when they come online in 2015.

Senator MURKOWSKI. Can you give me some parameters? You say that you will have these expenditures out there. How much are you looking to get out the door?

We said wanted shovel-ready projects, don't get me wrong, we want to encourage the advancement in the CCS. But it doesn't sound to me like you are able to expedite much of this in a manner as which we had intended.

Mr. MARKOWSKY. Yes. The shovel-ready projects, when you come with a large-scale CCS program, and many times these are new facilities, and it typically takes about a year to get all the preliminary work done and 3 years for construction and begin operation.

There is a ramp-up of expenditures during that period of time, and that is what you are seeing now. This first year is a slow ramp-up and where just very, very small amount of money is being expended. But in the next quarter, we are going to be starting to ramp up with detailed engineering. Then next year, in the spring and summer, we are going to be breaking ground on these projects, and that is when the large expenditures will begin, when you order and pay for the large equipment.

Senator MURKOWSKI. I mentioned in my opening comments about a project that is being considered in Alaska with utilizing the in situ gasification, where we can extract from the coal seams without digging a mine. Does the Department of Energy anticipate providing any assistance, financial or otherwise, to project developers in this area?

I would ask you, Ms. Castle, whether from a scientific perspective, do you have the information that you need to take a position on in situ gasification? If you can indicate whether we have financial assistance coming and then from the science perspective?

Mr. MARKOWSKY. Thank you again, Senator.

We have not received any requests for participation in the programs. The in situ and underground gasification concept, we had been exploring that in DOE early on in the 1980s. We have had some misfortunes because it wasn't understood exactly how that process works. Now there is a number of programs being pursued in China, Australia, India, and as you mentioned, in Cook Inlet.

It is a technology that has applications in a particular type of seam that typically is unmineable, and there is attractive benefits in those kind of seams. But we have not been approached for participation in that particular project or any project.

Senator MURKOWSKI. Ms. Castle, on the science?

Ms. CASTLE. Senator, I don't know that we have enough information currently in order to be able to take a position on the feasibility of the in situ gasification.

Senator MURKOWSKI. Will you let me—

Ms. CASTLE. I think—

Senator MURKOWSKI. Let me just make sure that—this is a process that has been around for a considerable period of time. Are you suggesting that we just haven't looked at it from a U.S. perspective, or when you say you don't have the information, what specifically are you lacking?

Ms. CASTLE. I think that you were asking for—I was thinking that you were asking for our position on the specific project in Alaska?

Senator MURKOWSKI. No. Just whether or not from a scientific perspective you think that the in situ process for gasification is one that is sound and we should be pursuing, whether through incentives or just allowing for facilitation?

Ms. CASTLE. Let me just say that I don't have sufficient information to answer that question, and if I could answer it for the record, I would be happy to do that.

Senator MURKOWSKI. Thank you.

Thank you, Mr. Chairman.

The CHAIRMAN. Senator Dorgan.

Senator DORGAN. Mr. Chairman, thank you very much.

I apologize for being late, but I have read your testimony and appreciate both of you being with us today.

The American Recovery and Reinvestment Act, that was passed by Congress last year, included \$100 million in funding that I secured for projects for the beneficial use of carbon. I mean, there are a couple of different ways to deal with carbon. One is carbon capture and sequestration through geologic means, which is a way to address it as a bridge to continuing to use coal in the future.

Another way is to find beneficial uses for carbon, and we had a witness at one point before the Senate Energy and Water Appropriation Subcommittee that said to think of carbon as a product and that we should find beneficial uses for carbon. There are beneficial uses, such as enhanced oil recovery, which is a beneficial use that also sequesters the carbon.

But I want to ask you, let me hold just for a moment. It is—

The CHAIRMAN. Why don't—I know. Yes. Did someone send for a doctor?

Senator DORGAN. Dr. Barrasso is—

The CHAIRMAN. Oh, Dr. Barrasso has gone.

[Paused.]

The CHAIRMAN. OK, I think we are OK to go ahead. Why don't you continue with your question, Senator Dorgan?

Senator DORGAN. All right. Thank you.

I was talking about carbon capture and sequestration and also beneficial uses for carbon. It seems to me that in order to provide

the funding for the full potential of these technologies and to be able to use coal in the future in a different way, it is going to require a substantial amount of money. The question is how do we raise money for carbon capture and sequestration and beneficial use technologies in appropriation cycles? My guess is probably not very easily in the regular appropriation cycle in the future.

So it has been supported that there be a small wires charge universally applied that would raise the kind of funding necessary. I would like to ask for the department's assessment of a wires charge approach.

Mr. MARKOWSKY. Thank you for that question, Senator.

I think when you look at large-scale demonstrations, the one thing that you would like to have is the predictability of funding for them. As I mentioned before, these programs typically take a number of years. Besides a solicitation, you are going to take 4 to 5 years to go through the engineering, permitting, engineering design, and construction. So it is good to have a basis that you will be able to fund those on a multiyear basis.

So the department would support any program that provides a certainty of funding for large-scale demonstration programs.

Senator DORGAN. My sense is that we are not going to have an energy future without the use of coal, but the use of coal has to be substantially different than the way we have used coal in the past. I understand that reducing carbon emissions in a very significant way is important, but my concern is that we make sure that we have targets and timetables as well as the funding for the scientific inquiry that occurs from now until then so that we can continue to use coal in a very different way.

I do think that the science and technology are going to unlock many, many opportunities. I think probably all of us on this committee could describe a half a dozen proposals out there that people are working on that they insist represent "the answer."

Now, not all of them will be the answer, but there are some approaches out there that if we can scale up and demonstrate at commercial scale are going to allow us to use coal in a very different way. This committee spends a lot of time working on other energy policy issues, such as renewable energy, which I strongly support, among other issues, but the question is with 50 percent of the electricity coming from coal, how do we manage to continue to use coal in the future?

Now I think Senator Murkowski mentioned the Dakota Gasification plants in North Dakota, we have one of the only applications where we take coal and turn it into synthetic natural gas. They were going to build a good number of those plants many decades ago, and now it sits on the northern prairies.

They turn coal into synthetic natural gas, put it in a pipeline, and move it around the rest of the country. They capture 50 percent of the CO₂ and put that in a pipeline and move it to the oil fields of Alberta, Canada, where they use the CO₂ to enhance oil recovery.

So it is a project from which we can learn a lot, it seems to me. You can have beneficial uses for CO₂. But I just come back to the point that we really do need to have an adequate stream of funding over a number of years, perhaps 10 and 20 years, to unlock the

science and the technology which will allow us to understand how to capture and sequester carbon and to use it for beneficial uses.

That is why we put \$3.4 billion in the economic Recovery Act to invest in a range of CCS projects. But that is just a start because it is going to cost much more than that. Do you have estimates of what you expect is needed over the next 20 years, either of you, in terms of the funding requirements?

Mr. MARKOWSKY. We have not developed those estimates at this point.

Senator DORGAN. But if there is a proposal—I happen to favor a proposal for a wires charge in order to raise that funding. Senator Rockefeller has a proposal. Senator Voinovich, I believe they have a joint proposal. I happen to think it makes some sense to do that.

You are saying the department and the administration would look favorably upon any reasonable approach that begins to accumulate the funding necessary for these investments?

Mr. MARKOWSKY. No, I think that is correct. I think we know that if we are going to continue with the second-generation technologies I mentioned and demonstrate those, and of course, after you do that, you are probably going to be doing advanced research to keep pushing that envelope.

It is going to require a certainty when you talk about large-scale demonstration and to entice investors to participate in that, a certainty of funding. So any kind of mechanism that gives you a certainty of funding certainly would be very positive.

Senator DORGAN. If I might just ask one quick question, are you as excited about beneficial use as I am? I think the potential of beneficial use is very substantial.

Mr. MARKOWSKY. I am. Matter of fact, you mentioned the \$100 million. We have 12 proposals, and we are going to be looking at those, and we are going to down-select those to maybe 6 or 8, and we have got some exciting prospects in it—algae with various chemicals, actually making a fuel from it, making a cement product from it. So there is a lot of potential besides EOR. It is a shame to store that product because you spend a lot of money capturing it, and you have got to find a way to really use that beneficially.

Senator DORGAN. Thank you very much.

The CHAIRMAN. Senator Bunning.

Senator BUNNING. Thank you, Mr. Chairman.

First of all, I would like to thank both you and Senator Murkowski for holding this hearing. Several weeks ago, I, along with Senators Barrasso and Bayh, sent a letter to the committee outlining the importance of having a hearing on clean coal and the technologies surrounding carbon capture. That was a letter we sent to you.

While the focus of this hearing is not coal, carbon capture and sequestration will play an enormous role in reducing CO₂ emissions from coal. So while this is not specifically a coal hearing, I am approaching it from the perspective of how this technology can help us with the use of this critical resource.

Coal is incredibly important to my State, Kentucky. The industry provides over 60,000 jobs, including about 15,000 coal miners. Those numbers show just how vital coal is to the State of Ken-

tucky. If I did not keep that in mind, I would not be doing a very good job representing the people of Kentucky.

However, besides just jobs in my State, coal is essential to the American energy needs. As it has been stated before, it provides about 50 percent of the country's electricity. No matter what some might say or try to do, coal will not just go away. It is a clean, abundant, and domestic source of energy.

In fact, coal makes up about 94 percent of the known energy reserves found in the United States of America, 94 percent, compared to 4 percent of natural gas and 2 percent for crude oil. Thus, we have to live with coal and find a way to use it that meets our long-term environmental standards.

Carbon capture and sequestration can help us do that. That is why in the stimulus package, we put \$3.4 billion and \$600 million to be used to discover ways to capture carbon, CCS technology that you are supposed to be figuring out a way to spend. Sixteen million dollars in over a year and 4 months, in my opinion, is not acceptable.

We all know how difficult it is to build out, but if you don't get the people to build out with in hand, you never accomplish the goal that you set out to do. Certainly, the Congress put \$4 billion in that stimulus package. I think there is a bright future for CCS, but if we don't—Dr. Markowsky, if we don't do it and do it quickly and do it right, it isn't going to happen.

I have dealt with the Energy Department now for 12 years here in the Senate and 12 years in the House of Representatives. If there is one thing I have found out, they don't do things very fast. So I am asking you, begging you, to get underway and get this technology perfected. We have got people spending billions of dollars in the private sector to do what the Department of Energy has been given \$4 billion to do.

Just in 2 places—one in Owensboro, Kentucky, one in Paducah, Kentucky—we are trying to do exactly what Ms. Castle has said. We have a dispute. The Government doesn't own the surface, but they want to sequester the carbon underneath, and we have a dispute whether they can do it or whether they can't do it.

It is in the Illinois basin in southern Illinois, and the Paducah plant wants to liquefy coal and also bring natural gas and aviation fuel out of that same coal. But they have to capture, and we guaranteed them to capture over 90 percent of the CO₂. I am asking you, please get those projects underway because we are not going to be able to diverse quickly enough from coal to produce enough energy for this country to run on and stay competitive with those that are not using sequestration of CO₂.

In China and India, they are laughing at us as a country. They are laughing at us because they told us they are not going to do any carbon capture and sequestration. They are going to continue to burn coal as we used to.

So, please, I am asking you to speed up and do it properly.

The CHAIRMAN. Did you want to make any comment in response?

Mr. MARKOWSKY. Yes, if I may? Yes, I can appreciate the frustration of both Senator Murkowski and yourself, Senator Bunning. But I can assure you I have spent 30 years of my life engineering, designing, and building power plants and the other 10 of the 40

years pursuing power plants. So I am a fellow who likes to build power plants. I am pushing that.

In parallel with that, we are advancing the technology because I don't think we should sit on a technology. We are advancing that. We are looking at advanced technologies, the 4 that I identified, because I think beside demonstrating these technologies, which are critical to integrate CCS into 2 types of concepts—electric power production and the various industrial facilities—we need to get that culture going.

But we need to accelerate that technology and develop the next round of technologies. We are looking at computer simulation to basically help us push that even faster. We have got a major effort in simulating power plant components and systems to accelerate the deployment of CCS.

We are pushing it, sir, and I will continue doing that.

Senator BUNNING. We are going to keep your feet to the fire. I know this committee will.

The CHAIRMAN. All right. Senator Barrasso.

Senator BARRASSO. Thank you very much, Mr. Chairman.

Ms. Castle, thanks so much for your comments and for your support of what I am trying to accomplish with S. 1856. I completely understand the concerns that you have raised when the surface area is not owned by the Federal Government, what the mineral rights are and some of the additional issues that you have raised.

I would say I am committed to working with you to take that next step, and I would hope that you would work with my office, as well as the committee and the chair and the minority side as well, in coming to solutions because some of the key points that you have raised are not addressed by this legislation.

Specifically now, looking at carbon capture and sequestration on public lands right now, I think you are receiving applications for projects. Could you tell me how you are handling those applications to move ahead with projects for carbon capture and sequestration?

Ms. CASTLE. We are receiving applications for site characterization. That is the first step to ensure that geologically the sites are suitable for this kind of effort. Those applications are currently being processed by the Bureau of Land Management, pursuant to their authority for rights-of-way under the Federal Land Policy and Management Act.

Senator BARRASSO. Do you think Title V of the Federal Land Policy and Management Act provides you the necessary authority to issue permits then for long-term commercial-scale carbon storage facilities?

Ms. CASTLE. Senator Barrasso, as I mentioned, we have some concerns that it would be—because of the scale and the financial investment required for a commercial long-term sequestration project, we think that it would be beneficial to have more explicit authority. We are operating under the authority of the Mineral Leasing Act and FLPMA. Those are from 1920 and 1976, respectively.

Carbon sequestration was not contemplated when those laws were enacted. So we think that to deal with the issues that we can see arising in connection with long-term CCS, that it would be desirable to have more explicit authority.

Senator BARRASSO. Thank you.

As this goes forward, I don't know what kind of public participation you are expecting then in the permitting process, guidelines that the department would follow when it comes to the project's notification of adjacent property owners and things like that. Have you given some thought as to what would be needed as this goes on?

Ms. CASTLE. That has been discussed, and there is a process for dealing with public notification and comment within the Bureau of Land Management. I can't provide you with the details. I would be happy, though, to answer that question in writing for the record.

Senator BARRASSO. I have some additional questions for you to answer in writing. I don't want to go through all of them and take your time. We have a second panel as well.

Is the process of permitting these projects on Federal land consistent not just across your department, but also with, say, other land management agencies? Not just the Department of Interior, but also with the Forest Service and the Department of Agriculture, are you working with others?

Ms. CASTLE. Yes, sir. Certainly, in connection with Carbon Capture and Storage Task Force, those are issues that are being considered by all of the 14 agencies that are involved there. The BLM is the agency charged with responsibility for management of the entire Federal mineral estate. So that encompasses a mineral estate owned by the Forest Service and various other Federal agencies.

Senator BARRASSO. So then I can look forward to working with you and with the committee as we go forward to address some of the additional concerns that you have raised today?

Ms. CASTLE. Yes, sir.

Senator BARRASSO. Thank you.

Thank you, Mr. Chairman.

The CHAIRMAN. Thank you very much.

Let me switch subjects and take the occasion of you being here, Dr. Markowsky, to ask about another subject that is in your jurisdiction there. That relates to the Strategic Petroleum Reserve and the product reserve that we have proposed as part of the bill that we have reported out of our committee.

I think we have got another hurricane season on the horizon, and I would just be interested in your thoughts as to whether we are doing what we need to do to prepare for that as far as maintaining supplies of refined product in areas that might be affected by hurricanes?

Mr. MARKOWSKY. Thank you for that question, Senator.

Last year, we embarked on a study to scope out the desirability of a refined product reserve similar to SPRO. That was somewhat inconclusive. We looked at just 2 events this year. We embarked on a more definitive study looking at the probabilistic nature of hurricanes to try to come up with a cost benefit. We hope to have a study completed by June.

But what we are doing, essentially, last year we looked at the consequences of the prior hurricanes, and we saw that we needed to harden the systems, the refineries, and the pipelines. What the

refineries have done is they have elevated their electrical switch gear to ensure that they will not be damaged by water intrusion.

We have worked with the local utilities to set up a priority to restore refineries and also pipeline pumping stations and tank farms along the 2 continental and plantation pipelines. They have diesel-powered generators to help the pumping facility. So we feel that we are in good shape.

We looked again this year to look at possible options to procure what we call "tickets," options for refined products. We looked at all the commercial tankage. It is full. There is just no available excess tankage. They are maintaining their refined products of gasoline and diesel at a maximum capacity.

So the way we would take a look at it, we have got the refined products there. We have got to make sure that we get electric power to it when we have a disruption. At SPRO, we are mobilizing. We have diesel generators at Bayou Choctaw. In case refineries need crude and we are out of power, we have got diesel-powered pumps that will be able to pump water into our caverns to extrude the oil to move in the pipeline.

So I think we are as prepared as we can at this point, Senator. The CHAIRMAN. Thank you very much.

Let me just see if Senator Murkowski had additional questions for this panel.

Senator MURKOWSKI. Just one last question, Mr. Chairman. This relates to the level of coordination between the Department of Energy and the Department of the Interior.

I mentioned in my opening statement that it is important that we work together to move these policies. When we talk about the location of energy infrastructure and how we are going to move this CO₂ through pipeline to the storage points, the question would be to both of you how your agencies are dealing with this as an issue, how you are coordinating with other Federal agencies to clarify the roles so the project developers know? Then further, whether or not the current state of the CO₂ pipeline regulation is sufficient? Does it need further clarification? Do we need to endorse any pending legislation that is out there? Can you give me a little bit of status on how we move the CO₂?

Mr. MARKOWSKY. Thank you for that question, Senator Murkowski.

We have those 2 issues on our table with the CCS task force, both the pipeline issue and also who regulates the pipeline. Right now, we have got just under 4,000 miles of CO₂ pipelines, extensive network now, and there are projections of tens of thousands of miles of pipeline. So the issue of who is going to regulate that, which now is not clear. It is an issue that is being studied.

