THE FUTURE OF COAL UNDER CLIMATE LEGISLATION

HEARING

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OF THE

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THE FUTURE OF COAL UNDER CLIMATE LEGISLATION

TUESDAY, MARCH 10, 2009

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON ENERGY AND ENVIRONMENT,
COMMITTEE ON ENERGY AND COMMERCE,
Washington, DC.

The subcommittee met, pursuant to call, at 9:35 a.m., in Room 2123 of the Rayburn House Office Building, Hon. Edward J. Markey (chairman) presiding.

Members present: Representatives Markey, Doyle, Inslee, McNerney, Dingell, Boucher, Green, Gonzalez, Matheson, Barrow, Waxman (ex officio), Upton, Hall, Stearns, Whitfield, Shimkus, Pitts, Sullivan, Scalise, Barton (ex officio), and Terry.

Staff present: Matt Weiner, Clerk; Alexandra Teitz, Senior Counsel; Joe Beauvais, Counsel; Melissa Bez, Professional Staff; Ben Hergst, Senior Policy Analyst; Lindsay Vidal, Press Assistant; and Michael Goo, Counsel.

OPENING STATEMENT OF HON. EDWARD J. MARKEY

Mr. MARKEY. Welcome to the Subcommittee on Energy and Environment, and our very important hearing on the Future of Coal Under Climate Legislation. For the information of the members, this hearing is being televised, recorded by C-Span, and we thank Mr. Shimkus for his help in making sure that we have the cameras working. We have portable cameras in here today showing the ingenuity of technological innovation when necessity requires, and that breakthrough is the same kind of breakthrough that I think we are going to hear in coal and its sequestration and other potential processes.

Before we get started this morning, I want to inform the members and their staff that tomorrow from noon to 1:00 p.m., the Secretary General of the United Nations, Mr. Ban Ki-moon, will brief our members and their staffs. The subject of the briefing will be global climate change and the international negotiations leading to the U.N. climate conference this December in Copenhagen. This briefing is for subcommittee members and their staffs only and will not be open to the public or the media. Secretary General Ban will address the subcommittee after which members will have an opportunity to direct questions to him. This is a great chance for us to have an open exchange with the Secretary General on this critical issue, and I strongly urge the members to attend so they can do so.

There is a growing consensus that to avoid catastrophic climate change, we must cut global greenhouse gas emissions by at least 50 percent by 2050. U.S. emissions must be cut by at least 80 percent in the same period. Those objectives, quite simply, cannot be achieved unless we act quickly to control coal-fired powered plants. Coal supplies half of all electricity in the United States, and we have the largest coal reserves in the world. China and India also have abundant reserves and are even more coal dependent. But while coal is plentiful, it is also the leading source of global warming pollution. Coal-fired power plants are responsible for over a quarter of all U.S. and global greenhouse gas emissions. We are at a watershed moment.

By 2030 U.S. electricity demand is expected to increase by 30 percent and global demand will double. Coal's role in meeting that demand will play a huge role in determining the fate of our planet. Globally as many as 3,000 coal-fired power plants are projected to be built by 2030. These new plants alone would increase global emissions by 30 percent. At the same time, coal's future here in the United States is deeply uncertain. In the face of escalating public opposition and regulatory risk dozens of planned coal-fired plants have been cancelled in the last 2 years.

The Department of Energy's Energy Information Administration is now predicting a flat line in construction of new coal plants over the next 20 years. Meanwhile, the Environmental Protection Agency is expected to move forward with regulation of carbon dioxide emissions from power plants and other sources under the Clean Air Act. Carbon capture and storage or CCS offers a path forward for coal and opportunity for the U.S. economy and a bridge to a low carbon future. CCS generally involves capturing CO_2 emissions at the source and disposing of the CO_2 in deep geological formations. All indications are that CCS is a viable interim solution to the coal problem.

CCS could also dramatically increase domestic oil production by providing abundant CO_2 for enhanced oil recovery. Ultimately, CCS can go beyond geological disposal. For example, Silicon Valley based Calera Corporation is proposing to convert captured CO_2 into cement. That technology could be a game changer, a win-win solution that would dramatically reduce cement's carbon footprint while sequestering billions of tons of CO_2 from power plants. All these advances are possible but only if we enact the right policies to drive innovation. The economic recovery package passed last month includes 3.4 billion in advanced coal technology funding much of which will be used for CCS demonstration projects. But ultimately only climate legislation can provide CCS the boost it needs to create jobs and unleash the private sector's vast resources and ingenuity. We need regulatory drivers and strong incentives.

An economy wide cap on global warming pollution will provide the long-term investment incentive, but the cap alone will not insure rapid deployment of CCS. To drive innovation, we must require new coal plants to use CCS by a certain date. At the same time, we must provide robust financial incentives for early development of this technology. This carrot and stick approach was included both in my ICAP legislation and in the discussion draft put forward by Mr. Dingell and Mr. Boucher last year. If we fail to

bring CCS online quickly, we will have the worst of all worlds. Coal's future here in the United States will remain dim and the fleet of coal-fired plants being built in China and India will swamp whatever emissions reductions we achieve at home.

But if we blaze this trail, the world will follow, and we will reap the environmental and economic rewards of leadership. I trust that this morning's hearing will help guide us in that endeavor.

Mr. MARKEY. Let me turn now and recognize the ranking member, the gentleman from Michigan, Mr. Upton, for his opening statement.

OPENING STATEMENT OF HON. FRED UPTON

Mr. UPTON. Thank you, Mr. Chairman. The future of coal mirrors the future of our economy. Coal provides inexpensive American made energy to power our manufacturing sector and keep electricity affordable for millions of Americans, and, like it or not, without coal the U.S. would hemorrhage millions of jobs. Electricity rates would skyrocket and we would become dependent on imported natural gas to meet electricity demand. In a recent hearing, Treasury Secretary Geithner said cap and trade will increase the cost of energy on those fuels that are high in carbon. For people whose behavior is energy, and energy use doesn't change, the cost will go up. Translation, coal has a big target on its back and America's working families already struggling will get stuck with the bill. Now is not the time to send those costs higher. Now is not the time to turn our back on coal.

It is imperative that we continue to take advantage of our Nation's vast coal resources, which have the promise to produce clean and affordable power for generations, and in our quest to reduce greenhouse gas emissions and protect the environment, we must promote clean coal technologies that will not only keep costs down from consumers but also foster new jobs and a strong economy. These technologies exhibit great promise and encouraging advancements in carbon capture. We will be able to responsibly fortify our Nation's energy supply with American made energy and protect the pocketbooks of our Nation's consumers as well. Last year, members of this committee introduced legislation that would block any new coal-fired power plant without carbon capture and sequestration.

At the same time, I introduced bipartisan legislation with Representatives Boucher, Barton, and Shimkus that would spur investment in CCS technologies, and surprisingly none of the co-sponsors of the anti-coal bill co-sponsored our bill that would insure CCS actually would become available. We plan on reintroducing our CCS deployment bill in the next few days, and I would hope members of this committee would join us in co-sponsoring that important legislation. In '08, the IEA noted CCS offers a viable and competitive route to mitigate CO_2 emissions. Current spending and activity levels are nowhere near enough. Investment in CCS will only occur if there are suitable financial incentives. The next 10 years will be critical.

To put our existing policies in perspective, wind currently enjoys a subsidy of $24.35 per megawatt hour versus 44 cents for coal, 24.35 versus 44 cents. Wind must be an important part of the overall equation, but it will never compare to the base load generation

that we need for coal. To replace the 3,300 megawatt coal-fired plant in Monroe, Michigan that sits on 200 acres and runs at greater than 90 percent capacity would require 6,000 wind turbines covering some 300,000 acres generating a 30 percent capacity and over 2,300 megawatts of natural gas generation to act as a backup at nearly double the cost. By insuring that CCS becomes available, we won't need to set arbitrary mandates that will send electricity rates through the roof and American jobs overseas.

We have a choice, pursue irrational policies that will bankrupt America's working families and eviscerate our economy or pursue sound policies that in fact will improve our environment, preserve the intensity of our economy, and keep costs down for consumers. We are clearly at a crossroads. Whatever course of action we pursue, we do so with the economy in a precarious position. By using a common sense, no regrets legislative approach that focuses on deployment of all clean energy, we can avoid a costly cap and trade scheme that will have no impact on emissions from the developing world. Instead, we will advance technology that creates U.S. jobs and provides the opportunity to export. Working Americans will be better off. I yield back.

Mr. MARKEY. The gentleman's time has expired. The Chair recognizes the chairman of the full committee, the gentleman from California, Mr. Waxman.

OPENING STATEMENT OF HON. HENRY A. WAXMAN

Mr. WAXMAN. Thank you very much, Mr. Chairman. Today's hearing is about the future of coal, and as we seek to reduce both domestic and global greenhouse gases addressing the use of coal will be at the center of our efforts in the years to come. The U.S. has abundant reserves of coal, and generating electricity from coal is inexpensive relative to other fuel types. Currently roughly half of our Nation's power is supplied by coal. Although coal is abundant the emissions resulting from its use are massive. Burning coal results in roughly twice as much carbon dioxide being emitted as compared to using natural gas.

Coal-fired plants, which are large and typically have life spans measured in decades, can emit millions of tons of carbon dioxide per year. Today about 80 percent of the CO_2 emissions from domestic electricity generation come from coal. The U.S. and other countries are recognizing there is simply no way we can continue to use coal the way we do today if we intend to tackle climate change in a meaningful way. State energy companies and particularly the investment community have all begun to understand this new reality. With EPA regulation of carbon pollution imminent, new coal facilities are facing longer details and more cancellations. Climate change legislation that provides a framework for the substantial reduction of greenhouse gas emissions and that lays down clear rules going forward will provide a certainty to the marketplace. This is necessary to protect our planet, necessary to insure the long-term viability of coal, both domestically and globally.

Today's hearing will examine the technologies that could allow for the continued use of coal while substantially reducing carbon dioxide emissions. In particular, we will hear about the technologies that will enable us to capture carbon and store it in geo-

logic formations and underground. I believe these technologies hold great promise. The individual components of carbon capture and storage or CCS technologies are well understood and in many cases have been used in industrial settings for years. The challenge ahead of us is putting all the pieces together in a way to enable the cost effective production of low carbon electricity from coal.

I hope this hearing will explore the ways in which federal climate legislation can help industry deploy CCS to realize its full economic and technical potential. Accomplishing that objective is essential if coal use is to be part of our Nation's low carbon energy future. I look forward to hearing the input of our witnesses on what role coal can play as we seek to address the threat of global climate change, and as we transform our Nation's economy to low carbon sources of power. Thank you, Mr. Chairman.

[The prepared statement of Mr. Waxman follows:]

Opening Statement of Rep. Henry A. Waxman
Chairman, Committee on Energy and Commerce
"The Future of Coal under Climate Legislation"
Subcommittee on Energy and Environment
March 10, 2009

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I look forward to hearing the input of our witnesses on what role coal can play as we seek to address the threat of global climate change and as we transform our nation's economy to low-carbon sources of power.

Mr. MARKEY. Thank the gentleman. The Chair recognizes the gentleman from Texas, Mr. Barton.

OPENING STATEMENT OF HON. JOE BARTON

Mr. BARTON. Thank you, Mr. Chairman. I appreciate you starting this hearing at 9:30. You saved me from having to go to a political meeting at the NRCC, so there is one good thing about this. It is good to have the hearing record being established on climate change and potential legislation. I am seriously supportive of establishing a true and fair record. And I think today's hearing is probably the—I am not sure how many others you are going to have, but I believe this is one of the most important ones, if not the most important, because as the chairman just pointed out, and other members of the panel, we are generating half of our base power load of electricity with coal, and it is an abundant domestic resource.

We have somewhere between 250 and 500 years of supply of coal depending on the technologies that we choose to employ, and something that is not often said but I think needs to be said it is our cheapest base load fuel source. I know the advocates of climate change legislation aren't too concerned about the cost but if you look at the map of states, states like Kentucky and West Virginia and Ohio, their average retail price for electricity is somewhere between 5 and 6½ cents a kilowatt hour. They get over 90 percent of their electricity from coal, generated by coal power. On the other hand, if you look at your state, Mr. Markey, it gets only 2 percent of its electricity from coal generation and its base load cost, retail cost, is 15.4 cents kilowatt hour.

The full committee chairman's State of California's electricity cost at retail is almost 15 cents. Well, you know, you compare 5 cents to 15 cents, that is 300 percent cost differential. Now if you are a Hollywood producer, it probably doesn't matter much, but if you are a manufacturer that is operating on a 2 percent margin, and you have to decide whether to keep your plant open in Ohio or move it to Mexico or China, it matters a lot. So coal matters. Our economy matters. We are in a very serious economic situation, and if we start shutting down coal-fired power plants, we just make our economic problems worse, not better.

The issue at hand is the capture of CO_2. Now CO_2 is not a criteria pollutant under the Clean Air Act. It is not like lead. It is not like sulfur dioxide. It is not ozone. It is not like any of those things. CO_2 is a naturally occurring compound. It is a greenhouse gas. That is a true statement. It is not a pollutant in the sense of the word that it is harmful to public health. I am producing CO_2 as I speak. I drink 3 or 4 Diet Dr. Peppers a day. They have CO_2 in them. That is what makes it a carbonated beverage. So it is a little bit different breed of cat.

And we can be on both sides of the issue. Somebody like me who is a climate change skeptic, and somebody like Mr. Markey or Mr. Waxman, who is a true believer, and still think that we need to do something to capture or convert CO_2 if we can do it economically, if we can do it economically. We don't want to raise the price of coal to 15 cents a kilowatt hour at retail. We don't want to destroy the industrial base of America. So if we get this right, and Mr.

Boucher has got a bill to do the research to see if there is a technology that works. I am a co-sponsor. I am going to be a co-sponsor when he reintroduces it some time in the near future. If we can get coal right in America, Mr. Markey can be happy, and I can be happy, and everybody can be happy, and all God's children can be happy, but we got to get it right. We can't kill coal.

And so I am glad to see David Crane here. His company is a big industrial producer of electricity in Texas, and we are proud that he is although I wish he wasn't headquartered in New Jersey. It kind of galls me but that is the way it is. I am glad to see Mr. Hawkins here because he is one of the international experts, and I am glad to see somebody from the Mining Association in Ms. Patton, who is going to talk about some of the liability issues. This is a good panel, Mr. Chairman. And, as I said earlier, this is I think the most important hearing and if we get this hearing right and the policy coming out of it right our country has a chance to stay economically competitive. So with that, I yield back.

Mr. MARKEY. We thank the gentleman. The chair recognizes the gentleman from Michigan, Chairman Emeritus Dingell.

