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SEAB SUBCOMMITTEE'S 90-DAY REPORT

HEARING

BEFORE THE

COMMITTEE ON ENERGY AND NATURAL RESOURCES UNITED STATES SENATE

ONE HUNDRED TWELFTH CONGRESS

FIRST SESSION

TO

RECEIVE TESTIMONY ON THE SECRETARY OF ENERGY ADVISORY BOARD'S SHALE GAS PRODUCTION SUBCOMMITTEE'S 90-DAY REPORT

OCTOBER 4, 2011

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SEAB SUBCOMMITTEE'S 90-DAY REPORT

TUESDAY, OCTOBER 4, 2011

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

The committee met, pursuant to notice, at 10:06 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. The hearing will begin.

Thank you all for coming today.

The purpose of this hearing is to receive testimony on the Secretary of Energy advisory board's shale gas production subcommittee's 90-day report.

In recent years, a number of factors have raised the prominence of natural gas as a resource. New applications of technologies such as horizontal drilling and hydraulic fracturing have led to more domestic natural gas production and have led to a reassessment of the U.S. technically recoverable resources.

The international focus on reducing greenhouse gas emissions has favored the lower carbon intensity of natural gas for power generation. The recent tragedy in Japan at the Fukushima nuclear plant has led both the Japanese and the German officials to speak—speak strongly about fuel switching to natural gas to replace, or at least, to supplement their remaining nuclear fleet.

Concerns about our dependence on foreign oil have led some to propose switching our cars and trucks from imported gasoline and diesel fuel to domestic natural gas. Proponents of domestic manufacturing have argued that a larger, more stable gas supply at competitive prices will lead to a resurgence of investment in manufacturing in this country.

The promise of the expanded domestic natural gas resources comes with a responsibility to address environmental concerns as well as human health and safety issues. Those concerns arise with increased natural gas exploration and production, particularly in areas that have not previously experienced a natural gas boom. The public has increasingly expressed concerns about the wastewater management of flow back fluids from natural gas wells, as well as the potential for groundwater contamination. Residents who live on top of, or adjacent to, the shale gas resources have also expressed concerns about the potential for noise pollution, diminished air quality and contamination of water resources.

Recently, there's been increased scrutiny of fugitive methane emissions occurring during the natural gas extraction process. Methane is such a potent greenhouse gas that if even a small fraction of the overall natural gas extracted escapes to the atmosphere, the overall greenhouse gas emissions from natural gas usage increase substantially.

Some experts have claimed that fugitive emissions from natural gas extraction are routinely high enough that switching to natural gas could actually be worse than continuing to use coal, while many other experts have disputed these claims. If natural gas is to be used as a lower carbon alternative to other fossil fuels, the issue of fugitive emissions is—is one that we must quantify, and understand more fully and address appropriately.

I expect environmental, and human health and safety concerns related to developing unconventional gas resources can be managed, but only if they are addressed through a transparent, diligent and safe approach to well-site and wastewater management throughout each stage of the gas extraction process.

I believe that that is what we will be addressing here today as we hear from the Secretary of Energy' advisory board shale gas production subcommittee members concerning their recently released 90-day report. We're very—very fortunate to have this panel of experts.

Before I introduce them, I'll call on Senator Murkowski for her comments.

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

Senator MURKOWSKI. Thank you, Mr. Chairman.

Appreciate you scheduling the hearing this morning. A special thanks to all of our witnesses for joining us.

I want to particularly acknowledge you, Dr. Yergin. Your latest book, "The Quest," about global energy issues is one that, well I have to admit, I haven't started reading it yet; several of my staff have. In fact, I think that the staff director here for the committee is particularly groggy this morning as he was going through it last night. I'm told that the early reviews are favorable. I also understand that it does include a chapter on shale gas and how that resource will factor into just about every major energy decision that we will make in the coming year. So I'm looking forward to that.

I do appreciate the chance to learn more about the Secretary of Energy advisory board's recent report. to spend some time thinking about the future of one of our nation's most promising resources.

Natural gas is clean-burning and abundant. It's well understood. It's scalable. It's clearly in our best interest to takes steps to ensure that we maintain a stable and an affordable supply into the future by encouraging its safe and responsible development. That's the point of our being here this morning.

While this hearing doesn't necessarily mean that this committee endorses, or even agrees with, everything within the report, it certainly does confirm the importance of the subject and the reality that the report embraces.

We've witnessed some game changing technological innovations that have unlocked tremendous volumes of previously inaccessible

natural gas. These resources are already benefiting our nation by further diversifying our energy supplies, growing our economy and creating thousands upon thousand of well-paying American jobs.

I do think it's important to remember that success stories in the energy world have historically involved ingenuity and innovation by a few where many have seen previously impossible challenges. So whether we're talking about something like constructing the Trans Alaska pipeline up north or, as we'll discuss today, cracking the code on how to economically and safely develop our unconventional gas resources. I think that America should encourage and allow for this kind of ingenuity and innovation in the private sector. We should look for the same types of individuals to overcome the challenges that crop up with all of the activity surrounding such a great level of development.

As I've said many times before, responsibly developing all of our resources is of paramount importance to us as a nation, and I think natural gas is certainly no exception there. We cannot realize the many benefits of our tremendous natural gas resource unless we commit to safe, environmentally acceptable production and delivery within a framework of appropriate regulation and access.

I do welcome the efforts of the subcommittee to proactively find ways to increase the transparency and improve the efficiency of the extraction process.

Mr. Chairman, I'll conclude by, again, thanking you for scheduling this hearing. Many of our members, myself included, are champions of natural gas. I think greater use of natural gas would move our nation in the right direction in terms of energy security, economic growth and environmental protection. I think these are 3 vitally important goals and every one of them should be achievable.

With that, I thank you and I look forward to the testimony.

The CHAIRMAN. Thank you very much.

Let me introduce our witnesses today.

First is Dr. Daniel Yergin, who's Chairman of the IHS Cambridge Energy Research Associates and the author of this book that Senator Murkowski just referred to which we all congratulate him on.

The second is Dr. Stephen A. Holditch, who is Department Head and Professor of Petroleum Engineering at Texas A and M University in College Station, Texas.

Third is Dr. Mark Zoback, who is the Benjamin M. Page Professor at the Department of Geophysics at Stanford. Thank you for being here.

Finally Katie McGinty—Kathleen McGinty, who is the Senior Vice President and Managing Director of Strategic Growth with Weston Solutions in West Chester, Pennsylvania. Thank you very much for being here.

Why don't each of you take 5 or 6 minutes, and summarize your—the main points you think we ought to understand on this subject and we will, of course, include the full written statement that you've prepared for our record.

Dr. Yergin, why don't you begin?

STATEMENT OF DANIEL YERGIN, CHAIRMAN, IHS CAMBRIDGE ENERGY RESEARCH ASSOCIATES

Mr. YERGIN. Mr. Chairman, ranking members—Mr. Chairman, ranking members, members of the committee.

I want to say on behalf of all the members of the subcommittee, we really appreciate this opportunity to come and share with you what we learned in the 90 days that we spent working on this study.

The study—we were tasked with—and also by the way, Senator Murkowski, Senator Bingaman, let me thank you for your gracious words about "The Quest". So thank you.

We were tasked with developing a study by President Obama in his March 31, 2011, speech in which he declared that recent innovations have given us the opportunity to tap large reserves perhaps a century's worth of shale. But in order to facilitate this development, ensure environmental protection and meet public concerns, he instructed Secretary Chu to establish—to ask the subcommittee, which had already been established, to address the safety and environmental performance of shale gas production.

Senator Bingaman, you've sketched out were the major environment concerns that we focused on water quality, air quality and community impact. Our conclusion is that these environmental—the need for environmental protection can be met if approached properly. To that end, we made 20 recommendations concerning best practices, technological innovation, and regulatory processes.

We do so with the recognition that almost overnight, in energy terms, shale gas has become a major and critical national resource. Senator Murkowski remarked on that things seem to happen overnight and they don't, and there was 25 years of really hard work and innovative effort that went into shale gas before it achieved the prominence that it did. There was a sense that it was a few people who really carried it on. But today, shale gas accounts for 30 percent of U.S. natural gas production and is expected to rise dramatically in the foreseeable future. Of course, natural gas is one of our backbones. It's a quarter of our total energy.

If we went back 5 years ago, none of this would've been expected. Instead, it would've been thought that we would've been importing very large amounts of LNG, perhaps $100 billion' worth of imports a year for that. Now, we are mostly self-sufficient in terms of natural gas. Natural gas prices have fallen substantially, meaning lower bills for industry, for homeowners. Several hundred thousand jobs have been created in the last few years. Natural gas consuming industries have invested literally billions of dollars in the last few years because of this resource in a way that they would not have expected to half a decade ago. The development of shale gas has represented major new revenue sources. The State of Pennsylvania and localities in Pennsylvania last year took in $1.1 billion in shale gas revenues in the State.

This is part of what was also described in concurrently in a National Petroleum Council study "Prudent Development," which was released on September 15th to the Secretary of Energy which talked about, and it used the word surprising reassessment—upward reassessment of U.S. oil and gas resources, the result of technological advance.

Now, of course, the rapid development of shale gas in the last few years has created this series of environmental issues and concerns which are the topic of our report. My colleagues will—subcommittee colleagues will speak about the specific environmental issues and how to mitigate them those water quality, air quality and community impact.

Altogether we have 20 recommendations. One of the starting points that runs through the whole thing is the need for much more complete measurement of water quality, air quality and specifically methane that the Chairman referred to. Many of the recommendations focus on best practices and technological innovation. They also emphasize the importance of community engagement and the need for disclosure and transparency. They recognize a central responsibility of State regulation in this area.

Our subcommittee chairman, Professor John Deutch who couldn't be here, wrote in his letter to the—to the committee that, "The subcommittee believes that these recommendations if implemented combined with a continuing focus on and clear commitment to measurable progress in introducing best practices based on innovation and field experience represent important steps toward meeting public concerns and ensuring that the nation's resources are being responsibly developed."

But there are a couple of recommendations that I'd just like to highlight. We all realize, and you all know better than anybody, the difficult decisions that have to be made about the Federal budget and the challenges this creates, both for the Congress and the administration. There are 2 areas of very modest fund raise—of funding that we—that would pay back to the Nation and in terms of Government revenues a hundredfold.

One is the need to support at a modest level what's called STRONGER or the State Review of Oil and Natural Gas Environmental Regulations. This is very important because the States are both the frontline and the backbone of regulation, and this enhances their performance. Similar support should be provided to the Ground Water Protection Council. The other refers to what both the Chairman and the Ranking Member discussed in terms of technology.

The second is to provide targeted Federal R and D support in developing the technologies that address the environmental issues and promote continuous improvement and best practices. This includes the Research Partnership to Secure Energy for America.

These are both very small sums of money but these investments would pay, as we concluded, enormous returns first and foremost in meeting the environmental objectives and facilitating the great potential that's been identified as shale gas would contribute to energy security, economic development and job creation. As a result of all of this, generate a lot of revenues that would flow to the Federal Government, to State and local governments.

So thank you very much for the opportunity to join this morning and to my colleagues.

[The prepared statement of Yergin follows:]

PREPARED STATEMENT OF DANIEL YERGIN, CHAIRMAN, IHS CAMBRIDGE ENERGY RESEARCH ASSOCIATES

I appreciate the opportunity to appear before the Senate Energy committee for this discussion of what we learned from the Secretary of Energy Advisory Board Subcommittee 90-Day Report on shale gas production.[1]

I am Daniel Yergin, chairman of IHS Cambridge Energy Research Associates. I am the author of a new book, The Quest: Energy, Security, and the Remaking of the Modern World, which describes the development of shale gas, among other topics.[2]

It was a privilege to serve on this Subcommittee, which was constituted in January 2011. The Subcommittee was tasked with developing a study report by President Obama in his March 31, 2011, speech, in which he declared that "recent innovations have given us the opportunity to tap large reserves-perhaps a century's worth" of shale. In order to facilitate this development, ensure environmental protection, and meet public concerns, he instructed Secretary of Energy Steven Chu to have this subcommittee address the safety and environmental performance of shale gas production.

We focused on three major environmental concerns: water quality, air quality, and community impact. Our conclusion is that the need for environmental protection can be met if approached properly. To that end, we made 20 recommendations regarding best practices, technological innovation, and regulatory processes.

We do so with the recognition that almost overnight, in energy terms, shale gas has become a major and critical national resource. Two years ago, the very concept of shale gas was hardly known, either in the Nation or in Washington DC, and even the spelling of "fracking"—or "fraccing," or "fracing"—has been a subject of dispute.

Today shale gas accounts for about 30 percent of total US natural gas production, and this is expected to rise dramatically in the foreseeable future. Natural gas itself is one of the backbones of our economy, providing about a quarter of the country's total energy.

This abundance of natural gas is very different from what was expected a half decade ago. It was then anticipated that constraints on domestic natural gas production would result in high prices for consumers and the migration of gas-using industries-and the jobs that go with them-out of the United States to parts of the world with cheaper supplies. The United States was also expected to be importing substantial amounts of natural gas in the form of liquefied natural gas (LNG). That would have added as much as $100 billion to our trade deficit.

None of that has occurred . . .

Instead,

- The United States has become, except for imports from Canada, mostly self-sufficient save for some LNG imported to cope with pipeline constraints and seasonality.
- Gas prices have fallen substantially, lowering the cost of gas-generated electricity and home heating bills.
- Several hundred thousand jobs have been created in the United States.
- Gas-consuming industries have invested billions of dollars in factories in the United States, something which they would not have expected to do half a decade ago-creating new jobs in the process.
- The development of shale has created significant new revenue sources for states-for the state of Pennsylvania and localities in that state, for example, $1.1 billion in revenues in 2010.

Shale gas-the unconventional natural gas revolution-has been called the biggest energy innovation of the past few decades. The chairman of our Subcommittee, Professor John Deutch of the Massachusetts Institute of Technology, has described shale gas as responsible for "perhaps the biggest shift in energy-reserve estimates in the last half century."[3]

The new National Petroleum Study Prudent Development: Realizing the Potential of North America's Abundant Natural Gas and Oil Resources, submitted to the Sec-

[1] Secretary of Energy Advisory Board, Shale Gas Production Subcommittee 90 Day Report, US Department of Energy, August 18, 2011.

[2] Daniel Yergin, The Quest: Energy, Security and the Remaking of the Modern World (New York: Penguin, 2011), Chapter 16, "The Natural Gas Revolution" (www.danielyergin.com)

[3] John Deutch, "The Good News about Gas," Foreign Affairs, January—February 2011.

retary of Energy on September 15, details what it describes as the "surprising" upward reassessment in US oil and gas resources-the result of technological advance.[4]

Shale gas only burst into public view in 2008 and 2009. Yet as I describe in The Quest, this was the result of a quarter century of technological development and progress and innovation-a process that had involved much disappointment and trial and error until the end of the 1990's.

In the past few years, the rapid development of shale gas has also created environmental concerns and issues, which are the topic of our report. Commercial development of shale gas had begun in traditional oil and gas-producing states. But these concerns became much more visible when development spread into the "Mighty Marcellus"—that is, the Marcellus Shale that is found in Pennsylvania, West Virginia, and New York State. Although western Pennsylvania had been the birthplace of the oil and gas industry, that was a long time ago and under very different conditions. In modern times, this was a new activity, particularly on this scale, and in a more densely populated region.

My Subcommittee colleagues will speak about the specific environmental issues and how to mitigate them. These concern water quality, air quality, and community impact. Professor Steven Holditch, chairman of the petroleum engineering department at Texas A&M, has 40 years' experience with the science of hydraulic fracturing. Mark Zoback, professor of earth sciences and geophysics at Stanford University, is an expert on the forces in the earth that control geologic processes. And Kathleen McGinty was Secretary for Environmental Protection for the State of Pennsylvania and served as chair of the White House Council on Environmental Quality.

Altogether, as noted, the report contains 20 specific recommendations about these issues. One of the starting points is the need for much more complete measurement of water quality, air quality, and specifically methane. Many of the recommendations focus on best practices and technical innovation. They also emphasize the importance of community engagement and the need for disclosure and transparency. They recognize the central role of state regulation in this arena.

As Professor John Deutch wrote to the committee: "The Subcommittee believes that these recommendations, if implemented, combined with a continuing focus on and clear commitment to measurable progress in introducing best practices based on technical innovation and field experience, represent important steps toward meeting public concerns and ensuring that the nation's resources are being responsibly developed."

We came at this report from a variety of perspectives and, as we examined the issues and listened to public testimony, came to a consensus on our recommendations.

But there are a couple of recommendations that I would like to highlight. We recognize the difficult decisions that have to be made about the Federal budget and the challenges this creates for both the Congress and the Administration. But there are two areas of modest funding that would pay back to the nation-and government revenues-many hundredfold.

The first is to support at a modest-level STRONGER-the State Review of Oil and Natural Gas Environmental Regulations. This is very valuable because the states are both the frontline and the backbone of regulation. Similar support should be provided to the Ground Water Protection Council.

The second is to provide Federal R&D support on developing the technologies that address the environmental issues and promote continuous improvement and best practices. This includes support for the Research Partnership to Secure Energy for America.

These two investments would pay enormous returns, first and foremost in meeting environmental objectives and facilitating the achievement of the great potential of shale gas, and by so doing would contribute to energy security, economic development, and job creation-and, as a result of all this, generate considerable revenue flows to Federal , state, and local governments.

Dr. Daniel Yergin is chairman of IHS Cambridge Energy Research Associates. His new book The Quest: Energy, Security, and the Remaking of the Modern World has just been published (www.danielyergin.com). The Quest addresses the natural gas revolution in Chapter 16.