Also the issue of basically putting in pipeline, the safety and acquisition. We hope to have that—we will have that report ready when the task force submits a report to the President in August.

Senator MURKOWSKI. In August?

Mr. MARKOWSKY. Yes.

Senator MURKOWSKI. OK.

A final question then is whether or not, and Senator Dorgan mentioned the beneficial uses of CO₂, should CO₂ that is clearly a valued commodity for enhanced oil recovery, should that be treated

the same way as CO₂ that would be sequestered? Is there any reason to treat them differently?

I mean, one is used to enhance the oil product. The other, we are basically just storing. Do we look at them differently from a regulatory perspective?

Mr. MARKOWSKY. We are looking at that issue in terms of the regulations with respect to storage. There is an issue in terms of there has been extensive amount of CO₂ injected for enhanced oil recovery, and there are need for regulations for geological sequestration. That is an issue that is being worked on with EPA—

Senator MURKOWSKI. Is the task force also looking at this as well?

Mr. MARKOWSKY. The task force is working on that, but EPA is also looking at that with respect to injection and monitoring. They hope to have a rule—they are going to have a rule out by the end of this year.

Senator MURKOWSKI. Ms. Castle.

Ms. CASTLE. As I understand it, Senator, I mean, CO₂ is a fungible commodity, but the difference with sequestration is the injection at pressure, and that generates different impacts, different issues. So the regulatory structure may be different as a result. But as Dr. Markowsky says, that is one of the issues that is being addressed by the task force.

Senator MURKOWSKI. Thank you, Mr. Chairman.

Thank you.

The CHAIRMAN. Senator Dorgan.

Senator DORGAN. Let me just make one final point, and it relates to something that Senator Bunning said. I think many share the urgency that he feels about moving ahead.

Yet I think it is also important to understand this is not formula funding that you have been given. The \$3.4 billion is funding for which you are going to select some very large projects that will be consequential, and it is very important that these projects be carefully selected so that they are able to accomplish what we want to accomplish. So I want you to do it as quickly as we can, but I want you to do it right. I know Senator Bunning would want the same thing.

But it is easier to get formula funding out the door. I understand that. When we provide formula funding, we would expect that to move out the door. But this \$3.4 billion is designed to support some very significant, new, cutting-edge, large projects. I understand the concern from the Senator from Wyoming, that a small percent has gone out the door at this point. But having said all that, all of us want you to not only do it well and do it quickly, but to do it right.

Mr. MARKOWSKY. If I could just mention some of the things we are doing? In CCPI-3, we selected 2 gasification projects, somewhat different. One produces hydrogen for electric power generation and also a product, and the second one basically will be co-production of urea, again using state-of-the-art gasification technology, which I still call "first generation."

We also have selected 3 post combustion projects, which have different post combustion technologies. That is critical that we operate those in an integrated fashion. However, I feel that we need to

accelerate the development of that to go to the next generation, which is going to have significant cost reduction.

On the industrial sector, we are looking at cement kilns. We are looking refineries. So we are looking at the spectrum of post capture-type of technology.

Senator, I believe, given the technology we have, we are covering the nature of the industry that we need to cover to get the integrated information to take the next step.

Senator DORGAN. Each of these necessarily will be fairly large projects?

Mr. MARKOWSKY. Yes.

Senator DORGAN. That is why making a mistake on one could be very costly for the American taxpayer. So you have a great opportunity with this money that comes from the Recovery Act, and all of us want you to use this in a very significant way to develop the answers that we need as we move forward to determine what is the bridge to be able to use coal in the future.

Mr. MARKOWSKY. That is our objective, sir.

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

Why don't we go ahead and go to the second panel at this point?

Let me introduce the second panel as they are coming forward to the witness table. Robert Hilton is vice president of power technologies. He is at Alstom Power here in Washington. Mark Brownstein is Deputy Director of Energy Programs with the Environmental Defense Fund. Adam Vann, who is legislative attorney with the American Law Division of CRS, Congressional Research Service. Ben Yamagata, who is the executive director of the Coal Utilization Research Council. Kurt House, who is the chief executive officer with C12 Energy in Cambridge, Massachusetts.

So we very much appreciate all of you being here. Why don't we start with you, Mr. Hilton, and just go right across the table hear, and each of you take about 5 minutes. We will include your full statements in the record as if read. But if you could make the main points that you think we need to understand, that would be very helpful.

Mr. Hilton.

STATEMENT OF ROBERT HILTON, ON BEHALF OF MS. MACNAUGHTON, CB, SENIOR VICE PRESIDENT, POWER AND ENVIRONMENTAL POLICIES, ALSTOM POWER

Mr. HILTON. Thank you. Good morning.

I would like to thank Chairman Bingaman and Ranking Member Murkowski, as well as the entire committee, for this opportunity to address these issues on CCS.

Alstom is a global leader in the world of power generation and transportation infrastructure. We employ more than 81,000 people in 70 countries, including 6,000 full-time permanent employees in 47 States in the United States That number virtually doubles when you include workers hired for specific projects.

We are proud of our growth in the U.S., highlighted by our nearly \$300 million investment in a new turbine manufacturing facility in Chattanooga, Tennessee, and a new wind manufacturing facility in Amarillo, Texas.

Alstom is a leader in the field of CCS with 12 pilots, demonstrations, and commercial-scale plants in operation or design and construction. We are proud to be partnering with AEP in operating what is thought to be the only real project capturing and storing significant quantities of CO₂ from an existing power plant, namely the Mountaineer plant.

Alstom is commercializing 3 capture technologies, and these will be available commercially by 2015 is the target. All of these technologies can be retrofitted to the existing fleet.

We are here to talk specifically about 3 bills under your consideration. The first of these is the draft bill by Senators Rockefeller and Voinovich. Alstom strongly supports this bill. We believe the funding structure and mechanism proposed in the draft will achieve the targeted number of plants which the industry, the administration, and Congress have deemed necessary for successful implementation of commercial-scale technology.

Alstom suggests a revision to the restrictions on funding. Alstom has been a leader in technology development and commercialization throughout its history. We have brought many technologies to the marketplace. The experience has led us to be wary of upfront prescriptive sizing definitions for funding.

For instance, with over 50 years experience in the air pollution control area, we know that plants validated at the 200 to 300 megawatt level for post combustion CCS are fully adequate for unlimited deployment on full industry-wide application. Other technologies like oxy-fired boilers will take larger demonstrations.

We need to allow for demonstrations at the 100 to 300 megawatt level on key applications such as CCS applied to gas turbines, an application that will be critical under any scenario if we are to reach our goals in 2030 and 2050. Too much attention has been focused on identifying CCS with coal. The application of CCS to all fossil fuels, particularly natural gas, will be absolutely critical to meet these reduction targets.

We reiterate that Alstom sees the Rockefeller-Voinovich draft as a critical and comprehensive bill to support the commercialization of CCS. The Responsible Use of Coal Act provides a necessary additional dimension to the Rockefeller and Voinovich draft. Our commitment to innovation means that the technology we are commercializing today may well not be the ultimate and optimal solutions in the future.

The Rockefeller-Voinovich bill is valuable for addressing the near-term commercialization opportunities. But the Casey bill is also valuable in providing support for several levels of the next-generation technology, which our country's power system will need.

Alstom urges that consideration be given also to broadening the bill to include all fossil fuels, not just coal. As we stated earlier, we need CCS to be applied to all fossil fuels, gas as well as coal, as well as other industrial processes.

Finally, Alstom also S. 1856, sponsored by Senator Barrasso, as addressing an important prerequisite for making CCS a commercial reality. We will have accomplished nothing if we commercialize the capture technology and have not addressed the ultimate disposition of the CO₂.

Alstom would also take this opportunity to urge the committee to consider measures in energy legislation to incentivize the industry to upgrade and improve the efficiency of the existing fleet on the supply side. The fact is we will need to continue to rely on coal and gas plants for a large part of our generation well into the future. We need these plants to continue to run as optimally as possible.

Upgrading the efficiency of the existing fleet will prolong its life, provide us breathing space to make the needed investments in replacement plants, compensate for load growth and load loss resulting from additional controls, and finally, reduce carbon emissions on a massive scale. One estimate has upgrading the existing fleet reducing CO₂ by as much as 12 percent, a huge step toward our goal, and all this technology is now available.

Last, I would reiterate a call made by Alstom and a broad section of business, labor, environmental, and other organizations for Congress to pass climate legislation that preserves and creates jobs, enhances energy security, and enables the U.S. to contribute the clean technology leadership that the world needs. To those who would question how soon CCS will be available, Alstom is on record as saying 2015.

All of these bills are important steps in that direction and deserve support on their own merit. However, absent the certainty that can only come from a broad legislative and regulatory framework making clear a price for CO₂, businesses will not make the substantial investments needed to support CCS and other innovative technology options.

We thank the committee for the opportunity to comment.
[The prepared statement of Ms. MacNaughton follows:]

STATEMENT OF JOAN MACNAUGHTON, SENIOR VICE PRESIDENT, ENVIRONMENTAL
POLICIES, ALSTOM POWER

Good morning. My name is Joan MacNaughton. I hold the position of Senior Vice President responsible for Power and Environmental Policies for Alstom Power. I would like to thank Chairman Bingaman and Ranking Member Murkowski as well as the entire Committee for this opportunity to address these key issues on Carbon Capture and Sequestration (CCS).

Alstom is a global leader in the world of power generation and transportation infrastructure that sets the benchmark for innovative and environmentally friendly technologies. More than 50% of the power plants in the United States have Alstom equipment, and 25% of the world's electricity is generated on Alstom equipment. Alstom has the world's largest service business devoted to the maintenance of power generation equipment and is the world's largest air pollution control company.

Alstom employs more than 81,000 people in 70 countries, and had sales of \$26.7 billion in 2008-2009. In the U.S., Alstom employs approximately 6,000 full time permanent employees in 47 states. That number virtually doubles when you include workers hired for specific projects. We are very proud of our growth in the U.S., highlighted by our nearly \$300 million investment in a new steam turbine manufacturing facility in Chattanooga, TN that will open in a few months; and our proposed new factory for wind manufacturing facility at Amarillo, Texas.

Alstom has a broad portfolio of power generation technology options: including coal, oil, natural gas, wind, hydro, and nuclear. Based on this diversity of offerings, Alstom has been promoting its strategy of "Clean Power Today". We are clear we will need a balance of all these technologies to reach our goals for carbon, both on technical and economical grounds. Significant pillars of our program are rapid and successful deployment of non-CO₂ sources of generation, namely nuclear and renewables; reduced CO₂ emissions through more efficient generation; and the capture of CO₂ from fossil fuel powered generation (CCS).

Alstom is a leader in the field of CCS with 12 pilots, demonstrations, and commercial scale plants in operation or design and construction worldwide. We are proud to be partnering with AEP in operating what is thought to be the only real project capturing and storing significant quantities of CO₂ from an existing power plant, namely the Mountaineer Plant in West Virginia.

Alstom is commercializing three capture related technologies: chilled ammonia, advanced amine, and oxy-firing, with the focus on having the first of these technologies commercially available in 2015. All of these technologies can be retrofitted to existing power plants.

We are here today to specifically address three bills under consideration by the Committee on the subject of CCS.

The first of these is the draft bill by Senators Rockefeller and Voinovich. Alstom strongly supports this bill. We believe the funding structure and mechanism proposed in the draft will achieve the targeted number of plants which the industry, the Administration, and Congress have deemed necessary for successful implementation of commercial scale capture technology.

Alstom would offer the following comments as an enhancement to the draft bill. We recommend that industry groups representing carbon capture technology suppliers be added to either the Partnership Council or the Technical Advisory Committee or both. Including these key voices would provide important expertise as an input to the decision process.

Alstom also suggests a revision to the Restrictions on funding. Alstom has been a leader in technology development and commercialization throughout its history. We have brought many technologies to the market place. This experience has led us to be wary of upfront prescriptive size definitions for funding. The size of demonstration required will vary according to technology type. For instance, with over 50 years experience in the air pollution control area, we know that plants validated at the 200-300 MW level for post-combustion CCS are fully adequate for unlimited deployment on full industry wide application. But other technologies such as oxy-fired boilers will require larger demonstrations because of technical factors related to boiler design. On the other hand, we need to allow for demonstrations at the 100MW—300MW level on key applications such as CCS applied to gas turbines—an application that will be critical under any scenario if the world is to reach the levels of reduction proposed for 2030 and 2050. Too much attention has been focused on identifying CCS with coal. The application of CCS to all fossil fuels, particularly natural gas, will be absolutely critical to meet the ultimate future emission reduction goals of 50% and 80%. We therefore suggest that the restriction of funding for the size range 100MW—300MW be removed. If the goal is to ensure adequate funding for larger scale demonstrations needed across the broad range of technologies, perhaps the Bill should stipulate the attainment of that goal in the remit given to the Partnership Council and the Technical Advisory Committee.

We reiterate that Alstom sees the Rockefeller/Voinovich draft as a critical and comprehensive bill to support the commercialization of CCS. We strongly welcome it and urge the committee to move forward with such legislation, and to do so without delay if we are to build a whole new industry and roll out CCS on the scale required by 2030.

Senate Bill 1134, “The Responsible Use of Coal Act of 2009” sponsored by Senator Casey, provides a necessary additional dimension to the Rockefeller/Voinovich draft. Our commitment to innovation means that the technology we are commercializing today may well not be the ultimate or optimal solution in the future. Alstom has extensive experience with technology development across different fuels. We are clear that technology and cost reduction in power generation in any field will only be achieved by innovation and the continued funding of research, development and demonstration at a significant scale. The Rockefeller/Voinovich bill is valuable for addressing the near term commercialization opportunities. But the Casey bill is also valuable in providing support for several levels of the next generation technology which our country’s power system will need. Like many technology developers, Alstom is already exploring several additional revolutionary technologies for CCS in addition to those which are nearer to market. Again, however, Alstom urges that consideration be given to broadening the bill, to include all fossil fuels and not just coal. As we stated earlier, we will need CCS to be applied to all fossil fuel power generation, gas and coal, as well as to other industrial processes. Technical breakthroughs in one fuel may well be applicable to others in the case of CCS. This bill would provide support for those future technologies and accordingly Alstom sees this portion of the bill, widened to include other fuels as well as coal, as an essential component of the wider strategy for meeting the goals of emission reduction through CCS.

Finally, Alstom also sees Senate Bill 1856 sponsored by Senator Barroso as addressing an important prerequisite for making CCS a commercial reality. We will have accomplished nothing if we commercialize the capture technologies and have not addressed the ultimate disposition of the CO₂ captured. The approach to pore ownership on Federal lands in the Barroso bill is an important step towards dealing with storage issues, and Alstom welcomes inclusion of such legislation in the developing CCS strategy and legislative portfolio. We would also point out that there are other excellent examples both from individual States and from the European Union which could be considered within this context.

Alstom would also take this opportunity to urge the Committee to consider measures in energy legislation to incentivise the industry to upgrade and improve the efficiency of the existing fleet on the supply side. Our electricity needs are set to grow—even if we attain the ambitious levels of improvement in efficiency on the demand side which we and many experts believe are necessary. Nor can we meet these growing needs just from increased use of renewables and nuclear, valuable though both these sources will be for meeting emission reduction targets. The fact is we will need to continue to rely on coal and gas plants for a large part of our generation. And we need these plants to continue to run as optimally as possible. Upgrading the efficiency of the existing fleet will prolong its life; provide us breathing space to make the needed investments in replacement with new plant; compensate for load growth and load loss resulting from additional controls; and finally, reduce carbon emissions on a massive scale. Improving efficiency means more megawatts from each ton of fossil fuel, thus contributing to improving our security of fuel supply as well as ensuring better continuity of electricity supply. One estimate has the upgrading of the existing fleet to reduce carbon emissions potentially by as much as 12% from the reported current baseline—a huge step towards our goals. More importantly, implementing efficiency upgrades now actually significantly reduces the levels of CO₂ reduction needed in future years. And, best of all, the technology already exists today, at proven commercial scale.

Lastly, I would reiterate previous calls made by Alstom and a broad cross section of business, labor, environmental, and other organizations for Congress to pass climate legislation that preserves and creates jobs, enhances energy security, and enables the US to contribute the clean technology leadership that the world needs. The technologies exist to make such policies achievable. To those who question how soon CCS will be available, we say, drawing on experience from our extensive demonstration program, that Alstom is on record as having the capture process commercially available in 2015. All of these bills are important steps in that direction and deserve support on their own merit. However, absent the certainty that can only come from a broad legislative and regulatory framework making clear a price for CO₂, businesses will not make the substantial investments needed to support CCS and other innovative technology options.

Such investments risk being held back by current uncertainties over the policy framework. By passing practical and well targeted measures such as are contained in these three Bills, the Congress will kick start the creation of a whole new industry, creating hundreds of thousands of high quality jobs and preserving many others in the coal mining industry. As the rest of the world increasingly puts these policies in place, with huge investments in low carbon technologies, for America not to do so would put American competitiveness and prosperity at risk. It cannot be right to let current uncertainties persist, and that is why we at Alstom support these pieces of legislation which we hope will move the country and the industry closer to the goal of a competitive and thriving low carbon economy.

We thank the Committee for this opportunity to comment.

The CHAIRMAN. Thank you very much.
Mr. Yamagata, go right ahead.

STATEMENT OF BEN YAMAGATA, EXECUTIVE DIRECTOR, COAL UTILIZATION RESEARCH COUNCIL

Mr. YAMAGATA. Mr. Chairman, Ranking Member Murkowski, and members of the committee, my name is Ben Yamagata. I am the executive director of the Coal Utilization Research Council. A list of our membership is included with my written statement.

I thank you for the opportunity to discuss Title II of draft legislation offered for comment by Senators Rockefeller and Voinovich. At the outset, let me express our support for the 5-title draft legisla-

tion that Senators Voinovich and Rockefeller have distributed for comment.

While CURC members differ with specific elements of the draft, I want to emphasize that this proposal, in its entirety, is the most comprehensive and far-reaching initiative yet proposed to address the variety of issues related to the successful widespread introduction of CCS technology.