OPENING STATEMENT OF HON. JOHN D. DINGELL

Mr. DINGELL. Thank you, Mr. Chairman, and thank you for holding this hearing. It is an important one. The future of coal is an issue that must be addressed if we are to succeed in passing meaningful climate change legislation. As we all know, currently coal generates more than 50 percent of the United States electricity supply. We have hundreds of years of coal reserves. Realistically, coal must and will play a significant part in our energy future. The challenge, however, is to balance the need for dramatically reducing their greenhouse gas emissions with the continuing need for coal to power this Nation. To meet this challenge legislation must spur development and deployment of carbon capture and sequestration, CCS technology.

China and India's reliance on coal makes the need for this technology that much greater. And when I hear my friends amongst the environmentalists tell us how we should develop technology, I agree, but this is some of the technology that should be developed here. One approach this committee considered at a hearing last year is Mr. Boucher's Carbon Capture and Storage Early Deployment Act. I was very sympathetic and remain so to that excellent piece of legislation. This bill is based on recommendations put forward last year by the advanced coal technology work group, an advisory panel to the EPA. I urge this committee to look at this draft legislation when considering broader climate change legislation although some changes may be appropriate given CCS provisions in the stimulus bill incorporating large scale grant programs to accelerate the commercial demonstration of CCS and for testing carbon dioxide storage sites which is essential to the success of CCS and therefore essential to the success of comprehensive climate change legislation.

We are also becoming aware of the fact that there are now technologies which can be used by this country to convert CO_2 emissions from power plants into a useful raw material for other industrial processes. This also must be pushed forward. The committee

should also consider the CCS deployment program that Representative Boucher and I and other members of this committee released last year. We proposed an incentive system for carbon capture and sequestration technology. Power plants or large emitters that adopt CCS technology early would receive bonus allowances. A similar incentive system was included in the Blueprint for Action put forward by USCAP, an alliance of industry and environmental groups. Both the Boucher-Dingell draft and the Blueprint for Action coupled with the incentive program with requirements that insure that newly permitted coal-fired facilities will employ technology to capture and store carbon emissions.

The date for compliance, however, merits further discussion in my view as we yet do not know when CCS technology can be ready. Therefore, in this hearing I look forward to hearing more about progress being made on CCS technology and prospects for wide scale commercial use. Many questions still need to be answered including can we achieve significant reductions in greenhouse gas emissions before CCS technologies are ready. Are we doing enough to insure that these technologies are on track? How will carbon stored underground impact water resources and the environment generally? What happens to CO_2 after it is captured? Who owns it? Who is responsible for keeping it safe? These are just a few of the important questions that need to be answered about carbon capture and sequestration technology.

I look forward to hearing from our witnesses and learning more about the future of coal and climate legislation, and I warn that this country must proceed carefully, wisely and well lest we create greater harm than benefit. I thank you, Mr. Chairman.

Mr. MARKEY. We thank the gentleman. The chair recognizes the gentleman from Kentucky, Mr. Whitfield.

OPENING STATEMENT OF HON. ED WHITFIELD

Mr. WHITFIELD. Chairman Markey, thank you very much, and we certainly appreciate this important hearing on coal and the impact that environmental legislation and climate change legislation can have on this industry. I noticed that over the last couple of days the 2009 International Conference on Climate Change has been meeting in New York City, and basically that is a group of skeptics of global climate change. Primarily, I noticed in reading some of the speeches yesterday they were talking about the atmosphere of people creating an alarmist state on this whole issue, and that is one of the reasons why this hearing is particularly important because when you have one entity, the coal industry, providing 50 percent of the electricity in our country and then recently we met with a group of Chinese who came over, energy experts, and they quoted—they set out the fact that in China they are bringing on one new coal-powered plant into operation about every 2 weeks.

And that is why it is so vitally important that as we look at climate change legislation, we look at cap and trade legislation. We look at renewable mandates and the impact that that can have on the economy in the U.S., particularly at this time when our economy is weakening, unemployment is going up, if we do not move very carefully then I believe that we can put the United States at an economic disadvantage to other countries particularly like

China and India who are relying more and more on the fuel that produces electricity at the most economical cost.

And the thing that is really frustrating about all this is that as we look at the models projecting the future of global warming it is really almost impossible to detect the total cost of what the impact of that might be, and yet we can very clearly demonstrate the cost of renewable mandates and how much they will increase electricity, how that will make us less competitive in the global marketplace and will go a long way, I believe, in harming our economy as we try to come out of this economic decline. So I look forward to this hearing. I think it is vitally important and I yield back. I see I have no time to yield back.

Mr. MARKEY. The gentleman's time has expired. The chair recognizes the gentleman from Pennsylvania, Mr. Doyle.

OPENING STATEMENT OF HON. MICHAEL F. DOYLE

Mr. DOYLE. Mr. Chairman, I would like to start by thanking you for having this important hearing today. Mr. Chairman, it is clear that coal remains the fuel that powers the world for years to come even as we work dramatically to expand our own Nation's renewable energy technologies. Your recognition of this fact is much appreciated, and I want to offer you my continued support as we put together policies and incentives to encourage the rapid and immediate deployment of widespread carbon capture and storage technologies. In a hearing last week, British Secretary of State for Energy and Climate Change, Ed Miliband, warned our committee about the massive expansion of the Chinese economy expected over the next decade. This is an economy that is 78 percent powered by coal and has projected increases in emissions that are many times the current emissions of the entire European Union.

Without widespread development and deployment of CCS technologies here in the United States, and the selling of these technologies to nations such as China, we will never be able to achieve the worldwide reductions we need to combat climate change. It is not a question of if we can do this, it is a question of how fast can we get it done. The building and export of clean technology such as CCS will revitalize our Nation's manufacturing base as America will become a world leader in the production of clean and cheap energy. Investments in CCS technology as well as those in wind and solar power will help lead this energy revolution here at home while the technologies we export will generate tremendous carbon reductions abroad.

I look forward to continuing to work closely with you, Mr. Chairman, so that we can make the widespread deployment of CCS a reality here at home as well as abroad. And I yield back.

Mr. MARKEY. We thank the gentleman. The chair recognizes the gentleman from Illinois, Mr. Shimkus.

OPENING STATEMENT OF HON. JOHN SHIMKUS

Mr. SHIMKUS. Thank you, Mr. Chairman. I will try to respect your comments from last week and start in third gear, not overdrive, as I did last time. To my colleague from Pennsylvania, I think that was the same guy who said he is not going to permit a single new coal-fired power plant in his country in that discus-

sion, and I think that is what this is all about. I also want to appreciate the C-Span coverage, Mr. Chairman. This is really important for the public to understand and if this is our only shot then we need to take advantage of it. And it is a very good panel. I want to agree with Congressman Barton.

Here is an article from the Alton Telegraph, 3,000 workers needed for refinery construction. There is an expansion going on. 100 full-time jobs will be added. This is what I want to see in the coal industry, but what I see especially—and we talked about this too last week, Mr. Chairman, is Peabody, you are going to get tired of seeing this, Peabody 10, 1,000 mine workers closed because of the Clean Air Act amendment, actually 1,200. These are the individuals who lost their jobs. That is my passion and that is my focus. I actually found out more stats. This is another request I have for you, Mr. Chairman, to invite the United Mine Workers here to talk about the impact of job loss because I am throwing out what happened in the Midwest. Hopefully, they can give me the reasons why they are strangely silent on this bill, but after the '90 amendment in Southern Illinois alone 18,200 mine workers were working the mines in southern Illinois.

That United Mine Worker region was reorganized into a 3-state region that represented only 4,000 United Mine Workers. There is a devastating effect on this to jobs, rural America, and coal areas of this country. We better, in the words of John Dingell, tread very carefully. And I yield back.

Mr. MARKEY. The gentleman's time has expired. The chair recognizes the gentleman from Texas, Mr. Green.

OPENING STATEMENT OF HON. GENE GREEN

Mr. GREEN. Thank you, Mr. Chairman. And seeing my colleague from Illinois hold up that sign about 1,000 workers needed to expand that refinery, we do expand refineries in my part of the country. And it is interesting following the merger, you say the United Mine Workers, I have the same thing in my area, the United Steel Workers. We don't have any steel plants, so to speak, in my area, but now they represent all my refineries so it is interesting what the market and the economy has done. Today's hearing reflects on the critical need to address coal's future, both under climate legislation and within our broader national energy security strategy.

While coal emits high levels of carbon dioxide, it is also one of our Nation's most abundant energy resources. Long-term strategies must be in place to reduce coal's carbon footprint and incentivize new technology development for carbon capture and sequestration, CCS, in order to utilize our vast coal reserves. CCS is one of the most important possible solutions for climate change unlike capture carbon injection technology is well-established and has been used for enhanced oil recovery for over 30 years. The Permian Basin in west Texas is home to the majority of carbon dioxide injection in the entire world. This is good news for addressing climate change and producing more domestic energy.

Federal policies to encourage the development of CCS related technologies are key to avoiding severe cost disruptions in our economy. Several cost models for climate change tell us that one of the largest variables for the impact of energy costs under the cli-

mate change program is the availability of CCS. EPA's analysis last year of the Leiberman-Warner bill indicated that CCS could account for 30 percent of CO_2 reductions by 2050 which would involve injecting several gigatons of CO_2 underground. If CCS technologies were unavailable or not commercially viable these reductions would have to come from elsewhere and likely at a higher cost.

I hope today's hearing and testimony will shed some light on the most appropriate policies and approaches to develop CCS technologies when allowance prices may not be sufficiently high to encourage rapid development of CCS. And, Mr. Chairman, like my colleague from Texas, I want to welcome Mr. Crane. NRG has a great office in Houston and does a lot of different things. Although we will try to do NRG just like we did Calpine. Calpine actually expanded more alternatives and natural gas facilities in my district than they did in California so they opened up an office in Houston and California Energy is now Calpine in Texas, so we don't mind you expanding your office in Houston. I yield back my time.

[The prepared statement of Mr. Green follows:]

Congressman Gene Green
Energy and Environment Subcommittee Hearing
"The Future of Coal Under Climate Legislation"
March 10, 2008

Today's hearing reflects on the critical need to address coal's future both under future climate legislation and within our broader national energy security strategy.

While coal emits high-levels of carbon dioxide, it is also one of our nation's most abundant energy resources.

Long-term strategies must be in place to reduce coal's carbon footprint and incentivize new technology development for Carbon Capture and Sequestration, or CCS, in order to utilize our vast coal reserves.

CCS is one of the most important possible solutions for climate change. Unlike capture, carbon injection technology is well-established and has been used for enhanced oil recovery for over thirty years.

The Permian Basin in West Texas is home to the majority of carbon dioxide injection in the entire world. This is good news for addressing climate change and producing more domestic energy.

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EPA's analysis of last year's Lieberman-Warner bill indicated that CCS could account for 30% of the CO2 reductions by 2050, which would involve injecting several Giga-tons of CO2 underground.

If CCS-technologies were unavailable, or were not commercially-viable, those reductions would have to come from elsewhere and likely at higher cost.

I also hope today's hearing and testimony will shed some light on the most appropriate policy approaches to develop CCS-technologies when allowance prices may not be sufficiently high to encourage rapid CCS-deployment.

Thank you Mr. Chairman, I yield back my time.

Mr. MARKEY. The gentleman's time has expired. The Chair recognizes the gentleman from Florida, Mr. Stearns.

OPENING STATEMENT OF HON. CLIFF STEARNS

Mr. STEARNS. Good morning, and thank you, Mr. Chairman. As pointed out by other speakers, the United States is the Saudi Arabia of coal, and we talked about the huge reserves that we have in this country. Recently, some of this research was put together in a paper that was published in the Stanford Law Review, December addition, so that I am a strong advocate of coal, and I was happy to see that President Clinton recently said—excuse me, President Obama recently said—"This is America. We figured out how to put a man on the moon in 10 years. You can't tell me we can't figure out how to burn coal that we mine right here in the United States of America and make it work." So I think his statement, Mr. Chairman, shows that he recognizes, with the huge reserves we have, it is a national security to use that and learn to mine it right and to figure out to burn coal that does not affect our environment.

It is so abundant in this Nation. In fact, on the average, coal costs $1 to $2 per million BTU compared with $6 to $12 per BTU for oil or natural gas and because of this plentiful and cost-effective coal reserves, power plants fueled by coal account for more than half of this Nation's electricity production, but because of the recent regulatory uncertainty surrounding climate change legislation, only 12 new coal-fired power plants have been built in the United States since 1990.

Coal is a prime source of energy throughout the world as pointed out, particularly their moving ahead in China and will inevitably remain so as worldwide energy demand continues to rise. So, Mr. Chairman, any meaningful effort to achieve long-term, sustainable reduction in global greenhouse gas emissions will depend on the development and deployment of new energy technology including advanced clean coal technology and carbon capture and sequestration. The rapid development demonstration of widespread deployment of such technologies are of paramount importance in any reasoned and effective effort to address climate change concerns. Thank you, Mr. Chairman.

Mr. MARKEY. We thank the gentleman. The Chair recognizes the gentleman from Washington State, Mr. Inslee.

OPENING STATEMENT OF HON. JAY INSLEE

Mr. INSLEE. There is widespread agreement that the future of the country's economy, the future of the planet, my grandkids' future depend upon the ability to find a technology to use coal cleanly. But I want to make two points that have not been made here yet. Point number one, this requires a major, technological transformation. It requires us to really look at the horizons and know the companies that are challenging those horizons right now. I want to list three of them. The Ramgen Power Systems Company in Bellview that has a compression technology that might reduce the cost of compression of CO_2, which is necessary for geological sequestration by 30 percent.

The Calera Cement Company that has found a technology where you can sequester CO_2 from coal-fired plants in building materials so that we can make CO_2 part of our buildings rather than wasting it and putting it below ground. The Sapphire Energy Company in San Diego that has a way to take algae that can eat the CO_2 from the smoke stacks and produce a gasoline product chemically undistinguishable from gasoline. We need these technologies to advance, and that leads to point two. We have to have a fund by which to fund this research and development. And here is the point I want to make to my friends who want to advance coal. To have that fund, we have to have an auction of the permits under the cap and trade system.

If, and only if, we have an auction that will generate revenues that can be used to help the coal industry develop these technologies does coal have a future in this country or anywhere on the planet. If we are going to sell these technologies to China, which we have to do so that China will not destroy the planet Earth, we are going to have to have a fund to invest in these technologies. The biggest debate in Congress this year on energy will be about this issue of whether we are going to have an auction, or whether we are going to give these permits away, and what we are going to use the money for, and I hope my friends who advocate for coal recognize the existence of this industry depends on actually having auctions and having the revenues that can save this industry for a future for the United States.

So I know that seems counter-intuitive to some of my friends of coal, but until we realize the necessity of those revenues, we are not going to get this job done. Thank you.

Mr. MARKEY. The gentleman's time has expired. The Chair recognizes the gentleman from Louisiana, Mr. Scalise.