Dr. Yergin is a member of the Secretary of Energy Advisory Board. He previously chaired a US Department of Energy Task Force on Energy R&D. He is a member of the National Petroleum Council and vice chair of its new study Prudent Develop-

[4] National Petroleum Council, Prudent Development: Realizing the Potential of North America's Natural Gas and Oil Resources, Report Submitted to the Secretary of Energy on September 15, 2011.

ment: Realizing the Potential of North America's Abundant Natural Gas and Oil Resources.

Dr. Yergin received the Pulitzer Prize for his book The Prize: the Epic Quest for Oil, Money and Power.

The CHAIRMAN. Thank you very much.

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

STATEMENT OF STEPHEN A. HOLDITCH, P.E., DEPARTMENT HEAD, PETROLEUM ENGINEERING, TEXAS A&M UNIVERSITY, COLLELGE STATION, TX

Mr. HOLDITCH. Thank you and good morning. I'm very pleased to be here.

Shale gas is for real. Shale gas currently supplies about 30 percent of the natural gas we use in the United States. A Department of Energy report in 2009 and recent developments that have occurred since then seem to say there's over 900 TCF of technically recoverable resource just in the shale gas plays that have been developed over the last 5 or 10 years. Not all of this 900 TCS—TCF of technically recoverable gas is economically recoverable, but the way to convert it from technically recoverable to economically recoverable is to increase the technology used to extract the gas so that we can get more gas out per well and reduce the cost per well. We do that with—with research.

It's clear to me that the United States has a real opportunity to develop its unconventional gas reservoirs, shale gas, tight gas and coal bed methane to dramatically improve the energy security of the United States. The U.S. can use the abundance of natural gas to generate electricity and we can use it for motor fuel which would reduce oil imports. Natural gas should be used with wind, solar and geothermal to create a clean energy package for the electric grid because when the wind's not blowing and the sun's not shining, you need the natural gas to supplement the electricity. So it's a—it's a—it's not wind or solar or natural gas, it's all 3 combined is what we have to do.

However, shale gas development must be done correctly. In our 90-day report, we recognized there are real issues with water, air, air emissions, and community impact and these must be addressed by the oil and gas community. I think we all agree on the committee and—and most folks do. You can't really improve something that you can't measure. So our committee has—has recommendations in there on—on what we need to do to improve our measurements, and from that we'll have data to improve our actions.

If you read recent news articles on hydraulic fracturing, the process is often described as pumping in a mixture of water and toxic chemicals under high pressure under the earth. This description is far from the truth. Most fracture treatments consist of 99.5 percent pure water and sand, and only 0.5 percent of what we pump in the ground are chemicals. Many of these chemicals are gelling agents to increase the viscosity, surfactants and bactericides. The—the gelling agents are just thickening agents like guar gum, which is used in a lot of food products. Surfactants are just your Dawn dishwasher liquid. The biocides are just the Clorox, the same chemicals we have in our homes. So these chemical are pumped in the

ground. They are needed but they're in very minute quantities and they're really not all that—that dangerous on their own.

But the SEAB subcommittee, we recommended that the industry should measure and post on a publicly available Website the volume and the composition of what's being pumped in the ground. Then we should measure and determine the volume and the composition of what flows out of the well. The industry should track the water from the time it's—it's initially collected until it's finally disposed of. We need to be collecting the information on what goes in the ground, what comes out of the ground because then we'll know exactly what's happening, and if there are—they'll more than likely there won't be issue but if there are issues, we've measured them and we can fix them.

In my opinion, currently drilling and hydraulic fracturing activity in the shale gas does not really affect drinking water aquifers. I've been working on hydraulic fracturing for over 40 years. My master's thesis in 1970 was on hydraulic fracturing of low permeability gas reservoirs, and there's absolutely no evidence that fractures can grow from miles under the ground up to the surface to the aquifers.

So I think we—we just really need to concentrate on—on what the issues are and deal with them. As you might expect from a university professor, I can see a number of areas where additional research would be useful. There's a lot of information in our report, which I will not cover, but let me just mention a few bullet points on some of those research areas.

We need to improve the technologies used to clean water that is produced from the ground so that it can be—we can remove the impurities and reuse the water. There's a lot of companies actually working on that right now.

We need to improve the chemistry of the fracture fluid additives so that we can use saline water rather than fresh water so we're not computing with other uses for fresh water.

We need to continue the development of microseismic technology to remotely map these fractures and—and know what they're doing. As my colleague said, we recommend continued funding of organizations such as STRONGER and FracFocus.org. At Texas A and M University, we have a project called Environmental Friendly Drilling which is partially funded by the Research Partnership to Secure Energy for America. If the Environmental Friendly program is doing all the right things in emissions testing, clean up technology of produced fluids, and they even have a project on developing disappearing roads. So additional funding to this Environmental Friendly Drilling program or other programs like that could—could make a successful program—program and improve it measurably.

Thank you.

[The prepared statement of Mr. Holditch follows:]

PREPARED STATEMENT OF STEPHEN A. HOLDITCH, P.E., DEPARTMENT HEAD, PETROLEUM ENGINEERING, TEXAS A&M UNIVERSITY, COLLEGE STATION, TX

Good Morning. I am Stephen A. Holditch and I am the Head of the Department of Petroleum Engineering at Texas A&M University. I am serving on the Secretary of Energy's Advisory Board Shale Gas Subcommittee. I have been working on how to develop low permeability, unconventional gas reservoirs using hydraulic frac-

turing since 1970. The following testimony represents only my views of the issues and my interpretation of what the report suggests. This testimony does not speak for the other members of the subcommittee.

Shale gas is for real

Shale gas currently supplies around 30 percent of the natural gas we use in the United States. A Department of Energy Report in 2009, and recent developments suggests that new Shale Gas Development in the last 10 years has added over 900 Tcf[1] of Technically Recoverable Resources (TRR) from Shale Gas.[2] Not all of the 900 Tcf is currently Economically Recoverable Resources (ERR), but under the correct cost and price structure, much of it can be converted from TRR to ERR. Research into new drilling and completion technology is needed to increase shale gas recovery. In 1997, Rogner estimated the gas in place in Shale reservoirs worldwide was over 16,000 Tcf. On the basis of the research we have conducted at Texas A&M University, we think the number should be closer to 50,000 Tcf of gas in place in Shale reservoirs worldwide.

It is clear to me that the United States has a real opportunity to develop it's unconventional gas reservoirs (shale gas, coal gas and tight gas) to dramatically improve the energy security in the United States. The U.S. can use the abundance of Natural Gas to generate electricity and for motor fuel, which should reduce oil imports. Natural gas should be used with wind, solar, and geothermal energy to create a clean energy package for the electric grid.

In addition, the same technology we are using in Shale Gas reservoirs, namely horizontal drilling and hydraulic fracturing, are currently being used in South Texas, West Texas, the Bakken Formation in Wyoming and North Dakota, and most recently in Ohio to increase oil production in the United States. Oil production in the Lower 48 states has increased during the past year for the first time in decades.

Shale gas development must be done correctly

The oil and gas industry understands, and the SEAB Subcommittee Shale Gas Production 90-Day Report clearly states, that there are real issues with water, air emissions, and community impact that must be addressed by the oil and gas companies. The SEAB Subcommittee suggested that the industry should improve what it measures and disclose all non-proprietary data on publically available websites. I am of the opinion that 'you cannot improve what you do not measure'.

In my testimony today, I will deal with water issues, air quality issues and research that could help improve the development of shale gas.

Water and Fracture Fluids

If you read recent news articles on hydraulic fracturing, the process is often described as pumping in a mixture of water and toxic chemicals under high pressure. This description is far from the truth. Most fracture treatment fluids consist of 99.5 percent percent pure water and sand. About 0.5% of the fluid is made up of gelling agents, surfactants, and biocides. Virtually all of these chemicals can be found in a typical home. Gelling agents are typically guar gum, which is used in many food products to viscosify the product. A surfactant is just soap, like Dawn dishwashing fluid. Biocides are use to kill bacteria, like the Clorox we use in our homes. Granted, we do not want to drink these fluids, but they are all found in our homes. However, the concentration of these 'chemicals' is very minute and does not pose a danger to fresh water aquifers, if the field operations are conducted properly.

The SEAB Subcommittee recommended that the industry should measure and post on a publically available website

- the volume and composition of what is pumped into the wells during fracturing operations,
- the volume and composition of what flows back to the surface during clean up operations, and

[1] Tcf is the terminology for Trillion Cubic Feet at standard pressure and temperature.

[2] OGIP refers to the original volume of gas contained in a reservoir before production begins. Using current technology, and disregarding costs, prices, and other investment criteria, the proportion of OGIP that can be technically produced is called Technically Recoverable Resouosrces (TRR). TRR is gas that we know where the gas is located and we have developed the technology to produce the gas; however, the gas may or may not be economic to produce under existing gas prices of drilling costs. TRR is also gas that can be produced but no pipeline exists to market the natural gas. When the economic conditions allow the natural gas to be produced at a profit, a portion of TRR can be economically produced and is referred to as Economically Recoverable Resources (ERR). ERR is usually booked as proved reserves. TRR can be thought of as possible or probable reserves. OGIP is the total resource base.

- the industry should track water movement from initial collection to final disposal.

The SEAB Subcommittee also believes the industry should take baseline measurements of all water wells in the vicinity of any shale gas well prior to drilling. In fact, most operators already do this.

It is my opinion that current drilling and hydraulic fracturing activity does not adversely affect shallow drinking water aquifers. I have been working in hydraulic fracturing for 40+ years and there is absolutely no evidence hydraulic fractures can grow from miles below the surface to the fresh water aquifers. However, for other reasons, there could be problems in aquifers. If problems do occur in fresh water aquifers, then a thorough investigation of the development history in the area needs to be conducted to find the problem. Once the problem is understood, it can be fixed.

Air Emissions

It appeared to me during the course of the work by the SEAB subcommittee, that the issues involving air emissions have not received the same focus as the issues involved with water. When you move into a new geographic area to develop shale gas, the number of diesel engines used to power drilling rigs and the truck traffic involved in the operations can be significant. Again, as with water and fracture fluids, it is not possible to make intelligent changes to improve the situation if you do not make measurements. In the case of air emissions, we need to do a better job of taking base line air quality measurements prior to shale gas development operations, and continue monitoring air quality during and after development. If there are no real issues with emissions, fine. If problems are discovered, fine also, because now we know and we can take steps to solve the problems.

We were told that if pad drilling is used to drill 6–8 wells per pad, the truck traffic involved with the operations can be reduced by over 50 percent. Also, in South Texas, some companies are converting rigs and trucks to run off of natural gas, rather than diesel. There are other issues involving air emissions that others on the subcommittee can discuss in more detail.

Research, Development and Data Bases

As you might expect from a University Professor, I can see a number of areas where additional research would be useful. For brevity, I am including a bulleted list of the most important areas. Some of these area are already under development by industry, but additional research funding would speed along the technology.

- We need to improve the technologies used to clean the water produced after a fracture treatment to remove impurities and make the water available for reuse.
- We need to improve the chemistry of the fracture fluid additives so that we can use saline water for fracturing rather than fresh water.
- We need to develop more affordable technology to monitor air quality and methane emissions during the entire life of a shale gas well, from drilling to production.
- We need to continue development of micro-seismic technology to remotely map the hydraulic fractures as they are being created.
- We recommend the continued funding and development of organizations such as Stronger and data bases such as FracFocus.org to allow data from shale gas wells to be posted online for any interested party to review.
- At Texas A&M University, we work in a project called Environmentally Friendly Drilling (EFD) that is funded in part by the DOE through the Research Partnership to Secure Energy for America (RPSEA) and also by the oil and gas industry. EFD is doing all the right things in terms of air emissions testing, cleanup technology for produced fracture fluids, to working on how to build disappearing roads. An increase in funding for EFD could take a successful program and improve it measurably.

The CHAIRMAN. Thank you very much.

Mr. ZOBACK.

STATEMENT OF MARK D. ZOBACK, BENJAMIN M. PAGE, PROFESSOR OF EARTH SCIENCES, DEPARTMENT OF GEOPHYSICS, STANFORD UNIVERSITY, PALO ALTO, CA

Mr. ZOBACK. Good morning. It—it's a pleasure to be here and to have the opportunity to comment on our subcommittee's report.

For about the past 30 years, I've been trying to quantify the forces in the earth that control earthquakes, hydraulic fracturing propagation and other geologic processes. For about the last 5 years or so, my Ph.D. students and I have been doing research on optimizing production from shale gas and shale oil reservoirs.

To be brief, I'm going to limit my comments to—to 3 topics: avoiding gas leakage from wells and potential contamination of shallow aquifers, minimizing the use of fresh water during hydraulic fracturing and the handling of the contaminated water that flows back out of the well after hydraulic fracturing has been completed.

Let me say at the outset that like the other members of our committee, I—I personally believe there is no question that shale gas resources can be developed in a manner utilizing horizontal drilling and multistage hydraulic fracturing that protects the environment and minimizes the impact on nearby communities.

But as everyone knows, there have been a number of accidents and incidents associated with shale gas development. These accidents have—have done damage to water supplies, have caused environmental harm and have raised concerns, logically, among the public about whether these resources can be developed safely.

It's unfortunate that almost everything that has occurred and has gone wrong with shale gas development has been referred to as hydraulic fracturing. As Dr. Holditch just testified, the chemicals used in hydraulic fracturing are relatively benign, steps are being taken to make them even safer and our committee recommends full disclosure of the composition of hydraulic fracturing fluids.

What is important to emphasize is that the most important step that can be taken to prevent gas leakage and to prevent surface aquifers now and in the future is good well construction. A well that is improperly cased and cemented has the potential to leak gas whether it is hydraulically fractured or not. It is critical for State and Federal regulators to work closely with private industry to design and construct optimally secure wells with multiple barriers of casing in cement to prevent gas leakage and to protect water supplies over the potential 20 to 30 year lifetime of these wells.

The second point I wanted to make concerns conservation of water resources. As millions of gallons of fresh water are utilized in each well that is hydraulically fractured, it's possible to make significant advances to conserve water resources by carrying out fewer hydraulic fractures in a given well and by pumping smaller volumes. These are, again, areas where research would have a major payoff.

As Dr. Holditch pointed out, in many parts of the country industry has moved to drilling multiple wells from a single pad. Pad drilling not only greatly improves the efficiency and—of drilling and fracturing operations, it minimizes land use, lowers the overall impact of drilling operations on local communities and makes regional planning easier to lessen the cumulative impact of shale gas development activities in any given area.

In some cases, pad drilling creates the opportunity for temporary pipelines to be used instead of having to truck all the water in. In

one case I know about in Canada, water wells were drilled into deep saline aquifers to provide the drilling pad with enough low quality water, water that was unfit for domestic consumption or irrigation, to carry out 150 hydraulic fracturing operations. The flow back water was then returned to the saline aquifers and no fresh water was used at all.

The third and final point I'd like to make concerns the water that flows back after hydraulic fracturing. In some cases, very little water flows back; in other cases, as much as 25 to 50 percent of the injected water flows back contaminated with brine, metals and potentially dangerous chemicals that are actually picked up in the shale itself.

As Dr. Holditch mentioned, our committee has recommended that the volume, composition and disposition of these waters be carefully monitored and disclosed via publicly available Websites. Our committee has also noted the recycling of hydraulic fracturing fluid, which is especially prevalent in the Northeast, is a welcome development and will hopefully be used more and more throughout the industry. Reuse of flow back water avoids a number of potential problems associated with transport and injection of the—as well as the expense and extensive water treatments, so again, another area where research and development would have a big payoff.

So as we said in the conclusion of our subcommittee's 90-day report, the public deserves assurance that the full economic, environmental and energy security benefits of shale gas development will be realized without sacrificing public health, environmental protection and safety.

Mr. Chairman, thank you for the opportunity to speak to the committee this morning. I personally believe we are well on our way to identifying the kinds of actions needed to provide the public with—with this type of assurance.

[The prepared statement of Mr. Zoback follows:]

PREPARED STATEMENT OF MARK D. ZOBACK, BENJAMIN M. PAGE, PROFESSOR OF EARTH SCIENCES, DEPARTMENT OF GEOPHYSICS, STANFORD UNIVERSITY, PALO ALTO, CA

My name is Mark Zoback, I am a Professor of Geophysics at Stanford University and a member of the Secretary of Energy's Advisory Board Shale Gas Subcommittee. For your general information, I am also serving on a National Academy of Engineering committee that has been investigating the Deepwater Horizon accident. My field of expertise is in quantifying the forces in the earth that control earthquakes, hydraulic fracture propagation and other geologic processes. I started doing research on hydraulic fracturing over 30 years ago and my PhD students and I have been carrying out a number of collaborative research projects, mostly with private industry, to better understand how to optimize production from shale gas reservoirs.

As you have had the opportunity to read our 90-day report and you've already heard from Professor Holditch, there are only a few additional points I'd like to make. In fact, I will limit my comments to issues related to three topics—avoiding gas leakage from wells and potential contamination of shallow aquifers, minimizing the use of fresh water during hydraulic fracturing, and the handling of the contaminated water that flows-back out of shale gas wells after hydraulic fracturing.

Let me say at the outset that like the other members of our subcommittee, I believe that utilization of domestic shale gas and, as Dr. Holditch mentioned, domestic shale oil, resources are extremely important to our nation. I personally believe that there is no question that they can be developed in a manner (utilizing horizontal drilling and multi-stage hydraulic fracturing) that protects the environment and

minimizes impact on nearby communities. Moreover, because of the abundance of gas and oil resources found in organic-rich shales globally, the standards and procedures we use to develop these resources in an environmentally responsible way in the United States could have far-reaching affects.