With my allotted time, let me make 4 points. First, coal will be used around the world in the foreseeable future. Let me give you some metrics. We emit about 2 billion tons of CO₂ annually from the U.S. power sector and some 6-plus billion from the entire U.S. economy.

China emits 5.6 billion tons annually just from the energy sector alone. Left unabated, that number is projected to rise to 16.2 billion by 2050. China is building the equivalent of one new commercial power plant every week. China is both the largest user of coal in the world, as well as the larger emitter of CO₂.

To achieve a greater than 80 percent reduction in CO₂ emissions by 2050, given the projected use of coal globally, CCS is imperative. We can't be successful with the climate issue without successfully using CCS.

If we are forced to do so, that is without using CCS, according to the International Energy Agency, it will cost at least 90 percent more, nearly doubling the cost to achieve the level of reductions proposed by mid century.

Second, the pieces of CCS are available, but we have yet to integrate all of those pieces into a demonstrated operating whole, at least in the utility sector. Moreover, with our current technology and with the lack of economies of scale, CCS is expensive.

We estimate, as does DOE and others, that the CO₂ capture systems can add a third more cost to a power plant when installed, retrofits even more, including parasitic use of the power from those plants. That is why financial incentives right now are so important.

President Obama recently reiterated a commitment to make sure that 5 to 10 CCS projects are demonstrated and operational by 2016. While welcomed, this is also not enough, especially with respect to the storage of carbon dioxide in deep saline formations.

The National Research Council, an arm of the National Academy of Sciences, the Secretary of Energy's National Coal Council, and many others have concluded that many more CCS projects beyond the numbers cited by the President will be required. It is important to note that in order to ensure completed demonstrations by 2016, projects must be underway. We must act now.

Most significant, in our judgment, we are nowhere near the level of financial commitment needed to get a sufficient number of projects underway and completed before 2025 or 2030, let alone 2020. This leads me to the third point. That is general comments about the provisions of Title II of the draft proposal set forth by Senators Rockefeller and Voinovich.

While we have significant concerns about several features of the Title II proposal, again, we are grateful for this important initiative. I outlined in my written statement and attachments some of our principal areas of concern. In the interest of time, let me simply state the wires charge by which industry and its customers

would self-finance CCS demonstrations would—excuse me, is an important element of the proposal. We prefer the provisions that were included in the House-passed H.R. 2454 program to the program that has been detailed in the Senators’ draft.

We are further concerned that several CURC members that have CCS projects underway or under consideration will not be eligible for the incentives in the proposed bill as a result of the recommended size of the project criteria. Also, there is a need to clarify eligibility to ensure that both regulated and unregulated electric utilities will qualify.

We believe that funding incentives for public power utilities needs to be added. Finally, we need assurances that the funds collected from ratepayers will be available. Realistically, that cannot be assured through the annual appropriations process.

All of these issues, in my judgment, are eminently fixable. We look forward to working with the Senators and this committee to address these concerns.

Fourth and finally, the other 4 titles of the draft legislation presented by Senators Rockefeller and Voinovich must also be addressed. CURC has recommended a 5-point program similar in many respects to that proposed by the Senators.

We believe that each element of the program must be acted upon. No single element alone is enough. We ask for the consideration by this committee and other committees with pertinent jurisdiction that you consider and act upon all the elements of the Senators that they are proposing.

To effectively address CO₂ emissions while continuing use of this country’s most abundant fossil fuel, CCS is imperative. It will be expensive. Patience must be exercised. We cannot succeed without Government assistance, but also we cannot succeed without CCS.

Thank you, and I look forward to your questions.

[The prepared statement of Mr. Yamagata follows:]

PREPARED STATEMENT OF BEN YAMAGATA, EXECUTIVE DIRECTOR, COAL UTILIZATION RESEARCH COUNCIL (CURC)

Introduction

On behalf of the membership of the Coal Utilization Research Council (CURC) I thank the Committee for this opportunity to testify on Title II of draft legislation distributed by Senator Jay Rockefeller and Senator George Voinovich on March 20.

The CURC is an organization of major U.S. coal producers, electric utilities that rely upon coal to generate electricity, major equipment manufacturers, state governments and academic institutions. A membership list is attached (See: Attachment 1).

Title II of the Senators’ draft would authorize the establishment of a twenty gigawatt demonstration and early commercial deployment program focused upon carbon capture and sequestration (CCS) technology. CURC supports the concepts in this proposed legislation and we look forward to working with the Senators and also with this Committee and others to refine this draft proposal prior to introduction.

As requested by Committee staff, this testimony focuses specifically upon title II of the draft legislation related to incentives for a 20 gigawatts CCS “pioneer plants” program.

II. Summary of the important points in this written statement:

- Four key elements of CURC’s testimony:
 1. To insure that CCS technology is effective and affordable and to achieve these goals within the mid-century timeframe being discussed for CO₂ reductions we must begin the Rockefeller/Voinovich title II program NOW.

2. The scope of the proposed title II program is broad (20 GWs) and will be expensive (as much as \$40 billion over a 20+ year period). The National Academy of Sciences, the Senator Byron Dorgan “Pathways” initiative comprised of a large and diverse cross-section of interests, including NGOs, industry, academia, as well as the International Energy Agency and many others have concluded that a large-scale CCS demonstration-deployment program is essential to the rapid commercialization of CCS. More importantly the IEA has concluded that the successful deployment of CCS could reduce overall costs of reductions by up to 97%!

3. CURC supports the concepts of title II of the draft legislation and recommends several modifications to the draft including:

- Consideration of an electric utility industry-led accelerated CCS demonstration program similar in scope and administration to the “wires charge” authorization included as section 114 of H.R. 2454 in lieu of the 10 GW special funding program proposed in the Senators’ draft. While the approaches to a fee on electricity consumption to finance a CCS demonstration program differ and CURC’s electric utility members, in particular, have agreed upon the program included in H.R. 2454, the CURC fully endorses the concept of such a fee-based program to support the demonstration of CCS particularly if the program insures that there will be a diversity of CCS technologies demonstrated. This diversity of options will provide industry with the ability to choose which option is most favorable to a particular circumstance.

- The draft legislation sets forth eligibility criteria based, in part, upon the size of demonstration projects. As currently drafted this criterion would eliminate from eligibility certain CCS projects now under consideration. The size limitation must be adjusted. CURC has offered a different size of project criteria which we believe retains the objectives of the proposed program while still insuring that large-scale demonstration projects will qualify. We urge the substitution of this modified size standard.

- Clarification of language in the draft proposal to insure that all of the proposed financial incentives are available to a specific project (e.g. project should be eligible for investment as well as production tax credits) and also to include subsidized bond financing and or tax grant options for not-for-profit public power and electric cooperative utilities not otherwise eligible for the proposed tax incentives.

4. Finally, Congress is encouraged to adopt the “comprehensive” carbon management program for coal as reflected in the Rockefeller/Voinovich discussion draft. Each title of the Senators’ discussion draft is vitally important, in the judgment of CURC members, to successful widespread commercial deployment of CCS.

III. Why Coal and CCS technology?

Coal is an important contributor to the U.S. and global energy mixes. In the U.S., coal provided 23% of total energy consumption in 2008, according to the DOE Energy Information Administration. About 90% of coal in the U.S. goes to electric power generation, and that coal generates about half of our electricity. Globally, coal is about 27% of total energy consumption and 40% of electricity generation. Coal use in the U.S. has been relatively constant for several years, and is expected to remain so in the future, but globally coal has been the fastest growing fuel form for the past decade, in total Btu’s. EIA projects that 94% of growth in global coal use between 2006 and 2030 will be in non-OECD countries. Much of that growth will be in China, which currently uses about three times as much coal as the U.S. and is building approximately one new coal-based power station every week of the year.

Coal provides, and will continue to provide, reliable and low cost energy and power to billions of people around the world. But, to address the continued and growing need for coal we must address the carbon dioxide emissions that result from coal use. CURC is absolutely confident that given sufficient time and financial assistance technology will be available to address the CO₂ emissions resulting from the use of all carbon-based fuels, including coal and natural gas.

In the U.S., coal contributes about 31% of total emissions of greenhouse gases, according to EPA’s latest inventory. That figure is exceeded only by petroleum (35%). Without a significant reduction in emissions from all fossil fuels, including coal, we have no chance of meeting those legislative goals demanded by some like an 83% reduction in GHG emissions by 2050. For coal, the only practical ways of achieving such results are to either not use it, or to apply CCS technology. Given the economic and energy security contributions of using coal, and the clear certainty that the de-

veloping nations will continue and expand their use of coal, CCS appears to be the more realistic choice. Others have reached this same conclusion. You may recall the oft-quoted statement by former U.K. Prime Minister Tony Blair: “The vast majority of new power stations in China and India will be coal-fired. Not ‘may be coal-fired’; will be. So developing carbon capture and storage technology is not optional, it is literally of the essence.” In the International Energy Agency’s analysis of GHG mitigation options (Energy Technology Perspectives, 2008) the IEA concluded that a scenario including the assumption that CCS was available and effective was 97% cheaper than a scenario without CCS. IEA has concluded that: “CO₂ capture and storage for power generation and industry is the most important single new technology . . .”

The importance of CCS might best be explained when described in the context of the various paths that must be pursued to achieve what the Intergovernmental Panel on Climate Change (the IPCC) has concluded as necessary reductions in global greenhouse gas (GHG) emissions of 50-85% below current rates by 2050 in order to limit warming to 2-2.4 °C. In 2008, the International Energy Agency published its analysis of measures needed to achieve a 50% decrease below current GHG emission rates by 2050.¹ *Figure ES.2 (below), taken from that report, summarizes the report’s findings.

IV. What is the Current Status of CCS?

Most of the major components needed for CCS have been used commercially. They have not, however, ever been combined on a commercial scale power plant anywhere in the world. With respect to storage technology, we have extensive experience in the U.S. with enhanced oil recovery, which retains a large portion of the CO₂ injected to produce additional crude oil, but there are only a handful of projects globally that are injecting large quantities of CO₂ into the largest potential “sink” for CO₂: deep saline geological formations (essentially porous rocks saturated with brackish water, a mile below the earth’s surface). The USDOE has two relevant demonstration programs underway—the Regional CO₂ Sequestration Partnerships program, focused on storage of CO₂; and, the Clean Coal Power Initiative (CCPI), focused on integrated power plant capture and storage projects. In addition, the FutureGen project, an integrated gasification combined cycle (IGCC) equipped with carbon capture and storage technologies, hopefully, will be fully underway with completion of construction and initial operation by 2015. This first-of-a-kind project will capture and sequester one and one-half million tons of CO₂ annually.

It is important to note that if all the ongoing projects go forward, and that is always an uncertainty, in 2016 we will have experience with two saline storage projects and four, or more other power plant and industrial projects that have the goal of CO₂ capture and storage in EOR formations, and they are important, especially for deploying CCS in the near-term—but they will not give us needed experience with saline storage which is necessary for unlocking the greater potential of CO₂ storage in deep geologic formations.

My point is not one of complaint about the current demonstration program—it is the most advanced and aggressive in the world. My point is that this is not enough to launch a program critical to the world’s future in the time frames discussed by the President and in proposed legislation. This level of undertaking is further explained and amplified by others including the following:

1. America’s Energy Future, a recent report by the National Research Council, concluded that 15-20 CCS projects totaling 10 gigawatts (GW) of capacity were needed in the next decade, in order to accommodate broad deployment of CCS in the time thereafter. The NRC report said, “A failure to demonstrate the viability of these technologies [both CCS and advanced nuclear systems] during the next decade would greatly restrict options to reduce the electricity sector’s CO₂ emissions over succeeding decades. The urgency of getting started on these demonstrations to clarify future deployment options cannot be overstated.” [emphasis added]

2. The total number of projects and scope of demonstrations recommended by the National Research Council study is generally consistent with the conclusions drawn by CURC. Our members have carefully examined the need for a variety of CCS demonstrations to address both technical and financial issues of uncertainty and concluded that it will be necessary to support as much as 15 gigawatts of CCS-related capacity. Importantly, this does not need to be electricity generation only. Indeed, many of the early, commercial-scale projects uti-

¹Energy Technology Perspectives, 2008, International Energy Agency, OECD, 2008.

* Figure has been retained in committee files.

lizing coal or petroleum coke will convert those fossil fuels to a useful energy product like substitute natural gas (SNG). And, these projects will also capture CO₂ emissions. However, at least five gigawatts-equivalent of the CCS projects must have as a part of the demonstration the storage of captured CO₂ into deep geologic formations. We cannot emphasize enough the importance of gaining the handling, storage, verification and monitoring experience that will come with this type of permanent storage.

3. Finally, over the period of several months last year a group of environmental organizations, industry organizations, experts from academia and technology providers convened under the auspices of Senator Byron Dorgan (known as the Dorgan “Pathways” initiative) to determine if they could agree upon the need for and amounts of financial support required to encourage the rapid development and deployment of CCS technology. That diverse group of interests was able to achieve some agreement over the need to support CCS deployment and most important, agreed that large amounts of government assistance was essential to early success of CCS (a brief description of the “Pathways” project and conclusions are attached to this written statement* as Attachment 2). Much of the financial requirements and timing for CCS development contemplated by the “Pathways” participants are reflected in two titles of the draft proposal of Senators Rockefeller and Voinovich.

These analyses suggest a much more aggressive target than that set by the Obama Administration, and greatly exceeds activity now underway. It is important to recognize that time is of the essence on moving forward with this work.

V. What is our Analysis of the Draft Rockefeller and Voinovich Legislation?

Committee staff suggested that I focus my remarks on Title II of draft legislation released for comment by Senators Rockefeller and Voinovich on March 20, 2010. The primary obstacle to more activity demonstrating CCS technology is money. Title II of the Senators’ draft proposes to address this issue by taking the money from two sources. Under Subtitle A of Title II, the first 10 gigawatts of CCS-equipped capacity would be funded by utilities which use fossil energy to produce electricity. A small fee placed on those utilities, and based on their total generation by each fossil fuel, would provide a pool of about \$2 billion per year for 10 years, or \$20 billion altogether. The second 10 gigawatts of CCS-equipped capacity are governed by Subtitle B and would be eligible for a production tax credit for captured and stored CO₂, loan guarantees, and an investment tax credit funded from general tax revenues. Hence, Title II proposes a practical solution to the greatest problem in getting more demonstration units built in the near term. It has identified a source of funds. In CURC’s activities in this area, it has become clear that industry will support the general concept of a “wires charge” to pay for the initial demonstration program, and to pay the private sector share of both that program and the taxpayer-assisted program. Finally, if the IEA’s cost projections are even close to correct, electricity consumer and taxpayer support of these Pioneer projects will be rewarded with electric power which is much less expensive than it would otherwise be, if and when a climate program reaches its more aggressive stages.

The Subtitle A funds would be administered by DOE and used to pay a production subsidy, in dollars per ton of CO₂ captured and stored (or converted). Projects with higher %-capture, or earlier in time, would get a higher rate per ton. The details of how much the subsidy would be for specific projects or overall are not prescribed in the draft. The goal of the program is to provide incentives for at least 10 GW of CCS-equipped capacity.

Subtitle B of Title II provides for amendment of the internal revenue code to:

- Extend the current Section 45Q production tax credit to any eligible unit placed in service prior to January 1, 2017. The credit amounts to either \$10/ton or \$20/ton of CO₂ captured and stored, with the amount depending on whether the storage is associated with EOR or saline formations, for the first 10 years of unit operation with CCS.
- Provide \$20 billion in loan guarantees for up to 10 gigawatts of new and retrofit units with CCS is authorized by an amendment to Section 1704 of EPACT-2005.
- Provide that units eligible under Section 1704 may also elect to receive a 30% Investment Tax Credit for the incremental cost of the CCS systems (but not for the basic power plant or industrial process unit).

*Attachment has been retained in committee files.

Key Issues of Concern to CURC

We applaud Senators Rockefeller and Voinovich for taking a leadership position on the advancement of this critical technology. In my view, this is the most constructive legislative package supporting CCS yet offered, in terms of its ability to generate additional demonstration facilities NOW. However, there are several issues that require modifications prior to introduction (See: attachment 3 for a comparison of the provisions proposed in the draft legislation by Senators Rockefeller and Voinovich and recommendations, very similar to section 114 of H.R. 2454, that CURC has previously provided).

The first, and foremost, is the structure of the section 201 program, the "Carbon Capture and Sequestration Early and Effective Deployment Fund Act of 2010" which includes the assessment of a fee on electricity consumption by certain customers.² Simply stated, we believe that the program initially considered and adopted in the House-passed climate bill related to an industry-funded demonstration program, the so-called "Boucher wires charge" more clearly reflects a suitable structure. I have taken the liberty of attaching a CURC-prepared document that compares the provisions of the draft legislation to provisions that CURC supports. There are immense possibilities in the Senators' draft legislation to address our concerns and CURC and our members stand ready to offer further, detailed views in this regard.

It is significant that electric utilities, both regulated and non-regulated, as well as the association of state utility regulators (NARUC) have agreed upon the level of fees to be assessed on all utility customers as well as the administration of the demonstration program. That agreement was reflected in the CCS demonstration program included in H.R. 2454, section 114. The Rockefeller-Voinovich discussion draft substantially alters critical elements of section 114. In addition to conforming the amount of fees to be levied and the customer base that would be asked to provide funds for the demonstration program to H.R. 2454, the Committee and Senators Rockefeller and Voinovich must retain a mechanism that will ensure that the funds collected for the program be available only to the program and that they not be subject to an annual appropriations process that immediately draws into question whether funds will be available from one appropriations cycle to the next.

Second, we are very concerned that the eligibility requirements to participate in either the 10 gigawatt demonstration program, funded by the assessments on electricity consumption, or the 10 gigawatt pioneer plant or "first mover" program that provides a variety of tax and other financial incentives to early commercial scale projects, are overly restrictive. Indeed, several of our members currently engaged in first of a kind CCS-related projects have reported that their project will not qualify for the proposed programs. We assume that is not the intent of the senators to exclude these projects that will pioneer the needed experience with CCS technology.