OPENING STATEMENT OF HON. STEVE SCALISE

Mr. SCALISE. Thank you, Mr. Chairman. I look forward to hearing the testimony from the panel as we continue the process of exploring all of the various pieces that are involved in coming up with a comprehensive national energy policy. I think as many of these issues are discussed it shows the problems that are created by the fact that our country doesn't have a comprehensive strategy. But we have got to also recognize that coal is still a very viable and inexpensive source of energy, and in fact, is a backup source of energy for many of these renewable sources as we advance more wind and solar technologies, and I encourage us to do that. We all know that the wind doesn't blow all the time. We all know that the sun isn't shining all the time and that coal is a backup source for many of those renewable sources of energy, and some people do have a desire to bankrupt the coal industry. We have heard those comments.

I think we need to be much more pragmatic about encouraging clean coal technologies to advance as opposed to literally bankrupting an industry that provides so much of our power in an inexpensive way and in a way that can be captured in a much more clean and economic process. And so, I think as we look at some of these proposals, and especially the cap and trade proposals that are before us which in essence is an energy tax, a tax on energy, that

by some estimates would cost American families up to $1,300 a year more in increased energy costs. I think that is a very dangerous road to go down as we are talking about economic shortfall where we are trying to get our economy back on track. Let us make sure that we don't create policies that cost our economy thousands more jobs and cost American consumers up to $1,300 a year more in energy taxes.

There is a better way to do it. There is a cleaner way to do it, and let us pursue those technologies instead of trying to bankrupt some at the benefit of others, so look forward to hearing the panel. I yield back the balance of my time.

Mr. MARKEY. The gentleman's time has expired. The Chair recognizes the gentleman from California, Mr. McNerney.

Mr. MCNERNEY. Thank you, Mr. Chairman. Well, we clearly need to include coal in our national energy mix, but I am not really sold on carbon sequestration technology. We have the geologic formations. We probably have the technology, but are we going to be able to do this cost effectively. That is what I am hoping you all can sell me on. I am open-minded about it. I want to see what we can do here, but I am a person that is going to have the same sort of skepticism that my friend from Washington State has, so I look forward to your testimony. I yield the balance of my time.

Mr. MARKEY. The gentleman's time has expired. The Chair recognizes the gentleman from Pennsylvania, Mr. Pitts.

OPENING STATEMENT OF HON. JOSEPH R. PITTS

Mr. PITTS. Thank you, Mr. Chairman. I would like to thank you for convening this hearing today. The role of coal in climate change discussions is an important one. As most people know, coal is the most abundant energy resource in the United States and is particularly plentiful in my home State of Pennsylvania. It plays a crucial role in Pennsylvania's economy and will continue to do so as long as economically stifling climate change legislation does not force many coal-fired electricity plants out of business. While I believe it is essential to protect our environment and atmosphere, I do not believe it is prudent to bankrupt an industry that not only produces nearly 50 percent of our electricity today, but also provides jobs to countless Pennsylvanians and Americans throughout the country.

Passing cap and trade legislation right now would certainly have a negative effect on the coal industry and on consumers who pay low prices for coal-generated electricity. It is essential that we work towards utilizing clean coal technology. We must take decisive action to insure that coal generation can continue while taking steps to improve the process of carbon capture and sequestration. We must ensure that liability issues are resolved so that carbon capture and sequestration projects can forge ahead. Investors, owners, and operators need to have confidence that litigation will not squander their investments. We also need to continue to work towards reducing the cost of carbon capture and sequestration projects so that it becomes a practical and economically sensible process. If people truly believe we need to mitigate the effects of carbon in the atmosphere.

It is every bit as important to pursue ways to use coal in a clean manner. I look forward to hearing the testimony today, and I yield back.

Mr. MARKEY. The gentleman's time has expired. The Chair recognizes the gentleman from Virginia, Mr. Boucher.

Mr. BOUCHER. Thank you, Mr. Chairman. I am going to waive opening statement and reserve time for questions.

Mr. MARKEY. The gentleman reserves time. The Chair recognizes the gentleman from Nebraska, Mr. Terry.

Mr. TERRY. Thank you, Mr. Chairman. I am an interloper on this subcommittee today. Obviously, Nebraska is about 70 percent dependent on coal, so I want to hear what the industry has to say, and I will yield back.

Mr. MARKEY. We thank the gentleman, and now we will turn to our witnesses, and we begin by welcoming Mr. David Hawkins who is the director of the Natural Resources Defense Council's Climate Center. He is also a former assistant administrator of the EPA and has more than 30 years of experience on air quality, climate change, and energy policy issues. We welcome you, sir. Whenever you are ready, please begin.

STATEMENTS OF DAVID HAWKINS, DIRECTOR, CLIMATE CENTER, NATURAL RESOURCES DEFENSE COUNCIL; DAVID CRANE, PRESIDENT AND CHIEF EXECUTIVE OFFICER, NRG ENERGY, INC.; IAN DUNCAN, ASSOCIATE DIRECTOR FOR EARTH AND ENVIRONMENT SYSTEMS, BUREAU OF ECONOMIC GEOLOGY, UNIVERSITY OF TEXAS AT AUSTIN; FRANK ALIX, CHIEF EXECUTIVE OFFICER, POWERSPAN CORP.; HAROLD P. QUINN, JR., PRESIDENT AND CEO, NATIONAL MINING ASSOCIATION; AND LINDENE PATTON, CHIEF CLIMATE PRODUCT OFFICER, ZURICH FINANCIAL SERVICES

STATEMENT OF DAVID HAWKINS

Mr. HAWKINS. Thank you, Mr. Chairman. Thank you for inviting me back to the committee. I would like to highlight six points in my prepared testimony. The first is that to prevent a climate catastrophe, we simply cannot keep using coal the way we use it today. Coal is so abundant that even if we put a small fraction of the carbon that it contains into the air global temperatures would rise to dangerous levels. New coal plants now on the drawing board around the world would put more carbon dioxide into the air over their operating lives than all the CO_2 emitted from previous use of coal in human history.

The second point is that carbon capture and disposal is ready for commercial deployment today, but without a strong climate protection law this deployment simply will not happen. Third, the failure to enact climate protection legislation would be disastrous for the climate, but ironically it would not assure a sustainable role for coal in the United States. Today regulators and investors are saying, wait a minute, when it comes to new coal. The most recent Energy Information Administration forecast flashes projected coal builds for new coal builds in the United States by 60 percent from the forecast that it issued just a year ago. Other than plants already under construction, the EIA projects that essentially now

new coal plants would be built for over a decade if climate policy remains unresolved.

The fourth point is that coal needs more than carbon capture and disposal for it to serve as the 21st century fuel. Shameful practices like mountaintop mining removal, conventional air pollution, coal ash management, these things have to be fixed as well, but carbon capture and disposal could make coal and climate protection compatible. The fifth point is that carbon capture and disposal could help reduce our dependence on imported oil as well. NRDC estimates that the CO_2 captured in a robust carbon capture and disposal program could support an expanded, enhanced oil recovery industry large enough to back out about 2 million barrels of imported oil every day by 2020 and about 5 million barrels per day by 2025. In addition, electricity made from coal plants with carbon capture and disposal could back out more oil by powering plug-in hybrids.

The sixth point I will make is that business leaders and environmental groups are coming together and have proposed a policy package that would both help protect the climate and speed deployment of carbon capture and disposal in the United States. In January of this year, the U.S. Climate Action Partnership, USCAP, issued its Blueprint for Legislative Action. In addition to an economy wide cap on global warming pollution, the Blueprint recommends a four-part package for using carbon capture and disposal to cut coal plant emissions. The first recommendation is to direct EPA and other agencies to adopt rules required for CO_2 transport and disposal, second, to fund 5 gigawatts of coal plants with carbon capture and disposal by 2015, third, to enact CO_2 emission standards for new coal plants now, and, fourth, to provide direct payments to create incentives for carbon capture and disposal in the early period of the cap program.

Enactment of this package, Mr. Chairman, and members of the subcommittee, would make carbon capture and disposal a reality in the United States in the next few years and would show leadership to the world. Thank you.

[The prepared statement of Mr. Hawkins follows:]

David G. Hawkins

Director, Climate Programs

Natural Resources Defense Council

Testimony

Before the
Subcommittee on Energy and Environment
Committee on Energy and Commerce
Unites States House of Representatives

Hearing on

The Future of Coal under Climate Legislation

March 10, 2009

Summary

Coal use today is responsible for large and mostly avoidable damages to human health and our water and land. Coal use in the future, along with other fossil fuels, threatens to wreak havoc with the earth's climate system. Coal has fueled economic growth in the world's largest economies. But we cannot solve the climate crisis unless we cut coal's global warming emissions dramatically. We have the tools to do this. Energy efficiency, increased reliance on renewables like wind, solar, and biomass, and capture of carbon dioxide from power and industrial coal plants followed by geologic disposal (CCD or CCS) can play a major role in harmonizing our economic, security and climate protection goals.

But these tools will not be deployed at the required scale unless we enact new laws to cut global warming pollution. New coal plants forecast to be built globally in the next two decades, if not equipped with CCD, will emit 30 per cent more carbon dioxide (CO_2) in their operating lives than has been released from all prior human use of coal. We cannot afford to delay enactment of policies to prevent this train wreck.

The US Climate Action Partnership (USCAP), of which NRDC is a member, has proposed a Blueprint for Legislative Action that combines an economy-wide cap and trade program with performance-based policies focused on reducing CO_2 emissions from coal use. NRDC believes this program can be effective in protecting the climate and managing the transition to a cleaner energy future. CCD can also deliver major energy security benefits as well.

Congress needs to enact this year a comprehensive climate protection program containing these elements. Well designed measures can phase in CCD on new coal plants with only very modest impacts on retail electricity prices. Government support of initial large-scale capture and injection projects will be needed to speed deployment and build confidence.

Testimony of David G. Hawkins

Director, NRDC Climate Programs

Thank you for the opportunity to testify today on the subject of coal and climate legislation. My name is David Hawkins. I am director of Climate Programs at the Natural Resources Defense Council (NRDC). NRDC is a national, nonprofit organization of scientists, lawyers and environmental specialists dedicated to protecting public health and the environment. Founded in 1970, NRDC has more than 1.2 million members and online activists nationwide, served from offices in New York, Washington, Los Angeles and San Francisco, Chicago and Beijing.

Today, the U.S. and other developed nations around the world run their economies largely with industrial sources powered by fossil fuel and those sources release billions of tons of carbon dioxide (CO_2) into the atmosphere every year. There is national and global interest today in capturing that CO_2 for disposal or sequestration to prevent its release to the atmosphere. To distinguish this industrial capture system from removal of atmospheric CO_2 by soils and vegetation, I will refer to the industrial system as carbon capture and disposal or CCD. CCD can be applied to many different sources of CO_2 but today I will focus on its role in cutting emissions from coal use.

The growing attention to CCD stems from a few basic facts. We now recognize that CO_2 emissions from use of fossil fuel result in increased atmospheric concentrations of CO_2, which along with other so-called greenhouse gases trap heat, leading to an increase in temperatures,

regionally and globally. These increased temperatures alter the energy balance of the planet and thus change our climate, which is simply nature's way of managing energy flows. Documented changes in climate today along with those forecasted for the next decades, are predicted to inflict large and growing damage to human health, economic well-being, and natural ecosystems.

Coal is the most abundant fossil fuel and is distributed broadly across the world. It has fueled the rise of industrial economics in Europe and the U.S. in the past two centuries and is fueling the rise of Asian economies today. Because of its abundance, coal is cheap and that makes it attractive to use in large quantities if we ignore the harm it causes. However, per unit of energy delivered, coal today is a bigger global warming polluter than any other fuel: double that of natural gas; 50 per cent more than oil; and, of course, enormously more polluting than renewable energy, energy efficiency, and, more controversially, nuclear power. To reduce the contribution to global warming from coal use, we can pursue efficiency and renewables to limit the total amount of coal we consume but to reduce emissions from the coal we *do* use, we must deploy and improve systems that will keep the carbon in coal out of the atmosphere, specifically systems that capture carbon dioxide (CO_2) from coal-fired power plants and other industrial sources for safe and effective disposal in geologic formations.

The Toll from Coal

Before turning to the role of CCD I want to repeat what I have said in prior testimony about harms from coal as it is used today. The role of coal now and in the future is controversial due to the damages its production and use inflict today and skepticism that those damages can or will be reduced to a point where we should continue to rely on it as a mainstay of industrial economies.

Coal is cheap and abundant compared to oil and natural gas. But the toll from coal as it is used today is enormous. From mining deaths and illness and devastated mountains and streams from practices like mountain top removal mining, to accidents at coal train crossings, to air emissions of acidic, toxic, and heat-trapping pollution from coal combustion, to water pollution from coal mining and combustion wastes, the conventional coal fuel cycle is among the most environmentally destructive activities on earth. Certain coal production processes are inherently harmful and while our society has the capacity to reduce many of today's damages, to date, we have not done so adequately nor have we committed to doing so. These failures have created well-justified opposition by many people to continued or increased dependence on coal to meet our energy needs.

Our progress of reducing harms from mining, transport, and use of coal has been frustratingly slow and an enormous amount remains to be done. Today mountain tops in Appalachia are destroyed to get at the coal underneath and rocks, soil, debris, and waste products are dumped into valleys and streams, destroying them as well. Waste impoundments loom above communities (including, in one particularly egregious case, above an elementary school). Thousands of miles of streams are polluted by acid mine drainage. In other areas surface mine reclamation is incomplete, inadequately performed and poorly supervised due to regulatory gaps and poorly funded regulatory agencies. As we have learned in recent months, coal ash dumps are enormous, ubiquitous, and almost completely unregulated, leading to disasters like those which occurred at several dumps recently.

In the area of air pollution, although we have technologies to dramatically cut conventional pollutants from coal-fired power plants, in 2004 only one-third of U.S. coal capacity was equipped with scrubbers for sulfur dioxide control and even less capacity applied selective catalytic reduction (SCR) for nitrogen oxides control. And under the previous administration's so-called CAIR rule, even in 2020 nearly 30 per cent of coal capacity would still not employ scrubbers and nearly 45 per cent would lack SCR equipment. Moreover, because the previous administration deliberately refused to require use of available highly effective control technologies for the brain poison mercury, unless corrective action is taken, we will suffer decades more of cumulative dumping of this toxin into the air at rates several times higher than is necessary or than faithful implementation of the Clean Air Act would achieve (to say nothing regarding harms from other toxins the rule ignores).

Finally, there are no controls in place for CO_2, the global warming pollutant emitted by the more than 330,000 megawatts of coal-fired plants in the U.S.; nor are there any CO2 emission standards adopted today for old or new plants save in California.