Preventing Gas Leakage and Water Contamination

As everyone knows, there have been a number of accidents during shale gas development operations. These accidents have caused damage to water supplies and understandably have raised concerns among the public about whether shale gas can be developed safely. It is unfortunate, however, that the concern about the safety of shale gas development has focused almost entirely on hydraulic fracturing. As Dr. Holditch testified, the chemicals used in hydraulic fracturing fluids are relatively benign, steps are being taken to make them even safer, and our committee recommends full disclosure of the composition of hydraulic fracturing fluids. What is important to emphasize is that the most important step that can be taken to prevent gas leakage and protect subsurface aquifers, now and in the future, is good well construction. A well that is improperly cased and cemented has the potential to leak gas whether it is hydraulically fractured or not. It is critical for state and Federal regulators to work closely with private industry to design and construct optimally secure wells, with multiple barriers of casing and cement to prevent gas leakage and to protect water supplies over the potential 20–30 year lifetime of these wells. This is one area where groups such as STRONGER (the State Review of Oil and Natural Gas Environmental Regulation) might be particularly helpful.

Conservation of Water Resources

The second point I want to make concerns conservation of water resources, as millions of gallons of fresh water are utilized during multi-stage hydraulic fracturing in every shale gas well that is drilled. It is possible that significant advances can be made to conserve of water resources by carrying out fewer hydraulic fractures in a given well and by pumping smaller volumes.

As Dr. Holditch pointed-out, in most parts of the country industry has moved to drilling multiple wells from a single pad. As he said, pad drilling not only greatly improves the efficiency of drilling and fracturing operations, it minimizes land-use, lowers the overall impact of drilling operations on local communities and makes regional planning easier to lessen the cumulative impact of shale gas development activities in a given area. In some cases pad drilling creates the opportunity for temporary pipelines to be used to provide water (instead of trucking it in) and in one case that I know about in Canada, water wells were drilled into a deep saline aquifer to provide a drilling pad with enough low quality water, unfit for domestic consumption or irrigation, to carry out 150 hydraulic fracturing operations.

Dealing with Flow-Back Water

The third point I want to make concerns the water that flows back after hydraulic fracturing. While the amount of flow-back water after fracturing varies from region to region, 25–50 percent of injected water flows back in some areas and can be contaminated with brine, metals and potentially dangerous chemicals picked up from the shale. As Dr. Holditch mentioned, our committee has recommended that the volume, composition and disposition of these waters be carefully monitored and disclosed via a publicly available website. Our committee also noted that the re-cycling of flow-back water for use in subsequent hydraulic fracturing operations, is becoming increasingly more common in the northeast, is a welcome development. Re-use of flow-back water avoids a number of potential problems associated with transport and injection or the expense and difficulty of extensive water treatment operations. This too is an area where research and development could be particularly valuable.

As we said in the Conclusion of our sub-committee's 90–day report: The public deserves assurance that the full economic, environmental and energy security benefits of shale gas development will be realized without sacrificing public health, environmental protection and safety. Mr. Chairman, thank you for the opportunity to your committee today. I personally believe we are on our way to identifying the kinds of actions needed to provide this assurance.

The CHAIRMAN. Thank you very much.

Kathleen McGinty, we're glad to have you here. Go right ahead.

STATEMENT OF KATHLEEN A. McGINTY, SENIOR VICE PRESIDENT AND MANAGING DIRECTOR, STRATEGIC GROWTH, WESTON SOLUTIONS, INC., WEST CHESTER, PA

Ms. MCGINTY. Thank you very much, Mr. Chairman and members of the committee.

It's a pleasure to join you and my fellow task force members as well.

As its been said, shale gas is a game changer economically in terms of the promise of air quality benefits in the production of energy, especially electricity and also, I think in a positive way in terms of geopolitics, around energy.

Shale gas, though, is an industrial activity and so there are impacts. Our conclusions were that those impacts could be managed. To say they could be is not to say they are managed. It's to say that this is not a once-and-done. But with all stakeholders vigilant and participating through a process that would emphasize measurement, disclosure, inclusion and continuous improvement that we can see the production and the benefits of this resource to our environment and economy without the attendant negative consequences that have been of concern.

So for example on water, as has been referenced, our conclusion was that contrary to common perception, frack fluids per se are very unlikely to contaminate drinking water. However, the methane being unleashed from the shale formation can migrate into those drinking water resources. So 2 things that we talk about in the report important to that. One, upfront characterization of the geology; in my home State of Pennsylvania, critically important. Why? Because shale operations are unfolding where we have had historic well development long before any standards were in place, and so the methane can find those old pathways and travel through them.

The second thing important is what Dr. Zoback referred to in terms of proper well casing and cementing. Put those measures together and the chance of methane contaminating drinking water dramatically reduces.

Air quality, there too, a potential significant benefit as natural gas powers and provides electricity. However Senator Barrasso, even in places, rural places we've wound up with L.A.-style smog resulting from some of the intensity of these operations. Now is that not manageable? It is manageable. In States like Wyoming and Colorado have really stepped up and, in fact, have already dramatically taken on this challenge through 2 or 3 important measures.

So with respect to conventional air pollutants, significant progress in fuel switching in terms of engines, in terms of trucking, in terms of efforts that can clean up the power sources used at the well-sites. Filters being deployed on equipment to reduce particulate matter that otherwise becomes part of a pollution challenge.

A significant movement toward something that's being referred as green completions. Now, this can be challenging from an infrastructure point of view because what's required is to have the gathering and some of the midstream pipeline infrastructure in place at the time of well completion. Important to air quality because the methane pollution that's of concern seems to happen mostly just at

that time of well completion. So if that methane, instead of being vented or flared can be captured and put to productive use, one, there's an economic upside to capturing that resource. Two, it very significantly takes on the methane problem otherwise of concern.

Third, we looked at community impacts, quality of life and the—the cumulative impact of significant industrial activity where it was not common practice. Here too, efforts can improve the situation, especially through several initiatives. One is better sharing of information. The variety of States already do collect almost on a well by well basis significant information about how much water is being used at that well, what the production profile has been at that well. States are moving now to also note whether there have been violations of environmental regulations associated with that well.

What we found, though, is the data bases don't talk to each other very well. They can be intimidating or difficult for a community to access. So investment in those data bases to answer the public's questions about the performance of those wells, very important.

Last I'll just highlight, again, in bolstering the public's confidence baseline data to see, what was the condition of air quality and water quality before shale activities started? Sometimes that's an eye opener in terms of historic challenges that are there before shale operations.

Finally, finally what we have seen is when the process is open and neighbors get to participate in the permitting and in the welcoming of these operations, a lot of the issues with respect to quality of life can be handled straight on, and enable the industry to grow in a way that is fully welcomed by the community.

Thank you, Mr. Chairman and members of the committee.

[The prepared statement of Ms. McGinty follows:]

PREPARED STATEMENT OF KATHLEEN A. MCGINTY, SENIOR VICE PRESIDENT AND MANAGING DIRECTOR, STRATEGIC GROWTH, WESTON SOLUTIONS, INC. WEST CHESTER, PA

Mr. Chairman and Members of the committee: My name is Kathleen McGinty. I am Senior Vice President of Weston Solutions, Inc. an environmental company focused on and investing in sustainable property redevelopment, clean energy and clean water. Previously I was Secretary of Environmental Protection for the Commonwealth of Pennsylvania and Chair of the White House Council on Environmental Quality. It is an honor to appear before you today and to join my colleagues who served with me on the Secretary of Energy's task force on shale gas.

The task force is gratified by the largely positive response to our work. There are some corrections and some amplifications that are in order as we take our interim report to final, but many commentators have emphasized the need for implementation and their own intention to move forward. In this testimony I am pleased to share with you the key issues we identified and the best practices we recognized as effective in addressing those issues.

THE RESOURCE AND THE INDUSTRY

Mr. Chairman, let me begin by underscoring the point made by my colleagues in their prepared testimony: shale gas resources are abundant in the United States. Shale gas has already generated significant economic opportunity, substantially changed the equation with respect to energy security, and has begun to reshape electricity markets in a way that offers air quality benefits. This point with respect to the robustness of the resource, while perhaps evident, bears stating. Even until quite recently questions were presented as to whether shale wells might produce in a robust manner initially, but then decline rapidly, or alternatively, if they would have staying power. Experience to date in the field shows a very strong pattern of production.

As my colleagues have also noted, with the production of this resource comes environmental and quality of life issues that are real and demanding of attention. Simply put, shale gas production is an industrial activity. As such, it will have impacts that need to be managed with seriousness of purpose and enduring commitment.

In our report, we offer a framework to guide efforts to minimize adverse effects: practices and impacts should be Measured and Disclosed, and performance must be Continuously Improved.

WATER

The quantity of water consumed in shale operations is modest compared with other water uses and is typically a small fraction of total water consumed in a given area. Still, shale operations consume water in quantities significantly greater than conventional gas operations (an order of magnitude greater), and the continued growth of the industry means that its demand for water will similarly continue to grow. A conservation-oriented approach toward water then is appropriate and important.

Our task force found that the recycling of produced and flowback water is an increasingly common practice in the shale industry and a positive step in managing water needs. Getting to the next level of treatment and eventual discharge of fluids (meeting discharge standards) is harder. Many companies are active in the space and much innovation is occurring around the development of mobile treatment platforms. Yet, the economics are difficult, particularly in areas where water resources are abundant and/or where there is the option of disposing used water in underground injection wells. It seems that some financial, regulatory and/or resource availability driver will be needed to support adoption of this next level of water treatment and conservation.

Water quality—in addition to water quantity—concerns apply to shale operations. Much has been said about the composition of fracturing fluids in this regard and our task force called for full, with modest exception for truly proprietary information.

Much attention has also been trained on the fear that fracturing can and has contaminated drinking water. Here, our conclusions diverge from common perception. We found that shoddy shale operations can adversely impact water quality in at least two key ways I will discuss here. Yet, fracturing per se seems not to be the culprit.

Instead, the two leading areas of concern are: well development, and surface handling of water.

My colleague Dr. Zoback has spoken to the need for robust practice in well casing and cementing in order to prevent methane migration from the gas formation to ground water. T his is "job one" and perhaps "first among equals" of the measures that can ensure water-safe operations.

Other best practices related to this should be highlighted as well. In our report we spoke about the need for rigorous geologic and hydrologic characterization in advance of and during well drilling. The goal here is to discover potential communication pathways and vulnerable water resources. In my home state of Pennsylvania, these practices have been found to be particularly important since shale activity is unfolding in areas that historically have seen extensive mineral extraction activity, with wells and mines developed before modern standards were in place and abandoned without proper closing and capping. Moreover, alluvial and other "tricky" formations have been encountered that could enable migration. Indeed, long before shale operations commenced, methane detection and management has been a significant concern in many communities across the commonwealth as homes and businesses have dealt with sometimes explosive levels of methane, fugitive from these historic operations. Advanced characterization of the soil, rock and water as well as techniques such as microseizmic testing, the use of cement bond logs, and the onsite presence of individuals with expertise in "reading muds" (and knowing if problem areas are being encountered) are best practices in ensuring against the escape of methane and other contaminants.

As noted, our task force found that surface operations are as important as practices "down hole" in preventing water contamination. We had the opportunity to visit well operations that are demonstrative of the state-of-the-art. It is evident that conventional measures designed to protect against erosion and sedimentation (silt fences and the like) are not sufficient at well sites. Instead, at sites we visited, special mats are being deployed to cover the well pad area; double berms are being built; and catchment areas are being put in place to trap fluids and muds, fuels and spills so they do not run off.

These measures and one other are important in protecting surface resources and in bolstering the public's confidence: disclosure of produced water composition and

tracking of and disclosure of the disposition of produced and flowback water. Our task force's recommendations in this regard build on the movement in industry and by regulators to disclose fracturing fluids. We think that knowing what is coming out of the well (in addition to what is going in) is important, so we call for disclosure of what is produced. We also think that knowing where the fluids go during their life cycle is important. So, we identify the tracking and manifesting of shale fluids as a best practice.

AIR

Air quality is an issue growing in importance in shale operations. Wyoming and Colorado have moved forward with significant requirements to stem polluting practices, and U.S. EPA has proposed new regulations as well.

Here's what we found: two types of pollution challenges present with respect to shale operations. Conventional pollutants like volatile organics and oxides of nitrogen combine to cause ozone problems in some areas. A second problem relates to the greenhouse gas impact from the methane, itself.

On the first, initiatives are underway by some in industry and by regulators to clean up emissions from generating equipment, compressor stations, and the like, even as filtering equipment is recommended to capture particulates, and some are switching from diesel to gas to power operations and potentially to run vehicles.

The greenhouse gas impact of methane is a different story. Methane is a potent greenhouse gas, with a global warming potential that is some 21 times that of carbon dioxide. The methane/greenhouse gas problem largely occurs at the time of well completion and is caused by the venting of those first pulses of methane produced by the fractured formation, before the well is either shut in or fully operational (and tied to the mid- and downstream- transmission network). (Fugitive methane from processing and transportation infrastructure can add to this greenhouse gas pollution impact).

Some operators flare this gas. This is a better approach than venting from a greenhouse gas perspective (since the methane is then converted to carbon dioxide). However, pollution is still a concern with combustion, and neighbors often do not like the sight of the flares. Moreover, there is economic loss of the gas, itself with flaring.

"Green completions" incorporate measures into the well completion process that address this problem. Specifically, in green completions, gas and hydrocarbon liquids are physically separated from other fluids and delivered directly into equipment that holds or transports the hydrocarbons for productive use. There is no venting or flaring. This practice then links upstream activities with mid- and dowstream- efforts, a practice that works well in some areas but will require acceleration of effort in other areas to permit and build the needed gathering and distribution infrastructure. Several states and EPA are calling for green completions in their regulations.

A final piece to the air issue that we dealt with in our report relates to the life cycle carbon footprint of methane. Relatively little analysis has been done to date and the studies that are out there differ significantly in their conclusions. The questions center on how much methane becomes fugitive from shale operations and the associated downstream equipment, as well as how to understand the methane impact when it is used in power plants and other equipment that might be more efficient than equipment burning other fuel sources. Some studies take this end use into account and come up with a positive assessment of methane's greenhouse gas performance, others do not and reach a different conclusion. We therefore call for an effort to collect data in a robust and systematic way and then to report out results after rigorous peer review. The task force is encouraged to see that some Industry and environmental groups are already at work looking at how best to build an effort of this nature.

COMMUNITIES, QUALITY OF LIFE AND CUMULATIVE IMPACT

The task force heard testimony from individuals who were grateful for the employment opportunity shale development had offered them, particularly in the economic downturn the country has suffered. Others had strongly negative or mixed views. Concerns often centered around quality of life in towns that had not been the scene of intensive industrial activity prior to shale production. Truck traffic, noise, and the pollution issues addressed above were among the most common complaints. Concern was also heard from neighbors and from conservation groups that habitat was being fragmented with adverse impact on wildlife, or sensitive streams were threatened.

Our task force felt that it is extremely important to address these concerns. We recommended four kinds of approaches that are needed to deal respectfully and ef-

fectively with concerns that are legitimate and heartfelt and to bolster the public's confidence that the industry is conducting itself responsibly.

First, information disclosure and effective sharing of information: here, the task force recognized that there already are repositories of data that speak to the industry's performance. Some of those data bases (for example, some of the information collected by states), are hard to access or complex in their presentation of data. We recommend investment in efforts that systematize and simplify the availability of this information.

Meanwhile, we found that the initiative "FracFocus" (www.fracfocus.org) is very effective in the collection and presentation of fracturing fluid data—painstakingly reported on a well by well basis. FracFocus has come together in a remarkable way and in short order. However, we felt the focus of FracFocus is too narrow and we called for a broader array of chemicals to be disclosed on this website (all chemicals, not just chemicals of concern to OSHA). At the same time, we heard testimony from the Groundwater Protection Council and its associated organizations who have built FracFocus that they would like to expand their reach to air emissions and other issues of concern. The task force was encouraged by and supportive of this direction and would encourage public funding for the effort.

Second, baseline data: to understand the relative contribution shale activities are making to pollution challenges, it is important to understand what air and water quality was in a given area before shale production commenced. In some jurisdictions the collection of this data is becoming the norm (e.g. in Pennsylvania since the data can be used in defense against a pollution charge), in addition, some industry groups are organizing to collect and disseminate this information. Care can and should be taken to protect the privacy of individual homeowners (by releasing data in an aggregated fashion, for example). But knowing whether methane in drinking water was pre-existing or caused by a shale operation is critical to assessing the real impact of this industry and again, to winning the public's confidence in the industry. The task force therefore called for the regular collection and communication of baseline information.

Third, mechanisms to define and demonstrate continuous improvement by the industry: STRONGER (State Review of Oil and Natural Gas Environmental Regulations (www.strongerinc.org)) is an effective organization whose reach the task force felt should be expanded. This coming together of state regulators, industry and nongovernmental groups in a joint peer review of the adequacy of various state oil and gas regulatory programs is an encouraging demonstration of the ability of varied stakeholders to find common ground. Moreover it seems that the states who have their programs reviewed by STR0NGER take the critiques seriously and implement suggested changes.

STRONGER operates on a very modest budget, however, and is only able to do a limited number of reviews at any given time. So the task force recommends increased funding for STRONGER to grow its capabilities.