Specifically, section 205 (i) and section 252 (c) of the draft set forth two different size criteria for CCS projects to be eligible for the Title II programs. We urge that these criteria be identical and that qualifying criteria be premised upon the assumption that the size of the project, once successfully completed, will enable that technology to thereafter be replicated at commercial scale in some instances or scaled-up in other instances to thereafter operate at full commercial scale. This size standard will be different based upon the technology involved but industry and the Department of Energy, we believe, could easily determine standards to define commercial scale and also determine if a given project will demonstrate a technology that can be subsequently constructed at full commercial scale. To account for a variety of circumstances and technologies CURC has recommended that the size standard include an absolute size of at least 200 MWs or equivalent of nameplate capacity to account for CCS retrofits for a portion of very large power plants or at least 20 percent of the total nameplate generating capacity to encompass smaller projects. Again, the goal of the Title II program should be to focus on the pioneer plants that constitute the first generation of CCS projects that will operate in commercial settings. Also with respect to eligibility it is important that all electric utilities, those

²A structural issue which has been raised regarding the Draft Discussion is the exclusion of residential electricity users from the lines charge assessment. These customers constitute about one-third of electricity use, so their exclusion raises the fee significantly for the remaining customers (commercial and residential electricity users). Under this construction, the fee could reach burdensome levels, particularly for the manufacturing sector, which is struggling to survive in the current recession. The basic principle of minimizing the fee per payer by having a large base of inclusion is defeated if a large segment of the potential payers are excused from the assessment. I would urge the authors of the draft proposal and this Committee carefully reconsider the issue of "who pays" in order the spread the cost impacts across all electricity rate-payers.

that are regulated and those operating in deregulated markets, have opportunities to access the variety of financial incentives. Equally true, CURC supports changes to Title II that will insure that public power entities are also eligible for funding under the programs.

In addition, subtitle III of the draft bill provides a tax credit under new section 45R of the Internal Revenue Code for 62 GWs of capacity that are installed with CCS systems. Although very supportive of this provision, we have one major concern with an ambiguity with the eligibility requirement. Specifically, the requirement can be read to require the capture and sequestration of at least 65% of the total CO₂ emissions from the entire unit. For the same reasons already noted above, the application of capture levels to the entire will be infeasible at the larger-sized existing coal-fired units and, in such cases, only a portion of the flue gas will be treated by CCS technology. For this reason, CURC recommends that the 65% capture level be measured based on the capture levels achieved by the treated portion of the flue gas, instead of all of the flue gas from the unit. This approach is consistent with how the CCS bonus allowance program is administered under the Kerry-Boxer bill.

VI. The Need for a Comprehensive Carbon Management Program for Coal

The CURC strongly supports the comprehensive nature of the draft legislation proposed by Senator Rockefeller and Senator Voinovich. While we have not commented upon other elements of their proposal we note the importance of their initiative in seeking to address the issues that our membership considers of utmost importance to the successful development and, thereafter, widespread commercial deployment of CCS.

Finally, while we have not commented, in this written statement upon the other titles of the draft legislation proposed by Senator Rockefeller and Senator Voinovich, CURC wishes to state its support for these important titles, as well. There are modifications that we would recommend and we look forward to working with those senators, as well as this and other jurisdictional committees of the Congress to modify this important proposal. We thank you for the opportunity to provide this statement.

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

**STATEMENT OF MARK S. BROWNSTEIN, DEPUTY DIRECTOR,
ENERGY PROGRAM, ENVIRONMENTAL DEFENSE FUND**

Mr. BROWNSTEIN. Thank you, Mr. Chairman, Ranking Member Murkowski, members of the committee.

I am pleased to testify on behalf of the 700,000 members of the Environmental Defense Fund. Since 1967, EDF has linked science, economics, and law to create practical solutions to society's most urgent environmental problems.

There is no more urgent environmental problem facing our world today than global climate change. A changing climate will have significant disruptive effects on our economy and the environment. Current methods of energy production are a major source of the pollution causing climate change. They have brought us great prosperity, but that prosperity is not sustainable.

Fortunately, there is a bright economic future for the United States in a low-carbon, clean energy technologies. EDF's energy program is singularly focused on accelerating our Nation's transition to this bright future. The work of this committee is critically important to achieving that bright future, and we are happy to do all that we can to work with you to achieve it.

EDF strongly believes that the most important thing we can do to accelerate our Nation's transition to a low-carbon, clean energy economy is to put a price on carbon. Unless and until there is an economic reason to avoid dumping greenhouse gas pollution into the environment, advanced new technologies that excel at deliv-

ering clean, low-carbon energy will sit on the shelf. There simply will be no market for them.

A price on carbon, however, by itself, will not achieve everything that we would like to achieve in the timeframe we would like to achieve it. Limited efforts to remove economic stumbling blocks or clarify legal or regulatory relationships are, in fact, required.

We also need to chart a new course for coal. Coal-fired power plants are the single largest source of carbon dioxide pollution in our Nation today, and current methods of coal production and use place a heavy and unacceptable burden on public health and the environment.

However, while we might wish it were otherwise, coal will likely play an important role in our economy—and the economy of many other industrial nations—for many years to come. Therefore, the challenge is to develop and deploy technologies and strategies that can substantially reduce or prevent the worst consequences of coal production and use. Carbon capture and storage is critical to the future of coal.

As a technical matter, CCS is ready to begin commercial deployment today. All of the necessary technologies exist. What is missing is the market driver to cause companies put the pieces together and invest in deploying them.

Beyond this, what is needed is a clear legal framework for securing subsurface rights for geologic storage of CO₂, a well-defined liability regime, and judicious use of subsidies to accelerate the learning curve on CCS deployment and development. On this point, we are encouraged by the work of Senators Rockefeller and Voinovich, as well as the proposal made today by Senator Casey.

When taken in context with the work that the House of Representatives has already done on this matter, we see a real consensus forming on how to move forward with CCS. Based on the history of other technologies, we fully expect that the costs of CCS deployment will come down, and project development will become routine.

But we caution as CCS develops, specific attention needs to be paid to the importance of proper site selection and proper site operations. Geologic sequestration is not something that can be done just anywhere, casually, or with limited skill. It requires sophisticated preparation, execution, and oversight by both the companies and regulators involved.

Government's work with industry should be specifically targeted at helping to further develop the appropriate analytical and monitoring tools and rigorous procedures for achieving this objective.

Finally, as to Senator Barrasso's bill, we understand it to be clarifying basic principles of common law as it pertains to Federal property, and we support that.

EDF appreciates the opportunity to provide testimony on carbon capture and storage, looks forward to working with the committee on CCS in the context of comprehensive climate and energy legislation targeted at accelerating our Nation's transition to a clean, low-carbon energy economy.

Thank you.

[The prepared statement of Mr. Brownstein follows:]

PREPARED STATEMENT OF MARK S. BROWNSTEIN, DEPUTY DIRECTOR, ENERGY
PROGRAM, ENVIRONMENTAL DEFENSE FUND

Mr. Chairman, I am pleased to testify before the Senate Energy and Natural Resources Committee on behalf of the 700,000 members of the Environmental Defense Fund. Since 1967, EDF has linked science, economics and law to create practical solutions to society's most urgent environmental problems.

There is no more urgent environmental problem facing our world today than global climate change. A changing climate will have significant disruptive effects on our economy and our environment. Current methods of energy production are a major source of the pollution causing climate change. They have brought us great prosperity, but this prosperity is not sustainable. Fortunately, there is a bright economic future for the United States in a low carbon, clean energy economy. EDF's Energy Program is singularly focused on accelerating our nation's transition to this bright future. The work of this committee is critically important to achieving this bright future, and we are happy to do all we can to assist you in your work.

EDF strongly believes that the most important thing we can do to accelerate our nation's transition to a low carbon, clean energy economy is to put a price on carbon through federal climate and energy legislation. Unless and until there is an economic reason to avoid dumping greenhouse gas pollution into the environment, advanced new technologies that excel at delivering clean, low carbon energy will sit on the shelf. There simply will be no market for them. A price on carbon creates that market, and will stimulate innovation and investment in a wide array of new clean energy technologies and clean energy services, at a scale and pace that only the private sector can deliver.

At the same time, we know that a price on carbon, by itself, will not achieve everything we would like to achieve in the timeframe we need to achieve it. Sometimes limited efforts to remove economic stumbling blocks, or clarify legal or regulatory relationships are required. The bills that are the topic of this hearing today highlight this point.

The bills before this Committee today deal with largely with the challenge of charting a new course for coal. We will not get to where we need to go in terms of dramatically reducing greenhouse gas pollution and substantially reducing the current environmental foot print of our energy economy by continuing on a business as usual path with coal. Coal fired power plants are the single largest source of carbon dioxide pollution in our nation today, and current methods of coal production and use place too often place a heavy and unacceptable burden on public health and the environment.

At EDF, we recognize that coal will likely play an important role in our economy—and the economy of many other industrial nations—for many years to come. Therefore, the challenge is to develop and deploy technologies and strategies that can substantially reduce or prevent the worst consequences of coal production and use. Carbon capture and storage is critical to the future of coal, and indeed, over the long term, natural gas as well.

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, "commercial" scale projects. In 2005, the IPCC Special Report on Carbon Capture and Storage concluded that the fraction of carbon dioxide (CO₂) retained in "appropriately selected and managed geologic reservoirs" is likely to exceed 99 percent over 1000 years.

The IPCC also concluded that the local health, safety, and environmental risks of CCS are comparable to the risk of current common activities such as natural gas storage, enhanced oil recovery, and deep underground storage for acid gas, if there is "appropriate site selection based on available subsurface information, a monitoring programme to detect problems, a regulatory system and the appropriate use of remediation methods to stop or control CO₂ releases if they arise." The IPCC and others with geology expertise have also noted that the risk of leakage will tend to decrease with time.

As a technical matter, CCS is ready to begin commercial deployment today. All of the necessary technologies exist. What is missing is the market driver to cause companies put the pieces together. As stated earlier, this comes with a price on carbon.

But beyond this, what can help accelerate the development and deployment of CCS technologies is a clear legal framework for securing subsurface rights for geologic storage of CO₂, and judicious use of federal dollars to accelerate the learning curve on CCS development and deployment. The bills proposed by Senator Barraso and Senator Casey make important contributions in this regard.

Based on the history of other technologies, we fully expect that the costs of CCS deployment will come down and project development will become routine. As we understand it, the intent of Senator Casey's bill is that the federal government, through the Department of Energy's National Energy Technology Lab (NETL) in Pittsburgh, should be a full partner with industry in identifying those strategies and practices that will yield the best results in terms of safe, effective, and efficient capture and storage of CO₂ pollution from coal. We support this objective.

As government and industry do this work, we strongly advise that specific attention needs to be paid to the importance of proper site selection and proper site operations. Geologic sequestration is not something that can be done just anywhere, casually, or with limited skill. It requires sophisticated preparation, execution, and oversight by both the companies and regulators involved.

In particular, one of the most important objectives in assuring the safe, successful geologic sequestration of CO₂ is assuring that formation fluids—the brines pre-existing in the sandstone formations where the CO₂ is to be stored—are not driven out of the underground storage area and into an underground source of drinking water. NETL, in its partnerships with industry, will want to make sure that projects are identified and engineered in such a way that:

- 1) there are confining zones of sufficient quality and lateral extent to confine both displaced formation fluids and injected CO₂;
- 2) there is a definition of "zone of elevated pressure" that is designated to guard against either CO₂ or formation fluids being driven into a drinking water supply;
- 3) there is high quality modeling of both the injected CO₂ plume and the displaced formation fluids;
- 4) where necessary, there is monitoring of ground water quality and any geochemical changes above the confining zone; and
- 5) there are remedial response plans in the event problems appear to be developing.

We would add that NETL's work with industry should be specifically targeted at helping to further develop the appropriate analytical and monitoring tools and rigorous procedures for achieving the objectives outlined above.

As to Senator Barraso's bill, it is essential that any federal legislation attempting to clarify pore space ownership on federal property not disrupt long-standing rules of property. Clear and predictable property rules are the cornerstones of free and functioning markets. It is our understanding that Senator Barraso's bill is modeled after pore space legislation enacted by the Wyoming Legislature for Wyoming, and that the purpose of Wyoming's legislation was to clarify Wyoming's rules in relation to past deeds and future transactions, without fundamentally changing the long-standing relationship between surface and subsurface rights in the state. Assuming this is the case, we support Senator Barraso's efforts to accomplish a similar purpose for federally owned pore space on federal land.

For further consideration of the pore space ownership issue, I recommend to the committee a paper* authored by Ian Duncan and Jean Philippe Nicot, of the Bureau of Economic Geology, Jackson School of GeoSciences, University of Texas, Austin, and my colleague, Scott Anderson of EDF's Austin, Texas office, a copy of which is attached to this testimony.

EDF appreciates the opportunity to provide testimony on these two important pieces of legislation, and we look forward to working with Senator Casey, Senator Barraso, Chairman Bingaman and the rest of the Committee to advance CCS in the context of comprehensive climate and energy legislation targeted at accelerating our nation's transition to a clean, low carbon energy economy.

The CHAIRMAN. Thank you very much.
Dr. House.

**STATEMENT OF KURT ZEN HOUSE, PH.D., PRESIDENT, C12
ENERGY RESEARCH FELLOW, MIT**

Mr. HOUSE. Chairman Bingaman, Ranking Member Murkowski, and members of the committee, thank you for the opportunity to appear before you today to discuss the science, the economics, and the industrial development of carbon dioxide capture and storage.

*Attachment has been retained in committee files.

It is a great honor to be able to provide this committee with my perspective as a scientist and as an entrepreneur working in this field.

For context, I will provide you with a brief description of my activities in this area. In 2008, I received my Ph.D. in geoscience from Harvard University, where my doctoral research focused on the physics and chemistry of CO₂ in the subsurface, as well as on chemical processes designed to convert CO₂ into stable carbonate minerals. Since then, I have been a research fellow at MIT, and I have started a company to do CCS that is backed by some of the most well-respected venture capitalists in the world.

In my testimony, I will make 4 points related to CCS. My first and most important point is that CCS is an essential for addressing greenhouse gas emissions, while simultaneously maintaining a robust and affordable energy supply for the Nation. America's coal and natural gas reserves contain nearly 4 times the energy content of Saudi Arabian oil. But without the large-scale deployment of CCS, it is arithmetically impossible for us to use those reserves while simultaneously making significant cuts in our greenhouse gas emissions.

Furthermore, the existing industrial infrastructure of CO₂-emitting facilities represents well over \$1 trillion of invested capital. But again, it is impossible to make meaningful cuts in our CO₂ emissions without either dismantling the majority of that invested capital or by doing CCS.

My second point is that geology matters. The importance of getting the geology right is an issue that I actually think has not received proper attention to date. The geologic and geophysical communities have developed tremendous expertise in understanding the behavior of buoyant fluids in the subsurface. From this expertise, we can make rigorous assessments of the sequestration capability of specific geologic formations.

Long-term storage reliability is a concern of CCS, and indeed, there are many places in which trying to do CCS would, in fact, be a bad idea. But there are also many locations where CO₂ can be permanently stored.

It is important for the viability of the industry that regulatory agencies establish processes to certify specific formations as actual sequestration fields. Wyoming and Montana have addressed this well by developing in-State processes by which the boards of oil and gas conservation can certify candidate storage sites.

My third point is that the CCS industry will only advance if the relevant stakeholders are appropriately included in each project. Strong stakeholder opposition can kill any energy project.

For example, it is crucial that existing mineral rights owners, as well as land owners who we believe own the surface—own the pore space by precedent, be appropriately communicated with and, if necessary, compensated for by developers at an early development stage of CCS storage projects.

I have significant experience working with such stakeholders on early stage projects, and with the appropriate ground work, it is my that CCS has been welcomed in these communities as an industry similar to that of oil and gas that is both safe as well as compatible with multiple uses of the land.

My final point is that the major hurdle for moving CCS forward is the difficulty associated with securing finance in an uncertain regulatory environment. This committee can accelerate the CCS industry by addressing CCS legal issues to minimize unnecessary risk and, importantly, by providing financial incentives for early stage CCS projects. Senator Barrasso's bill reduces one item of risk by explicitly reinforcing on public lands the common-law precedent that a storage space belongs to surface estate, and we support this bill strongly.

The key to jump-starting the CCS industry, however, is the passage of incentives for first mover projects. The wind industry, for example, installed just 1 megawatt of wind power in 1996, but it installed over 10,000 megawatts last year, and that growth has been driven almost entirely by State-level renewable portfolio standards and Federal-level production tax credits.

So a similar set of incentives for CCS, such as the CO₂ storage tax credit discussed by Senator Rockefeller and others, would accelerate the rate of CCS and result in meaningful cuts in CO₂ emissions.

So, in conclusion, I would just reiterate that given the appropriate geology, we have the technology as well as the industrial know-how to do CCS today. If, however, we fail to provide the appropriate financial incentives for doing CCS or if we fail to bring stakeholders onboard with early stage CCS projects, then the industry will not grow. If the CCS industry does not grow, then we will be unable to make meaningful cuts in our CO₂ emissions, or we will be forced to dismantle our country's significant base of CO₂-emitting industrial facilities.

As such, I urge the committee to move forward with the relevant legislation, and I look forward to your questions.

[The prepared statement of Mr. House follows:]

PREPARED STATEMENT OF KURT ZENZ HOUSE, PH.D., PRESIDENT, C12 ENERGY RESEARCH FELLOW, MIT

Chairman Bingaman, Ranking Member Murkowski, and Members of the Committee, thank you for the opportunity to appear before you today to discuss the science, the economics, and the industrial development of carbon dioxide (CO₂) capture and storage, (commonly abbreviated to CCS). I consider it a great honor to be able to provide this committee with my perspective as a scientist and as an entrepreneur working in this field.