Mr. Chairman and members of the subcommittee, the environmental community is criticized in some quarters for our generally negative view regarding coal as an energy resource. But I would ask you to consider the reasons for this. Our community reacts to the facts on the ground and in the air and those facts are far from what they must be if coal is to play a role as a responsible part of the 21st century energy mix. Rather than simply decrying the attitudes of those who question whether using large amounts of coal can and will be carried out in a responsible manner and spending millions on TV ads that paint a misleading picture of coal's actual performance, the coal industry in particular should support policies to correct today's abuses and then implement

those reforms. Were the industry to do this, there would be real reasons for critics of coal to consider whether coal can in fact provide more benefits than harm going forward.

The Need for CCD

Turning to CCD, NRDC opposes new coal plants that do not capture their CO_2 and supports rapid deployment of capture and disposal systems for any new coal sources. Such support is not a statement about how dependent the U.S. or the world should be on coal and for how long. Any significant additional use of coal that vents its CO2 to the air is fundamentally in conflict with the need to keep atmospheric concentrations of CO2 from rising to levels that will produce dangerous disruption of the climate system. Given that an immediate world-wide halt to coal use is not plausible, analysts and advocates with a broad range of views on coal's role should be able to agree that, if it is safe and effective, CCD should be rapidly deployed to minimize CO2 emissions from the coal that we do use.

Today coal use and climate protection are on a collision course. Without rapid deployment of CCD systems, that collision will occur quickly and with spectacularly bad results. The very attribute of coal that has made it so attractive—its abundance---magnifies the problem we face and requires us to act now, not a decade from now. Until now, coal's abundance has been an economic boon. But today, coal's abundance, absent corrective action, is more bane than boon.

Since the dawn of the industrial age, human use of coal has released about 150 billion metric tons of carbon into the atmosphere—about half the total carbon emissions due to fossil fuel use in human history. But that contribution is the tip of the carbon iceberg. Another 4 *trillion* metric

tons of carbon are contained in the remaining global coal resources. That is a carbon pool nearly seven times greater than the amount in our pre-industrial atmosphere. Using that coal without capturing and disposing of its carbon means a climate catastrophe.

And the die is being cast today for that catastrophe, not decades from now. Decisions being made today in corporate board rooms, government departments, and congressional hearing rooms are determining how the next coal-fired power plants will be designed and operated. Power plant investments are enormous in scale, more than $1 billion per plant, and plants built today will operate for 60 years or more. The International Energy Agency (IEA) forecasts that more than $5 trillion will be spent globally on new power plants in the next two decades. Under IEA's forecasts, about 1800 gigawatts (GW) of new coal plants will be built between now and 2030—capacity equivalent to 3000 large coal plants, or an average of ten new coal plants every month for the next two decades. This new capacity amounts to 1.5 times the total of all the coal plants operating in the world today.

The astounding fact is that under IEA's forecast, 7 out of every 10 coal plants that will be operating in 2030 don't exist today. That fact presents a huge opportunity—many of these coal plants will not need to be built if we invest more in efficiency; additional numbers of these coal plants can be replaced with clean, renewable alternative power sources; and for the remainder, we can build them to capture their CO_2, instead of building them the way our grandfathers built them.

If we decide to do it, the world could build and operate new coal plants so that their CO_2 is returned to the ground rather than polluting the atmosphere. But we are losing that opportunity with every month of delay—10 coal plants were built the old-fashioned way last month somewhere in the world and 10 more old-style plants will be built this month, and the next, and the next. Worse still, with current policies in place, none of the 3000 new plants projected by IEA are likely to capture their CO_2.

Each new coal plant that is built carries with it a huge stream of CO_2 emissions that will likely flow for the life of the plant—60 years or more. Suggestions that such plants might be equipped with CO_2 capture devices later in life might come true but there is little reason to count on it. While commercial technologies exist for pre-combustion capture from gasification-based power plants, most new plants are not using gasification designs and the few that are, are not required to incorporate capture systems. Installing capture equipment at these new plants after the fact is still a long shot for traditional coal plant designs and expensive for gasification processes.

If all 3000 of the next wave of coal plants are built with no CO_2 controls, their lifetime emissions will impose an enormous pollution lien on our children and grandchildren. Over a projected 60-year life these plants would likely emit 750 billion tons of CO_2, a total (from just over two decades of investment decisions) that is 30% greater than the total CO_2 emissions from all previous human use of coal. Once emitted, this CO_2 pollution load remains in the atmosphere for centuries. Half of the CO_2 emitted during World War I remains in the atmosphere today. One thousand years from now, 15 per cent of World War I CO_2 pollution will still be in the air.

As a first order of business we must prevent the harm from this onrushing train of new coal plants. What can the U.S. do to help? We should adopt a national policy that new coal plants be required to employ CCD without delay. By taking action ourselves, we can speed the deployment of CCD here at home and set an example of leadership. That leadership will help reconcile coal and climate protection; it will bring us economic rewards in the new business opportunities it creates here and abroad; and it will speed engagement by critical countries like China and India.

To date our efforts have been limited to funding research, development, and limited demonstrations. Such funding can help in this effort if it is wisely invested. But government subsidies cannot substitute for the driver that a real market for low-carbon goods and services provides. That market will be created only when requirements to limit CO_2 emissions are adopted.

New Coal Build in the U.S.

I have discussed the phenomenal projected growth in global coal power generation. Until recently, the projections for the U.S. also showed very large increases in new coal power plants. One year ago our Energy Information Administration (EIA), in its 2008 Annual Energy Outlook, forecast that 100 GW of new coal plants would be built by 2030 (increasing the U.S. coal fleet by nearly a third above the current 330 GW of capacity). However, in its most recent projection EIA has cut its estimate of new coal build in the U.S. by 60 per cent, projecting that only 42 GW of new coal will be built between now and 2030. Moreover, EIA projects that once the plants currently under construction are built there will be a decade of essentially *no* additional coal

projects, with new projects appearing only around 2025. I need to emphasize that this is *not* an EIA estimate of the impact of climate protection legislation. To the contrary, this is what EIA estimates will happen with *no* action on climate legislation. Why this major change in EIA's estimates? Well, for the first time EIA has incorporated into its projections what it observes is happening in the private sector U.S. energy market in the absence of climate legislation. EIA states its new projection "reflects the behavior of investors and regulators who, in their investment evaluation process, are implicitly (or explicitly) adding a cost to many proposed power plants that employ GHG-intensive technologies." (EIA, Press Release, Dec. 17, 2008).

The reality is that contrary to the assumptions of the coal lobby, blocking action on climate protection is not an effective strategy for a sustainable coal industry. In the absence of climate legislation virtually every significant coal project is being challenged (and most are challenged successfully), investment banks are taking a harder look at carbon risks, and state regulators are rejecting plants as too risky given the uncertainty about policies that are likely to require actions to reduce these projects' carbon footprint.

Meanwhile, faced with the obligation to comply with the Supreme Court's ruling that the Clean Air Act requires regulation of CO_2 as a pollutant (absent a factually impossible showing), EPA is expected to take steps soon to establish CO_2 emission limits from a number of sources, including fossil-fueled power plants. If written in accordance with the law, these EPA rules will put an end to the construction of new coal plants that release all of their CO_2 to the air.

NRDC believes it is possible to implement such rules in a manner that is entirely compatible with meeting our needs for electric power from secure energy resources at reasonable costs. However, there are a number of reasons why both environmentalists and supporters of coal should favor enactment of legislation that complements and provides greater definition for the existing Clean Air Act authority while providing additional policies to speed deployment of CCD for the new coal plants that may be built. First, EPA rules by themselves will not get reductions at the scale and pace we must achieve. Second, new EPA rules are likely to be litigated but legislation could substantially narrow the issues and uncertainties associated with such litigation, or possibly avoid it completely. In addition, legislation could provide a framework for equitable sharing of the likely additional costs of the first generation of coal plants employing CCD. It is possible that a consensus could emerge that would endorse such cost sharing in order to gain additional support for comprehensive climate protection legislation.

Policy Actions to Speed CCD

NRDC supports inclusion of policies to deploy CCD in broad climate protection legislation. We need those policies both to deal with the new coal plants that are built in the U.S. and to create the conditions that will speed the commitment to strong climate protection policies by countries like China, where last year a large new coal plant started up about every four days. There is no reasonable expectation that China will turn its back on coal in the near future and a U.S. CCD deployment program could make it apparent to China and the world at large that climate protection does not require abandoning the appropriate use of coal as an energy resource.

There are three key policies to speed deployment of CCD systems:

- A comprehensive cap on greenhouse gas emissions;
- Emission performance standards for new coal plants;
- Cost-sharing for added expenses for CCD projects in the near-term.

This package of policies is included in the recent Blueprint for Legislative Action released by the U.S. Climate Action Partnership (USCAP). While I am testifying today on behalf of NRDC and not USCAP as a whole, NRDC is a USCAP member and we support these policy proposals.

Why do we need these policies? While research and development funding is useful, it cannot substitute for the incentive that a genuine commercial market for CO_2 capture and disposal systems will provide to the private sector. The amounts of capital that the private sector can spend to optimize CCD methods will dwarf what Congress will provide with taxpayer dollars. To mobilize those private sector dollars, Congress needs a stimulus more compelling than the offer of modest handouts for research. Congress has a model that works: intelligently designed policies to limit emissions cause firms to spend money to find better and less expensive ways to prevent or capture emissions.

Where a technology is already competitive with other emission control techniques, for example, sulfur dioxide scrubbers, a cap and trade program like that enacted by Congress in 1990, can result in more rapid deployment, improvements in performance, and reductions in costs. Today's scrubbers are much more effective and much less costly than those built in the 1980s. However, a CO_2 cap and trade program by itself may not result in deployment of CCD systems as rapidly as we need. Many new coal plant design decisions are being made literally today.

Depending on the pace of required reductions under a global warming bill, a firm may decide to build a conventional coal plant and purchase credits from the cap and trade market rather than applying CCD systems to the plant. While this may appear to be economically rational in the short term, it is likely to lead to higher costs of CO_2 control in the mid and longer term if substantial amounts of new conventional coal construction lead to ballooning demand for CO_2 credits.

Recall that in the late 1990's and the first few years of this century, individual firms thought it made economic sense to build large numbers of new gas-fired power plants. The problem is too many of them had the same idea and the resulting increase in demand for natural gas increased both the price and volatility of natural gas to the point where many of these investments were idle for years.

Moreover, delaying the start of CCD until a cap and trade system price is high enough to produce these investments delays the broad demonstration of the technology that the U.S. and other countries will need if global coal use remains high. The more affordable CCD becomes, the more widespread its use will be throughout the world, including in rapidly growing economies like China and India. But the learning and cost reductions for CCD that are desirable will come only from the experience gained by building and operating the initial commercial plants. The longer we wait to ramp up this experience, the longer we will wait to see CCD deployed here and in countries like China.

Accordingly, we believe the best policy package is a hybrid program that combines the breadth and flexibility of a cap and trade program with well-designed emission standards and incentives

that are focused on key technologies like CCD. Such policies serve two purposes. First, they assure that no new coal plants are built without CCD systems. New coal plants with uncontrolled CO_2 emissions will increase costs for others now or in the future or both. Second, they provide a stimulus for early and significant deployment of CCD systems. These two purposes may appear to be the same but they are not. Requiring new coal plants to use CCD will not assure early deployment of CCD if no new coal plants are built for some time. And without a mandatory emission standard there is no assurance that construction of conventional coal plants will be prevented. But a combination of emission standards and financial incentives can achieve both of these objectives.

First, we need a CO_2 emissions standard that applies to new power investments. California enacted such a measure in SB1368 in 2006. It requires new investments for sale of power in California to meet a performance standard that is achievable by coal with a moderate amount of CO_2 capture. CO_2 emission performance standards also were included in Chairman Markey's iCAP bill, H.R. 6186, introduced in the last Congress.

Second, we need a mechanism to assure that individual firms making investment decisions have an economic rationale to deploy and operate CCD in the period before the market price for CO_2 under a cap program is high enough to provide that rationale by itself. This can be accomplished by providing a financial incentive for avoiding CO_2 emissions by using CCD. A specified dollar per ton payment for CO_2 avoided, similar in effect to a production tax credit, can accomplish this objective.

These two measures work together to achieve a result that neither could accomplish alone. The mandatory emission standard prevents the construction of new coal plants without CCD, something that could happen in the absence of a standard during the early period under a cap program. The financial incentive payment avoids placing the entire incremental cost of the first CCD units on the customers of the companies that build the plants. This cost sharing avoids significant rate impacts from implementation of the mandatory emission standard and avoids creating an incentive to build new natural gas fired power plants.

USCAP Recommendations

As I mentioned, the USCAP Blueprint for Legislation Action contains a comprehensive proposal for CCD deployment as part of a broad climate protection law. In addition to an economy-wide cap, the Blueprint recommends Congress adopt the following measures:

- requirements for the government to issue needed regulations for siting CO_2 repositories and pipelines;
- government financial support to build 5 GW of CCD-equipped commercial power plants by 2015;
- a transitional program to pay for tons of CO_2 emissions avoided through use of CCD;
- mandatory emission standards for new coal plants that are not already permitted as of today.

USCAP recommends a mandatory emission standard of 1100 pounds per megawatt hour (lbs/MWh) for coal plants permitted between now and 2020 and an 800 lbs/MWh mandatory standard for plants permitted after the start of 2020, with authority for EPA to establish tighter

standards as justified by technical and economic feasibility considerations. Compliance with the initial emission standard would be required upon startup for plants permitted after January 1, 2015. For plants permitted between now and January 1, 2015, compliance would be required within four years after either 2.5 GW of commercial scale CCD power plants are operating in the U.S. or 5 GW of such plants are operating globally. This recommendation guarantees that any proposed coal project not already permitted today must meet an emission standard that requires the operation of CCD, either upon startup or early in its operating life.

USCAP support for this important policy is tied to enactment of a substantial program to provide financial incentives for capturing CO_2. USCAP calls for a program of direct payments on a dollar per ton of CO_2 avoided basis for the first ten years of operation of CCD systems. Payments would be based on two sliding-scales. Higher payments per ton avoided would be provided for earlier projects to reflect estimated higher costs and to provide an added incentive for early operation of CCD projects. The payment schedule would be highest for the first 3 GW of projects in the program, with successively smaller payments for later projects. In addition, a separate sliding scale would provide higher dollar per ton payments for projects with higher capture rates. This would reflect the expected higher costs for high capture rate systems and would provide an incentive to achieve lower emission rates than the minimum mandatory emission standard. For example, for a project in the first 3 GW of the program that achieved a high level of capture (85-90%), the payments for the expected incremental costs are estimated to be on the order of $90 per ton avoided. USCAP recommends that the total size of the financial incentive program should be large enough to support on the order of 72 GW of CCD projects.