At the same time, we thought a new effort by industry, joining together with nongovernmental organizations and experts in government and academia, aimed at defining best practices, tailoring them to the different conditions in different regions of the country, and providing metrics through which progress can be measured would be an important new initiative. There is much to build on here, including the work of the American Petroleum Institute in identifying best practices. Making this work more broadly inclusive of stakeholders and experts, making it specifically relevant to the diversity of shale formations, and making it measurable as to outcome would do much to ensure progress and bolster confidence.

And fourth, providing the mechanism for public engagement: the task force encourages jurisdictions to create the space for neighbors to have meaningful voice in the process of having the shale industry become present in their community. Different approaches might prove effective here. Upfront engagement and/or in the permitting process might help establish where shale development will be welcomed and where it will be discouraged. Discussion of issues like how to manage truck traffic to enhance safety (e.g. by avoiding school bus routes) and/or to minimize nuisance, might help avoid quality of life concerns. Scientific efforts to define sensitive ecosystems and water bodies can be helpful in gaining agreement among stakeholders to protect fragile resources.

The issues are many and varied and the mechanisms for engagement can be equally diverse. However, the task force calls for efforts to enable people and companies to talk and have their respective viewpoints heard, understood, and dealt with in meaningful way.

CONCLUSION

Shale gas is a game changer in energy with significant promise economically, in terms of national security, and in improving environmental quality. Real issues attend this industrial activity however. The task force believes these issues can be managed if there is measurement, disclosure, and deep commitment to continuous improvement. We are gratified by the largely positive response to our report and encouraged especially that individuals and organizations are moving forward to identify and implement best practices that ensure the responsible conduct of shale operations across the country.

The CHAIRMAN. Thank you and thank you all for your excellent testimony.

Let me start with 5 minutes of questions, and then we'll have a round of 5 minute questions from the committee here.

This focus on sound well-casing and cementing that, I think, several of you referred to, Dr. Zoback, I think you had a main point on that. I assume that this is not a question of having to do more research as to how you properly case and cement a well. People know how to do that. The question is: how can you be sure that each time a well is drilled, it is properly cased and cemented? I would assume that that involves training of drilling operators. Did you folks look at that issue and make any recommendations or conclusions about what more is needed to be done in that regard?

Mr. ZOBACK. Senator, you're exactly right. This is the—the proper way to drill, case and cement a well is something industry knows very well. Whether it's carried out as well as it should be in each and every case is—is—is a—is an open question.

One of the things our committee called for was the—the proper exchange of information and making sure that both industry and State regulators were carrying out these operations in the best possible way. So that when there are geologic surprises in a given area that would require a—a casing program to be locally adapted, that information isn't just known to one—one operator who's encountered it. But that information is immediate—immediately made known to everyone and the reg—it's something the regulators look for.

Training of the regulators is—is another important issue and how to work with the—the—the companies to make sure that, for example, when the casing and—and the cement have been, you know, installed they are, in fact, functioning as—as they are designed to function. The types of pressure tests and other tests that are done is—is something that takes some degree of training to—to interpret and—and to acknowledge whether or not, in fact, the well is ready to go.

So, these are all areas where we thought this—this process of—of exchanging information, developing standards and communication between different States and between the companies and the regulators in a given place would have—would have a lot of impact.

Mr. CHAIRMAN. Let me ask about work the EPA is doing. They recently issued draft rules to control air emissions from oil and gas production, and transmission and storage. Do these rules go far enough in addressing the concerns you talk about in your report or are they not relevant to that? What's your view on that?

Ms. MCGINTY. Senator, they are very relevant to one aspect of the air quality issues. Actually, both those issues with respect to air quality that we've touched on, both in terms of the ozone-re-

lated air quality issues as well as the methane-related air quality issues. The way they go about addressing those challenges is to begin to layout a sense of performance measures with respect to the equipment that is used at well-sites. They also point to this idea or this requirement of green completions to capture that methane pulse that otherwise is vented at the time that the well is completed.

I think that the measures seem to be the right measures, the kind of measures that can and would meaningfully reduce pollution. The—if there's concern about those measures it's the—the permitting aspects that might be associated with—with the implementation of those measures. So I think that's still being worked through.

The CHAIRMAN. Let me also ask about this. My understanding is EPA is doing its own study on the whole issue of hydraulic fracturing and it's not expected to be out until the spring or summer of 2014. How does this—how does what you folks are doing here in this current study that you've just talked to us about, how does that relate to what they're doing, or is there interaction there? Were they involved in any of your—your conclusions?

Mr. YERGIN. Let me say, certainly we met with EPA. They came and to the hearings that we held. We held discussions with them to understand what their objectives are. I think Professor Holditch, aren't you involved in the EPA study——

Mr. HOLDITCH. No.

Mr. YERGIN [continuing]. Too? But we were aware that it's 2014 is a long time horizon for it.

The CHAIRMAN. Dr. Holditch, did you want to make a comment? Go ahead.

Mr. HOLDITCH. Yes, sir. They—the—what they decided to do was to take 5 or 6 case histories where there had been reported issues with groundwater contamination, and they were going to study those in great detail and try to find out exactly what happened. They just concluded it was going to take them several years to dig into the problems in enough depth to come up with a solution. So they're just looking at some case histories.

The CHAIRMAN. But—but they're looking at those case histories in order to come up with some general recommendations, or rules, or regulations that would apply. Is that right or not?

Mr. HOLDITCH. I'm not sure what their ultimate goal is. They—they're just trying to find—we have some contaminated freshwater aquifers. They're trying to determine how it was contaminated and if it is linked to any shale gas drilling. It could be more than likely a bunch of old wells that were drilled 20, 30, 40 years ago could be the issue more than the new wells, or it could be things such as abandoned mines. So they're just trying to find out what happened and then I guess based on the basis of that will determine what to do next.

The CHAIRMAN. Alright. Senator Murkowski.

Senator MURKOWSKI. Thank you, Mr. Chairman.

Just to follow up on that. I'm also told that in addition to the EPA fracking study, that BLM is preparing their fracking regs. Has there been any coordination with BLM in terms of where they're going, any sharing of the data or information? Dr. Zoback.

Mr. ZOBACK. Yes, we—we've also met with BLM and we discussed with them, in fact, most closely the way in which their inspectors interact with the oil and gas operators on Federal lands. So, we've been in communication with them and we're aware of what they're doing and they're certainly aware of—of our subcommittee's activities.

Senator MURKOWSKI. I recognize that we're all looking at where the Federal dollars are coming from to do all of these assessments. It would certainly seem to make sense that there be some level coordination, or at least sharing of the information there between EPA, you and the BLM.

Let me ask about gap analysis here with what the States are doing in terms of regulation and the feds. In the report you, as a subcommittee, indicate that you're not going to weigh-in on whether or not the States or the Federal Government should have the lead in regulating natural gas development.

But just from a practical perspective, wouldn't it make sense to determine first whether or not the States are doing an adequate job in terms of the regulation? Or whether the State-Federal mix is working? Do we need to basically do some kind of a gap analysis here to determine whether the regulations are effective before we make recommendations to change any of the regs? This goes out to the whole panel here cause I think this is——

Mr. HOLDITCH. OK.

Senator MURKOWSKI [continuing]. What we want to know here.

Mr. HOLDITCH. Let—let me just say one short thing about it and then some of the other panelists. You know, I've lived my—worked my whole career in—in the State of Texas. The Texas Railroad Commission does an extremely well job of—of regulating the oil and gas industry. They had—you cannot drill a well and set surface casing without informing the Railroad Commission. You can't pump a cement job without informing the Commission. They do a very good job of regulating.

We also had other regulators from Arkansas, and Colorado, and Oklahoma and other States testify in front of us, the—the—the historic oil producing States. They all indicated that they think they're doing a—a very good job too.

So there might be some States with less history in the oil and gas industry who might need to, you know, step up their regulations on oil and gas drilling and completions and permitting. But—but the consensus that I—I—I observed from these public meetings we had were that—that the—the oil States where a lot of this work is going on seems to feel like they're doing an adequate job of regulating and—and I see no reason to challenge that.

Mr. YERGIN. Senator Murkowski.

Senator MURKOWSKI. Thank you.

Mr. YERGIN. If I could add to that. To use your phrase "gap," I think there's a gap in perceptions because I think there's this view that oil and gas activities are not regulated. But, in fact, what I was—we were all, I think, very impressed by the quality and the focus and the experience, the long experience of the States in terms of regulating oil and gas. Even ultimately that responsibility would devolve back to them as well.

So I think Katie McGinty can certainly address Pennsylvania, but I think that there's a very strong tradition—tradition and that's—and that's really the backbone of it. I think it's not as well-recognized, in fact, in some—some circles. So I think there is a—a very strong fabric there.

Senator MURKOWSKI. I appreciate that distinction and I'd ask you, Ms. McGinty, because Pennsylvania has taken some pretty aggressive steps, in a short period of time whether it's strengthening its water withdrawal regs, strengthening its drilling standards, the buffer between operations and streams, or increasing the fees. Pennsylvania——

Ms. MCGINTY. Right.

Senator MURKOWSKI [continuing]. Clearly has stepped it up, if you will. Was there discussion amongst the subcommittee in terms of what, for instance, States like Pennsylvania have done to address the concerns as to whether or not as a State you're adequately covering all the regulation that's necessary?

Ms. MCGINTY. Yes, Senator, you know, I think your original question is a good one. At some point, someone should delve into in more detail than we did who's the optimal actor to do this job or that job?

We came away with a sense that, one, there was much effort underway. Two, that additional steps needed to be taken. Three, some of the people of responsible parties were, indeed, taking them.

So even as we gather here today just yesterday, the Governor of Pennsylvania announced additional protections, further setbacks and buffers that will be required around private drinking wells, public water resources, and rivers and streams.

In our report, we also point to areas where in terms of your phrase, a gap, where we think there is a gap where more work is needed. So in disclosure, we've made a lot of progress now along the fracturing fluids themselves. Texas has passed a law; many States have passed a law. It's becoming common practice that all of those chemicals will be disclosed.

But we said it should go further and what comes out of the well and the produce of flow back water, the contents of that should be disclosed as well and there are other examples in the report. So the gap we saw was the gap of the need for continuous improvement where it exists. Where do we need to bolster our efforts? As compared to this particular regulator or that particular regulator needs to do more than that entity is doing today.

Senator MURKOWSKI. Thank you. Mr. Chairman.

The CHAIRMAN. Senator Wyden.

Senator WYDEN. Thank you, Mr. Chairman.

I want to thank all of you for your professionalism and it's been very helpful.

Let me begin, if I might, with—with you, Dr. Yergin. I have been reading more about the practice of flaring, the burning off of natural gas that is uncovered during oil production. Did your committee look at this issue, and in your view is this an issue that policymakers ought to be digging into now?

Mr. YERGIN. I think should really turn that question to Professor Holditch who is the one who's the most deeply experienced with that.

Senator WYDEN. Professor.

Mr. HOLDITCH. Flaring is—is regulated. If you drill a new oil well and you don't have a pipeline in there for the natural gas, you can flare the well under permit for just a short time. Then if you don't get a pipeline in, you have to shut the well in.

We did talk about flaring in our subcommittee, and the consensus was it would be—we don't want to flare gas. We want to—only—only when necessary. It's better to—to capture the gas and sell the gas. But—but flaring is actually preferred over just venting the gas. So—so it is an issue that is regulated by the States and—and it's usually a win for everybody. If you can sell the gas you'll—you get more revenue and you do less harm to the environment. So flaring is something that needs to be watched.

Senator WYDEN. Let me—let me turn to you, Dr. Yergin on a—on a policy matter sort of for the future, and you and I have—have touched on it. So there is this host of issues, you know, fracking, the issue of water, the impact on communities. There are a variety of issues. You have talked, I think, very eloquently about this sort of patchwork of rules and—and regulations, State approaches, Federal approaches, a variety of—of different regulatory approaches.

My sense is that the Federal Government, because the Federal Government owns oil shale lands and gas shale lands, would be a very good place to try to bring together all of the stakeholders, industry folks, scientists, environmental people and try to come up with the kind of comprehensive approach that could give us new information about best practices. To really look at the various practices that are now underway by industry and, in effect, use those, you know, Federal lands as a kind of laboratory to come up with the best practices.

I've talked to Secretary Salazar about this. I think they're interested in it. But I'd be interested in—in your thoughts about, you know, the Federal Government making a significant contribution in this area by looking at these Federal lands as a place to develop the kind of best practices and—and protocols frankly that, I think, you all touch on in the report.

Mr. YERGIN. Best practices is a theme that runs throughout the report and it's also recognition that best practices aren't static, they—they evolve over time. So I think, as you say, Federal lands and Government's ownership of them is one arena for that.

One of the strong recommendations that we also made is kind of a regional approach to addressing best practices, not only on Federal lands, but in different regions that the issues in Pennsylvania will be different than the issues in Texas. So I think as a focus for the—for going forward with this endeavor that that's a very good one around which to—to build it.

Senator WYDEN. Would any of the other panel members like to touch on this? Ms. McGinty?

Ms. MCGINTY. Sure. Thank you, Senator. I think it's a—a great idea and I do think that BLM in our conversations with them has an eye on trying to do just that to move the industry forward and to enable production, but to help discover what these best techniques are.

I do think the one footnote in caution is the one that Dan was just point to, which is the geologic differences make——

Senator WYDEN. Right.

Ms. MCGINTY.—A world difference in terms of the kind of measures that are needed to ensure water safe and air safe, if you will, production efforts.

Senator WYDEN. I think that's a point well taken. I was struck by Senator Murkowski's, you know, point with respect to information sharing and the question of the agencies in a lot of these instances not sharing, you know, information. It would seem to me that if you looked at Federal lands particularly in the kind of context that Dr. Yergin and you, Ms. McGinty, have mentioned that we would try it in a variety of different, you know, regions. We could pick up on the useful idea Senator Murkowski's talking about which is sharing information.

Ms. MCGINTY. Um-hmm.

Senator WYDEN. Look at best practices, get all the Federal agencies really singing from the same, you know, hymnal and walk away after a period of time with some ideas that could be recognized, in effect, as the gold standard and widely supported by a variety of stakeholders. So I'm going to probably be contacting some of you about this—in the future. But I thank you for your good work and my time has expired, Mr. Chairman.

The CHAIRMAN. Senator Barrasso.

Senator BARRASSO. Thank you Mr. Chairman and thanks for the opportunity to emphasize the importance that American natural gas plays in America's economy.

The development of our natural gas can go a long way toward getting America back to work. It's going to create lots of jobs in many of our local communities and it will generate much needed revenues, as we heard today for State and local governments as well as for the Federal Government. It will also enhance America's national security. Increasing the development of American natural gas is a win-win proposition. It should be embraced by all of us. The Shale Gas Production Subcommittee recognizes this in its report, and I commend you for doing so.

Of course, the focus of the report is not the promise of American natural gas. The focus is the environmental impacts associated with developing and using this resource-specifically recommendations to reduce those impacts. To this end, the report could have I think, done much more to underscore the success that States have had in regulating oil and gas development. Take, for example, the issue of disclosing fracking fluid composition.

The report recommends that regulatory entities should immediately develop rules to require disclosure of all chemicals used in hydraulic fracking fluids on both public and private lands. The State of Wyoming has done that on both public lands and with our private lands. Wyoming implemented the disclosure regulation over a year ago. Not only that, Wyoming has made this disclosure part of the approval process on applications for permits to drill and nearly all of this information is available to the public. The report, however, makes only a passing reference to State regulations in this area.

My point is simple. States have vast experience regulating oil and gas development. They're best situated to regulate this sector of our economy and Washington should continue, I believe, to allow

States to regulate oil and gas development without creating additional levels of bureaucracy.

Dr. Yergin, it's always a privilege to have you before the committee. I have enjoyed the visits that we have had. As one of the foremost experts on the history of oil and gas development, can you give the committee maybe a better understanding of the central vote that States have played in regulating oil and gas development?

Mr. YERGIN. That—that goes back to Senator Murkowski's comments as well. I think that one of the really strong things that came through is the—is this the depth, the seriousness and the historical experience that States bring to this. As the discussion was continuing, I was also thinking if one chooses community engagement, States are much closer to the communities than the Federal Government.

So and that's why one of the recommendations we made was for the supporting of the—of the collaboration and exchange of knowledge and information among the States. But I certainly come out of this, the night—the—the time that we spent on this very impressed by the—by the extent and the seriousness—and the seriousness of the States. As I said before, I think there's a tendency to assume that this isn't going on but it's been going on for decades. As you said, the States are—are—are at the leader and—and—and bring that long experience to it.

Senator BARRASSO. So then, if Washington steps in, begins to regulate areas historically regulated by the States, is there a danger of creating excessive regulations and discouraging the development of the resources?

Mr. YERGIN. Certainly you can end up having a kind of superstructure on top of a superstructure that would make investment more difficult, that would greatly take much longer time to get things done, and also sort of get further away from the communities.

Senator BARRASSO. Professor Holditch, in your written testimony,you said you have been working in hydraulic fracturing for 40-plus years and there is absolutely no evidence hydraulic fractures can grow from miles below the surface to the fresh water aquifers. That is a very strong statement.

Professor Zoback, in your written testimony you said," It is unfortunate..., that the concern about the safety of shale gas development has focused almost entirely on hydraulic fracturing." Would either of you like to elaborate a bit on those comments?

Mr. HOLDITCH. I—I—I've been working in this area. I've been—I've built hydraulic fracture mathematical models. I've—I've analyzed hundreds of wells. I've been out in the field and these fractures grow hundreds of feet up or down. They don't grow thousands of feet up or down. As soon as you quit pumping and the pressure's relieved, the fractures close so it's just virtually impossible for—for that to happen.