For context, I will provide you with a brief description of my activities related to this area. In 2008, I received my Ph.D. in Geoscience from Harvard University, where my doctoral research focused on the physics and chemistry of CO₂ in the subsurface as well as on a variety of chemical processes designed to convert CO₂ into stable carbonate minerals. Since then, I have been a research fellow at MIT, where I have continued to study the behavior of CO₂ that has been injected into the subsurface, and I have started a venture capital backed company that is working on several early stage CCS projects.

In my testimony, I will make five points regarding CCS. These five points support the central conclusion that without CCS, it will be extremely difficult make significant and affordable cuts in greenhouse gas emissions, while maintaining a secure and reliable supply of energy for the nation.

The first and most important point that I wish to make is that CCS is essential for addressing greenhouse gas emissions, while simultaneously maintaining a robust and affordable energy supply. America's coal and natural gas reserves contain nearly 4 times the energy content of Saudi Arabian oil; but, without the large-scale deployment of CCS, it is arithmetically impossible for us to use those reserves-neither the coal nor the natural gas, and certainly not both-for productive purposes, while simultaneously making significant cuts in our greenhouse gas emissions. Further-

more, the existing industrial infrastructure of CO₂ emitting facilities (e.g., power stations, refiners, chemical plants, etc.) represents well over \$1Trillion of invested capital; but again, it is arithmetically impossible to make stated cuts in our CO₂ emissions without either dismantling the majority of that installed capital or by doing CCS.

Let me give an example to illustrate. The wind industry-which is doubtless a success story in the energy sector over the past decade-currently displaces approximately 50MT of CO₂ per year.¹ Retrofitting just six large coal power stations to capture 90% of their CO₂ would have the same impact. In short, CCS can enable both the productive use of America's prodigious energy reserves and the continued use of its CO₂ emitting infrastructure, while simultaneously decreasing our greenhouse gas emissions.

The second point is that the technology to do CCS is here today. There is a persistent notion that the technology for doing CCS is still years away. That notion is false. Thanks to the portability of the technology from the multi-trillion dollar oil, gas, and chemical industries, we know how to separate CO₂ from mixed gas streams; we know how to move CO₂ in pipelines; and we know how to inject and store CO₂ safely in the proper geologic structures. Indeed, essentially every aspect of the CCS process is currently being performed at scale in some industrial process.

That is not to say that CCS will be easy; but it is to say that the project risks are not fundamentally technological. Rather, the primary project risks involve getting complicated systems integration correct and importantly, being able to secure finance for large scale CCS investments in an uncertain regulatory environment. Systems integration and complex engineering are great strengths of American industry; while coping with uncertain regulations can be done-but only at unnecessarily increased expense.

My third point is that geology matters. The importance of getting the geology right is an issue that I believe has not received proper attention to date. The geologic and geophysical communities-including oil & gas operators-have developed tremendous expertise in understanding the behavior of buoyant fluids in the subsurface. From this expertise, we can make rigorous assessments of the sequestration capability of specific geologic formations. The sequestration capability of a given geologic formation depends on (1) the rate at which CO₂ can be safely injected into the formation and (2) the ability of the formation to safely confine the injected CO₂ to a well defined zone.

Safety remains a major concern of the American public with respect to CCS, and there are many places in which trying to store CO₂ would be a very bad idea; but there are also many locations where CO₂ can be safely and permanently stored. It is important for the viability of the industry that regulatory agencies establish processes to certify specific formations as sequestration fields. The Montana State legislature has done this very well by developing a unitization process by which the state's Board of Oil & Gas Conservation will certify candidate sequestration sites. In my opinion, state agencies such as that are well-equipped to handle this process and should be encouraged to do so.

My fourth point is that the CCS industry will only advance if all the relevant stakeholders are appropriately included in each project. Strong stakeholder opposition can and will kill any energy project. As such, it is crucial that existing owners of mineral rights as well as land owners be appropriately communicated with and compensated at an early development stage of any CO₂ storage project. I have significant experience working with such stakeholders on early stage CCS projects in several different communities. Through this experience, I have found that face-to-face discussion and honest negotiation have been very effective in getting the relevant stakeholders onboard. Indeed, with the appropriate groundwork, CCS has been broadly welcomed in these communities as an industry similar to oil & gas production or natural gas storage that is both safe as well as compatible with multiple land uses such as ranching, farming, and recreation. Furthermore, the geologic structures being targeted for CO₂ sequestration are often in the vicinity of existing oil & gas activities, but if managed properly, the CCS project can occur symbiotically with these activities.

My final point is that the major hurdle for moving CCS projects forward is the difficulty associated with financing large industrial projects in an uncertain regulatory environment. This committee can significantly accelerate the CCS industry by addressing CCS-specific legal items to minimize unnecessary risk, and-more importantly-by providing a set of financial incentives for early stage CCS projects. Senator Barrasso's bill reduces one item of risk by explicitly reinforcing, on public

¹American Wind Energy Association, 2010.

lands, the common-law precedent that storage space belongs to surface owners; and Senator Rockefeller's bill provides valuable startup funds for RD&D.

The key to jump starting the CCS industry, however, is the passage of a set of financial incentives for first mover projects. The US wind industry, for example, installed 1 MW in 1996 and over 10,000MW last year, and that growth has been driven almost entirely by a combination of state-level renewable portfolio standards and federal-level production tax credits. A similar set of incentives, such as the CO₂ storage tax credit proposed by Senator Rockefeller and others, would dramatically accelerate the rate of CCS adoption in the United States.

In conclusion, I would like to reiterate that given the appropriate geology, we have the technology as well as the industrial know how to do CCS today at power-plant scale. If, however, we fail to either provide the appropriate financial incentives for doing CCS, or if we fail to bring stakeholders on board with each CCS project, then the industry will not grow in the US. And, if the US CCS industry does not grow rapidly, then we will either be unable to make meaningful cuts in our CO₂ emissions, or we will be forced to dismantle our country's significant installed base of CO₂ emitting industrial facilities. Furthermore, we will be constrained from responsibly harnessing America's prodigious fossil fuel reserves.

Thank you, and I look forward to your questions.

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

**STATEMENT OF ADAM S. VANN, LEGISLATIVE ATTORNEY,
AMERICAN LAW DIVISION, CONGRESSIONAL RESEARCH
SERVICE**

Mr. VANN. Mr. Chairman, members of the committee. My name is Adam Vann, legislative attorney for the Congressional Research Service.

CRS is pleased to be afforded the opportunity to discuss the committee's consideration of legislation related to carbon capture and sequestration or, if you prefer, carbon capture and storage.

In testimony today, CRS is addressing a legal issue associated with CCS projects—who owns or controls the subsurface pore space where carbon dioxide would be sequestered or stored?

Of particular concern is whether the property rights to this subsurface pore space are conveyed any time mineral rights are conveyed. Mineral rights, of course, are an interest in something that is generally subsurface.

As you know, S. 1856 addresses this very issue with respect to Federal lands. It is important to do so because of the many instances in which the mineral rights on Federal lands are leased to private entities.

Most existing legal instruments related to subsurface property rights, including mineral right leases, do not specifically address ownership and control of pore space. So in order to determine who holds the relevant property rights, one must interpret the language found in such legal instruments and ascertain how it might apply to subsurface pore space to be used for CCS.

Traditionally, property law issues are addressed by State law. So CRS has analyzed relevant State common law precedent in similar or analogous situations involving subsurface property rights.

Based on this analysis, a detailed review of which can be found in CRS's written testimony submitted to this committee, it is the opinion of CRS that the vast majority of relevant case law suggests that subsurface pore space is not conveyed in typical mineral rights agreements—and that would include mineral rights leases on Fed-

eral lands—but instead would remain with the grantor or holder of the surface rights in most cases.

CRS believes it is likely that even absent any legislation, a court would find that the holder of the surface rights, the Federal Government in the case of Federal lands, rather than the holder of the minerals rights, would have the relevant property interest in pore space for purposes of any CCS project.

S. 1856 declares in part that “the ownership of any subsurface pore space located below a Federal surface estate shall be vested in the Federal Government.” Thus, it is the opinion of CRS that S. 1856 is in line with the current understanding of the law of the United States regarding subsurface pore space.

This rule of property law, stating that pore space is not conveyed along with mineral rights, has been referred to as the “American rule.” Other legal commenters have stated that this American rule would likely be the majority rule in the States. It is, indeed, the opinion of CRS that this rule would likely be adopted in virtually every American jurisdiction.

Indeed, 3 States have enacted legislation declaring that in the absence of specific conveyance to the contrary, subsurface pore space is vested with the owner of the surface estate, and reportedly there are similar bills being considered in 2 other States as well.

Now a vesting ownership of subsurface pore space in Federal lands in the Federal Government should not prove controversial vis-a-vis mineral rights lease holders. There is language in S. 1856 that CRS wishes to flag as a potential ambiguity.

S. 1856 declares that ownership of the subsurface pore space is “vested in the Federal Government.” However, that ownership is not limited by the bill to cases in which the Federal Government has conveyed mineral rights, but covers subsurface pore space in all Federal surface estates.

This could prove problematic where the Federal Government may have conveyed a subsurface property of interest other than mineral rights such that the recipient might be able to claim that the conveyance did transfer an interest in the subsurface pore space. In such cases, S. 1856 could be considered a taking of the property of the grantee who had previously held this particular subsurface property interest such that the grantee would need to be justly compensated, pursuant to the takings clause of the Fifth Amendment.

Another potential ambiguity is the provision in S. 1856 concerning the applicable law in construing conveyances that have occurred or will occur prior to the enactment date of the bill. This is the phrase that begins, “All conveyances of Federal land executed before the date of enactment of the section shall be construed in accordance with the provisions of this section.”

This provision may not apply to a claim seeking compensation for a taking of a subsurface property right. The reason for that is that this type of claim would depend on the applicable law at the time of the conveyance, not at the time the claim was brought. Also, this language concerning the applicable law might not have the intended effect because it applies only to “ownership interests.”

Mineral rights and other subsurface interests can be and often are conveyed as leases or other property interests that may poten-

tially not be considered “ownership interests.” The applicability of the specified language in S. 1856 to these interests may be unclear.

Mr. Chairman, that concludes my prepared statement, and I would be happy to answer any question that you or other members of the committee might have. CRS looks forward to working with the members and staff on this issue in the future.

[The prepared statement of Mr. Vann follows:]

PREPARED STATEMENT OF ADAM S. VANN, LEGISLATIVE ATTORNEY, AMERICAN LAW
DIVISION, CONGRESSIONAL RESEARCH SERVICE

Mr. Chairman and Members of the Committee: My name is Adam Vann. I am a Legislative Attorney with the American Law Division of the Congressional Research Service at the Library of Congress, and I thank you for inviting me to testify today regarding the Committee’s consideration of legislation related to emerging carbon capture and sequestration (or, as it is sometimes called, carbon capture and storage) technology. For purposes of this testimony, I will refer to it as “CCS.” My testimony will focus on legal issues related to CCS technology; specifically, concerns over who maintains ownership and control over the “pore space” in which the carbon dioxide would be stored or sequestered under most of the emerging CCS models.

At the outset, I should note that as an attorney, my testimony will be limited to legal issues related to CCS, including pore space ownership and control. I cannot speak to technological, economic, or other policy concerns related to CCS. I am certain that my colleagues at this hearing or my fellow Congressional Research Service analysts can ably field any such inquiries. Furthermore, my testimony will not cover other legal issues commonly discussed in the context of CCS technology, including, among others, problems related to potential difficulty obtaining liability coverage and concerns related to trespass of adjacent property.¹ My testimony will be confined to pending legislation and issues associated with ownership of subsurface pore space.

Background

CCS technology is among the many proposals to address concerns over the impact of carbon dioxide emissions from man-made sources on the environment. Unlike most other proposals, CCS technology is not intended to reduce the quantities of these emissions; rather, it would capture these emissions at their source and “sequester” or “store” them at sites with the appropriate geologic characteristics.² Any entity wishing to operate a CCS facility must therefore own or control the pore space in which the carbon dioxide would be sequestered or stored. However, since CCS technology is not yet in existence and was not even considered until recently, most existing legal instruments related to property rights do not address ownership and control of pore space, and to the best of my knowledge, none of them refer to ownership and control of pore space for purposes of sequestration or storage of carbon dioxide. Therefore, in order to determine who holds the relevant property rights, we must interpret the language found in such legal instruments and ascertain how it might apply to pore space to be used for CCS. In doing so, we can look to interpretations of courts who have reviewed similar or analogous property rights disputes.

Traditionally, property law issues are handled at the state level. Indeed, most of the analogous disputes regarding subsurface “pore space” to date have been handled under state law, and presumably would be handled under state law going forward. These disputes, and subsequent actions by some state legislatures, have produced what I will refer to as the “majority rule” that holders of mineral rights do not, merely by virtue of these rights, have ownership or control of subsurface pore space. However, to the extent that CCS projects might take place on lands owned or controlled by the United States, determinations of pore space ownership and control become an issue for the federal government. S. 1856 recognizes this federal role and, as I understand it, attempts to resolve the issue going forward by declaring that “[t]he ownership of any subsurface pore space located below a Federal surface estate

¹For further discussion of several legal issues related to CCS technology, see CRS Report R41130, *Legal Issues Associated with the Development of Carbon Dioxide Sequestration Technology*, by Adam Vann, James E. Nichols, and Paul W. Parfomak. See also Philip M. Marston and Patricia A. Moore, *From EOR to CCS: The Evolving Legal and Regulatory Framework for Carbon Capture and Storage*, 29 *Energy L.J.* 421, 475 (2008).

²For further information on geologic aspects of emerging CCS technology, see CRS Report RL33801, *Carbon Capture and Sequestration (CCS)*, by Peter Folger.

shall be vested in the Federal Government,” unless conveyed along with the surface estate or previously severed from the surface ownership.³

S. 1856, if enacted, would govern subsurface pore space rights on Federal lands going forward. However, if any aspect of the bill or similar language results in a transfer of existing subsurface rights of a private entity to the Federal government, that private entity would be entitled to just compensation under the Fifth Amendment of the United States Constitution.⁴ Therefore, it is worthwhile to consider whether any private entity aside from the owner of surface rights might be able to claim ownership of, or control over, the relevant subsurface rights. The most obvious candidate would be the owner of “mineral rights” on/under the Federal land in question, as mineral rights are, generally speaking, rights to something that is subsurface.

The Majority Rule: Pore Space Control Does Not Transfer with Mineral Rights

In order to determine: (1) the extent to which S.1856 would deviate from the current understanding of subsurface property interests under state and federal law; and (2) whether holders of mineral rights or other property interests might be entitled to just compensation for loss of their interest in the pore space pursuant to S. 1856, we must look at both state and federal common law and currently existing statutes and regulations.

It is the opinion of CRS that the vast majority of relevant case law suggests that a reviewing court would likely find that the pore space that would be used in CCS is not conveyed with mineral rights, but rather in most cases would remain with the holder of the surface rights. The vast majority of legal precedent suggests that the property owner, not the holder of mineral rights, would have the relevant property interest in pore space for purposes of any CCS project. Indeed, most legal experts who have studied this issue have reached a similar conclusion.⁵ In the case of Federal land on which the mineral rights are leased, this means that, although the holder of the mineral rights would of course have certain rights that must be considered in using the property, the Federal government would have ownership of, and control over, the pore space that would be used for CCS. Experts have cited to a number of common law decisions in support of this conclusion.

An instructive precedent to consider from the federal court jurisprudence is *Emeny v. United States*.⁶ In *Emeny*, the United States Court of Claims⁷ was tasked with deciding whether the United States had acquired the right to store helium gas within a pore space formation on a certain property when the terms of the government’s lease with the owner of the pore space were limited to the sole purpose of mining and operating for oil and gas.

The plaintiffs in *Emeny* owned a tract of land in Texas which contained significant deposits of helium gas. The plaintiffs granted to a private gas company “oil and gas leases covering a total of approximately 217,000 acres of land, including the area which contains the Bush Dome.”⁸ The United States eventually obtained these oil and gas leases from the private oil company, along with the remaining mineral rights that had been reserved by the plaintiffs, and compensated the respective parties accordingly.⁹ However, in the lease with the United States, the plaintiffs expressly reserved for themselves the surface of the leased lands, “including any such structure that might be suitable for the underground storage of ‘foreign’ or ‘extraneous’ gas produced elsewhere.”¹⁰

Pursuant to the lease agreement, the United States commenced operations to extract the helium contained within the Bush Dome, and continued to do so for ap-

³S. 1856.

⁴The Fifth Amendment to the U.S. Constitution provides in part that “private property [shall not] be taken for public use, without just compensation.”

⁵See, e.g., Owen L. Anderson, *Geologic CO₂ Sequestration: Who Owns the Pore Space?* 9 *Wyoming L. Rev.* 97 (2009); Ian J. Duncan, Scott Anderson and Jean-Philippe Nicot, *Pore Space Ownership Issues for CO₂ Sequestration in the U.S.*, GHGT-9 Energy Procedia, Elsevier V.1 p. 4427–4430 (2009); Philip M. Marston and Patricia A. Moore, *From EOR to CCS: The Evolving Legal and Regulatory Framework for Carbon Capture and Storage*, 29 *Energy L.J.* 421, 475 (2008).

⁶412 F.2d 1319 (1969) (*Emeny*).

⁷The U.S. Court of Claims was the original court in which claims against the United States were tried. The U.S. Court of Claims was abolished in 1982. The court’s trial-level jurisdiction was transferred to the U.S. Court of Federal Claims and its appellate jurisdiction to the U.S. Court of Appeals for the Federal Circuit.

⁸*Emeny* at 1321. According to the court’s opinion, the Bush Dome “is a closed geological structure, or underground dome, in which gaseous substances can be stored ... The potential storage capacity of the Bush Dome is in excess of 52 billion standard cubic feet of gas.” *Id.* at 1321.

⁹*Id.* at 1321–1322.