Energy Security Benefits of CCD

In addition to providing a means for major reductions in CO_2 emissions from coal plants, CCD can also provide substantial energy security benefits. CCD can help reduce dependence on foreign oil while reducing CO_2 emissions in two important ways. First, substantial deployment of CCD can produce a reliable and affordable supply of CO_2 for use in domestic enhanced oil recovery (EOR) operations. For more than two decades U.S. producers have been using CO_2 to increase oil production in aging oil fields. From both an environmental impact and energy security perspective, these EOR barrels are the best barrels of oil we can buy. They are produced from fields that are already developed and use existing pipelines. Every barrel produced from these fields reduces pressure to develop pristine and vulnerable areas to supply that oil. Second, every barrel of this oil means one less barrel imported from hostile or unstable regimes abroad. Today EOR barrels make up only a small amount of total U.S. consumption—about 300,000 barrels per day. Why such a small amount? Believe it or not, it is because supplies of CO_2 are limited! Most EOR today uses CO_2 from naturally occurring CO_2 reservoirs and those are fully committed. Without a climate protection policy, the costs of deploying CCD at power plants and other industrial sources to supply EOR operations are too high to tap this huge additional supply of manmade CO_2.

With a program of CCD deployment like that recommended by USCAP, U.S. EOR production could back out millions of barrels per day of imported oil. An NRDC analysis of the impacts of climate legislation with CCD deployment, based on DOE studies of EOR potential, projects that increased domestic EOR using captured CO_2 could reduce oil imports by about 2 million barrels

per day in 2020 and as much as 5 million barrels per day in 2025. (http://docs.nrdc.org/globalWarming/files/glo_08061201a.pdf).

Second, if CCD is applied to the power fleet it can increase the penetration of plug-in hybrids compared to a scenario where CCD is not deployed, backing out even more imported oil. (*Id.*) These additional energy security benefits of speeding CCD deployment are considerable and should broaden the base of support for an integrated program of climate protection and energy reform.

Costs and other concerns

Let me add a few words about costs. With today's off the shelf systems, estimates are that the production cost of electricity at a coal plant with CCD could be as much as 40% higher than at a conventional coal plant that emits its CO_2. But the impact on average electricity prices of introducing CCD now will be very much smaller due to several factors. First, power production costs represent about 60% of the price you and I pay for electricity; the rest comes from transmission and distribution costs. Second, coal-based power represents just over half of U.S. power consumption. Third, and most important, even if we start now, CCD would be applied to only a small fraction of U.S. coal capacity for some time. With the financial incentives recommended by USCAP, the incremental costs of units equipped with CCD would be spread over the all consumers of fossil fuels. This should result in a very modest increase (on the order of two or three per cent) in average U.S. retail electricity rates attributable to a large-scale CCD deployment program.

Another concern that has been raised by some is the issue of liability for possible risks of CO_2 injected in geological formations. Some have called for governmental assumption of this liability. NRDC strongly opposes governmental indemnification as unnecessary and counterproductive to CCD deployment. The first point to note is that all expert assessments have concluded that the risks from properly conducted CO_2 injection projects are extremely low. The Special Report on Carbon Dioxide Capture and Storage published by the Intergovernmental Panel on Climate Change (IPCC) concluded that the risks were no higher than other industrial energy sector operations.

Risks from CCD can be divided into two phases: risks of leakage during the operation phase of CO_2 injection and longer term (hundreds of years) risks of leakage. Current EOR operations involve in some cases injection of CO_2 in amounts equal to a large coal-fired power plant. Private sector firms are carrying out these projects now with no governmental assumption of risk. While we are not privy to the contractual or insurance instruments that are employed to manage liability for these operational risks, it is clear that private sector commercial arrangements are sufficient for these firms to be comfortable in carrying out these projects.

Longer term risks should be addressed by a thorough pre-injection permitting process that requires a comprehensive site assessment and requires design, operational, and monitoring practices that provide a high level of confidence that injected CO_2 will remain where it is injected permanently. Some persist in asking what happens if some CO_2 does nonetheless get back to the atmosphere decades or centuries from now and paint pictures of damage actions being brought against the sources that injected the CO_2. We find this scenario hard to credit as a

serious obstacle to sources deciding to proceed with CCD now. Consider the choices facing the owner of a proposed coal power plant: it can emit its CO_2 to the air and half of what it emits will still be in the air 100 years from now. Or it can inject that CO_2 into geologic formations with a high degree of confidence that all of that CO_2 will still be in the formation 100 years from now. If one assumes a future legal regime that imposes damages liability on sources because of the presence in the air of CO_2 that they produced 100 years earlier, it will obvious to any competent risk manager that the potential liability from CO_2 injection is orders of magnitude smaller than the risk of continuing to emit that CO_2 directly to the air today.

Proposals for the government to shield firms from CCD liability are also counterproductive to the objective of deploying CCD. In addition to overcoming policy and economic obstacles, deployment of CCD depends on public acceptance of this unfamiliar technology. If the CCD industry is seeking government protection from liability it will be logical for the public to assume this technology is too risky for the private sector itself to accept, absent that shield. This is not factually correct but promotion of such liability shields could result in an enormous obstacle to public acceptance of CCD.

Finally, let me say a word about China and other developing coal-dependent economies. America became an industrial giant by using coal and countries like China and India are on a path to emulate that history. Both countries are interested in CCD technology but all indications are that they will wait to see what the U.S. does before making a commitment to this and the broader range of climate protection solutions we need. By showing leadership the U.S. can demonstrate seriousness of purpose that can be contagious. With our slower rate of new plant

construction we can also deploy CCD on new plants with a much smaller impact on our economy. The experience that early deployment of CCD in the U.S. can provide will help bring down costs of the technology, thereby speeding its adoption in other countries. Pursuit of such a program is not altruism. By getting ahead of the curve with CCD and other climate protection technologies, the U.S. can become a leading global marketer of climate solutions, helping bring back our economy and providing living wages to more American workers.

Conclusions

To sum up, since we will almost certainly continue using substantial amounts of coal in the U.S. and globally in the coming decades, it is imperative that we act now to deploy CCD systems. Commercially demonstrated CO_2 capture systems exist today and competing systems are being researched. Improvements in current systems and emergence of new approaches will be accelerated by requirements to limit CO_2 emissions. Geologic disposal of large amounts of CO_2 is viable and we know enough today to conclude that it can be done safely and effectively. EPA must act without delay to revise its regulations to provide the necessary framework for efficient permitting, monitoring and operational practices for large scale permanent CO_2 repositories.

A cap and trade program for greenhouse gases is essential to change the way we use coal but it does not assure in its early years the deployment of CCD technology. To achieve that objective, we need complementary policies that require minimum emission standards from new investments and incentives to deploy CCD broadly.

Finally CCD is an important strategy to reduce CO_2 emissions from fossil fuel use but it is not the basis for a climate protection program by itself. Increased reliance on low-carbon energy resources is the key to protecting the climate. The cleanest energy resource of all is smarter use of energy; energy efficiency investments will be the backbone of any sensible climate protection strategy. Renewable energy will need to assume a much greater role than it does today. With today's use of solar, wind and biomass energy, we tap only a tiny fraction of the energy the sun provides every day. There is enormous potential to expand our reliance on these resources. We have no time to lose to begin cutting global warming emissions. Fortunately, we have technologies ready for use today that can get us started.

Mr. Chairman, that completes my testimony, I will be happy to take any questions you or other members of the subcommittee may have.

Mr. MARKEY. Thank you, Mr. Hawkins. Our next witness is David Crane. Mr. Crane is President and CEO of NRG Energy, a leading wholesale power generation company. He has many years of experience and was previously the CEO of International Power. We welcome you, sir. Whenever you are ready, please begin.

STATEMENT OF DAVID CRANE

Mr. CRANE. Thank you, Mr. Chairman. Thanks to members of the committee and particularly Congressmen Barton and Green for their kind words to me. And I want to start by thanking you for addressing climate change and combating climate change which we believe is the critical task before us. We think clean coal is the key to successful combating of climate change and carbon capture and sequestration is the key to clean coal, so again we applaud you shining a spotlight on this technology, this issue which unfortunately remains obscure to the American public.

NRG is a company that owns power plants. We own 24,000 megawatts of power plants across the country. That is enough to power 20 million American homes. About 1/3 of our generation is coal. I think we are the fifth largest consumer of Powder River Basin coal, and we span the great expanse of red states to blue states in that we have coal-fired power plants in Texas, Delaware, New York State, and, Chairman Markey, in your home state of Massachusetts.

We are not a rate-based utilized. We are not able to socialize the cost that we bear to the public but they are borne by our shareholders, and since 2006 we have been investing our shareholders' money in decarbonizing generation. We built 270 megawatts of wind in Texas. We announced last week an intent to build 500 megawatts of solar thermal plants in California and New Mexico, and we believe we will be the first company to build a new nuclear plant in the United States having filed with the NRC a year and a half ago to build a 2,700 megawatt nuclear plant in Texas, which our company has already spent close to $200 million on just to file the permit.

All told, what we have going so far would be about a $10 billion investment and create about 9,000 high paying jobs. If we succeed in all we do, we would achieve a significant reduction in our carbon intensity. As a company currently we produce about 64 million tons of carbon emissions in the United States in order to make about 70 to 80 million megawatt hours of production. But when you hear the list of things we are doing, noticeably absent from that list is clean coal, and if I say one thing that this committee remembers one of the things I have been saying to our investors when they say, David, are you really able to develop nuclear power plants, I say developing nuclear power plants in this environment is easier than doing clean coal. That is the part that is really a challenge.

But this is not for want of trying on our behalf. In 2006 we won an award from the State of New York to build an integrated gasification combined cycle plant. Two years later after spending over $10 million of our shareholders' money, that project which was started by the Pataki Administration was cancelled by the Patterson Administration and in fairness to the Patterson Administration it just proved that doing a full-blown IGCC project with CCS was

just beyond the reach of any private company working with any state at this point in time so again we heartily support the federal government's effort to support this. I would just like to quickly list what we see as the five main obstacles to going forward with commercial scale CCS. Obviously, the first one is there is no price on carbon in the United States right now. The second would be even if there was a price it would be unlikely be set at a level that would incent carbon capture and sequestration.

The lack of a proper legal and regulatory scheme proved to be an enormous impediment to us with our New York project. The fourth point would be that the normal government incentives, production tax credits, loan guarantees are not particularly useful in the course of CCS, particularly when you are talking about post-combustion carbon capture, which of all forms of carbon capture is by far the most important because of its ability to be retrofitted on existing plants. My colleague, Mr. Alix, will, I am sure, talk about that more. And the fifth point, which in this day and environment there is actually no money available from our normal sources for anything much less new technologies.

So I would like to just a few thoughts for the committee to consider. One is I think that the big bang approach to going with CCS as maybe reflected by FutureGen is not going to be the quickest or the most cost-effective way to go forward. I have nothing against FutureGen, but I think there are other things that the committee can incent. I think that when looking at brown field coal plants, I think one thing the committee should recognize is that our analysis indicates that the best use for those plants is not to be retrofitted for post-combustion carbon capture but probably to be converted to gas so that they confirm renewables on a basis. And the last point I would make, and I respectfully would disagree with Congressman Inslee, whose book I have read and who I respect in his opinions but we don't support 100 percent auction because we think that the best people to get the carbon out of coal are coal companies and coal-using power general companies, so we support the USCAP Blueprint which calls for transitional and partial allocations plus auction for early funding. So thank you, Mr. Chairman.

[The prepared statement of Mr. Crane follows:]

Testimony of David Crane
CEO and President
NRG Energy, Inc.

The Future of Coal under Climate Legislation

Chairman Markey, Ranking Member Upton, and members of the Subcommittee: Good morning, and thank you for inviting me to testify today. My name is David Crane and I am the Chief Executive Officer and President of NRG Energy. I want to also thank you for your commitment to debate and develop legislation to address climate change, and your recognition of the importance of addressing the future of coal, and specifically carbon capture and sequestration (CCS) as part of that legislation. You are to be applauded for focusing on a topic that is obscure to the public but fundamental to winning the fight against climate change in our children's lifetime. As I will explain, I think it is quite likely that the future for the use of coal as a resource in America will be brighter if CCS is effectively deployed as part of climate legislation than otherwise.

First let me tell you about NRG. In the US, we own and operate some 24,000 MW of power plants, enough to power 20 million American homes, in Massachussets, Connecticut, New York and the Delmarva Peninsula, through Louisiana, Texas, and into California. About 7000 MW of these plants burn coal, 1100 MW are nuclear, and the rest are a mix of natural gas, oil and, more recently wind. We're a merchant generator – we have no captive customers or rate-base to absorb extra risks and costs, and so we are extra aggressive in reducing risks and costs.

We are a large coal user, and a large emitter of CO2. But we have been working hard to change that. NRG is a leading developer of zero carbon technologies – just in the last few months, we have energized 270 MW of new wind farms in Texas, agreed to develop and invest in 500 MW of solar thermal projects in California and New Mexico, and achieved major milestones in our 2700 MW new nuclear project in Texas. These zero carbon projects, which will add up to one-half the capacity of our existing coal fleet, represent more than $10 billion in new investment, and have already started to create over 9,000 high paying construction, engineering and operating jobs. And that's just the beginning.

Our efforts to decarbonize are proceeding in anticipation of a price being imposed on emitting carbon into the atmosphere. We need a climate change bill that provides this price for carbon and a set of complementary policies to make decarbonizing of the US power sector and economy really work. To that end, we are active members of USCAP and were deeply involved in developing its *Blueprint for Legislative Action*. We strongly believe that it offers a real, effective and pragmatic approach to the key climate issues. In particular, we believe a well-designed "cap and invest" program with transitional, "no-windfall" allocations, is needed to ensure that companies like ours can quickly make massive investments in these costly and challenging new technologies – and that such investment is essential to protecting the climate and our economy.

Perhaps no new technology is more costly and challenging right now than carbon capture and sequestration or CCS. At the same time, none is more critical to solving the climate change problem. CCS is so critical because of the dramatic increase in the use of coal globally, especially in the developing countries of China and India. Last November, the International Energy Agency projected that increased coal use will account for more than half of the global increase in CO2 emissions by 2030, and that three-quarters of the total increase will come from China, India and the Middle East. Clearly, the ongoing massive development of conventional coal plants in China and India means we need to make the development of post-combustion capture retrofit technologies the highest priority, along with a variety of technologies for new builds.

You may have noticed I did not include CCS on my list of NRG's low carbon achievements. This is not for a lack of trying. In 2006, we won an award from the State of New York to build a large scale IGCC project with CCS. Over the next two years, we spent close to $20 million engineering the project and demonstrating the viability of capturing, transporting and sequestering the carbon locally. Ultimately, because the costs and the legal and regulatory uncertainties became too high for us and the state to bear, we were forced to terminate the project.