Now once you start flowing the well back and you come up the casing, there could be issues, perhaps, but not during the hydraulic fracturing process as far as I know based on my 40–plus years of working in the area.

Mr. ZOBACK. I guess my comment would be that when you—when you look at the reported cases in—of environmental impact associated with shale gas development and they fall largely into 3 categories. One is leakage along well casings and the hydrocarbons come up and can contaminate the surface aquifers, or they can come all the way to the surface sometimes and cause problems.

The second problem has been leakage and spills, containment areas, reservoirs where flow back water and other—other dangerous substances are contained, have been—have reached uncontaminated water supplies.

There have been blowouts during the drilling of these shale gas wells, nothing catastrophic, but still serious incidents. All of these things are things we have to work to prevent and to minimize and none of these things have anything to do with hydraulic fracturing.

So hydraulic fracturing has sort of become a—a bumper sticker for everything that we need to watch out for and that's the problem. It—there—there are, you know, significant environmental impacts associated with shale gas development and we must minimize those impacts as we move forward. But simply the constant reference to hydraulic fracturing misrepresents what those impacts are and where the attention needs to be paid.

Senator BARRASSO. Thank you for the clarification. Thank you, Mr. Chairman.

The CHAIRMAN. Thank you.

Senator FRANKEN.

Senator FRANKEN. Thank you, Mr. Chairman.

Thank you for this—for this hearing and I'd like to thank all—all of those testifying for your testimony and for your work.

Dr. Yergin, you—you mentioned 2 main recommendations, funding regulatory entities like STRONGER is one, and Government funding of R and D, is that right?

Mr. YERGIN. Right.

Senator FRANKEN. OK. You said that the—the payoff for these reg—these—this funding would be hundredsfold in your testimony, right?

Mr. YERGIN. Right.

Senator FRANKEN. OK. So this is Government funding?

Mr YERGIN. Yes.

Senator FRANKEN. That's right? OK. We don't have natural gas—we don't have fracking in—in Minnesota. We do have a medical device industry which has user fees and pays for its regulation. I was wondering why this has to be Government funding. I mean, we're all concerned about money here. Are—are the oil and gas companies, are—are they doing OK?

[Laughter.]

Senator FRANKEN. Do they need—do they need help?

Mr. YERGIN. This isn't for the oil and gas companies. The—what we're addressing is 2 things. One is going back to the topic that has come up which is the States and facilitating a collaboration among the States so that they can share best practices and knowledge among them, and that's what STRONGER is about. That's what groundwater's about. So, I mean, this is talking, you know, cut—a few million dollars. These are not big sums, but it's to keep these——

Senator FRANKEN. But you want that to be Government, paid by the Government.

Mr. YERGIN. No, we recommended——

Senator FRANKEN. As opposed to——

Mr. YERGIN [continuing]. We reckon—it has been paid by the Government and recommend that it should be. That it's——

Senator FRANKEN. Should be paid by the Government.

Mr. YERGIN [continuing]. It's a Government activity. You know, as you know, there's——

Senator FRANKEN. Does it help facilitate the oil and gas recovery from the earth—from the earth?

Mr. YERGIN. What it does is it facilitates the regulatory process that—that we've been discussing this morning.

Senator FRANKEN. Right, and does that regulatory process help facilitate the extraction of oil and gas?

Mr. YERGIN. Yes, and it——

Senator FRANKEN. OK, so in other words this—this money that you want the Government to pay to help facilitate the extraction of oil and gas should be paid by the Government and not the oil and gas companies. That's your—that's your view.

Mr. YERGIN. I think that's——

Senator FRANKEN. Is that correct?

Mr. YERGIN. I think—I would think the committee recommends that yes this is an activity that is a useful Government activity.

Senator FRANKEN. OK. I——

Mr. YERGIN. The best we can do——

Senator FRANKEN. Actually, that wasn't my question. I understand that it's useful, and it's useful to the oil and gas industry. I was wondering why it isn't useful for the oil and gas industry to foot the bill for it considering that we—we've had this, you know, we've had a lot of budget discussions of late. Why are you recommending that the Government pay for the oil and gas?

Mr. YERGIN. I think it was not me recommending it. It was the committee that recommended the oil——

Senator FRANKEN. OK. Can any other member of the committee care to this discuss this? Kathy.

Ms. MCGINTY. Senator, if I might just add to the—the—the perspective that you're—you're sharing and I understand it. We had another concern or an objective in mind which is that as much as when you're looking at whether regulations are adequate or what is a best practice and what's not, the industry needs to be at the table and we need their expertise.

Our objective also was to provide the forums that average citizens could participate, that academicians who have expertise could participate. We kind of wanted to open the doors. We've talked about inclusive processes and that was a key recommendation that we made.

You know, there are industry groups out there that have done good work in setting out what they think are best practices. They typically or sometimes have not been developed in the context that have enabled the public to have a seat at the table and so some of these form stronger than others to enable those groups to participate.

Senator FRANKEN. Let me make the analogy again to the medical device industry.

Ms. MCGINTY. Um-hmm.

Senator FRANKEN. We're about to have hearings on—on that. The Food and Drug Administration gets money from the industry. They're—they have a very adversarial relationship sometimes with the industry that, I mean, doesn't stop the funding coming from the industry. Why wouldn't the industry pay for this?

Mr. HOLDITCH. Can I make a comment?

Senator FRANKEN. Yes, Mr. Holditch. All I'm trying to do is say that——

Mr. HOLDITCH. Yes, sir.

Senator FRANKEN [continuing]. That we have a budget crisis now.

Mr. HOLDITCH. Yes.

Senator FRANKEN. The—I know that—I didn't mean to be sarcastic about how the oil and gas industry is doing. We know they're doing very well. You're talking about funding R and D, and funding regulation that you say would benefit hundreds-fold.

Mr. HOLDITCH. Let—let—let me——

Senator FRANKEN. Yes, sir. Go ahead. I'm sorry, Dr. Holditch.

Mr. HOLDITCH. There—there's a common misconception that—that when the Department of Energy decides to fund research you're—you're—you're—you're supplying money to the big oil company. Why should you give money to Big Oil?

The—the bottom line is most of the money the Department of Energy allots for research, which is quite small, goes to universities. I have a thousand students in my department. I have a hundred Ph.D.'s. These are going to be the scientists and engineers that find the energy to power this country over the next 50 years. A good deal of the Federal money that goes to oil and gas research, goes to universities like Stanford, and Texas A and M, and University of Texas at Austin. We're using it for not only some oil and gas research, but we're using it to turnout the next generation of engineers to—that will find the—the energy we require to power this country.

Senator FRANKEN. Yes, but I was talking about what Dr. Yergin had suggested and he was talking about funding regulation of this particular in—of—of strong, you know, funding of STRONGER which is the State. What is it? What does STRONGER stand for?

Mr. YERGIN. Let's see.

Ms. MCGINTY. It's an acute——

Senator FRANKEN. It's an acronym.

Ms. MCGINTY. Yes. It's a peer review process that has the State's and other stakeholders review whether a particular State's regulations are adequate.

Senator FRANKEN. I'm sorry to go over my time but I'm just trying to—

Mr. YERGIN. I don't know. Can I——

Senator FRANKEN [continuing]. Just I—I only had—

Mr. YERGIN [continuing]. Can I—can I—can I clarify the—

Senator FRANKEN [continuing]. Really had one question.

Mr. YERGIN. During the Clinton administration, I chaired a task force for the Department of Energy on energy R and D. Energy R

and D is something that the Federal Government has funded very strongly since the Second World War. It goes back to George Washington.

We're not saying that, in this case, that they should fund R and D for oil and gas extraction. We're saying there are a series of questions about methane, about water quality. What you're really doing is funding scientists and graduate students, people writing Ph.D.'s, people to understand what's happening to the water or what's happening to the air. So that's when we talk, and how to manage those issues. So that's—we were—that's what we were talking about in the R and D side on, focused on the issues that are of public concern.

Senator FRANKEN. I—I actually, I totally understand that. I totally understand what you're saying and I'm not sure that you totally understand what I'm saying 'cause what you're saying is that you want R and D specifically tied to the results, the harmful results of fracking and of—of gas extraction. You want specific funding, in fact money, Government funding for a regulation of this. Yet, you want the Government to pay for it as opposed to the industry to pay for it. This and——

Mr. YERGIN. If——

Senator FRANKEN [continuing]. It bothers me because in the industry that I was talking about, in the medical device industry, the medical device industry pays user fees to the FDA, which certainly very often has an adversarial relationship. I don't understand why you—why the industry itself can't pay for this especially at a point where they seem to be making profits hands over fist——

Mr. YERGIN. But Senator Franken——

Senator FRANKEN. At the same time, we have this budget crisis.

Mr. YERGIN. Senator Franken, doesn't the Federal Government, the National Institutes of Health spend an enormous amount of money on medical R and D in the country?

Senator FRANKEN. Yes, but it—it isn't specifically to regulate the——

Mr. YERGIN. OK.

Senator FRANKEN. OK. I—I—I—I'm way over my time and I certainly believe in the DOE should be spending money on research. Don't get me wrong. I—I—I believe we should be spending more money on basic R and D and—and more money on getting Ph.D.'s to—for our students and more money at universities. I'm just saying in this specific instance, it's hard for me to understand why the industry shouldn't pay for this—this regulation and research that will provide hundredsfold returns for the industry, as you said. Thank you.

The CHAIRMAN. Why don't we go ahead with Senator Hoeven's questions?

Senator HOEVEN. Thank you, Mr. Chairman.

Hydraulic fracturing, I believe, is very important to the future energy development of this country and—and meeting our energy needs both in oil and in natural gas. Appreciate the tremendous experience that all of you bring to this study.

In our State, though we've been an oil and gas producing State for some time, nothing of the magnitude that we are now, and it's

directly related to our ability to do hydraulic fracturing, as you're aware, in the Bakken Formation.

For the last decade, I served as Governor of the State of North Dakota. When I started, our oil was—our oil production was much smaller and it was declining and companies, if they were still in our State, they were leaving it. We worked very hard to create a good environment so they would come invest and figure out how to do hydraulic fracturing economically. They knew the oil was down there. Doctor Price—you're all, obviously, very aware of Dr. Price's study. They knew there were oil reserves down there. The issue was being able to produce them economically and that meant figuring out the technology to do hydraulic fracturing, which now they do on a regular basis. Our State produces about 450,000 barrels a day and we'll pass California pretty soon and be the third largest producing State in the country. I don't know that we can catch Alaska; they—they produce a lot but we're—we're running hard.

So when you say the State has a lot of experience in this area, thank you. That's right. In looking at your recommendations, how do we make sure that we continue to allow States to be the primary regulator, do the good job that they are doing and not get into a one-size-fits-all because hydraulic fracturing is different in different locations? The geology is different, the product they're pursuing is different, the elevations are dramatically different. We're talking about producing oil 2 miles underground, a long way from any potable water source that's used versus shallow gas and so forth.

So when you make recommendations, I understand, certainly, the national data base. We'd have to have some discussion about who does that, particularly with States as primary regulator, but when we talk about air emissions, when we talk about water management systems, even when we talk about management and disclosure on hydraulic fracturing fluids. Explain to me what these recommendations, how we walk this forward in a way where the States remain the primary regulators, continue to work with the industry and don't get into, again, the Federal Government coming in and saying, "OK. This is how everybody's going to do it whether it makes sense or whether it's economic or not," because that's the exact kind of thing that was driving our countries—our companies to other countries to produce oil and gas.

We need the investment in these new technologies here which will not only produce far more energy for this country, but do it with better environmental stewardship. I'd just like you to take a swing at that because, obviously, we've got this report now, next step. How do we do this in a way that encourages energy development with States as the primary regulator rather than a one-size-fits-all? Again, it tends to dampen our efforts to produce more energy in this country.

Mr. YERGIN. Let me——

Senator HOEVEN. Dr. Yergin, if you'd start.

Mr. YERGIN. Yes, I'll start. First of all let me say, we're all in awe of North Dakota and what's been accomplished.

Senator HOEVEN. We're off to a great start, Dr. Yergin, I must say.

Mr. YERGIN. Right. It's quite an amazing story that, as you say, you'll soon be third, but North Dakota, the fourth largest oil producing. Bakken, just a few years ago, was 10,000 barrels a day. So it's a combination of technology, entrepreneurship and a sound regulatory environment. So it's extraordinary.

I think, you know, in terms of answering it, we have one person at the table who's been both a Federal and a State regulator, Katie McGinty, and maybe you'd like to take the swing first.

Ms. MCGINTY. Thanks Dan. Senator, thank you for your question.

I—I—2 things. First what's not said in our report, we didn't come up with any conclusion that was that the deckchairs need to be shuffled around. In fact, I'd say while it was not our charge to look at that, there was nothing in the testimony we heard or the substance that we focused on and in the what needed to be done that led to a—a glaring conclusion that there was an actor missing from the scene. So I think one thing that's significant is, again, what we—what we don't say. We did not reach any conclusion like that.

But I—but I do want to underscore, Senator, I think your point in terms of how do we ensure that things continue to grow, and we continue to see the opportunity that you've realized in your State and many States are seeing as well? That's what these recommendations are about. They're about the—the continuous improvement that is always needed to ensure the public's confidence and to ensure that the industry is, in fact, moving forward in a responsible way.

We think these recommendations are at the heart of that: improving the equation on water quality, air quality. You know, the States are doing a good job. We've referenced Wyoming and Colorado's work in putting new requirements in place on air quality. So we don't make a recommend that a different entity ought to do it, but we do recommend—make recommendations that say, more needs to be done.

Senator HOEVEN. Go ahead, Dr. Zoback.

Dr. ZOBACK. One of the unique things about these shale reservoirs is that geologically, they have one thing in common and—and that is they are roughly 1 million times less capable of allowing fluid to flow through them than a standard oil and gas reservoir. This is why hydraulic fracturing is needed. So it's been the development of this technology that has unleashed this—this—this resource.

The—as my colleague Ms. McGinty pointed out, we recognize that the differences, geologic differences from place to place sort of put the States in the right position to do this, to do the regulation because we didn't see a one-size-fit-all solution. This is why we endorse groups such as STRONGER to allow the States to learn from each other and take what is a—a national resource at some level. The shale gas reservoirs are found in 23 different States, but also to have it regulated on a more local level where the local expertise can adapt the regulations to local conditions.

Senator HOEVEN. Dr. Holditch.

Mr. HOLDITCH. I've been working on the technology of drilling, completing and fracturing wells for a long time, and I think it's very clear the technology changes with time. The technology

changes depending on the geology and the geography. You—you can't drill a—a—a Haynesville shale well the same way you drill a Bakken shale well or you drill a well in Arkansas. So local control, local understanding of best practices is—is really the best way to go.

As—as we saw in our public meetings, virtually all of the industry and virtually all of the regulators, the State regulators think everything is just fine right now with the—with—with the—with the process, we're going to have to keep updating the regulations, for example, on fracture fluid disclosure. But there's nothing broken with the system now. We just have to turn our crosshairs on some few different problems and make sure we—we solve those problems.

Senator HOEVEN. Yes. Mr. Chairman, I'll wrap up there. I see I'm over my time, but I think that's the right place to end up. That's very important in terms of implementing these recommend—recommendations, that we do it in a way where we empower the States and empower the industry to continue to move forward, but accomplish some of these objectives versus kind of fallback to EPA stepping in and saying, "Now everybody's going to do it this way."

So I would just encourage you as you interact with the EPA that that remain part of your message. I would look—I would appreciate any, if you have any written comments that you would like to submit to my office that we could look at to try to move the EPA in that direction, I—I'd appreciate very much receiving them.

Thank you for your work.

The CHAIRMAN. Senator Udall.

Senator UDALL. Thank you, Mr. Chairman.

Thanks to you, and the ranking member, for holding this important hearing.

I want to thank the panelists for your great work on the subcommittee itself.

I like, I think most if not all of the members of this committee, support developing shale gas resources to reduce our dependence on foreign oil and to help us transition to clean and renewable energy sources. But we've got to take the necessary steps to address the public's concerns about fracking in particular. I think you all would agree.

I've emphasized that one well contaminated or one person made sick is one too many. But I also would tell you, as Ms. McGinty and others talked about the situation in Colorado, that natural gas production is a strong economic driver across our country. There's a potential to create even more jobs, which is the focus, certainly, of the Congress and of Americans at large.

In your report, I think it's fair to say, you highlight and then you emphasize that there's a critical need to adopt best practices in areas such as well development, construction with the focus on casing, cementing and pressure management, as well as minimizing water use and limiting vertical fracture growth.

If I could, I'd like to follow up on Senator Wyden's question. How do you suggest developing and implementing best practices to provide quality assurance for well construction? Will you propose, the subcommittee, an action plan for forming a national organization

to develop these best practices? Then, what concrete steps should the Government and industry take in the short term to better inform the public about shale gas development and the environmental impact? Easy, short questions. Doctor?

Mr. HOLDITCH. Yes. Let me just say one, short little thing and then maybe the other on the subcommittee would like to add to it.

I—in—one of the biggest issues any time you drill any well for any reason is to protect the—the freshwater aquifers. In—in Texas, we have maps of all the aquifers. When you permit a well, you have to know, they tell you exactly how deep you have to go to set casing. When you get to that depth, you call up the Railroad Commission. They send someone into the field and make sure the casing is run properly, and make sure it's cemented properly and—and if it's not, you have to take remedial stapes.