¹⁰*Id.* at 1323.

proximately three decades until the Bush Dome was empty. After the Bush Dome was emptied, the United States sought to store helium gas produced elsewhere inside of the now empty pore space.¹¹ The plaintiffs argued that they were entitled to just compensation for the government's use of the Bush Dome as a helium storage facility because pursuant to the language of the lease agreement, the government only had a right to extract the gas contained within the pore space and no right to use the pore space for storage of helium gas produced elsewhere.

After a consideration of Texas common law, the court in *Emeny* agreed with the plaintiffs that the government's property interest did not include the right to use the pore space for gas storage, and ordered the United States to pay the plaintiffs just compensation for its use of the Bush Dome as a helium storage facility. According to the court, "[t]here is no reasonable basis on which the rights granted to the [United States] in the . . . oil and gas leases could be construed as including the right to bring to the premises and store there gas produced elsewhere."¹²

The West Virginia courts reached a similar conclusion in *Tate v. United Fuel Gas Company*.¹³ In *Tate*, the highest court in West Virginia addressed the question of pore space ownership once the minerals contained therein had been extracted. The owner of the land deeded the land to another man, but expressly reserved to himself the "oil, gas . . . and all minerals . . . underlying the surface of the land."¹⁴ The new owner then deeded the surface estate to Virgil Tate, subject to the same exceptions in the original deed, including the reservation of the mineral estate for the original owner. After extracting all of the oil from the pore space, the original owner eventually leased his remaining mineral rights to the defendant, United Fuel Gas Company. United Fuel Gas Company then used this mineral rights property interest to store gas produced elsewhere in the empty pore space.

Plaintiff Tate, the owner of the land subject to the underground property interest leased to United Fuel Gas Company, asserted that the lease between the original owner and United Fuel Gas Company which gave United Fuel the "remaining" mineral rights was invalid, since the original owner/holder of the mineral rights only had a right to extract the contents of the subsurface estate, not the right to use the pore space for other purposes. The Supreme Court of West Virginia agreed with Tate and held that the express reservation of mineral rights only granted to the original owner/mineral rights holder (and his lessee, United Fuel Gas Company) a right to exploit the gas and minerals contained within the pore space, not a right to use the pore space itself for the storage of gas produced elsewhere.¹⁵

According to Tate, the owner of the mineral rights likely would not have the right to the use or lease the pore space for carbon dioxide capture and sequestration, unless the owner of the surface estate expressly allows the owner of mineral rights to use the pore space. This conforms with what is referred to here as the "majority rule" (and others have called the "American rule") that pore space is not conveyed with a standard conveyance of mineral rights.¹⁶

Another case that reached a similar conclusion is *U.S. v. 43.42 Acres of Land*.¹⁷ In this case, a federal district court had to determine whether the surface owners, mineral owners, or both should receive compensation from the government for land acquired for the construction of an underground crude oil storage tank.¹⁸ One defendant owned the land under which a crude oil storage tank was to be constructed. The other defendant owned the rights to the minerals that needed to be extracted to construct the underground storage tank. The United States intended to construct this storage tank by extracting the salt contained inside of the subterranean geological structure and then using the evacuated underground formation as a storage

¹¹ *Id.* at 1322.

¹² *Emeny* at 1323.

¹³ 71 S.E.2d 65 (1952) (*Tate*).

¹⁴ The pertinent language of the deed stated that "[t]he oil, gas and all minerals . . . underlying the surface of the land hereby conveyed are expressly excepted and reserved from the operation of this deed . . . it being understood [sic] that the term 'mineral' as used herein does not include clay, sand, stone, or surface minerals except such as may be necessary for the operation for the oil and gas and other minerals." *Tate* at 67–68.

¹⁵ *Id.* at 72.

¹⁶ Some legal writings have referred to this rule as the "American rule." This terminology is used in contrast with the "English rule" that the mineral rights owner retains the right to the subsurface space even after the minerals have been extracted.

¹⁷ 520 F. Supp. 1042 (1981) (*Acres*).

¹⁸ In his opinion, Judge Veron writes, "Simply stated, the issue to be decided by this court is: who is entitled to be compensated for the value of the hole in the ground to be created by construction of the underground storage cavern[:.] the land owners or the mineral owners?" *Acres* at 1043.

area.¹⁹ Both defendants claimed an exclusive right to be compensated by the United States for its taking of the property pursuant to the Energy Policy and Conservation Act.²⁰

To utilize the subsurface for the extraction of brine and the creation of storage facilities[,] a well is drilled so as to penetrate the salt formation. Water is forced into the formation through the well, the salt is withdrawn as brine, and a cavity is left in the salt mass because of gradual dissolving of the salt and a resulting erosion by the leaching process. The jug shaped cavity, or 'jug[,] formed by this leaching is used for the storage of hydrocarbons. A jug is 100 feet or more in depth, with capacity for storing over a million barrels of one of the various hydrocarbons. A thick barrier of salt must be retained around each jug to form a satisfactory wall for the containment of the stored product.

Acres at 1043.

Since Acres was a case of first impression under Louisiana law, the court considered common law authority from other jurisdictions to inform its opinion, and concluded that ". . . the general rule in common law . . . provides that, after the removal of minerals, the opening left by the mining operations belongs to the land owner by operation of law."²¹ Since the minerals had not yet been removed from the pore space by the United States and since the resulting pore space needed to be used by the United States for crude oil storage, the court ordered the United States to compensate both the landowner and the mineral rights owner.²²

Although the question of compensation was the primary focus of the court in Acres, the determination that both the surface and mineral estate owners should be compensated by the government was based on the rationale that the mineral estate owner has an interest in the minerals contained within a pore space, while the surface estate owner retains an interest in the pore space itself.²³ While virtually all authors and scholars have concluded that the case law clearly favors a rule attaching pore space ownership and control to the surface estate or remaining estate over the holder of mineral rights, some have noted that the precedent is far from unanimous.²⁴ Two cases commonly cited in support of the argument that a mineral rights conveyance also conveys ownership and control of pore space are *Mapco v. Carter*²⁵ and *Central Kentucky Natural Gas Co. v. Smallwood*.²⁶

In *Mapco*, multiple parties had interests in the surface and mineral rights of a parcel of land in Texas. As a result of a previous court-ordered partition, the surface and mineral rights were divided among the various co-owners. Despite the fact that the co-owner *Mapco* only possessed a minority interest in the mineral rights in addition to the surface rights, *Mapco* decided to extract and sell the salt contained beneath its portion of the partitioned land without the consent of the other co-owners.²⁷ When the salt was completely extracted, *Mapco* "plugged" the empty cavern with concrete and abandoned it, thereby rendering it unusable as storage space for gas or petroleum products.²⁸

Ultimately, the Court of Appeals of Texas ordered *Mapco* to compensate the co-owners of the mineral rights because, as mineral rights co-owners, they were also entitled to an amount of the proceeds from *Mapco's* sale of the salt equal to their respective interests in the partitioned land.²⁹ The court held that under Texas law, "this interest in minerals is an interest in real property. Thus, the fee mineral owners retain a property ownership, right and interest after the underground storage facility . . . had been created."³⁰

This result suggests that mineral rights are not merely a right to extract the minerals in question and an ownership right in said minerals, but also grant an ownership right in the subsurface formation left behind. However, in the opinion of CRS,

¹⁹The process by which crude oil reservoirs are created was described in Acres:

²⁰42 U.S.C. § 6249(a)-(f).

²¹Acres at 1045.

²²"[Owners of a mineral servitude] have no right to claim compensation for the value of the cavern to be created by removal of the salt. They should be compensated only for the value of the right to explore for and reduce to possession the minerals on the land in question. [The] land owners . . . own all remaining rights in the land, and they are entitled to be compensated for the underground storage value of the land." Id. at 1046.

²³Id. at 1045.

²⁴ See, e.g., Elizabeth J. Wilson and Mark A. Figueiredo, *Geologic Carbon Dioxide Sequestration: An Analysis of Subsurface Property Law*, 36 *Environmental L. Rev.* 10114 (2006).

²⁵808 S.W.2d 262 (Tex. 1991) (*Mapco*).

²⁶252 S.W.2d 866 (Ky. 1952) (*Smallwood*).

²⁷*Mapco* at 267.

²⁸Id. at 268-269.

²⁹Id. at 278-279.

³⁰Id. at 274-75.

this fact pattern may be distinguished from any hypothetical claim that mineral rights include an interest in subsurface pore space. In *Mapco*, the subsurface storage area was created by the excavation of the mineral. In contrast, pore space contemplated for use in CCS technology is naturally occurring, not created by the mineral extraction. Furthermore, the storage area in *Mapco* was actually comprised of the mineral in question (salt). Again, this would presumably not be the case with respect to pore space used for CCS.

In *Central Kentucky Natural Gas v. Smallwood*,³¹ the property owner executed an “oil and gas production and storage lease” conferring the right to drill for oil and gas and to store gas of any kind regardless of source in the subsurface.³² The lessee did not produce any gas, but gas that was removed from wells on adjacent lands in the area was stored under the surface and rentals were paid. The lessee paid the lessor only half of the rental fees, under the assumption that the rentals should be paid to the holder of the mineral rights, not the surface rights (the lessor had retained a 50% interest in the minerals).³³ The lessor claimed that the rent should be paid solely to him, as the owner of the surface estate and thus the subsurface formations in which the gas was stored.³⁴ The court ruled in favor of the lessee, finding that the stored gas was equivalent to “native” gas and that therefore revenue therefrom was attributable to the owner of that gas, i.e. the holder of the mineral rights.³⁵

However, the court’s decision was based solely on the classification of the stored gas as equivalent to the native gas. In fact, the court clarified that “[i]n reaching the conclusion that we reach, it is not necessary to determine whether the cavern or strata from which a mineral has been removed becomes the property of the mineral or surface owner.”³⁶ Indeed, the court references the “English rule” that subsurface spaces are owned by the mineral rights holder and then notes that “[t]he general rule in the United States seems to be otherwise.”³⁷ Thus, *Smallwood* does little to establish precedent contrary to the “majority rule” or the “American rule.”

Finally, it should be noted that some states have enacted legislation establishing default rules for pore space ownership and control. Three states have enacted relevant legislation: Montana, North Dakota, and Wyoming. In each of these states, the state legislature decreed that the surface owner, not the mineral rights owner, is the owner of the pore space to be employed in CCS technology.³⁸ Further, in the two states that are currently considering relevant legislation (Michigan and New York), the pending legislation reportedly would also declare that pore space does not belong to the mineral rights holder but remains with the surface estate.³⁹

It is worth pausing briefly to consider why this “majority rule” or “American rule” has been so widely adopted. There is a general principle in property law that any property right not expressly conveyed is retained by the owner or grantor.⁴⁰ Accordingly, courts have tended to interpret limited property grants (like mineral rights) from a fee simple owner narrowly, with the fee simple owner retaining all property rights not explicitly granted in the document. Thus, a grant of mineral rights would grant only what is explicitly granted in the “four corners” of the document. In the case of federal mineral rights leases, the conveying language usually is something similar to this: “This lease is issued granting the exclusive right to drill for, mine, extract, remove and dispose of all the oil and gas (except helium) in the lands described . . . together with the right to build and maintain necessary improvements thereupon.”⁴¹

Courts would thus likely be inclined to find that anything not explicitly mentioned, e.g. subsurface pore space or similar formations, would not be transferred, but would remain with the grantor, as the cases described above illustrate.

³¹2 S.W.2d 866 (Ken. 1952) (*Smallwood*).

³²*Id.*

³³33 *Id.* at 867.

³⁴*Id.*

³⁵*Id.* at 867–868.

³⁶*Id.* at 868.

³⁷*Id.*

³⁸Mont. Code Ann. § 82-11-181(3); N.D. Cent. Code § 47-31-03; Wyo. Stat. Ann. § 34-1-152(a).

³⁹Southern States Energy Board, “Carbon Capture and Sequestration Legislation in the United States of America,” March 2010, available at <http://www.sseb.org/documents/CCSLegMatrixshort.pdf>.

⁴⁰See, e.g., *Davis v. Peavy-Moore Lumber Co.*, 144 S.W.2d 878, 880 (Tex. 1940).

⁴¹U.S. Department of the Interior, Bureau of Land Management, Form 3100-11 (October 2008): Offer to Lease and Lease for Oil and Gas. CRS has also reviewed several other lease forms dating back to 1984, and all of them contain substantially similar language.

S. 1856

Given the aforementioned, S.1856 probably would not disrupt the current understanding of the ownership rights of the Federal government and mineral rights leaseholders in subsurface pore space, at least in the context of mineral leases. The latest draft of the bill that CRS has seen would establish that, as a rule, subsurface pore space below a surface estate owned by the Federal government would be owned by the Federal government. With respect to mineral leases, this is clearly in line with the “majority rule” or “American rule” that appears to have been adopted by virtually every court (and every state legislature) that has considered the question, as described in detail above; although, of course, no court has yet ruled on this issue with respect to use of subsurface pore space for CCS. Similarly, by establishing that “a conveyance of the surface ownership shall include the conveyance of the Federal pore space in all strata below the surface of the Federal land” unless previously reserved,⁴² the bill effectively clarifies that the application of the “majority rule” or “American rule” extends not just to exclude subsurface pore space from mineral rights conveyances, but in fact to attach such rights to the surface estate.

However, aspects of S. 1856 could prove controversial in other respects. First, the declaration that ownership of the subsurface pore space is “vested in the Federal Government” is not limited to cases in which the Federal Government has conveyed mineral rights, but in fact covers all Federal surface estates. This could prove problematic where the conveyances are for a property interest other than mineral rights, in which the grantee might be able to claim that the subsurface pore space was conveyed. In such cases S. 1856 might trigger a requirement that the grantee be justly compensated, as discussed in more detail below. Indeed, the testimony to this point should only be considered applicable to the extent that the property interests in question are mineral rights on the one hand, and the remaining estate on the other. The rights and obligations of any other conveyances would need to be considered on a case by case basis.

Another concern is the statement concerning the “applicable law” in construing conveyances prior to the enactment date of S. 1856. The provision would likely not be applicable to a claim seeking compensation for the “taking” of a subsurface property right under the terms of S. 1856, as such a claim would depend on the applicable law at the time of the conveyance, as discussed in more detail below. Also, the language might prove troubling because it applies only to “ownership” interests. Mineral rights and other subsurface interests can be, and often are, conveyed as leases or other property interests that may not be considered “ownership” interests. The applicability of this language to those interests may be a concern.

Takings Concerns

If S. 1856 is enacted, and subsequently it is determined that a private party previously had a property interest in the subsurface pore space located below a Federal surface estate, such a finding would not likely invalidate the enacted law. Instead, the party would likely be entitled to just compensation pursuant to the “Takings Clause” of the Fifth Amendment to the U.S. Constitution.

A takings claim resulting from S. 1856 or similar legislation would likely be in the form of a “physical/appropriations” takings claim.⁴³ Indeed, “[t]he paradigmatic taking requiring just compensation is a direct government appropriation or physical invasion of private property.”⁴⁴ Thus, in the case of a hypothetical loss of a real property interest in subsurface pore space, there is little question that the interest represents “property” that would require just compensation. The main question, therefore, would be whether S. 1856 or similar legislation would in fact divest a real property interest from any potential party.

As explained in detail above, a mineral rights holder on Federal lands would have difficulty arguing that the mineral rights interest included a property interest in the subsurface pore space. Therefore, it is unlikely that a party that holds only a mineral rights lease on Federal lands would have a compensable Takings claim as a direct result of S. 1856 or similar legislation. However, the expansive language in S. 1856, which preempts any claim to subsurface pore space property rights located below a Federal surface estate, is more likely to create a compensable taking. The Federal government grants leases, easements and rights of way, and other real property interests on (and under) Federal lands in many forms and for many purposes. It is not possible to conduct a comprehensive review of all such property in-

⁴² S. 1856

⁴³ For a more detailed discussion of the Takings Clause, the various types of Takings claims, and the applicable legal standards, see CRS Report RS20741, *The Constitutional Law of Property Rights “Takings”*. An Introduction, by Robert Meltz.

⁴⁴ *Lingle v. Chevron USA, Inc.*, 544 U.S. 528, 537 (2005).

terests. However, the possibility exists that some of these may encompass an interest in subsurface pore space (in whole or in part). If such a property interest does exist, the party holding the interest may well be entitled to Takings compensation upon the passage of S. 1856 or similarly worded legislation.

Also, it should be noted that this taking analysis addresses only potential physical/appropriations takings claims; that is, a claim that the legislation results in the loss of a real property interest in the subsurface pore space. Consideration of "regulatory" or other takings claims, in which the aggrieved party would argue that the law or regulation results not in a total loss of a property interest but rather in the reduction of the value of a property interest that the party continues to hold, are outside the scope of this testimony. However, the language in S. 1856 does provide that "[n]othing in this section alters any laws or case law in existence on the date of enactment of this section relating to the rights belonging to, or the dominance of, the mineral estate." This language may provide additional assurance to those concerned that mineral rights on Federal lands might be taken. Also, S. 1856 does not authorize CCS projects or any other activity. It simply attempts to classify ownership interests in real property. Because it does not authorize new activity, it likely would not, by itself, give rise to any regulatory or other partial takings claim.

Conclusion

As described above, S. 1856 likely would not represent a significant deviation from the current understanding of the real property rights associated with ownership and control of the subsurface pore space that would likely be employed in CCS technology. Common law, legal scholars, and state legislatures have, for the most part, agreed that subsurface pore space is owned and controlled by the holders of surface rights, not mineral rights. As a result, this legislation, or similar legislation, would likely not result in a compensable takings claim from a holder of mineral rights on Federal lands. However, there are some concerns about the breadth of the language in S. 1856 and potential takings of property interests other than mineral rights.

Mister Chairman, that concludes my prepared statement. I would be happy to answer any questions that you or other Members of the Committee might have, and I look forward to working with all Members and staff of the Committee on this issue in the future.

The CHAIRMAN. Thank you all for your excellent testimony.