We have also worked productively with Mr. Alix's company to explore a utility scale PowerSpan retrofit for one of our Texas plants and to use the CO2 for enhanced oil recovery in Texas, but funding uncertainties and logistical challenges have kept us from moving forward as quickly as we would like. We are developing an agreement to work with Basin Electric to share research and engineering knowledge with them as they move to implement a post-combustion CCS project at their gasification and power complex in North Dakota, and as we renew our efforts to develop a post-combustion carbon capture demonstration facility ourselves in Texas.

All these efforts pose serious challenges for any business that must serve customers at a reasonable, competitive price and provide a return to its shareholders. Here are the five main barriers, as I see them, based on our experience to date:

1) There is no price on carbon, so there is little reason to incur any substantial cost to capture it. Unlike other clean energy investments, the CCS equipment produces no commercially useful commodity, outside of limited use for enhanced oil recovery.

2) Even with a moderately high price on carbon, early CCS equipment is still likely to cost too much to install and operate without additional policy incentives. This is because the equipment faces typical "first of a kind" design, engineering and production costs, cannot offer standard commercial or performance guarantees, and has high "parasitic load" energy requirements that reduce plant output and efficiency.

3) There are only sporadic and very limited government incentives to bring these high and uncertain costs within reach.

4) There are no clear or final regulations to define the legal obligations of the developer, owner and operator and ensure that the various long term risks will be commercially manageable.

5) For all these reasons, it is more economical to build a natural gas plant or, if the price of carbon is low enough relative to the price of gas, even an efficient new coal plant.

To make CCS globally competitive, we need to address these five problems head on. The USCAP *Blueprint* contains what I think will be very effective solutions to these problems. Its key recommendations supporting CCS are:

- Quickly pass cap and trade legislation with the key components of the USCAP *Blueprint* - including initial "no-windfall" allocations that transition to a full auction;
- Establish a commercially friendly, environmentally responsible regulatory and legal framework for CCS;
- Quickly roll out an early demonstration program of some 5 to10 large scale projects:
- Provide strong, performance-based incentives for the rapid, competitive deployment of a very large number of additional commercial scale facilities;
- Create a backstop emission standard to prevent any significant subsequent deployment of new coal without CCS; and
- Provide additional incentives to repower existing coal plants – especially the most inefficient and heavy emitting ones – with much lower carbon alternatives.

This package has been designed to solve all of the key problems above.

Most importantly, it will rapidly lead to orders from companies like ours for CCS technology – lots of orders. That will allow companies like PowerSpan, GE, Siemens, Fluor, and others to scale up their factories and assembly lines, hire more skilled workers, buy lots of concrete and steel and high-tech devices, and rapidly reduce the costs of building this equipment. And, just as important, it will make them compete vigorously with each other to build it, sell it, install it and maintain it for companies like mine.

Those two factors – large scale production and vigorous competition – are the keys to turning high cost specialty products into globally competitive "must have" devices. And, until this technology is competitively priced in China and India, the projected 50% increase in global CO2 from coal is likely to continue unabated. These and other countries are also beginning to develop and deploy CCS technology. The U.S. needs to start fast in the race to competitively develop this technology, and we need to win it, so that America will be selling it there, rather than buying it there.

Finally, let me say why I think the right approach to climate legislation offers the brightest future for American coal and coal workers. Credible current assessments of firm new coal plant builds are about 16,000 MW.[1] Though many more – perhaps 65,000 MW -- are in various stages of development, the number has been shrinking rapidly and there is no way to tell how many of those will actually get built. At the same time, there are about 50,000 MW of smaller, older, inefficient coal plants over 50 years old that are likely to retire soon for economic reasons alone.

That suggests between 50,000 and 115,000 MW of coal plants are at risk of retirement or not being built, which would jeopardize a lot of coal mining, shipping and power plant jobs. The *Blueprint* sees that challenge, and addresses it head on with some 77,000 MW of new coal with CCS. And it would judiciously use public revenues from, for example, auctioning a fair share of the allowances, to leverage the much larger private sector investment needed make sure these plants are actually built efficiently and competitively.

I want to underscore this point. To ensure this private investment can take place, it is critically important to implement the *Blueprint's* transitional "no-windfall" allocations. This will allow competitive power companies like mine to continue to invest billions of dollars of our own money in these technologies, and also help regulated utilities avoid excessive rate-shock for their customers as they make similar investments. We all know that, once the allocation transition period is over, we will succeed or fail based on our success in decarbonizing our fleets – a risk that, in my view, will provide the supreme motivation for the power sector to aggressively deploy low- and no-carbon technologies during the transition period and to really make them work.

The massive private sector investment that will result from this combination of transitional allocations and targeted CCS support should provide far more coal-related jobs, including mining, heavy manufacturing, construction and power plant jobs, than a number of other policy approaches – including no action on climate – that fail to both stimulate and support competitive private sector investment. And, along with the ample offsets you discussed last week, it will help avoid an undue "dash to gas" and the economic dislocation that could result.

To sum up, like many in the business community, NRG wants to do the right thing for the climate and for the economy. We know coal is part of the problem, and we understand that it also has to be part of the solution. The measures we've discussed, as part of a comprehensive climate bill consistent with the USCAP *Blueprint*, offer a clear path to achieving this important goal in an environmentally effective and economically responsible manner. We look forward to working with this Subcommittee to create such a path quickly.

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[1] Cambridge Energy Research Associates, November, 2008. *How Much New Coal Power in North America?*

Mr. MARKEY. Thank you, Mr. Crane, and thank you for the shout out for Mr. Inslee's book as well. We appreciate that, and that is why we have these cameras working again. Our next witness is Mr. Ian Duncan, who is the Associate Director for Earth and Environmental Systems for the Bureau of Economic Geology at the University of Texas at Austin. Dr. Duncan was the geologic sequestration lead for the Texas FutureGen team and focuses on the technical and legal aspects of long-term carbon storage. We welcome you, sir. Whenever you are ready, please begin.

STATEMENT OF IAN DUNCAN

Mr. DUNCAN. Thank you, Mr. Chairman. I am part of the Gulf Coast Carbon Center at the University of Texas which is dedicated to doing the science, engineering, and policy research necessary to establish a successful sequestration industry in the Gulf Coast. My personal research is in the business operational and long-term risks associated with CO_2 sequestration. I am going to organize my remarks around the four questions that you asked, Mr. Chairman, in your invitation. The first question was what experience do we have from CO_2 enhanced recovery and other experience to help determine the feasibility of large scale CO_2 sequestration. The CO_2 EOR industry in the U.S., over 80 percent of it in Texas, has transported 600 million tons of CO_2 over the last 37 years. It has injected 1,200 million tons into oil reservoirs in west Texas.

Just to give you an example, the sack rock field currently injects about 30 million tons of CO_2 and each year 6 to 7 million tons of that is retained in the reservoir, and by that mark this is the largest sequestration project in the world if it was using anthropogenic CO_2. Only part of it is. The safety record of the industry is stellar. There are no deaths, no serious injuries related to the injection of this CO_2 or the transportation. As a scientist, that is somewhat problematical to me in that it is very difficult to calculate statistics from the set so I got some challenges as to how to do this. The second question, what degree of confidence can we have in the feasibility and safety of CO_2 sequestration? Let me first define risk. Risk is likelihood or probability times consequence.

Risky things typically have a probability of about 10 to minus 3. Things that we perceive as being not risky such as driving on the road and air travel have risks of about 10 to minus 4 or 10 to the minus 5. Most of the risks that I have evaluated and associated with CO_2 sequestration so far have risks in the order of 10 to the minus 5 to 10 to the minus 7, so there are several orders of magnitude, less risky than flying in a plane. Now that is not to say that CCS and carbon sequestration is going to be risk free. However, if it is done in a proper way if it is regulated well, I think the risk is comparable to other industrial operations. The one that we know least about is the long-term risk to contamination of water, and this risk is clearly site dependent. In other words, there are some sites where one could infer that the probability would be higher.

There are other sites where the consequences, the water resources are more valuable. This leads to the third question what are the principal regulatory obstacles. I would assess that the EPA has done a commendable job in its draft rules for class six wells,

however, there is no mechanism in the EPA rules to identify the best sites for sequestration. The regulations are purely binary, sort of like a pass-fail exam. The EPA does not in my opinion have the authority to drive a mechanism to select best sites.

Final question, what role can CCS play in expanding enhanced oil recovery and impact of U.S. oil supply. In Texas if we were capturing CO_2, we could gather an extra 3.8 billion barrels of oil. This is equivalent to discovering a giant field in Texas. However, there is an issue. There is no currently considered regulation of CO_2 EOR in terms of sequestration. I would think that a class 2A regulation, A being anthropogenic, would help to introduce sequestration as part of enhanced oil recovery, and this would help develop CCS in conjunction with enhanced oil recovery. Thank you.

[The prepared statement of Mr. Duncan follows:]

Statement by Ian Duncan

Bureau of Economic Geology

University of Texas at Austin

March 10th, 2009

Regarding

The Future of Coal under Climate Legislation

Carbon Sequestration Risks, Opportunities, and Learning from the CO2-EOR Industry

Submitted to

The U.S. House

Committee on Energy and Commerce

Subcommittee on Energy and the Environment

My name is Ian Duncan. I have a PhD in Geological Sciences and I am an Associate Director of the Bureau of Economic Geology (BEG) at the University of Texas at Austin. The University of Texas has arguably the largest group of researchers in the country focused on CO2 sequestration in deep brine reservoirs. The BEG is engaged in research in a broad range of energy related and environmental issues including CO2 sequestration. The BEG's Gulf Coast Carbon Center (GCCC) is an industry-academic-NGO collaboration working on geologic CO2 sequestration including Enhanced Oil Recovery CO2 EOR.

The GCCC's Frio Pilot Injection Project, led by the BEG's Dr Susan Hovorka and funded by the DOE's National Energy Technology Laboratory, was the first highly instrumented CO2 injection experiments in the world. The GCCC currently has a significant field-test of CO2 sequestration in brine reservoirs underway in Mississippi (Denbury resources Cranfield CO2-EOR site) part of the South East Carbon Sequestration Partnership led by the Southern States Energy Board (Dr Gerald Hill, Principle Investigator). This field test seeks to show the effectiveness of CO2 sequestration, and how we can best predict and document the long term retention of CO2 through modeling and monitoring. This study involves monitoring a multi-well injection of CO2 at a rate of a million tons of CO2 a year (equivalent to rates likely for full scale CO2 sequestration projects. The deep brine reservoir being injected into is the Tuscaloosa-Woodbine Formation one of the top few sequestration targets in the Gulf Coast. These studies are funded by on the order of $50 million in Department of Energy

funds and corporate matching funds (over 10 years). Preliminary results increase our confidence in our ability to monitor CO2 injections and to detect future possible leakage from the containment zone.

For the past nearly four years I have been doing research on the role that CO2 sequestration in deep brine reservoirs and associated with CO2 enhanced oil recovery (CO2-EOR) can play in mitigating greenhouse gases in the atmosphere and in increasing domestic oil production in the US. Recently I have been working on research to quantify the risks associated with carbon capture and storage (CCS) in general and CO2 sequestration in particular.

The key points that I would like to make are:

(1) Based on all the available information I believe that large scale CO2 sequestration in deep brine reservoirs can be done safely and effectively without endangering the nation's underground sources of drinking water (USDW).

(2) Based on the safe transportation of over 600 million metric tons of CO2 in the US over the last 37 years and the safe injection of over 1,200 million tons of CO2, it is clear that we have the ability to carry out the operational phase of CO2 sequestration in deep brine reservoirs safely and effectively.

(3) The long term risks of CO2 sequestration in deep brine reservoirs is strongly site dependant. The likelihood of leakage, the likely leakage rate, and the consequences of leakage in terms of possible damages to drinking water vary greatly between sites.

(4) Although the EPA has done a commendable job in developing their draft rules for class six UIC injection permitting, there rule making does not encompass any mechanism to encourage or require selection of the optimal sites for sequestration. Their

approach (as is the case for all permitting procedures that I am aware of) is the equivalent to a pass/fail exam. In my previous testimony to the Energy and Commerce Committee last year I suggested that EPA may well not have a legislative mandate for encouraging the identification and use the optimal sites (those with the lowest risk of long term leakage). I also suggested some mechanisms that could be used to solve this problem.

(5) In the near term, CO2-EOR combined with appropriate monitoring, mitigation, and verification, (MMV) can make a significant contribution to mitigating increases in CO2 emissions by putting man-made CO2 (CO2-A) into permanent storage in depleted oil reservoirs.

(6) Congress should appropriate funds for the DOE to support university research into CO2 sequestration associated with CO2 EOR and for individual investigator research outside of the Sequestration Partnership program. Such funding would help produce young engineers and geologists trained in CO2 related technologies and alleviate a shortage that is critical now and will grow more so in the near future.

Based on the available information from over 37 plus years of CO2 injection into geologic reservoirs in the Permian basin of Texas and on scientific knowledge from natural CO2 reservoirs, I believe that large scale CO2 sequestration can be done safely and effectively without endangering the nation's underground sources of drinking water (USDW). The CO2-EOR industry has more than 37 years of experience in successfully transporting and injecting CO2. In the US alone the industry operates over 13,000 CO2 EOR wells, over 3,500 miles of high pressure CO2 pipelines, has injected approximately 1,200 million tons of CO2 (22 trillion standard cubic feet) and produces about 245,000 barrels of oil a day from CO2 EOR projects. This testimony leverages the CO2-EOR

experience and information from natural gas storage, oil and gas exploration and published risk studies to conclude that large scale CO2 sequestration in deep brine reservoirs can be technically accomplished without incurring risks larger than those currently existing in oil and gas production and similar industrial activities. Early entry projects may require public incentives to overcome perceived risks in the absence of an established track record.

EVALUATING THE RISKS ASSOCIATED WITH GEOLOGICAL CO2 SEQUESTRATION

The Union of Concerned Scientists has suggested that "the potential environmental consequences and risks to public safety are generally acknowledged but frequently dismissed as minor" they further suggest that these concerns are "insufficiently studied through systematic research to date". They suggest that the three main "direct risks to humans" are:

1. "the potential for environmental risks to humans, such as catastrophic venting of CO2, i.e., the rapid re-release of stored gas in toxic concentrations from underground storage sites
2. the potential for potable aquifer contamination
3. the possible risk of induced seismicity (earthquakes) due to underground movement of displaced fluids".

Risk can be measured by a number of different metrics such as: the risk to society as a whole (the risk of climate change for example); the risk to an individual; the average individual risk of an exposed population, the average individual risk of the total

population and the overall average death rate. The individual risk is the probability of death at point in space and time as a result of any hazardous event. It is typically expressed as a probability of death per year. If multiple fatalities are possible from a single hazardous event then the societal risk is typically defined in terms of a relationship between the likelihood of a particular type of incident and the resultant number of victims.