So there are procedures for protecting the groundwater that are done State by State very well in—in—in all of the producing States. Those are the best practices that we need to make sure they get to other States that don't have this experience that—that—that we have in the oil producing States. That's where some regional centers of excellence where best practices are—are put together; this—this organization STRONGER actually does some of that.

So I think we really, we have the mechanisms in place. We've just got to push them forward.

Senator UDALL. Dr. Zoback.

Mr. ZOBACK. Yes. Thank you, Senator.

One of our recommendations we entitled, "Organizing for Best Practice," and it was to enable just the kinds of activities you were asking about and we—we feel there's a real—a real need for that.

The public is not well-informed on these issues. Industry and—and other stakeholders are not engaged with the public sufficiently, and the Federal and State regulators seem to be on their own—on own their own paths. So we felt that there was a real opportunity for these—these various groups to come together, and organize for best practice to share this information, and to share the information with the public so that they know what's doing—what—what's being done and—and how their interests are being—being protected. So that was an area where our—our committee made a number of specific recommendations.

Ms. MCGINTY. Senator, yes, just to build on that and an important part of that, I think, that's been kind of implicitly referred to it, but the inclusiveness is important. There are organizations like American Petroleum Institute that do have very good standards that they have produced to advise on well casing and cementing, and some of the other measures we're talking about. But 2 things are different.

One is that we—we are looking for in order to enhance the public's confidence in the industry that these efforts be open to other stakeholders. Second, that they be measurable so that if you take a certain precaution in terms of the cement that you are using, what's the measurable outcome in terms of water quality? Or if you use microseismicity to better understand and target your frack job, what's the outcome in terms of the efficiency of the pro-

duction of that resource? The efforts to date have not had that measurable component.

I think Dr. Holditch mentioned the environmentally friendly drilling. That's a good example of the kind of thing we were looking for. It's inclusive and it's looking at measurable progress. Then it's making it easy for the public to understand through a scorecard that it's working on that would rate the environmental effectiveness of the operations at a given well-site.

Senator UDALL. Dr. Yergin, do you, as the as dean of this group, do you have thoughts you might want to add?

Mr. YERGIN. I think I just support what my colleagues have said in—in this regard.

I mean, I think that the, you know, there's what happens in production and drilling the wells and everything, and then there's the perceptions that goes back to the gap question. It goes back to the question of some really do think that—that this development which has happened very rapidly is a kind of Wild West, and then because it's in Pennsylvania, also Wild East.

Senator UDALL. Um-hmm.

Mr. YERGIN. But, in fact, it's a—a highly, you know, it is a highly regulated activity at the State level, and continuing to push as—as it expands, to continue to push it and address the kind of questions you're talking about.

Senator UDALL. Mr. Chairman, I wonder if you'd indulge me with one additional question?

The CHAIRMAN. Yes, go ahead.

Senator UDALL. Your report emphasized that most of the problems associated with fracking have been linked to leaked or leaking well casings. If the well's not drilled right, then any number of fluids can leak into groundwater.

How can we, at the Federal level, State level for that matter, work with industry and scientists to improve research and development for fracking technology? Could you give any examples of the R and D that the Federal Government could support to improve extraction of shale gas and address public concerns about health and environment which is, after all, what we're discussing?

Mr. YERGIN. Yes, I think that's for Steve and Mark would be the ones to actually have the—but one of the things we do want to come back to in our work is the specific agenda. But as the dean, I'll turn it over to the 2 of them.

Mr. HOLDITCH. One of the things that—that the committee needs to understand if you don't already is that these—these shale gas developments in—in Oklahoma, Arkansas, Louisiana, Texas, Colorado, Wyoming, Pennsylvania are all going on in—in areas where we've been drilling wells for the last 50, 60, 70 years. There's tens of thousands of old wells in the same places we're drilling these shale gas wells.

So the—the casing and the cementing issues may go back to some wells that were drilled 20, 30, 40 years ago before they were properly regulated or maybe just corrosion has set in. So there could be, very well, issues in there and that's another whole can of worms, another whole set of problems we're going to have to deal with at some point in time, perhaps. But it doesn't really tie to wells that are drilled correctly right now.

I think the research we ought to be doing, to get back to your question is—is trying to come up with green tech and green fluids and—and ways to handle the produced water better.

Senator UDALL. Um-hmm.

Mr. HOLDITCH. Just take care of what we're doing and get—get, you know, maybe we can come up with another bactericide that—then we can get rid of the Clorox or something like that. So there—there is some research to do but—but I'm not all that concerned at all with the casing and the cementing of the new wells that we're drilling. It's the old wells that, I think, we need to be looking at.

Senator UDALL. Thanks again to the panel and I think what I hear all you saying was, "Do this right." Thank you again for the report. Look forward to working with you as we move forward to produce this really important resource, but to do it right.

The CHAIRMAN. Let me just ask a question that Dr. Holditch, in your testimony you say that, "We need to develop more affordable technology to monitor air quality and methane emissions during the entire life of a shale gas well from drilling to production."

Could you elaborate on that a little bit?

Mr. HOLDITCH. OK. I may have to punt on this one too over to Kathleen, perhaps. But—but I was under the impression. It—it's in our report and in our—in our comments that—that to really go out and make accurate measurements in—in a wide area of just what chemicals or what—what emissions might be occurring, the sensors to do those measurements are quite expensive, and it takes time to gather that data. I believe we—what we heard in—in the public meetings that we held is that—that—and—and some of our discussions is that we really need to take a look at how we can make better air quality measurements with lower cost sensors and still maintain the sensitivity we need to understand the air quality. Is that—does that?

Ms. MCGINTY. Hit it out of the park.

Mr. HOLDITCH. OK.

Ms MCGINTY. I'd just add that in the various pieces of the shale gas operations, some are—lend themselves more readily to measurement than other aspects.

So the—at the time of well completion, that's the time when you can really have your arms around: what is that pulse of methane that is produced when the well is being completed? It's a little tougher once that methane then travels into the gathering equipment, and the midstream, and the down street operations. Infrared technology is being used now to try to see where there might be fugitive methane from that infrastructure. As Dr. Holditch mentioned, there are sensors that are being developed to assist in that effort. But it is an area of improvement that's needed.

I'd also say just even at that green completion stage, there is a need for care in approach there too because the equipment needs to be styled such that you do not have any safety issue when that methane is being captured.

The CHAIRMAN. Do we have—are the States requiring monitoring of methane emissions in—in the drilling and—and operation of wells? I'm surprised if they are. Is that going on right now?

Ms. MCGINTY. No, I do not believe so. There are a couple of efforts that are beginning to come together. Our colleague, Fred Krup, who is part of our task force is working with a variety of companies in the industry to put an initiative together that would begin to gather that data. EPA has looked at this and, I think, has some modeling that they have put forward where you would impute what the methane emission might be. But in terms of direct measurement, our report calls for an effort that would get a better look at the lifecycle of methane emissions from shale gas operations.

Mr. YERGIN. In fact, I think we could just add that is, I think you alluded to in your opening statement, there's quite considerable debate as to the scale of the methane emissions. So, it cries out for proper measurement.

The CHAIRMAN. It does seem to me, I know we've had a lot of questions from Senators and testimony also about how, you know, this all ought to be done at the State level, all this regulation and all. It does seem to me that the monitoring of methane emissions, there might be some uniformity if—if, in fact there's technology available or developed that can be used to monitor methane emissions at a well-site. It seems like there's some uniformity that could be appropriate there and you wouldn't want a circumstance where one State says—

Ms. MCGINTY. Sure.

The CHAIRMAN.—"We could care less," about whether, what the methane emissions are from—from wells drilled in our State while someone else is trying to be more responsible and deal with it.

Mr. ZOBACK. If——

The CHAIRMAN. Dr. Zoback.

Mr. ZOBACK. Just to elaborate. The—the issues of tracking fugitive methane emissions is a—is a common issue to shale gas development in all 23 States and a number of these other environmental issues are—are common. Whether, you know, it's—it's a—it's a different story about how we go about addressing some of these outstanding problems, which is of national scale and regulating local operations which, I think, all of us feel is appropriately left with the States where the local expertise lies.

So because we're recommending that the States have primary jurisdiction over the regulation doesn't mean that there's not a need for a national program of research on some of these critical common issues that enable the lifecycle analysis to be done correctly.

The CHAIRMAN. What if you did the research and the Federal Government funded it, and it concluded that, yes, there was a cost effective, reasonably inexpensive way to monitor methane emissions at well-sites during the drilling process and otherwise. Then some kind of requirement that could be implemented would not seem, to me, inappropriate.

I mean, it wouldn't—it wouldn't make sense to say we're just going to leave it up to the States whether they actually do this monitoring. That—that's a difference of opinion, I'm sure, I would have with some of my colleagues up here.

Let me defer to Senator Murkowski for any additional questions she has.

Senator MURKOWSKI. Thank you, Mr. Chairman.

Good conversation. I will say I have learned a great deal just from the hour and half that we've had an opportunity to talk with you.

You know, I started off my questioning about this gap analysis, and I think it is clear that while it may not be misinformation maybe it's just not complete information. But there's so much discussion about, "Oh, this toxic soup of chemicals," that goes into the fracking and the need for full disclosure there. I think, Dr. Zoback, the word that you used was essentially these chemicals are somewhat benign. That it's through the process where the fluids are pushed out that you get the interaction that causes a different composition coming out, and that's what we need to be focusing on. It is a lack of understanding, I think, that causes concern.

Dr. Zoback, you mentioned that, "Hydraulic fracturing then becomes a bumper sticker for everything we need to watch out for." I think we all, as policymakers, need to be careful about not only the language that we use but how we describe certain processes because I think it does cause unnecessary alarm or concern.

It was interesting to hear from all of you a recognition that with hydraulic fracturing and this process has been around for, as you remind us Dr. Holditch, at least 40 years and then some. This allows us access to a resource that is both valued and needed and we need to do what we can to ensure greater access, but in a way that's the environmentally responsible. We can do that and there are clearly States that are working hard to ensure a level of regulation that, I think, we all hope for and want.

We just need to make sure that we don't try to apply a one-size-fits-all application. Your own study notes that, "The geological diversity means that engineering practices and regulatory oversight will differ widely among regions of the country." I think we respect that and need to ensure that when we're talking about the regulations we acknowledge just exactly that.

I listened carefully to your response, Ms. McGinty, about the best practices, and the reason why we need to have a new standard setting body cause when I looked at that, I thought immediately, "Well, why wouldn't we stick with API or AGA?" Both have demonstrated their abilities in setting existing standards. Maybe for some reason the message is not being understood clearly because of who's delivering it. I don't know if that's the issue.

You mentioned it's got to be more inclusive and I can understand that but I also note that you don't have involvement from anyone in the Federal Government. I don't know whether that was intentional or not, but I understand where you're coming from. Still, I'm loathe to set up yet one more standards setting body if it's just going to be kind of a duplication. If we're having an issue making sure that what these standard setting bodies are putting forward is not being understood, let's deal with that. But that is something that initially causes me a little bit of concern.

A question to each of you: You've got another report coming up, a status on the 180-day report. I guess this is within 6 weeks from now. What should we anticipate from that? Have you gathered anything from this discussion here this morning that you can then incorporate into that report? If so, I've got a lot of extra questions

for you. But can you give me some kind of a heads-up as to what we might anticipate? Dr. Yergin?

Mr. YERGIN. I think this is——

Senator MURKOWSKI. Since you're in the writing mode here.

Mr. YERGIN. Yes, exactly. I—you know, we are about 6 weeks out. I think what we—we're not—I—I don't think we're going to try to have a—a full, comprehensive report because we—we couldn't as we covered a lot of ground in this. But rather, to look at these series of recommendations we made and have some chart of what kind of progress has been made on them looking across the range of issues. So that's certainly one of the immediate things on the agenda.

I think there's a—a lot to carry away from this discussion including it is so interesting that the theme that runs through without is—is the Federal-State relationship and where does responsibility lie and clarifying that because even as I've been listening to the discussion, I was just thinking there's such a discussion out here that is just, doesn't recognize how this industry is regulated now or, indeed, that it is regulated. I think further clarification of that would be helpful.

Senator MURKOWSKI. Will your report look to the various States, the 23 States that currently have shale gas, how they are regulating? Does it incorporate that?

Mr. YERGIN. Kate—Kate—Katie, do you?

Ms. MCGINTY. Yes well, Senator, yes. So the best practices that we point to are typically drawn from the experience of the States.

So when we talk about, for example, how valuable it is to have that baseline environmental data and have it publicly disclosed that some States are already doing that; other States are not. So we—the heart of the report is drawn from those examples and those best practices.

One thing I certainly will take away is that we need to be more precise in our discussion about the effort to identify best practices and this inclusiveness that we call for. I understand you're hearing it as standards, maybe regulations, that kind of thing. What we're really doing is hearing the industry and others who, I think, have learned a bit from the public concern over fracking fluids. Industry now themselves are saying, "My goodness. Why—why did—why did we hold back so long before we all just got behind the idea of disclosure?"

So what's at the heart of our recommendation here is to say let's learn from that. Let's find places where people can genuinely have the information to understand. If we do, if you do that, then we think that there are plenty of ways people agree and find the common ground to move forward.

Mr. YERGIN. I think that that's an important clarification because we're not recommending that the existing standard setting groups be, you know, something new on top of that.

In best practices, what we're really trying to do is create an ongoing process for discussion among the players and the participants in this, so that that knowledge, whether they're companies, regulators, communities that they're all aware of it, and that best practices are evolving and that's the kind of forums that we were talk-

ing about getting. So it wasn't to say that there needs to be yet somebody setting standards.

Senator MURKOWSKI. Dr. Zoback.

Mr. ZOBACK. If I may. For—it's fairly obvious by this point that our committee was—was—was not charged with the question of who should be regulating what and we—we certainly stayed away from that issue. But—but the thing we are concerned about is implementation of our recommendations.

Senator MURKOWSKI. Um-hmm.

Mr. ZOBACK. So with—without then getting into who and how our recommendations should be implemented we—we came upon this idea of organizing for best practice as a way of bringing the stakeholders, you know, in—into the process to look at our recommendations and see how they could implemented. We, you know, we simply didn't have the charge, the expertise or—or it was not our role to—to say how they should be implemented, but we very much want to see them implemented.

So this idea of organizing for best practice was—was a step we could take without sort of exceeding the—the bounds of our—of our charge.

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

The CHAIRMAN. Senator Shaheen, you—you're sort of the clean up batter here. You go—go ahead and ask what questions you have. Thank you.

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

I—I apologize to the panel for being late. I had to preside over the Senate and unfortunately, I don't get a pass for that to come to the hearing. With the help of my staff, hopefully, I will not duplicate too many of the questions that have already been asked.

Do want to point out that I—I chair subcommittee on water and power, and we're hoping to do a follow up hearing to the hearing this morning to look at the impact of fracking on production of shale gas in the Eastern United States where, I think, some of the issues may be a little different than in other parts of the country. So hopefully, we can get in even in greater detail into some of the issues that you all are exploring this morning.

Ms. McGinty, given the impact that a fracking job gone bad can have on families, should we consider requiring the industry to go beyond today's best practices? You were talking about the importance of getting everybody together and actually being transparent about those best practices.

But how do we ensure that that actually happens, that complacency doesn't set in? That we don't have those examples where some corporate citizens or for whatever reason, may not be following best practices?

Ms. MCGINTY. Senator, I think it's essential that—that continuous improvement not just be a buzzword. I would say that in our meetings with industry, I think they feel the importance of this too, that with the concern over fracking fluids, for example, they learned a lesson that a bunker mentality does not work in furthering the industry. But—but we need to be genuinely be serious about continuing to advance the ball. So, what are some of the things that are very important?

You're looking at water—the water energy nexus. It's important to say that shale operations are a tiny fraction, generally, of the water consumed in a given location. However, the water needed to produce a shale well is still an order of magnitude greater than the water needed to produce a conventional well. So that says whether someone's requiring it or not, the community will expect a level of responsibility in the use of a water resource. It's in everyone's interest that we move to more efficient ways of handling and using water.

That community has concerns not only about what is being put down in the well, but they'd like to know what's coming out. Can we understand the full lifecycle of that water? I'll say, one of the recommendations we make in our report, that some in industry have said, "Well, that might be too expensive and there might be a better way of doing it," is we—we've talked about tracking and manifesting the water from the time it's withdrawn to the time it's used to produce the well. From the time it comes out, et cetera, to its final disposition; tracking and manifesting. We talk about, maybe there's a better approach.

But it gets to your question, it's about demonstrating to the public every day that there's nothing to hide. We're not going to hide it. We're going to continuously improve our performance.

Senator SHAHEEN. One of the things that I have certainly noticed in talking to business folks about water use is that whenever they have to pay for water use that that significantly changes the way they actually use the water. People try to be much more efficient about water usage when there's some cost involved.

Can you talk about whether—whether you found that to be true as you've looked at companies and they're using fracking to produce shale gas?

Any of you? Dr. Zoback, do you want to respond to that?

Mr. ZOBACK. I think that statement is—is generally true and—and, you know, economics is often a good driver.

The expense of hauling flow back water from Pennsylvania to Ohio because of the lack of—of permitted injection wells perhaps was one of the motivations for the reuse of water and recycling frack fluids. It was the driver, but ultimately it produced something that was not only good for the, you know, the economics of the development but it was also good for the environment. So often, you know, multiple goods can come from—from, you know, opportunities like—like the one you're mentioning.

Other opportunities are the one I cited where when you're drilling many wells and doing many fracks at a single site, it might even be efficient to drill a well into a saline aquifer and use a local supply of water that's unfit for any other purpose to do the fracking. So all sorts of things, all sorts of possibilities arise.