Let me ask a few questions. Dr. House, let me start with you. I guess I would just be interested in any thoughts you could give us as to the challenges involved in acquiring access to lands for CCS projects when the lands are public versus when the lands are private.

I mean, what is the current circumstance that exists in that regard? Is it possible to acquire or to pursue projects where you have public ownership of the land as well as private ownership today, or is one easier than the other?

Mr. HOUSE. That is an excellent question, Senator.

The best way to think about it, I guess, from our experience is private transactions are very effective, very efficient. Sort of independent negotiations between private entities can occur quickly and fast, and all the interests are clear. So, in many cases, that is the best way to go to identify sequestration potential that is owned for which the surface right and, if possible, the mineral right is well understood, and you can sign leases and move forward.

There is a geologic and geographic complexity that comes into account when you go specifically in the Mountain West regions, where the Federal Government owns tremendous amounts of land, and that land tends to be checkerboarded. It literally looks like a checkerboard if you look at sections and townships on maps.

So you can go and sign all the appropriate legal documents with all the appropriate private entities, but if you were to inject CO₂ in wells drilled even on the private lands, the CO₂ would flow in

the subsurface as it does in the appropriate geologic structure underneath, in some cases, some of the checkerboarded public lands.

So the public lands, if the surface is State public ownership, then they own the pore space there. So, you would need public—you would need a lease from the Government to complete that sequestration project.

So, for that reason, I think there is, unfortunately, in the basically west of the Mississippi, it would be very, very difficult to do projects without some degree of sort of public lands involvement, although, in many cases, a majority of the ownership can be private.

Now the situation changes when you get into the Midwest regions where there is very little Federal lands, and most of the lands are State lands, as well as private lands, in which case there are many projects in which you could go forward with entirely private leases.

The CHAIRMAN. Let me ask, and I haven't really studied this. But if the Federal Government owns the surface and the subsurface of land, why wouldn't the Federal Government want to retain the ability to lease the surface, lease the minerals, and lease the pore space in 3 separate transactions? Wouldn't that be the most beneficial thing from the point of view of the taxpayer or the Federal Government?

Mr. HOUSE. Yes, absolutely. Excellent point. So in the case where the Federal Government has what we call "fee simple" land, which means they own everything, which does occur in many places, then they would own the surface lands. They own the mineral estates, and then they own the pore space. So they could sign both mineral extraction leases, as well as CO₂ storage leases.

There are geologic situations in which that could be incredibly beneficial. So let me give you an example. If there are, say, there is oil deposits in shallow stratigraphic layers. So say 500 meters deep you have oil. Then maybe at 800 meters deep or 1,000 meters deep you have natural gas. Then maybe at 2,000 meters deep you have what we call a basal sandstone, or a reservoir layer that doesn't involve any hydrocarbon deposits.

In that case, you could actually have 3 different leases. You could have an oil operator removing the oil. These would be stacked vertically. You could have a gas operator removing the gas. You could have a sequestration operator injecting CO₂ beneath both of those operations all in a very symbiotic way. That would be a tremendously efficient use of sort of space, if you think about it.

The CHAIRMAN. Let me just ask one other question. Then my time is up. I am just concerned if we adopt or codify the so-called American rule, are we, on behalf of the Federal Government, giving up the ability to separately lease the pore space in land where we have already leased the surface?

Mr. HOUSE. If the Federal Government—yes, that is true. I mean, if the American rule is sort of considered the law of the land through the courts or through the legislature, then, indeed, in a case where the Federal Government would own the mineral rights, but not the surface rights, they would not have the right to lease the pore space. The private owner of the surface would, in fact, have that right.

It is important to note 2 things, though. First, from the point of view of the sequestration industry, that is not necessarily a bad thing. I mean, the lease can be signed with the Government, and the lease can be signed with private entities. In many cases, it is faster to sign them with private entities.

Then the second point is that, and this is extremely important, is that if it appears pretty strong that the mineral estate, in precedent, the mineral estate has sort of a superiority, which means that a sequestration operator could not develop a site, even if they got a lease from a private owner, that would damage a mineral estate property.

So you couldn't, in other words, inject CO₂ into a natural gas reservoir if the physical activity of doing it would sort of weaken the value or diminish the value of the natural gas. So you can only go forward with the operation if you could show in a scientific way that the operations of the sequestration occurs in a separate geologic stratum and would not negatively impact the natural gas reserve.

The CHAIRMAN. Senator Murkowski.

Senator MURKOWSKI. Thank you, Mr. Chairman.

I am pleased that all of you on the panel this morning have indicated that you believe that CCS is essential. If we are going to get to that low-carbon future, clean energy future, we have to figure out how we make CCS a reality.

So there were at least 3 of us here this morning who expressed a level of frustration with the stimulus funds, \$3.4 billion, that is directed to help facilitate it and just about 0.5 percent that has moved forward at this point in time. So we are frustrated, but I would have to imagine that you all are doubly frustrated that it is not moving quicker. But hopefully, we will see something on that.

Dr. House, you mentioned that we have to get the geology right, and I would think that this is something that, again, we need to know and understand with a little bit more certainty.

There was an issue over in Germany, I guess this was last summer, where there was some local opposition to a demonstration project there. Apparently, instead of sequestering underground due to opposition from the local residents, they apparently wound up venting the carbon dioxide into the atmosphere rather than storing it beneath the ground. Instead of "not in my backyard," it is "not under my backyard."

I don't know whether we have seen any opposition rising to even the concept of CCS and the concerns. Senator Barrasso, from Wyoming, has been dealing with this for years. But I think this is one of the instances where when we do our homework correctly and we identify where those appropriate geologic deposits are, then the concerns that some may have, that would be unfounded because you have repositories that allow for a level of safety and security.

This is a general question, and I will throw it out to all of you on the panel. Are we seeing or do you foresee any resistance to CCS here in the United States? What kind of educational effort do we need to give people a level of security or comfort that this is a process that we know and understand?

Mr. Hilton, if you want begin?

Mr. HILTON. Senator Murkowski, if I could clarify one thing? On that project in Germany, the resistance wasn't to the sequestration. Senator MURKOWSKI. OK.

Mr. HILTON. The resistance was actually to a bad plan by the utility who elected to truck the CO₂ through the small villages, and that is what the people objected to.

Senator MURKOWSKI. Okay.

Mr. HILTON. It wasn't the pipeline. It was trucking. So they were OK with putting it in the ground. They were OK with it being captured, but the method of transportation wasn't well thought out.

Senator MURKOWSKI. That is an important aspect of it. I appreciate you pointing it out.

Mr. HILTON. What we have been doing is, for instance, at Lacq, where we take a pipeline and go to depleted gas fields, the people of Lacq are extremely encouraged. Part of that is putting the deal together, if you will.

Senator MURKOWSKI. Right.

Mr. HILTON. Basically, TOTAL offered them back the royalties that they got when they used to have gas in the field, and this made the town extremely happy. Everybody is very happy with pipelines and that.

So your point is very well taken. It is education. It is understanding that this is not a risky proposition, that we understand sequestration. We understand pipelines, and we understand capture and getting the public to accept that. It is an educational process because this is something they don't know a great deal about.

So I think we as an industry have to do that and get the proper I will say information in front of people, to have their confidence in what we are doing. But as I said, so far, we haven't run into, at least in any of the projects Alstom has been involved with, any opposition. We do know there was opposition in Rotterdam, but that was directly under the town and you know—

Senator MURKOWSKI. Mr. Yamagata, on behalf of the Coal Utilization Research Council, is this an issue that you consider?

Mr. YAMAGATA. It is. It is, Senator. It is an issue that we have spent a great deal of time trying to deal with other than to echo the points that Mr. Hilton has made, and that is that it is very much an education process. The flip side of that being a numby-like reaction, and that comes mostly, I think, with not understanding what the technology is or what we are capable of doing.

Another point worth mentioning I think is just the enormous potential for deep storage even in the North American continent. Let me just give you a couple of examples. This comes from Battelle and DOE. Between 2050 and 2100, you would project about 330 gigatons of CO₂ that would otherwise be emitted. If you think about, that is 6 gigatons per year now.

The repositories, if you will, in the North American continent just in saline formations alone is something on the order of 3,600 gigatons. So, number 1, we have plenty—we believe we have plenty of storage capability. So that is probably not the issue if we do it right.

I do think, in sum, that the real issue here is education. Don't be flip about this because you will get the other side, the numby side of it. It will take the efforts of industry and Government to

educate land holders and others on the safety of what we are trying to do here.

Senator MURKOWSKI. Let me ask you, Mr. Brownstein, because within the environmental community, I think EDF has taken a position that is somewhat different than some of the other organizations. You have stated that you believe CCS is critical.

Is this an issue where we need to ensure that there is sufficient education and understanding about the process and the safety and security?

Mr. BROWNSTEIN. There is no question, Senator, that education is critically important. This is an issue that members of the committee, those of us on the panel are very used to discussing.

We have become very conversant with the technology and how it works. To the average American, this is something very new. So, there is a lot of work that needs to be done to educate the public about what the technology is and what the process is for doing this correctly.

But let me also say 2 other things. First of all, it becomes incredibly important that, in fact, we do do it correctly. That requires good rules to be in place so it is very clear to operators what is expected of them. It becomes incredibly important to have good regulatory oversight.

Both on the industry and the regulator side, we need to make sure that we have well-trained people. Investment in good education for geologists and engineers and making sure that they are part of this becomes incredibly important. We need to have qualified people.

The last thing that I would suggest is that I personally believe that some of the resistance to CCS goes to the larger question of the role of coal. In that regard, I believe that the coal industry and the utilities that depend on coal have a particular responsibility to make sure that if we are to move forward with continuing to use coal as part of our energy economy that we really are looking at the entire value chain and that we are doing everything that we can not only with regard to CO₂, but also how we mine it, how we deal with the waste and so on, to do it as environmentally responsible as absolutely possible.

Senator MURKOWSKI. I thank the members of the panel.

Thank you, Mr. Chairman.

The CHAIRMAN. Thank you all very much. I think it has been good testimony and a good hearing. We appreciate your input.

Oh, I am sorry. Senator Barrasso, I didn't see you come back in. Go ahead if you have any questions.

Senator BARRASSO. Thank you, Mr. Chairman.

I had some constituents from Wyoming who were visiting, and I went to the library to visit with them. But I was trying to listen to some of the answers.

Mr. Hilton, if I could, your company, Dr. House's company, I mean, you are at the forefront of carbon sequestration. You are going to make this a reality. You will be on the ground doing that. Obviously providing legal certainty is critical, and you are addressing that.

In Wyoming, over half of the land is owned by the Federal Government. As I think Dr. House mentioned, we have some of the

work done on the geology. I believe we have some of the best geologic structures and the best geology for long-term carbon sequestration.

When you are out there selecting potential sites for long-term carbon storage, can you give us a little bit of your thought process on Federal land versus private land and how you make some of those decisions?

Mr. HILTON. Normally, Alstom does not do sequestration. We basically do the capture portion. But I think the key issue is going to be where the plan is, obviously. I mean, you are east of the Mississippi, you are on private property.

It is going to be a question of transportation. What is it going to cost us, and how difficult is it going to be to put pipeline to get to places where you really have choice? I think that is really going to be the core issue, the ease of that.

I do think, just to comment on something that was said earlier, private—sequestration on private land will be quite complicated. If you look at the facility that we are involved with at Mountaineer, there are 2,000 private land owners immediately around the plant. To get mineral rights or to get pore space from all, if necessary, 2,000, it is going to be a very complicated issue, and it is going to be a very difficult issue.

That is why we are encouraged by seeing some States start to alter their view of ownership of pore space. I think it is absolutely critical, and it is something that has to happen to make this happen.

Senator BARRASSO. Dr. House, did you want to comment on that in terms of your making financial decisions and commitments?

Mr. HOUSE. Yes, absolutely. Certainly, we look at geology, “geology geology,” so to speak. Because the geology really does matter in terms of the reliability and the permanency of the storage. So that is critical. Obviously, proximity to sources is important, and then who owns—the complexity of the sort of legal access required is also important.

I would add, and this also goes to something Senator Murkowski asked earlier about sort of public acceptance. In our experience, people view these as oil and gas transactions, as things they are familiar with, as things they understand.

It is an industrial operation. It happens in the subsurface. It doesn’t have a great surface impact. So it is compatible with ranching or farming, et cetera. These leases are happening in very big, large ways, and so I actually think it is a very tractable thing and something that we are addressing actively.

I think there has been some discussion of police action around pore space, and I actually would—that really scares me, to be honest with you. I think if there was a broad attempt at sort of national eminent domain, that would create a million enemies immediately, whereas if it is their resource and if it is an arm’s length negotiation between private entities, then they become associated with the project. They are invested in the project. They want it to go forward.

They can benefit from it, as opposed to some sense that their assets are being stolen and that their homes are being put at risk.

So I think maintaining, as your bill does, that the pore space goes to surface estate I think is the right approach.

Senator BARRASSO. Mr. Vann, following up on Senator Bingaman's question earlier, would S. 1856 preclude the Federal Government from leasing the surface and leasing the subsurface?

Mr. VANN. I don't think so, no.

Senator BARRASSO. Yes, I agree.

Mr. VANN. In the case in which it owns both? No, I don't see anything.

Senator BARRASSO. OK. So it wouldn't. Then in instances of private surface ownership and Federal mineral ownership, to me, S. 1856 does not apply. So there would be no impact?

Mr. VANN. I agree. It is not relevant.

Senator BARRASSO. Thank you.

Thank you, Mr. Chairman.

The CHAIRMAN. Again, thank you all very much. I think it has been a useful hearing.

That will conclude our hearing.

[Whereupon, at 12:01 p.m., the hearing was adjourned.]

APPENDIX

RESPONSES TO ADDITIONAL QUESTIONS

RESPONSES OF MARK S. BROWNSTEIN TO QUESTIONS FROM SENATOR BINGAMAN

Question 1. Your written testimony discusses some important issues with adequate site characterization and maintenance of geological sequestration sites. Do you feel that the current direction of the DOE CCS regional partnership's research projects adequately address the sequestration component of CCS?

Answer. DOE's CCS regional partnerships are providing a useful forum for developing and implementing pilot projects that will help commercialize carbon capture and storage (CCS) processes and technologies. Of particular importance is that partnerships are taking place in several regions across a wide variety of geologies. This is important because the viability of CCS will vary across geologies, with some geologic formations being more suitable for sequestration than others, and some proving unsuitable at all. Going forward, increased priority should be given to characterizing the geology of various regions, particularly where the costs and technical challenges of sequestration are likely to be relatively higher. In addition, there is an ongoing need for public outreach and education, with a particular focus on environmental regulators and public utility commissioners, both of whom will require current and complete information to be able to assess the environmental and economic viability of CCS projects, respectively.

Question 2. Your testimony did not discuss the draft legislation proposed by Senators Rockefeller and Voinovich that would provide substantial funding for commercial deployment efforts of CCS technologies. Does EDF have an opinion on this draft legislation? We would appreciate your thoughts and/or comments on that legislative draft.

Question 3. Can you provide a brief comparison of coal/CCS incentives in ACELA, ACES and Rockefeller/Voinovich and indicate the preferred approach from EDF's perspective?

Answer. Questions 2 and 3 are interrelated; and so, below, we combine our answers to those questions.

The most important difference between the approaches to CCS commercialization taken in the Rockefeller/ Voinovich discussion draft and those taken in HR2454, the American Clean Energy and Security Act, is that the Rockefeller/Voinovich provisions are designed to operate independently of an energy policy that places a cap on greenhouse gas pollution.

It should be recognized at the outset that, without a mechanism that places a price on CO₂ emissions and that creates a market for avoiding those emissions, even the bestdesigned policies and programs are unlikely to result in broad deployment of CCS technologies. Without a price on carbon, there is simply no economic reason to do CCS.

That critical point aside, the Rockefeller/Voinovich draft in many ways reflects an emerging consensus on the key policy pathways that are needed in order to support development, commercialization and broad-scale deployment of carbon capture and sequestration technologies at coal-fired facilities.

Early Deployment

Both Rockefeller/Voinovich and HR2454 create early deployment programs that would operate for 10 years and fund CCS projects with revenue collected from utility "wires charges." Utility assessments would be based on the fossil-fuel generation mix of each utility, with the assessments under Rockefeller/Voinovich set at levels to bring in a total of approximately \$2 billion annually and assessments under HR2454 set to generate approximately \$1 billion annually. The Rockefeller/Voinovich draft states that the program should, to the maximum extent practicable, deploy projects capturing emissions from at least 10 GW of generating capacity.

This is in contrast to a more limited approach established under S.1462, the American Clean Energy Leadership Act. Under S.1462, DOE would provide technical and financial support to no more than 10 CCS demonstration projects, with the key support mechanism being the indemnification of the 10 project operators from liabilities that may arise from the projects. The question of how to best address risk management is addressed below in our response to question #4. So, here we will focus on the major differences between Rockefeller/ Voinovich and HR2454, neither of which address the liability question.

The Rockefeller/Voinovich draft builds off the CCS early deployment program established in HR2454 (which in turn was taken from Rep. Boucher's HR1689). Under both versions, new entities are established to administer the program—including the approval of projects and disbursement of funds. Under HR2454 this entity, the Carbon Storage Research Corporation, is made up of utility associations and public interest groups and operates as an arm of EPRI.

This structure raises governance questions, in that private entities are given full authority over the management and use of funds raised from electricity consumers for a public purpose. Rockefeller/Voinovich deftly resolves this issue by creating an entity, the CCS Program Partnership Council, made up of largely the same industry and public-interest actors but over which DOE maintains an important oversight role. The Council would review and recommend projects for financial assistance, but awards would ultimately be made by the Program Manager, who is appointed by the Secretary of Energy. In this way, the Rockefeller/Voinovich draft strikes a balance by relying on industry expertise to provide direction over the investments while making public officials accountable for final funding decisions.