A risk assessment of a geologic CO2 sequestration project would attempt to address the following four questions:

- What can go wrong (what are the possible adverse outcomes)?
- What is the probability or likelihood of these outcomes?
- What would the consequences (or damages) be of each of the possible outcomes at this site?
- In view of the uncertainty in the data used, how confident are we about the answers to these first three questions?

Adequate answers to these questions can be an important step towards gaining public acceptance of geologic CO_2 sequestration. Risk management is concerned with implementing processes and policies to both prevent and control risks. This is an approach widely used to manage hazards in oil and natural gas fields, refineries, and chemical plants. Risk is composed of two elements, the likelihood (probability) of an adverse outcome (hazardous event) and the magnitude of its consequences that is:

Risk = Likelihood x Consequences

This approach can address issues of public health and safety, employee safety, threat to USDW and other environmental damage. Geologic sequestration of CO_2 in deep brine reservoirs is an appropriate application of this approach it is a process-driven system that will exist for long times. The risks resulting from events that have significant consequences but small probabilities of occurrence are difficult to estimate in the absence of large datasets.

Before discussing the nature and magnitude of risks that will be encountered in the geologic sequestration of CO2 it is useful to have some understanding of risks in other industrial projects and common activities for comparison. For example in the case of North Sea offshore oil and gas production the upper limit of tolerance for risk to personnel is 1 in 1000 or 1×10^{-3} per year. This level of risk is industry practice and is consistence with the policy of the UK government. This is equivalent to a rate of just above 30 fatal accidents per 10^8 exposure hours. Mountain climbing has about the same level of individual risk as working on an offshore oil platform. In comparison driving an automobile has a risk of 1×10^{-4} per year and flying on commercial flights has a risk on the order of 5×10^{-5} per year.

An acceptable risk can be defined by: $P < (10{-}5/N^2)$ where P is the cumulative frequency per year and N the number of fatalities. Two zones (A and B) of tolerable risk can be defined as: A $(10{-}5/N^2) < P < (10{-}4/N^2)$ and B $(10{-}4/N^2) < P < (10{-}3/N^2)$. If the cost of risk reduction exceeds the benefits gained then the risk in region A is tolerable. The risks in region B can be regarded as tolerable only if risk reduction is impracticable or if it has a cost that is grossly disproportionate to any gain in safety. An unacceptable

risk (one that cannot be justified under any circumstances) can be defined as $P > (10^{-3}/N^2)$.

Geologic sequestration lacks a large historical data base that would enable computation of long term risks. The absence of such actuarial data for large scale CO2 sequestration projects and a still not settled regulatory framework, creates major obstacles to project financing, and ultimately wide-scale deployment. In the language of risk analysis such systems are "ambiguous". In essence the term ambiguity refers to imprecisely specified probabilities. Decision makers are more adverse to ambiguous situations than they are to risky ones. For example insurers are known to seek higher premiums for projects that are perceived as ambiguous, than for those known to be risk prone.

Scientists and engineers have a good understanding of the risks associated with CO2 sequestration in brine reservoirs in terms of the spectrum of risk elements. However, a consensus is lacking in the published literature as to the relative (and absolute) probabilities of adverse outcomes. There is a particular concern for the long-term risk in the post closure period of injection projects. The risk during the operational phase of CO2 sequestration projects is arguably relatively well understood can be adequately addressed through and existing financial risk management frameworks or straight forward modifications thereof.

The transportation of CO2 by pipelines for the CO2-EOR industry has an excellent safety record. No deaths or serious injuries have been associated with CO2 pipelines. The IPCC Report (that included both industry and academic authors) suggested that "If CO2 is transported for significant distances in densely populated regions; the

number of people potentially exposed to risks from CO2 transportation facilities may be greater than the number exposed to potential risks from CO2 capture and storage facilities" and that "Public concerns about CO2 transportation may form a significant barrier to large-scale use of CCS". A recent report prepared by the Australian Government suggests that although transport of carbon dioxide by pipeline is a potential safety hazard that this risk is "less that natural gas". The differences are that natural gas is highly flammable (and potentially explosive). Serious accidents associated with natural gas pipelines typically involve explosion or jet fire. Natural gas released by a pipeline rupture forms a buoyant vapor plume that typically will not in a persistent ground level vapor cloud. In contrast CO2 is non-flammable, heavier than air (producing ground hugging clouds when released in quantity) and causes death at high concentrations. CO2 leaking from a pipeline will not have the same dispersion as would natural gas. CO2 will have a tendency to pond in pits and topographic depressions. Recent modeling of the dispersion of CO2 clouds by scientists at Lawrence Livermore and Lawrence Berkeley National Labs suggests that dangerous CO2 levels generated from plausible releases from pipelines (or well blowouts) are highly unlikely to exist for "a very long time" and under most wind conditions disperse rapidly.

It must be noted that the sample size for CO2 pipelines is small compared to those for natural gas and hazardous-liquids transmission. Although CO2 pipelines have a near perfect safety record it is reasonable to conclude that in a statistical sense, the frequency of pipeline incidents involving CO2 should be similar to those for natural gas pipelines. The risk analysis group DNV, estimated the likelihood of small (3-10 mm) breaches in CO2 pipelines as 1.1×10^{-5} and for large (50-150 mm) breaches as 3.3×10^{-7} per meter of

pipe length per year. A similar calculation based on US CO2 pipeline statistics was made as part of the FutureGen EIS which estimated puncture failure frequencies as 1.9×10^{-5}/miles-year (1.18×10^{-4}/[kilometer-year]) and rupture frequencies as 9.55×10^{-5}/miles-year (5.92×10^{-5}/[kilometer-year]). Computation of risk from these probabilities requires knowledge of the consequences which is typically done on a site specific basis. Developing a quantitative understanding of the risks associated with large scale pipeline transport of CO2 for a future CCS industry will probably require generalizing the results from a significant number of site specific risk assessments similar to those done for the FutureGen sites.

It has been suggested in the literature that the incident rate CO2 pipelines can be estimated from that for natural gas pipelines. USDOT statistics recorded ten incidents of CO2 pipelines failures. The DOT data suggest that these incidents were caused by: relief valve failure (four incidents); weld, gasket, valve packing failure (three); corrosion (two); and outside force (one). Similar DOT statistics for a very large data set of natural gas pipelines in the US showed the reasons for failure as: outside force, including damage by contractors, farmers and utility workers (35%); corrosion (32%); other, such as vandalism, train derailment and improper operation of manual valves (17%); weld and pipe failures (13%); and operator error (3%). There is good reason to believe that the rate of incidents (rupture, puncture etc) for CO2 and natural gas pipelines should be the same if CO2 sequestration is implemented on a large scale. It is important to note that even if the rates of incidents for CO2 and natural gas pipelines begin to look the same in the future. my judgment is that the risk will still be lower for CO2 pipelines (a conclusion that appears to be increasingly supported by governmental reports and academic studies). I also

believe that the risk from rupture of CO2 pipelines is the largest risk facing a future CO2 sequestration industry. If this conclusion proves correct then this places strong bounds on the risks of geologic CO2 sequestration. Ultimately the risk from pipelines depends on: siting of the pipelines (risks are site specific); operation of the pipelines to minimize possible corrosion (particularly the current industry focus on keeping the water levels in the CO2 below saturation); and implementation of effective risk management and mitigation plans.

Unfortunately, public perception of the risks associated with geologic sequestration of CO_2 in deep brine reservoirs is strongly shaped by accounts of the effects of catastrophic releases of CO_2 (such as the Lake Nyos event), related to unique deep tropical lakes in equatorial volcanic terrains. Unfortunately many of the review papers on the topic of risk associated with CO2 sequestration have been written by researchers with little or no training in geology or the natural sciences. As a result a number of statements exist in the CO2 sequestration risk literature would lead a reasonable person to conclude that a "Lake Nyos" type incident could occur in the future associated with leakage from CO2 sequestration. I believe that these statements and other assertions of catastrophic results from leakage from deep brine reservoirs are not supported by the facts or any published analysis. It is important that these highly inflammatory misconceptions are corrected in published articles in refereed journals.

The risks of CO2 storage in a geological reservoir should be seen in the context of an engineered reservoir. The subsurface engineering technology that will form the basis of a new sequestration industry is in large based on equipment and approaches developed over the last 37 years for CO2-EOR. After consideration of possible ruptures of CO2 pipelines the next most plausible risk to public health and safety comes from the "blow out" or loss of control of a CO2 injection well. Injection wells are typically equipped with

"blowout preventer" technology to stop such events. Blowouts do occur rarely in association with CO2-EOR injection activity and understanding the nature and consequences of these events can help us predict the risk of such events occurring in association with future CO2 sequestration. There are currently 4,700 injector wells operating in the Permian Basin amounting to 40% of the CO2 EOR wells currently operating, the other 60% of wells being production wells. The total CO2 injected into the Permian Basin amounts to approximately 1,200 million tons of CO2. Almost certainly the number of injection wells that will be used for CO2 sequestration in brine reservoirs to inject an equivalent amount of CO2 will be far fewer. This is important to consider this when attempting to use statistics for blowouts of CO2-EOR injection wells in predicting the operational risk of large scale CO2 sequestration projects.

The International Energy Agency (IEA) has documented frequency estimates for natural gas well blowouts from three different data sources: (1) 2.02×10^{-5} major incidents/well-year for natural gas storage wells (estimated from worldwide data from the 1970s onwards); (2) 2. 5.1×10^{-5} accidents/well-year for natural gas storage wells (estimated from European data); and (3) 3. 5.0×10^{-5} blow outs from oil and gas production/well-year (estimated using data from the Netherlands). They note that failure (blowout) rates reported for natural gas storage wells are remarkably similar to those reported in offshore oil and gas wells. A 1997 textbook on injection technology, recommends using a well blowout frequency of $5.0X10^{-5}$ blowouts per well year for wells in the operational phase (production and injection wells). This blowout frequency is likely to be larger than that actually experienced due to outdated well design (in the data set, new operating practices that have been implemented since the study, and the broad

definition of blowout used in the study). A recent (2006) IEA study has suggested that the failure rate of a CO2 injection well during operation (blowout rate) can be estimated as 2.02×10^{-5} per well per year based on experience with natural gas injection wells from.

I am currently engaged in a research project that is examining the record of blowouts associated with the CO2 EOR industry. This study is in its initial phases. So far four blowouts associated with CO2 injection wells have been identified and another twelve are being evaluated. Although this study is incomplete the preliminary conclusions is that the incident rate is small. Significantly in considering the risk and consequences of blowouts during deep brine sequestration projects the differences between EOR and sequestration inject projects must be addressed. Typically CO2 sequestration injection wells will operate at a higher pressure than CO2-EOR injectors. Developing technologies for improved well integrity will be an ongoing focus in the design of future sequestration wells. Attention must also be paid to developing improved operational procedures.

The next most likely risk associated with CO2 sequestration is related to leakage into groundwater (USDW) from well bore failures (corrosion, cracked casing etc). From 20,271 cumulative site-years of underground natural gas storage experience, the IEA in 2006 identified eight leakage incidents that appeared to fit this category for a frequency of occurrence of 3.95×10^{-4} significant leaks/site-year. They found that the frequency of significant leakage from all underground mechanisms (sixteen incidents) was estimated at 7.89×10^{-4} significant leaks/site-year for all types of underground natural gas storage facilities. Because this estimate included salt caverns, and aquifers storage, this estimate

probably significantly overestimates the likelihood of such phenomena associated with CO2 sequestration.

The thirty seven plus years of history of CO2 injection involved in CO2 based Enhanced Oil Recovery in the US represent the most tangible evidence available for understanding the risks of CO2 sequestration in deep brine reservoirs. In the case of both pipeline incidents and blowouts; component failure rather than corrosion or human errors have resulted in the leakage of CO2. The rarity of corrosion related incidents reflects the industries success in implementing anti-corrosion measures. In the case of blowouts, incidents related to CO2 production wells from natural reservoirs and those that occurred during work over of production wells, resulting from unexpectedly early CO2 breakthroughs are not directly relevant to understanding the risk of CO2 sequestration in deep brine reservoirs. Although safety and health issues are always of paramount concern, the excellent safety and health record of the CO2 industry in the Permian Basin of West Texas may suggest that these issues are not a major component of the operational risk faced by a putative carbon sequestration industry.

Unfortunately some authors of academic papers have been intemperate in their use of language when addressing risk issues. One paper in 2004 suggested that the "acute hazards" related to geologic CO2 sequestration are "wellhead failure [blowouts], seismic hazard during injection, accumulation and explosion in lakes, and massive efflux in soils". This is rather odd language for a paper that in the numerical probability data presented apparently demonstrated that CO2 related incidents would be extremely rare. Another paper in 2003 suggested that the "most obvious local [associated with the surface release of CO2] risk" is related to "catastrophic leaks such as well blowouts or pipeline ruptures".

Similarly a 2005 paper suggests that "the most frightening scenario [related to risks associated with geologic CO2 sequestration] would be a large, sudden, catastrophic leak. This kind of leak could be caused by a well blowout or pipeline rupture". Both these papers apparently ignored (or were unaware of) the excellent safety record off the CO2-EOR industry in transporting and injecting CO2.

The risk that science has the least factual basis to constrain likelihoods is that of leakage through the seal or containment zone of the sequestration reservoirs, ultimately leading to pollution of drinking water. Leakage may be diffuse but most likely would be focused by transmissive faults or fracture zones. These issues are the subject of considerable current research effort. Though much of this research is not yet complete and only a small portion has yet been published, a consistent picture is emerging. First numerical modeling results support the assertion that the chances of catastrophic leakage through the seal are extremely small. In well chosen sites I believe that such a risk is effectively non-existent. The main impact of leakage through the seal (should it occur) will be on groundwater quality. Research so far suggests that both the likelihood of such leakage and the consequences that would results from it are site specific. Some sites are more likely to leek that others. If the seal of a reservoir does leak the consequences also vary from site to site. At some sites there are negligible quantities of drinking water and therefore the consequences are limited. I would argue that careful site selection is the key to controlling risk from slow (long term leakage). This type of risk will dominate the long term (post-closure) risk.

Although safety and health issues are always of paramount concern, the excellent safety and health record of the CO2 industry in the Permian Basin of West Texas, and the

absence of known negative impact on USDW suggest that these issues are not a major component of the business risk faced by a putative carbon sequestration industry. Having said this, it is very unfortunate that very little research funding is available to study and assess the wealth of potential information available from studying the results of the long term CO2 injections in the Permian Basin by CO2 EOR operators. Apart from a small DOE funded research project through the Southwest carbon Sequestration Partnership and led by the BEG, only very limited research is being done in this crucial area. I recommend that Congress should appropriate funds for the DOE to support university research into CO2 sequestration associated with CO2 EOR particularly in the Permian basin which has the longest history of CO2 injection in the world. An aggressive research program including pilot projects would help improve the performance of current EOR activity and enable the development of new more effective approaches that could increase oil recovery, reduce the geological and technical risks, and enhance sequestration rates incidental to CO2-EOR. Such funding would also help produce young engineers and geologists trained in CO2 related technologies and alleviate a shortage that is critical now and will grow more so in the near future.