Senator SHAHEEN. Given that there are reports of wastewater that's being disposed of in inappropriate ways, sent to treatment facilities not equipped to handle the type of waste, whatever. Is—do we have enough information about how the wastewater is being handled to be able to reassure the public that they are not in any, or not being exposed to any harm as the result of how the wastewater's being handled?

Ms. McGINTY. Senator, I do think that there is need for more transparency there. Referencing before whether it's tracking or manifesting or some other way to give the public confidence that the water is properly being handled. If I could jump in on what Dr. Zoback said 'cause I think he touched an important point in terms of the economics of water and how it impacts whether or not we might have innovation and better environment performance.

I do think it's tough for companies out there right now who are building on the success that Dr. Zoback talked about where we are recycling and concentrating the brines of the flow back water. Will we go the next step and then actually fully remove the brine so you have discharge quality water and can put it back into the water table or into surface water?

There's lots of companies out there, Dr. Holditch was saying the other day, how impressed he is. He has somebody knock on his door every day. They've got—they've got the answer. Many of them do, technically. The economics are really tough. They're tough when there is an abundant water resource. They're tough when there's the ability just underground inject the—the produced fluids. They're tough when there isn't some other driver that says, "Let's put a premium on conservative management of water."

So I do think that there's going to be need for some kind of new factor involved here, whether it's economic or policy or what have that enables some of these newer technologies to bring us to the next level—level of water treatment and conservation.

Senator SHAHEEN. Yes.

Mr. HOLDITCH. Can I make a statement?

Senator SHAHEEN. Dr. Holditch.

Mr. HOLDITCH. —I'm in the petroleum engineering department and I have a lot of people come talk to me about their technologies, and I've visited with 2 companies just last week. One has already built a plant north of Denver the—and they're about to build a plant in South Texas, and they're going to take not only flow back water from frack fluids, but they're going to take produced water. The industry produces about 3 times more water than it does hydrocarbon. They're building a plant with a new technology to take the produced water, clean it up so it can be fresh, good enough to be fresh water, and then they're going to take—take out the impurities and the salt, and sell the salt.

So there's a lot of entrepreneurs out there right now trying to take this problem we have and turn it into businesses. So I think the American entrepreneurship is going to help solve a lot of these issues in the first short term.

Mr. YERGIN. Just to add that the, you know, the whole shale gas development was about 20, over 2 decades to actually go from, you know, trying to make it work to work, and then it's only been 2008 when we've had this incredible growth in it. So, I think this process of—and a lot of—so we're talking about best practices, we're also talking about technological innovation and the 2 being linked. This is about the advance of technology and these issues have been identified. As Professor Holditch says, people are now focused on finding the technologies to address these issues. You know, that will—that's where the real solutions will come.

Senator SHAHEEN. Sure. One of—and again, I apologize if this has already been raised but one of the—when I was Governor in New Hampshire, we had an issue around a water bottling plant that was going to take significant amounts of groundwater, and there were no regulations or policy had not really looked at that issue because the technology had gotten ahead of where the policies in the State were.

Is that where we are with this technology? Do States need to re-examine their policies around how we regulate or incentivize shale gas production in a way that addresses some of these concerns?

Mr. YERGIN. I think one of the conclusions we came to, and while you were presiding there this morning, we were talking about it is that, in fact, there is a very well-developed State regulation of oil and gas. There's a kind of perception, though, that it doesn't exist, and that that is the foundation for it.

Obviously, there are 2 best practices we talk about, this group called STRONGER helping the States that are newer to the field gain expertise and knowledge about how to—to do it. But that seems to be the foundations on—on which—which we're working, but it is to enhance the capabilities of, call it, the new entrants.

Mr. ZOBACK. One—one area in which progress could be made is in lessening cumulative impacts of shale gas development and that's something we address in the report and water is central to that. That water resources be—be managed more on a regional than on a well specific scale.

Senator SHAHEEN. Right.

Mr. ZOBACK. That's something we emphasize and—and a place where organizing for best practice could have a big payoff.

Ms. MCGINTY. I—I do think this is an area where there is an opportunity for growth and improvement in terms of approach; some basics things.

State of Texas, for example, has most or all of the water resources in the State mapped; some other States do not. Now in Texas when you get your permit to drill that well, the State knows exactly what the depth of that water resource is and therefore says on the cementing and casing issue, they know exactly where you need the most protection. In other States, that information is not available and industry has to figure it out as they go, things like that just very important.

I know also that in some States there are tools that can look at the quantity of water withdrawn, but in other States, there may be authority over quality, protecting the quality of water but the situation in terms of quantity is whoever has the biggest straw wins. So, I know in Pennsylvania that we just had to figure it out in the western part of the State because we did not have a tool going into the development of the resource and—and needed to invent one.

So I think it's an area where the sharing of experience among States and a real and sincere focus on best practice and continuous improvement is important.

Senator SHAHEEN. Thank you. Mr. Chairman, you've been very tolerant, but can I ask one final question?

The CHAIRMAN. You—you can. Go—go right ahead.

Senator SHAHEEN. I've gone significantly over my time but this is just kind of a throw it out. I don't know if you, anybody has a

view on this but as, I'm sure you're aware, in recent months there has been some media attention to whether or not the amount of shale gas reserves in the country are really as high as some of the initial industry estimates have been. Concern that they may not provide the production levels anticipated because of the inability to access them.

Does any—do any of you on the panel have a viewpoint about that issue? Something totally outside your report.

Mr. HOLDITCH. Shale gas is—is for real. I mean, I've—I've looked at a lot of wells in—in production, and done engineering, and computed reserves and there it's—it's a game changer for this nation. If you take the—the shale gas that we're going to produce and use it for electricity and natural gas vehicles, you take the same technology on horizontal drilling and fracturing and—and you look at South Texas, West Texas, even Ohio now in the Utica Shale and Bakken, the oil production is going up in the United States for the first time in—in 20 or 30 years. Dr. Yergin can tell you a whole lot more about it than I do.

We—we're going to lessen our—our reliance on imported oil in the next 5 years. It's—it's just going to knock your socks off. It's going to be a game changer. It's really going to help our economy. Dr. Yergin and his company is probably the best in the world at evaluating this, so I'll let—let him kind of close it out.

Mr. YERGIN. Yes, I think the—the discussion about this has been pretty confusing. I mean, even some of the reports that one has seen that if you, is it apples and oranges that are being compared? It's very hard to tell. But the U.S. Geological, the one that was cited was actually the one that was supposedly the lower estimate was 40 times larger than their estimate of 10 years ago.

So I think the general view among professional geologists, the people who do this is that this is a very large resource. As Professor Holditch has—will—has instructed, not all wells are economic, not all of them, the shales are not evenly distributed in terms of the amount of gas. But every day, it seems, is the sense of the resource grows and we're seeing other regions of the world, of the United States and certainly other regions of the world.

So I think what President Obama said in his remarks that 100 years of supply is a—is a—is a pretty good guide. I know companies are finding when they acquire resources that, in fact, is they learn how to produce it. You know, reserves are not a finite concept. They're dependent upon economics and technology. They found that actually the resource is even larger.

So the numbers that are there are just, when we thought just 5 years ago, we're going to be importing all this LNG 'cause we didn't have any natural gas. It turns out to be a very different picture.

Senator SHAHEEN. Thank you all. Thank you, Mr. Chairman.

The CHAIRMAN. Thank you very much. Thank you all. I think it's been a very useful hearing. We appreciate.

That will conclude our hearing.

[Whereupon, at 12:02 p.m., the hearing was adjourned.]

APPENDIX

RESPONSES TO ADDITIONAL QUESTIONS

RESPONSES OF THE SECRETARY OF ENERGY'S SUBCOMMITTEE ON SHALE GAS PRODUCTION TO QUESTIONS FROM SENATOR BINGAMAN

Question 1. Based on the 90-day summary that you are here testifying about—I have a good idea of what efforts can be undertaken to ensure safe, sustainable domestic shale gas production. What's next for you all and this subcommittee? You've indicated that there is a second part you are working on—more like a 180-day report. Can you elaborate a little bit more about what we can expect in the second half of this report? What resources, if any, do you need to complete the report?

Answer. The Subcommittee submitted its final report on November 18, 2011, and disbanded. The final report focused on implementation of the recommendations presented in its first report. The final report is available at www.shalegas.eneray.gov.

Stakeholder Feedback

Question 2. Have you received much of a reaction to your study from public stakeholders? Other stakeholders? Can you elaborate on what the public's reaction has been?

Answer. Public comment was solicited at every stage of the Subcommittee's work. DOE maintained a website (www.shalegas.energy.gov) and received over 39,000 public comments throughout the process. Those comments may be viewed via the website and summaries of the comments are also provided. The Subcommittee is gratified by the generally favorable reception its reports have had from state and federal agencies, industry, and public interest groups. The composition of the Subcommittee has been criticized by some as including too many individuals with ties to industry and by other as not including enough individuals who have experience in industry.

Regulatory Revision

Question 3. Your report calls for public disclosure and open access to information critical to shale gas extraction—like the composition hydraulic fracturing fluids. You go further to mention the need for perhaps more standard regulations related to protecting water resources and air quality. Are you suggesting any new regulations in particular? Are these at the state or federal level (or both)?

Answer. Since DOE is not a regulatory agency, the Subcommittee avoided consideration of regulatory design. The Subcommittee made recommendations to strengthen regulatory controls and to improve public access to information, but it is up to the relevant regulatory agencies and other policy makers to decide how to implement those recommendations.

Question 4. You mentioned the need to collect baseline date prior to the onset of shale gas development activities. Should the collection of baseline data be made mandatory by the states as early as the permitting process, like under the Safe Drinking Water Act, Underground Injection Control Program? In areas where shale gas development is underway, how should operators and regulators address the need for baseline data . . . is it too late to get this information?

Answer. The Subcommittee strongly believes that having baseline information is important to accountability, but also recognizes that there are practical obstacles to its collection. In many cases such as background water quality measurements, it is not collected in a timely way. The Subcommittee recommends background data collection should be adopted as a best practice.

Question 5. I see that the Subcommittee made recommendations regarding the adoption of best practices. What steps should be taken to ensure that these best practices are adopted and utilized? Should there be any enforcement mechanism put in place to ensure the use of these best practices?

Answer. These are excellent questions, for which the Subcommittee did not prescribe definitive answers. For improvements in best practices to occur, the Subcommittee recommended that industry lead a multi-stakeholder process to answer these questions and develop a rigorous and credible system of continuous improvement. The Subcommittee favored a national approach to an industry best-practice organization but recognized that differences in state regulation and regional shale plays argued for a more decentralized approach. Industry is proceeding on a regional approach around centers of excellence.

Water Quality

Question 6. There has been considerable media attention to the issue of shale gas production, especially since the documentaries "Gasland" and "Haynesville" came out about shale gas development and its impacts on the communities and the environment around the shale gas production sites. Can one of you elaborate as to what is happening when I see videos of citizens who can light their tap water on fire? Is that gas related to shale gas production? Can you elaborate on this a bit? How might that gas have reached the fresh water aquifer?

Answer. The Subcommittee did not investigate specific incidents but received considerable public comment about them. EPA's water study may provide more definitive information and it is investigating several incidents under CERCLA, such as the recently released report on Pavillion, Wyoming.

Question 7. What are the barriers to implementing saline water usage for fracturing rather than simply using freshwater resources? What are the benefits and are there any potential negative impacts?

Answer. The Subcommittee did not address this question. Generally speaking, companies work within the applicable regulations in deciding on water usage.

Question 8. Why is recycling flowback water for reuse more common in the northeast part of the US, versus other geographic regions in the US where oil and gas operations are taking place?

Answer. The allocation of flow-back and produced water for reuse depends on local circumstances that vary widely in different shale plays across the country in terms of amount of water produced, availability of new water, alternatives for treatment and disposal.

It seems that a central message of the Subcommittee's report is that we need to look at the use of water in shale gas production operations from "cradle to grave" to make sure that both water quantity and quality are taken into account.

Question 9a. Do you care to comment on this observation?

Question 9b. Do other members of the panel have a view on this?

Answer. The Subcommittee believed that cradle to grave (system) management is an essential feature to effectively managing the environmental impact of water usage. All members of the Subcommittee agreed to the two reports and all of the recommendations.

Air Quality

Question 10. Your 90-day report recommends reducing air emissions from shale gas production. The EPA recently issued draft rules to control air emissions from oil and gas production, transmission and storage. Do you think these rules go far enough to address the concerns you outlined in your report? If not, what additional controls might you recommend?

Answer. The Subcommittee is pleased to see regulatory agencies addressing these issues, but it was not our task to evaluate specific regulations or regulatory policy questions. The Subcommittee made certain recommendations, for example a comprehensive study of the greenhouse gas footprint of natural gas production, which go beyond EPA's present plans.

Abandoned Wells & Safety

Question 11. An area of some concern when gas developers are going into an area, such as the Marcellus shale, is the occurrence of abandoned wells from oil and gas production that happened earlier in the 20th century. Do you think abandoned wells pose a problem for environmental and human health and safety? How would you recommend we address locating and properly plugging these wells?

Answer. Abandoned wells are a general problem for the oil and gas industry that will require attention by regulators and industry. Abandoned wells are a specific problem for new hydraulic fracturing operations in all areas. Plugging new shale gas wells is a matter for state and federal regulation.

Question 12. There have been quite a few onshore well blowouts (at least three notable cases) in the past year, in areas where shale gas production is occurring. Did you look into the cause of these blowouts? Did you consider whether these were the result of operator error, shortcomings in the regulations themselves, failure by

the state regulator to adequately enforce regulations, or perhaps a combination of many of these issues?

Answer. The Subcommittee did not investigate specific blowout incidents.

EPA Study on Hydraulic Fracturing

Question 13. The EPA is on track to have the results of their hydraulic fracturing study/research out by spring or summer of 2014. How does your report fit into that study? Did you work with the EPA when you were conducting the 90-day study? Do you think your recommendations will change at all based on the type of study they are undertaking? Do you think that the study they are undertaking is robust enough to adequately address many (or most) of the issues you raise in your report?

Answer. The Subcommittee consulted frequently with EPA officials throughout the process and was thoroughly briefed about the EPA study. Our study was produced on a much shorter time frame and addressed a broader range of issues, not just water quality, and so is complementary to EPA's work in many ways. In its second ninety day report the Subcommittee urged EPA to release information and regulatory guidance in the course of its water quality study.

Methane Leakage

Question 14. There have been several papers out in the past year that have highlighted the problem of natural gas leakage during the extraction process. The authors of these studies point out that if there is a large amount of methane leakage during the extraction of the resource, the overall carbon footprint of using natural gas could be much higher than we would expect if you consider just the point of combustion. Could one of you comment on how good our data is on methane leakage? Also, could you provide an assessment on whether or not there are ways that we could improve data collection about leakage and work to curtail methane leakage during natural gas extraction?

Answer. The Subcommittee believes this is an area where there are significant data gaps and much more research needs to be done to assemble reliable data and explore best practices for dealing with leakage issues. In our first 90 day report, we made three recommendations that bear on this question:

> (1) Enlisting a subset of producers in different basins to design and rapidly implement measurement systems to collect comprehensive methane and other air emissions data from shale gas operations and make these data publically available;
>
> (2) Immediately launching a federal interagency planning effort to acquire data and analyze the overall greenhouse gas footprint of shale gas operations throughout the lifecycle of natural gas use in comparison to other fuels; and
>
> (3) Encouraging shale-gas production companies and regulators to expand immediately efforts to reduce air emissions using proven technologies and practices."

Question 15. You mention in your testimony that the most important thing to ensure water-safe operations is to have sound well casing and cementing. How can we ensure that this takes place? Is this currently being regulated adequately by the states?

Question 15a. Do other members of the panel have an opinion on this?

Answer. Both regulators and industry play important roles in ensuring that well casing and cementing operations are done safely and soundly. All members of the Subcommittee agree with this point.

RESPONSES OF THE SECRETARY OF ENERGY'S SUBCOMMITTEE ON SHALE GAS PRODUCTION TO QUESTIONS FROM SENATOR MURKOWSKI

Question 1. There has been significant controversy over expenditures on programs for the promotion of "green jobs." Given the transformative effect that expanded natural gas production is already having on our economy, in addition to the environmental benefits derived from using natural gas for power generation and eventually transportation, isn't the U.S. essentially a green jobs world powerhouse already?

Answer. The Subcommittee agrees that natural gas production has had enormous benefits for the nation, including very significant contributions to employment, and, if environmental concerns can be managed responsibly, that its potential will continue to grow.

Question 2. Here on Capitol Hill, China has become something of a fascination. We regularly hear that the federal government has to spend what China spends, on the technologies China spends on, in order to keep up in the so-called clean energy race. What do you think about that approach? Is it a wise decision—or a smart

strategy—for the U.S. to view our energy supply as a race, let alone a government spending-based race that's driven by decisions made in China?

Answer. These are important questions, but are beyond the scope of the Subcommittee's work.

Question 3. In your new book you have a couple of very interesting chapters on China. In America, China is often cited as the leader in green energy with whom we have to keep up. Also here in the U.S., many oppose domestic production of oil and gas as a tactic to promote alternatives. In China's push for alternative energy, are they restricting the development of fossil fuels to promote the green energy or are they proceeding to develop all energy fronts?

Answer. The Subcommittee's work focused on methods of making shale gas production safer and more environmentally sound in the U.S. and did not investigate practices in China.