The other key difference between the two approaches is the size of the programs. As mentioned, Rockefeller/Voinovich would raise \$2 billion annually for 10 years; and HR2454 would raise half that amount. The question of whether it makes sense to double the size of the early deployment program, as originally negotiated with industry, rests largely on two issues: 1) concerns over consumer impacts, and 2) the efficacy of the commercial deployment programs contemplated in both Rockefeller/Voinovich and HR2454.

Clearly, doubling the costs imposed on electricity consumers—relatively minor though those costs may be for any given ratepayer—is a proposition that will be given close scrutiny. Under both Rockefeller/Voinovich and HR2454, 60% of state public utility commissions must approve the early deployment program before it can be established and utility assessments can commence. Ever conscious of consumer rate impacts, it's conceivable that the difference between a \$1 billion and \$2 billion annual program may be enough to cause a significant number of PUCs to balk.

However, because Rockefeller/Voinovich appears to be designed to operate in the absence of a price on carbon pollution, the success of the overall CCS deployment program becomes all the more dependent on funds generated from mandatory charges placed on consumers in the early deployment program—as opposed to the incentivebased mechanisms used to promote CCS development under the subsequent commercial deployment program. So, in this sense, doubling the size of the early deployment program almost becomes a necessity under Rockefeller/Voinovich.

Commercial Deployment Program

Both Rockefeller/Voinovich and HR2454 establish commercial deployment programs that take effect as the early deployment programs wind down. HR2454 incentivizes broad deployment of CCS by providing emission allowances for tons of CO₂ captured and sequestered, with bonus amounts given on a sliding scale for higher rates of capture and sequestration. The program is broken into two tranches, with the first 6 GW of capacity using CCS being guaranteed the bonus allowances and the next 66 GW of CCS being eligible for allowances under a reverse auction or other method.

Rockefeller/Voinovich mimics this structure, incentivizing the first 10 GW of CCS through loan guarantees and a 30% tax credit on the incremental costs associated with adding CCS technology to a project. For the next 62 GW of capacity, Rockefeller/Voinovich provides slide-scaling tax credit for tons sequestered, with higher amounts given for higher rates of capture. The Rockefeller/Voinovich approach can be seen as an elegant way of devising a similar structure to achieve similar ends as those contemplated in the HR2454 commercial deployment program—and doing so without the having the benefit of emission allowances as a resource to fund incentives. However, we are mindful of the difficult budgetary environment in which Congress currently operates and have concerns about whether the program would be fully funded to achieve its optimal ends.

In contrast, done within the context climate/energy legislation that caps and places a price on carbon, the CCS commercial deployment program could go forward

under a revenue-neutral approach that has both the benefit of being able to use emission allowance values to subsidize CCS deployment and a long-term price signal that will broadly incentivize industry to invest in CCS deployment.

Standards for New Coal-Fired Power Plants

Both Rockefeller/Voinovich and HR2454 set CO₂ emission limits for new-coal fired power plants. Rockefeller/Voinovich requires plants that are initially permitted before 2020 to achieve a CO₂ emission limit that reflects a 50% reduction from the carbon content of the fuel by the time there is 10 GW of CCS capacity in operation or by 2030 at the latest (or possibly later if a DOE report required under the legislation determines that CCS won't be commercially available until later).

Rockefeller/Voinovich is silent on what happens with plants that are initially permitted from 2020 onward. Presumably this question will be addressed as the bill authors further refine their discussion draft.

HR2454 requires plants that are initially permitted by 2020 to achieve a 50% reduction in CO₂ emissions by the time there is 4 GW of CCS capacity in operation or by 2025 at the latest (with EPA being given authority to extend the deadline). Plants initially permitted from 2020 onward must achieve a 65% emission reduction upon commencing operation.

EDF prefers the approach taken under HR2454, as it is more reflective of the standards recommended by the U.S. Climate Action Partnership in its "Blueprint for Legislative Action." The blueprint presents consensus recommendations that were negotiated among a broad group of industry and environmental stakeholders and, as such, provides a solid representation of what is both technically and economically achievable.

National Strategy

Finally, we would note that Rockefeller/Voinovich could benefit from the addition of language directing relevant federal agencies to develop a national strategy, including the promulgation of necessary rules, to address legal and regulatory barriers to CCS deployment and to ensure that CCS activities are held to standards that will be fully protective of public health and the environment. In particular, we would highlight the importance of developing strong standards for assessment and selection of geologic sequestration sites.

Language to this effect is included in HR2454. The coal working group lead by Senator Carper also produced national strategy language, which was included in S.1733, the Clean Energy Jobs and American Power Act, by Senators Kerry and Boxer.

Question 4. There have been many proposals introduced recently by various stakeholder groups concerning CCS liability and indemnity programs, what is EDF's opinion on how liability and indemnity should be addressed? Is there any one preferred approach?

Answer. For the past several months, EDF has been in a dialogue with Southern Company, Duke Energy, Zurich and a variety of other environmental and business stakeholders on the question of CCS liability and indemnity. From the start, the working assumptions of this dialogue have been:

- 1) that the best legal liability regime for CCS is one that ultimately place the full cost of CCS liability insurance and remediation costs firmly in the private sector and assures that individual developers will remain responsible for their actions;
- 2) at the outset of CCS commercialization, when there is a lack of operational experience and data upon which the private sector risk management services (e.g., insurance markets) can develop accurate actuarial data, a certain amount of limited government support will be necessary to facilitate CCS commercialization; and,
- 3) whatever federal government support is offered, it should be structured in a way that facilitates development of a commercial market for liability and risk management services.

We believe the first two assumptions are broadly reflected in S. 1462, and our ideas are intended to build on this work. Our goal is to develop a risk management program for early deployment of CCS, and an infrastructure maintenance program for CCS site post closure. In summary fashion the ideas we have developed to date would attempt to achieve the following:

- 1) Limited relief provided to CCS sites. Site operators take on "first dollar" liability on a per site, per-occurrence basis up to a certain amount. Then each site must contribute to an industry pool, also on a-per site, per-incident basis. Then the government assumes a portion of liability beyond the industry pool up

to a fixed amount for each site. Any remaining liability beyond the government's share reverts back to the site operator. The earlier a CCS site commences operation (i.e., in which tranche it is located), the more assistance it receives.

2) To be eligible for this program, the project developer of a proposed CCS sites apply to the Secretary of Energy to enter into a cooperative agreement. The Secretary is not compelled to enter into any cooperative agreements, thus placing the burden on the applicant to justify its project to the Secretary. Eligibility will depend in part on meeting underwriting criteria that are established for other sites participating in the program.

3) The program is limited. The Secretary can enter into cooperative agreements until a maximum of 40 GW of generating capacity in the United States is equipped with CCS. This equates to 12% of today's coal capacity. The Secretary is required to halt entering into new cooperative agreements, after 15 GWs of capacity (roughly 5% of current coal capacity) have been enrolled in the program, and at that point must undertake a review and determine that that the program is working and still needed to support commercialization of CCS.

4) Participants in the program, as a condition of receiving a cooperative agreement, to agree to pay into a trust fund to cover post-closure infrastructure maintenance and monitoring, measurement and verification costs associated with sites in the program. The trust fund will be funded through a fee per ton of carbon dioxide injected at a site participating in the risk management program. The draft authorizes the Secretary of Energy to recognize a Carbon Sequestration Management Authority (CSMA) to collect and manage the funds. The CSMA will not be a government entity, nor will the funds be government funds.

5) Establish a mechanism to deal with 'orphan' sites. Collect a 5-10 cent per ton fee from all CCS sites, regardless of whether they are participating in the risk management program, to cover remediation, infrastructure maintenance, and monitoring, measurement, and verification for sites where no responsible entity remains with the obligation and financial ability to perform such activities. Our ideas stand in contrast to other proposals that would relieve CCS site owners of all liability once closure of a site is achieved. We believe proposals that contain such blanket liability relief create the risk of moral hazard by offering the promise that at some point in the future, the site would become the sole responsibility of a third party.

EDF, and its partners welcome the opportunity to discuss these ideas with the committee.

RESPONSE OF ROBERT HILTON TO QUESTION FROM SENATOR BINGAMAN

Question 1. In your written testimony, you mentioned the need to broaden the scope of CCS deployment to other fossil fuels and industrial processes. Is Alstom partnering with any non-coal types of CCS projects at present? If so, could you please elaborate?

Answer. To achieve the targets for GHG CO₂ emissions set forth in draft legislation (e.g. Waxman Markey) of 50% in 2030 and 83% in 2050, we will need to place CCS on power generation from all types of fuel, particularly natural gas plants. Depending on the evolution in the next months and years with plant permitting, all studies show CCS on gas as critical. So far, this need for demonstration has been substantially ignored in decisions on public funding.

Alstom has seen the need and has a series of demonstrations aimed at fuels and applications other than coal. We are currently operating a 5Mw Chilled Ammonia Process demonstration pilot at E.ON's Karlshamn Plant in Sweden. This unit is running on oil as the fuel for the boilers. We developed the program on the concept that the unit would later be moved to a combined cycle natural gas power plant located nearby.

We currently have under construction a 40MW Chilled Ammonia Process demonstration plant at the Mongstad refinery in Norway. This project is funded by the TCM Consortium made up of Statoil (refinery owner), Gassnova and Shell. The CCS plant will initially operate on a combined cycle natural gas plant and then on flue gas from a refinery catalytic cracker unit. The Norwegian Parliament is expected to take an investment decision on the plant in 2014.

Alstom also had a contract with ADM under the Industrial ARRA work from the Department of Energy at its plant in Decatur, IL for our advanced amine technology. However, we have completed the phase I study and, due to uncertainty of

legislation, ADM has elected not to proceed with the phase II implementation of the CCS.

We continue to look for additional non-coal opportunities but uncertainty of the regulatory/legislative process for CO₂ control combined with no available government funding for the foreseeable future has essentially frozen the demonstration opportunities.

As we all know, the presumed goals mentioned above can only be achieved by application of CCS on all fuels, and with a wide deployment in the early 2020's. For that to be feasible requires a significant level of projects built and operational by 2015 or 2016 at the latest. This would provide the demonstration experience necessary to give industry the confidence to deploy and the suppliers of technology the confidence to make commercial offers. Without government subsidies this will not happen and under the current budgets for DOE there will be no more than the 5-6 commercial scale demonstration projects currently in design. Congress needs to act based on the legislation under the purview of the Energy and Natural Resources Committee review to fund a broad spectrum of demonstrations now.

RESPONSE OF KURT ZENZ HOUSE TO QUESTION FROM SENATOR BINGAMAN

Question 1. Can you elaborate on how you have been working to acquire private lands? Has that process of securing legal access to lands for CCS projects been any more or less challenging for public lands than for private lands? If so, could you please highlight any potential issues or challenges that you may have encountered?

Answer. It was an honor to testify to your committee, and I would like to request that you and your committee encourage the Secretary of the Interior to issue an interim CO₂ capture and storage (CCS) policy to help clear the path for industrious American entrepreneurs to invest in site characterization and eventually sequestration site construction. By expeditiously issuing such a policy, through which the study and commercial development of carbon sequestration sites involving federal lands can happen, the Department of Interior (DOI) will help to realize President Obama's stated goal of having CCS commercially deployed within 10 years.

I have been studying the physics, chemistry, and geology of CCS for nearly 7 years as an academic and as an entrepreneur. From this experience, I am confident that public lands will be part of many of the best carbon sequestration sites in the country, and as such there is a need for land management policy which balances the benefits of moving quickly to characterize those lands against the risks of making inadequately informed public commitments regarding new commercial activity on the land.

Fortunately, existing federal policy under the Federal Land Policy Management Act (FLPMA) provides the DOI with the necessary authority to act promptly and appropriately. Specifically, FLPMA authorizes DOI and other relevant agencies to expeditiously grant site characterization rights to private developers, while the granting agency withholds full authorization of any development rights until costs, benefits, and local impacts are fully evaluated. This type of two-step protocol has been applied to wind power development as well as to other emerging natural resource.

The use of such a process will enable carbon sequestration site developers to invest the tens of millions of dollars necessary for site testing and environmental analysis, and it will give those developers the confidence that if the resource is proven and the public benefits justify the inclusion of public land in further development, then, the developers will have the opportunity to recoup their substantial investment. By advancing this process, the DOI will enable rapid investment in the early stage development work as well as public confidence that the appropriate care will be taken such that the public interests to be comprehended and evaluated.

In all CCS projects, acquiring the legal access to the geologic reservoir is an essential first step. As I mentioned previously, my company is dedicated to making CCS an integral part of our nation's low-carbon, affordable, and reliable energy future. We are working in more than half a dozen different states, and our development work is financed 100% by private investors.

As I said in my testimony, private transactions are often the preferred route for resource development projects because they can be executed quickly and because the interests of relevant parties can be addressed through direct and private negotiation. In addition to private lands, federal and state lands are essential to the development of CCS projects in the United States because significant portions of private land in the Mountain West region are checker-boarded with federal land. Although regulatory clarity regarding development rights on public lands would speed up de-

velopment, the type of uncertainty involved in the usual FLPMA two-step grant is manageable.

For the past year, the Bureau of Land Management (BLM) has been conducting an internal policy review. Recently, this policy review appears to have been slowed down by two legal questions that, in the opinion of experienced legal experts, are settled law.

The first question involves the BLM's authority under the FLPMA to lease lands for CO₂ sequestration. Indeed, the Department of Interior (DOI) does have the authority to allow a broad range of energy development activities on Federal lands, including carbon sequestration, under the FLPMA (See the first attached legal opinion). The Congressional Research Service testimony to your Committee on April 20th agrees significantly with this conclusion.

The second legal question that BLM appears to be considering is whether or not CO₂ that is sequestered on public lands becomes a natural mineral that the BLM can then lease for extraction. This question is not as central to the development of the industry as the first question, but again, it appears to be a settled question. The majority rule codified by statute in many states and previously recognized by BLM for natural gas storage, provides that the storage operator retains title to injected gas (See the second attached legal opinion). Because ownership of injected gas remains with the storage operator, BLM would not have authority to grant third parties the right to produce injected carbon dioxide. Although this rule was developed with ownership of valuable minerals such as natural gas in mind, in the context of CO₂ it guarantees that responsibility continues to reside with the storage operator. That is that liability-and the asset-belongs to the operator.

I believe strongly that (1) CCS is an essential element of any strategy that has the goal of simultaneously making significant cuts in greenhouse gas emissions, while maintaining a robust and affordable energy supply, and (2) the CCS industry can only grow if land and mineral owners are appropriately brought into all projects. As the largest landowner in the country, the Federal government should move quickly to ensure that it does not become an obstacle to the creation of carbon sequestration projects ready to serve the public good.

RESPONSES OF JAMES MARKOWSKY TO QUESTIONS FROM SENATOR BINGAMAN

Question 1. Just last week, as I understand, the U.S. government, led by our Trade and Development Agency, signed an agreement to help design the first large-scale IGCC power plant in China. With U.S. government assistance, General Electric Energy will work in cooperation with the Chinese to develop the configuration and design parameters for this cutting-edge CCS-ready facility. Is the Department of Energy involved in that project, or others like it, in China and other rapidly emerging economies?

Answer. The Department of Energy is not involved in the IGCC project or any others like it in any rapidly emerging economies.

In 2007, NEIL provided technical oversight for a \$2 million IGCC feasibility study, without CCS, in India funded by the U.S. Agency for International Development (USAID). This study resulted in a recommended gasification technology as being the most commercially ready for a large-scale (100-MW) demo project using typical high-ash coals. Subsequently, during the U.S.-Indo Energy Dialogue in 2007 in New Delhi, DOE committed to participating on an IGCC Task Force with India's Ministry of Power, NTPC Ltd., and Bharat Heavy Electricals, Ltd. (BHEL). The IGCC Task Force will be discussed during a meeting of the Power & Energy Efficiency Working Group in New Delhi, in early May 2010.

Question 2. Please describe the efforts being taken to ensure that water rights and water quality will be protected in connection with development of policies and technology relating to carbon capture and sequestration.

Answer. The DOE is working through the Regional Carbon Sequestration Partnerships and its 30 field projects to demonstrate that underground sources of drinking water (USDWs) will not be adversely impacted by CO₂ injection operations and long term storage. Sixteen of these projects have completed their injections, and three are currently injecting CO₂ in deep saline formations, depleted oil fields, and deep unmineable coal seams. All of these projects are permitted under the U.S. EPA's underground injection control (UIC) permitting process which is designed to protect USDWs. To date, all of these projects have demonstrated that CO₂ injection into geologic formations is a secure and safe technology to mitigate greenhouse gas emissions. The DOE is also working through the Partnerships' field projects and several NGOs to address water rights and pore space issues. These field projects are all required to obtain leases for mineral, water, and/or pore space rights prior to

project operations. The DOE is also working to address these issues through the interagency task force on CCS and engaging with stakeholders from industry and the states to better understand issues regarding water rights and water quality.

[Responses to the following questions were not received at the time the hearing went to press:]

QUESTIONS FOR ANNE CASTLE FROM SENATOR BARRASSO

NOTIFICATION

Question 1. Public participation is a key part of the permitting process. What guidelines does the Department follow when it comes to carbon storage projects on public land?

Question 2. Is notice given to adjacent property owners, mineral leaseholders, and people with surface use permits?

AGENCY COOPERATION

Question 3. Federal lands are managed by various agencies within the federal government. There are different statutory chapters that apply to each agency and that cover different aspects of federal land management. Are the processes for reviewing, permitting, and overseeing carbon storage projects on federal land consistent across the various land management agencies within the Department of the Interior?

MINERAL RIGHTS

Question 4. S. 1856 makes clear that the mineral estate is dominant. Under existing law and regulations, how does the Department ensure carbon storage on public lands does not impact existing mineral leasing rights?

Question 5. Concerns have been raised regarding carbon sequestration's impact on ongoing mining activities. Mining lease holders use underground mining spaces as part of the ventilation system as mining continues. Does the Department recognize that these underground cavities are part of the mineral lease as long as mining operations continue?

Question 6. Would S. 1856 impact the Department's rules in this regard?

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