Question 4. In the New York Times editorial about the SEAB report, second-to-last paragraph states, "The panel was largely silent on the question of who should regulate the industry. But it made clear that while the industry can do much to improve itself, the EPA, other federal authorities and state regulators must step forward." That's the New York Times' analysis—that the EPA should take a lead role in regulation. Do you agree? If we want to ensure our shale gas resources are produced at a rate which keeps pace with cleaner energy demand, which agency or combination of agencies would be best?

Answer. The Subcommittee did not address the balance of responsibility between state and federal regulation. The states have historically been the principal regulator of oil and gas development on nonfederal lands. Numerous other regulatory functions are managed through a complex system of shared and delegated federal/state programs. The Subcommittee's second ninety day report did note that it has "unease that the present arrangement of shared federal and state responsibility for cradle-to-grave water quality is not working smoothly or as well as it should."

Question 5. I am interested to learn more about the Subcommittee recommendation to create a shale gas industry production organization, dedicated to continuous improvement of best practice through the development of standards. I agree that it makes sense to encourage best practices in the industry and that this gives the regulators and the public the confidence that the industry is self-policing and operating in the safest and most responsible manner. I am curious as to why the report does not acknowledge the already existing standards setting bodies, such as API and AGA. These organizations have already developed many standards related to hydraulic fracturing and are in the process of developing many more. It seems totally inefficient to require that an entirely new standard setting body be created. Is the lack of acknowledgement of these standards setting bodies an indication that you do not believe that they are sufficient?

Question 5a. The Subcommittee envisions that this new industry organization would be made up of member companies, NGOs and academic institutions, but does not mention any form of federal involvement. I wonder if the Subcommittee deliberately did not include the federal government in its list of prospective participants and for what reason it was excluded?

Answer. The Subcommittee did not exclude involvement of federal agencies in its consideration of its best practice organization models. There certainly should be a role for DOE, D0I, EPA, and USGS in the activities of such industry organizations.

The Subcommittee heard from the API in its public meeting and several members are familiar with the very valuable API and AGA standard setting activities. The Subcommittee stressed the importance of measurement and disclosure as central to monitoring improvement in practice and reduction in environmental impact. The Subcommittee has the impression that measurement and disclosure is not a central aspect of the current API and AGA standard setting activities.

You talk at length about the need for best practices in casing and cementing. You mention the fact that the API has a casing and cementing standard (API Standard 65-2), but then fail to comment on whether the API standard is sufficient, and if not, why not. The API casing and cementing standard covers both onshore and offshore operations and has been adopted into the federal regulations by the Bureau of Ocean Energy Management, Regulation and Enforcement.

Question 6a. Have you looked at this document?

Answer. Several members of the Subcommittee have reviewed this API standard.

Question 6b. My understanding is that this is a robust, technically sound standard that is designed to help ensure that methane migration does not occur before, during, and after drilling operations. Do you believe that this standard is insufficient?

As mentioned above this standard does not have measurement and disclosure as a part of the standard.

Question 6c. If so, do you think that the federal government made a mistake in adopting it into regulation?

Answer. The Subcommittee's task was to offer recommendations for ways to improve the safety and environmental performance of shale gas production and we believe that measurement and disclosure standards, if implemented, will have a beneficial effect.

Given that the Subcommittee membership includes the President of the Environmental Defense Fund, the head of the Pennsylvania EPA, and a well known environmental consultant, yet no active industry representative, there have been questions as to whether there exists any inherent bias amongst the Subcommittee members towards or against expanded natural gas development. Please explain how each member of the Subcommittee came to be a part of this Subcommittee.

Question 7a. Please explain how the panel is structured, what, if any, was the procedure for vetting the candidates, and whether adequate safeguards against bias or conflict of interests in the membership were taken?

Question 7b. If the members of the Subcommittee are not members of the SEAB, please describe who they are and whether they are deemed Special Government Employees, or Representatives.

Question 7c. Are the members on the Natural Gas Subcommittee identified anywhere within the FACA Database? If not, please explain why? If they are included, does the database identify their start and end date, their appointment type and term, as well as their pay plan (if any)?

Question 7d. Was the industry feedback solicited throughout the investigative process, and was industry input researched and considered, when not solicited?

Answer. The Subcommittee was selected by the Department of Energy and included members with experience in industry, the environmental community and states. Members were evaluated for conflicts of interest and agreed to recuse themselves if any such issues arose. As is typical with Secretary of Energy Advisory Board subcommittees, some members were not SEAB members but were drawn from the outside; they are not special government employees. The members of the Subcommittee are publicly listed on the SEAB website, including their biographical information (http://www.shalegas.energy.gov/aboutus/members.html). The selection of the Subcommittee members was also publicly announced by the Departmental on May 5, 2011. Members of the Subcommittee who are also members of the Secretary of Energy Advisory Board are listed in the FACA database with all of the required information. However, members of subcommittees that are not members of the full committee are not required to be in the FACA database and are not listed there.

All members began Subcommittee work on May 18, 2011, and ended work on November 18, 2011, and all were unpaid but per diem expenses were reimbursed.

As mentioned above, the balance of the membership of the Subcommittee was much criticized and thousands of the public comments received focused on the membership. The vast majority of those comments criticized the panel as too closely tied to industry.

Question 8. In the report, the subcommittee states that it will not weigh in on whether the States or the federal government should have the lead in regulating natural gas development. Yet, from a practical standpoint, shouldn't we first know whether the States are effectively regulating natural gas development, or whether the State/federal mix is appropriately balanced?

Question 8a. Should we not first complete a gap analysis of the regulations to determine whether the regulations are effective before making recommendations to change those regulations?

Question 8b. Isn't this the primary issue in front of us—whether the States are effectively regulating natural gas development?

Question 8c. If so, then how could the subcommittee not answer this question?

Answer. These are important questions that must be addressed by a group that has broader sponsorship than the DOE, which does not have regulatory responsibility. The Subcommittee did confer with the EPA, BLM and USGS and with a number of state regulatory authorities to learn how the regulatory process for shale gas production was evolving in the field.

Question 9. You provide many recommendations in your report, but for each recommendation you have not consistently described what is currently being done in the particular area. For example, you recommend that air regulation should be improved to minimize pollution of methane and other air pollutants. Yet EPA currently regulates air pollution and methane emissions though New Source Performance Standards, National Emissions Standards for Hazardous Air Pollutants, and National Ambient Air Quality Standards. In fact, EPA recently proposed a rule that is designed to significantly decrease methane emissions. Your report inaccurately stated that the new EPA rule is not designed to address methane emissions, yet the

rule is designed to do exactly that. In fact, the rule is designed to decrease methane emissions related to the hydraulic fracturing process. Will the 180 day report reflect this point and correct the mischaracterization of the rule?

Answer. There are no National Ambient Air Quality Standards for methane. EPA's proposed New Source Performance Standards and National Emissions Standards for Hazardous Air Pollutants for the oil and natural gas sector do not establish emission limits or standards for methane. The proposed rule contains emission limits for VOCs and EPA has recognized "many of the proposed requirements for control of VOC emissions also control methane emissions as a co-benefit." 76 Fed. Reg. at 52,756. We agree that these are interesting and important questions. The Subcommittee did not attempt in the short time given to it to conduct a survey of the history or content of every aspect of shale gas production and regulation.

Question 10. I agree with the finding of the report that resources dedicated to the oversight of the industry must be sufficient to do the job. But the report goes on to suggest that "fees, royalty payments and severance taxes are appropriate sources of funds to finance these needed regulatory activities," and I wonder if you could please clarify what you mean by this. Do you mean that the current level of fees, royalty payments and severance taxes are sufficient or are you saying that new fees, royalty payments and severance taxes are necessary?

Answer. The Subcommittee's recommendations are intended to underscore the principle that direct costs of the regulatory process should be part of permitting charges granted to licenses. There is a broader question about the general level of taxation of resource extraction that the Subcommittee did not address.

The Subcommittee recommends that states and localities adopt systems for measurement and reporting of background water quality in advance of shale gas production activities, but I wonder if the Subcommittee has evaluated how much this would cost and if it would even be feasible, given the various constraints that states and localities face. The report finding is that baseline measurements should be publicly disclosed while protecting landowner's privacy, yet there is no recommendation or discussion as to how this might be practicably accomplished. How can a policy protect landowner's privacy, and the value of that land, in the event that the baseline data would show very low quality water? One central theme of our recommendations is that development and disclosure of information is useful and necessary. Shale gas production has significant and undeniable benefits for the country, but controversy arises in part because of lack of information and attendant suspicions. We believe that information can improve public perceptions and improve both the production and regulatory processes. We firmly believe that if you measure something, you can improve it. In particular, gathering baseline information about water quality before production activity begins would resolve the frequent conflict between landowners alleging that their water has been contaminated and companies claiming the contamination was preexisting. We also recognize that there are difficulties in obtaining this information.

Question 11. I am concerned that there may be a lack of coordination between the SEAB review effort and the ongoing studies undertaken by EPA and by the BLM. Can you please explain what you know about the EPA National Fracking Study and about BLM's preparation of fracking "regulations"?

Question 11a. Has there been any formal or informal coordinating between EPA, BLM and your Board regarding fracking analysis?

Question 11b. What information, if any, related to the EPA fracking Study or the BLM effort has been provided to the SEAB?

Question 11c. Has EPA or BLM solicited any information or requested any consultation from the SEAB?

Question 11d. Given the budgetary constraints faced by these agencies, do you believe it would be beneficial for federal agencies to work together in addressing these issues?

Question 11e. Do you know if there was data from the EPA or BLM that shows that the concerns SEAB raised in their 90-day report have been resolved?

Question 11f. Could such data impact your 180-day report?

Answer. The Subcommittee consulted with EPA and the Department of the Interior (both BLM and the U.S. Geological Survey) and was briefed by senior officials at each agency. Agency officials appeared at public Subcommittee meetings and provided valuable information (all of 14 which is posted on the website). The Subcommittee understands that DOE, EPA, and Interior are working together on research issues and coordinate on other natural gas issues as they arise. DOE is providing technical assistance to EPA regarding its water study. We understand that all three agencies are actively reviewing our recommendations and taking steps to implement them as appropriate.

Question 12. The oil and gas producing states, the Interstate Oil and Gas Compact Commission, which represents those states, and the Groundwater Protection Council, among others, have shown persuasive evidence and record that the states are in the best position to regulate both oil and natural gas development. You even heard from a panel of state regulators who testified directly before the subcommittee that they have the expertise and resources to serve as effective regulators and that regulation should remain their responsibility. Do you disagree? Why does the report omit comment on this issue?

Answer. The Subcommittee met with each of these entities and benefitted greatly from information provided by them. We agree that a great deal of good work is being done by them. We also understood that states have historically been the principal regulator of oil and gas operations on non-federal lands. The Subcommittee was not tasked with making regulatory policy decisions so our reports refrained from doing so.

Question 13. Please describe the current safeguards in place to ensure that groundwater is protected in areas where fracking is used.

Answer. The Subcommittee did not in the short time available to it undertake a comprehensive survey of such practices, which we understand vary.

Question 14. Please describe the role of state regulatory bodies in overseeing and safeguarding water resources.

Answer. State regulatory bodies share oversight and enforcement responsibilities with the EPA on private land. The DOl's BLM shares oversight and enforcement responsibility with EPA on federal lands.

Question 15. Please describe the processes generally undertaken once water is recovered through the fracking process.

Answer. In general terms, flow back and produced water is stored temporarily in holding ponds and can potentially follow four different disposal pathways: (1) runoff to streams and waterways (almost everywhere prohibited), (2) reused as fracturing fluid for new wells, (3) injected in underground disposal wells, and (4) sent to treatment facilities. Each pathway is subject to different regulatory oversight.

Question 16. Please describe the depths where the shale is generally found, and the natural geologic barriers between the areas of exploration and production, and the freshwater aquifers supplying drinking water. Do these barriers provide additional protection, to the current safeguards in place, for our water resources?

Answer. Shale gas formations vary across the country as to depth. The risks to drinking water depend upon local circumstances, including surface activity. The great majority of shale gas formations being developed are thousands of feet below the depth of the water wells.

Question 17. There does not appear to be any direct recognition in the report of states' ability to quickly adapt to new levels of development and create an effective regulatory regime. Having worked for the Pennsylvania Department of Environmental Protection, were you able to share with the Subcommittee the strong steps taken by the State of Pennsylvania in just the past three years? (For instance, Pennsylvania has strengthened its water withdrawal regulations, has strengthened its drilling standards, now requires a buffer between operations and streams, has increased the fee required for an application for a drilling permit, and has increased its staffing from 88 to more than 200.) With Pennsylvania being so close to the center of this public debate, why is there not more discussion in the report of the steps taken by Pennsylvania to address many of the concerns raised in your report? Will the final report, as an example of how a state is proactively addressing and mitigating the impacts surrounding increased natural gas development, include more discussion of Pennsylvania's approach and experience?

Answer. The Subcommittee met with the head of Pennsylvania DEP, and with regulators from several other states, and has followed the state's activities regarding this issue. Ms. McGinty spoke specifically at the hearing to new measures the commonwealth had announced just the 16 day before the hearing that represent another important contribution to ensuring environmentally sound gas production.

Question 18. From an emissions standpoint, especially as regards power generation but also as regards fleet vehicles, is it preferable for natural gas supplies, to remain accessible and, thereby, abundant?

Answer. Yes, the Subcommittee agrees that natural gas is a very valuable source of energy for the nation for many purposes.

Question 19. From an emissions standpoint, especially as regards power generation but also as regards fleet vehicles, is it preferable for natural gas prices to remain at or near their current levels of affordability?

Answer. Lower energy prices benefit the consumer. The Subcommittee did not speculate on the likely future trajectory of natural gas prices.

RESPONSE OF THE SECRETARY OF ENERGY'S SUBCOMMITTEE ON SHALE GAS PRODUCTION TO QUESTIONS FROM SENATOR STABENOW

Question 1. In your 90 day report you briefly mention green drilling and fracturing fluids as an area that deserves more R and D. (p.32). What kind of alternative fracturing techniques are available today and how often are they used?

Answer. The Subcommittee is convinced that industry has the incentive to develop and adopt more efficient technical advances that will reduce the actual or potential environmental impact of shale gas production—several examples were mentioned in the first ninety day report such as real time monitoring of fracturing fluid placement, development of alternative fracturing fluids to water, induced seismicity, and so-called "green" fracturing fluids. The Subcommittee believes that the environmental aspects of shale gas development are appropriate subjects for federal research and development work.

RESPONSES OF THE SECRETARY OF ENERGY'S SUBCOMMITTEE ON SHALE GAS PRODUCTION TO QUESTIONS FROM SENATOR MANCHIN

Question 1. The Secretary of Energy Advisory Board Shale Gas Production Subcommittee ("Subcommittee") recommends improving public information about shale gas operations through the creation of a new access portal while also recognizing the value of expanding and using existing tools such as the Risk Based Data Management System. Has the Subcommittee fully researched whether a mechanism or portal currently exists through organizations such as the Interstate Oil and Gas Compact Commission that can serve as a central repository of information?

Answer. The Subcommittee understands that the Ground Water Protection Council, in cooperation with the IOGCC, operates an excellent and continually improving database for disclosure of fracturing fluids. We met with both entities and benefitted from the information they provided. The Subcommittee called for more expansive disclosure of additional types of information from a wide variety of state and federal agencies that already collect this information, beyond that which GWPC currently contemplates. We believe any other efforts in this area certainly should take into account and coordinate with the GWPC website and be complementary to it.

Question 2. The Subcommittee believes the creation of a new shale gas industry production organization dedicated to continuous improvement of best practice is necessary. Did the Subcommittee fully consider what organizations currently exist that could perform the function?

Answer. Yes, the Subcommittee considered a wide variety of possible organizational arrangements. For example, the Subcommittee had the benefit of information and briefings from API, which has managed a valuable standardization effort for many years. On balance, the Subcommittee believes a new industry led initiative is justified, emphasizing measurement, disclosure and use of these measurements to document a progress improvement in practice and environmental action.

Question 3. The Subcommittee is charged with identifying measures to improve the safety of shale gas production. Has the Subcommittee considered the operational onsite safety procedures and specifically, identification of a framework within which safety standards and procedures for each phase of the activity can best be established and impleriiented across the industry? Will the best practice recommendations address training aspects for workers and emergency response teams when accidents occur?

Answer. The Subcommittee did not attempt to provide detailed guidance on the specific content of operational safety or training procedures.

Question 4. Has the Subcommittee fully considered the application of existing laws and regulations for protecting air quality and water quality?

Answer. In the short time available to us, we did not conduct a detailed survey of applicable law and regulations that apply in this field.

Question 5. The National Energy Technology Laboratory ("NEIL") in Morgantown has supported shale gas related research for quite a number of years. Arguably, that research has provided some of the underpinnings to the extensive development of shale gas resources that is underway today. In fact, the Subcommittee makes note of a NETL analysis related to the greenhouse gas footprint for cradle-to-grave use of natural gas in its 90 day report. The Subcommittee recommends that additional assessment of the greenhouse gas footprint [related to shale gas development] be undertaken and that "a project of this scale will be expensive."

Answer. The Subcommittee is aware of the depth and variety of expertise at DOE and its laboratories, including NETL, as well as expertise in other agencies and research organizations.

Question 6. Does the Subcommittee recognize that NETL with its university, industry, and national laboratory partners is well positioned to lead such an effort?

What order of magnitude in terms of funding would the Subcommittee deem appropriate to complete this "expensive" project?

Answer. The Subcommittee defers to the Administration and Congress on appropriate funding levels, but agrees that the project is a worthy one and that NETL is one of several qualified candidates to perform the work.

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