It has recently been suggested that an effective system of regulation for geologic sequestration should share place the long-term risks of sequestration in public hands. I prefer to place the emphasis not on the government taking on the long term risk but rather on reducing risk of leakage by creating a regulatory framework that: (1) provides a mechanism to assure optimal site selection (2) minimizes risk by requiring adequate site characterization; (3) assures early detection of any leakage by insisting on deep monitoring; and (4) requires preventive action to lower the chance of leakage leading to adverse outcomes. Government resources should be deployed early in the project life

cycle, focused on optimizing selection and evaluation of sites. Providing careful oversight of risk assessments and then requiring early and vigorous implementation of preventative action will be more valuable than reserving resources to remediate problems that could have been prevented. It is possible that assumption of some long term risk by the public may be necessary to enable early entry projects to get financing.

Mr. MARKEY. Thank you, Dr. Duncan, very much. Our next witness is Mr. Frank Alix, CEO, and co-founder of Powerspan, a New Hampshire-based company, currently working on carbon dioxide capture technology for electric power companies. We welcome you, sir.

STATEMENT OF FRANK ALIX

Mr. ALIX. Thank you, Mr. Chairman, for the opportunity to share my perspective on the future of coal under climate legislation. My testimony today will focus on the prospects for commercial deployment of carbon capture technologies on coal-fired power plants. Powerspan has been developing and commercializing advanced clean coal technology since 1994. Our approach to CO_2 capture, called ECO_2, is a post-combustion process designed to capture 90 percent of CO_2 emissions. The technology is suitable for retrofit to the existing coal-fired generating fleet for new coal-fired plants. Pilot scale testing of our ECO_2 technology began in December of 2008 at FirstEnergy's Burger Plant in Southeastern Ohio. The ECO_2 pilot was designed to treat a 1 megawatt flue gas stream and capture 20 tons of CO_2 per day.

Initial testing has demonstrated 80 percent CO_2 capture efficiency which is a promising start. We recently completed two minor design modifications that we expect will increase the CO_2 capture rate to 90 percent. The pilot plant was built using the same type of equipment that we plan to use in commercial systems. Therefore, successful operation of the pilot unit will confirm our design assumptions and cost estimates for large-scale CCS projects. Although commercial scale CCS projects still have some risk, that risk is manageable because the major equipment used in the ECO_2 process has been used in other commercial applications at the scale required for CCS. Our experience in the emerging market for commercial scale CCS projects supports our optimism. In 2007, Basin Electric Power Cooperative conducted a competitive solicitation for a post-combustion C)s capture technology to retrofit their Antelope Valley Station, which is a coal-fired power plant located in Beulah, North Dakota. The Antelope Valley project will install CO_2 capture equipment on a 120 megawatt flue gas slipstream taken from a 450 megawatt unit. Basin Electric has targeted 90 percent CO_2 capture efficiency to provide 1 million tons of CO_2 annually for enhanced oil recovery.

Six of the leading CO_2 vendors for post-combustion capture technology responded to the Antelope Valley solicitation and after a detailed evaluation, Basin Electric selected Powerspan. This commercial CCS project is scheduled to start up in 2012. Since being selected for the Antelope Valley project, a feasibility study has confirmed that there are no technical limitations to deploying ECO_2 at the plant. The study estimated cost of less than $40 per ton for 90 percent CO_2 capture and compression. A similar study of ECO_2 recently conducted for a new 760 megawatt super critical coal plant estimates CO_2 capture costs of under $30 per ton. A third engineering study focused on ECO_2 scaling risks determined that our pilot plant will provide sufficient design information to confidentially build commercial scale systems up to 760 megawatts.

Independent engineering firms led the feasibility, cost, and scaling studies for our prospective customers. As a sign of our confidence, we will back our commercial ECO_2 installations with industry standard performance guarantees. Despite the promise indicated by the Basin Electric project, strong government action is needed to ensure timely deployment of CCS technology to support climate change mitigation goals. Government actions should focus on three areas: 1, a strong, market-based cap on greenhouse gas emissions; 2, a CO_2 emission performance standard for new coal-based power plants; 3, early deployment incentives for commercial scale CCS systems.

Incentives are needed to ensure early deployment of CCS because CO_2 capture technology is not yet commercially proven on large coal plants and early CO_2 prices will not be sufficient to offset CCS costs. To be most effective, CCS incentives must provide long-term CO_2 price certainty to facilitate project financing and must be awarded competitively, preferably by reverse auction in order to minimize cost while also providing a market signal on the real cost for early CCS installations. Early deployment of CCS technology will also create jobs and promote economic growth.

CCS projects require 3 to 4 years to implement and create significant economic activity over their duration. In addition, by incentivizing early deployment of CCS, the U.S. can assume a leading position in this critical sector and create a thriving, high-tech export business, and the quality jobs that come with it. In summary, CO_2 capture technology is commercially available from several qualified vendors with standard commercial guarantees. Independent studies show that early commercial installations of CO_2 capture technology are likely to be successful. The cost of widespread deployment of these technologies appear manageable, particularly when compared to the cost of other low-carbon electricity solutions.

The most important reason to promote early deployment of CCS is that post-combustion CO_2 capture technologies will preserve the huge investment in existing coal-fired power plants and allow us to effectively use abundant, low cost, coal reserves in the U.S. and developing nations, even in a climate constrained world. Thank you, Mr. Chairman.

[The prepared statement of Mr. Alix follows:]

Testimony of Frank Alix before the House Subcommittee on Energy and Environment; Hearing on The Future of Coal Under Climate Legislation, March 10, 2009

Good morning Mr. Chairman and Members of the Committee. Thank you for the opportunity to share my perspective on the future of coal under climate legislation. My name is Frank Alix and I am CEO of Powerspan Corp., which is a clean energy technology company headquartered in New Hampshire.

My testimony today will focus on the prospects for commercial deployment of carbon capture technologies on coal-fired power plants. Powerspan has been developing and commercializing advanced clean coal technology since its inception in 1994. Our approach to CO_2 capture, called $ECO_2^{®}$, is a post-combustion process for conventional power plants designed to capture 90% of CO_2 emissions. The technology is suitable for retrofit to the existing coal-fired generating fleet and for new coal-fired plants. ECO_2 is a regenerative process that uses an ammonia-based solution to capture CO_2 in the flue gas. Once the CO_2 is captured, the solution is regenerated to release CO_2 in a form that is ready for compression and pipeline transport for geological storage.

Pilot scale testing of our ECO_2 technology began in December 2008 at FirstEnergy's Burger Plant in Southeastern Ohio. The ECO_2 pilot was designed to treat a 1-megawatt (MW) flue gas stream and produce 20 tons of CO_2 per day. Initial testing has demonstrated 80% CO_2 capture efficiency, which is a promising start. We recently completed two minor design modifications that we expect will increase the CO_2 capture rate to 90%.

The ECO_2 pilot plant was built using the same type of equipment that we plan to use in commercial systems. Therefore, successful operation of the pilot unit will confirm our design assumptions and cost estimates for large-scale carbon capture and sequestration (CCS) projects. Although commercial scale CCS projects still have some risk, that risk is manageable because the major equipment used in the ECO_2 process—large absorbers, pumps, heat exchangers, and compressors—have all been used in other commercial applications at the scale required for CCS. The advanced technology in ECO_2 is innovative

process chemistry. Commercial application of this unique technology holds no special challenges and therefore has a high probability of commercial success.

Our experience in the emerging market for commercial-scale CCS projects supports our optimism. In 2007, Basin Electric Power Cooperative conducted a competitive solicitation for a post-combustion CO_2 capture technology to retrofit their Antelope Valley Station, which is a coal-fired power plant located adjacent to their Great Plains Synfuels Plant in Beulah, North Dakota. Their synfuels plant currently hosts the largest CCS project in the world, with three million tons of CO_2 captured annually and sold for enhanced oil recovery (EOR) in the Weyburn fields of Saskatchewan. The Antelope Valley project will install CO_2 capture equipment on a 120-MW flue gas slipstream taken from a 450-MW unit. Basin Electric has targeted 90% CO_2 capture efficiency to provide an additional 1 million tons of CO_2 annually for EOR. Six of the leading vendors of CO_2 capture technology responded to the Antelope Valley solicitation and after a detailed evaluation, Basin Electric selected Powerspan. This commercial CCS project is scheduled to startup in 2012.

Since being selected for the Antelope Valley project, a feasibility study has confirmed that there are no technical limitations to deploying ECO_2 at the plant. The study estimated ECO_2 costs of less than $40 per ton for 90% CO_2 capture and compression (in current dollars, with +/- 30% accuracy). A similar study of ECO_2 recently conducted for a new 760-MW supercritical pulverized coal plant estimates CO_2 capture costs of under $30 per ton, including compression. A third engineering study focused on ECO_2 scaling risk determined that the ECO_2 pilot plant will provide sufficient design information to confidently build commercial scale systems up to 760-MW, supporting that ECO_2 technology scaling risk is manageable. Independent engineering firms led the feasibility, cost, and scaling studies for our prospective customers. As a sign of our confidence in commercial deployment of ECO_2 systems, we will back our installations with industry standard performance guarantees.

Despite the promise indicated by the Basin Electric project, strong government action is needed to ensure timely deployment of CCS technology to support climate change

mitigation goals. Government actions should focus on three areas: 1) a strong, market-based cap on GHG emissions, 2) a CO_2 emission performance standard for new coal-based power plants, and 3) early deployment incentives for commercial scale CCS systems. Due to limited time, I will only elaborate on my third point, the need for CCS incentives.

Incentives are needed to ensure early deployment of CCS because CO_2 capture technology is not yet commercially proven and early CO_2 prices will not be sufficient to offset CCS costs. To be most effective, CCS incentives must provide long-term CO_2 price certainty to facilitate project financing, and must be awarded competitively, preferably by reverse auction, in order to minimize cost while also providing a market signal on the real costs for early CCS installations. Knowing actual CCS costs is extremely important to plant owners, investors, technology developers, and regulators in evaluating future investment and regulatory decisions. Competitively awarding CCS incentives is also consistent with how renewable portfolio standards are normally administered.

Early deployment of CCS technology will also create jobs and promote economic growth. CCS projects require 3 to 4 years to implement and create significant economic activity over their duration. For example, a single CCS project would cost between $250-750 million in capital expense and create up to 500 jobs at its peak, with the majority of materials and labor sourced in the US. However the government's cost of the CCS incentive program would not be incurred until CO_2 sequestration begins upon project completion. In addition, by incentivizing early deployment of CCS, the US can assume a leading position in this critical sector and create a thriving, high-tech export business, and the quality jobs that come with it.

In summary, CO_2 capture technology is commercially available from several qualified vendors with standard commercial guarantees. Independent studies show that early commercial installations of CO_2 capture technology are likely to be successful. The cost of widespread deployment of technologies such as ECO_2 appears manageable, particularly when compared to the cost of other low-carbon electricity solutions. And once we gain commercial CCS experience, future costs will no doubt decrease substantially.

The most important reason to promote early deployment of CCS is that post-combustion CO_2 capture technologies will preserve the huge investment in existing coal-fired power plants and allow us to effectively use abundant, low cost, coal reserves in the US and developing nations, even in a climate constrained world. If we are not successful in commercializing CCS technology in the near-term, it will be difficult for the world to meet its long-term goals for climate change mitigation.

Thank you Mr. Chairman. I would be pleased to answer any questions.

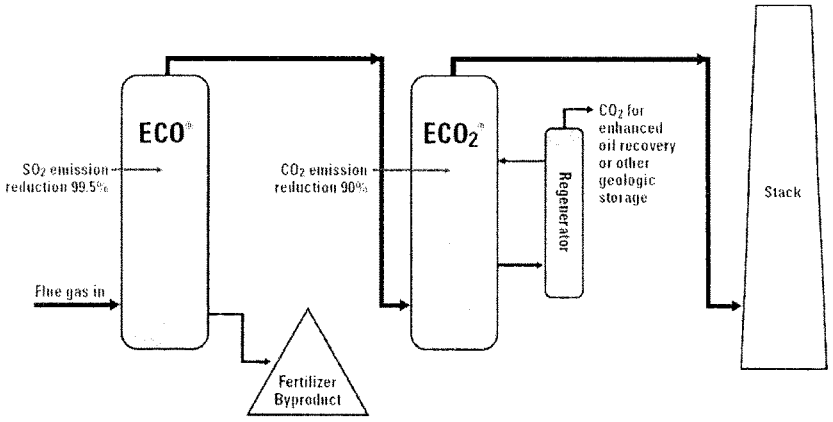
ECO_2® Technology for CO_2 Capture from Existing and New Coal-Fired Power Plants

Summary

Powerspan Corp.'s CO_2 capture process, called ECO_2®, can be applied to both existing and new coal-fired electric power plants to capture 90 percent CO_2 from the flue gas. The process is designed as an add-on system that could be deployed when needed and is particularly advantageous for sites where ammonia-based scrubbing of power plant emissions, such as our ECO® multi-pollutant control technology, is employed. The technology is currently being piloted on a 1-megawatt (MW) slipstream at a power plant in Ohio. The ECO_2 pilot unit employs the same type of equipment that will be used in commercial systems. Because the innovation of ECO_2 is in its process chemistry, not in new industrial equipment, the risk in scaling from the pilot scale to commercial scale carbon capture and sequestration (CCS) projects is manageable. Commercial scale ECO_2 demonstrations (120-MW; one million tons of CO_2 capture annually) are planned to be online in 2012, with the captured CO_2 to be used for enhanced oil recovery operations.

Technology Description

ECO_2 is a scrubbing process that uses an ammonia-based (not amine) solution to capture 90 percent CO_2 from the flue gas. The CO_2 capture takes place after the nitrogen oxides (NOx), sulfur dioxide (SO_2), mercury and fine particulate matter is captured using ECO technology or other air pollution control system. Once CO_2 is captured, the resulting solution is regenerated to release CO_2 and ammonia. The ammonia is recovered and returned to the scrubbing process, and the CO_2 is processed into a form that is sequestration ready. Ammonia is not consumed in the scrubbing process, and no separate by-product is created.



Incorporation of Powerspan's ECO_2® carbon capture process with the commercially available multi-pollutant control ECO® process

Technology Development

Powerspan has been developing the CO_2 capture process since 2004 in conjunction with the U.S. Department of Energy (DOE) National Energy Technology Laboratory under a cooperative research and development agreement. In December 2007 Powerspan announced it exclusively licensed a patent for the process from the DOE. The patent granted to the DOE represents the only patent issued in the U.S. to date covering a regenerative process for CO_2 capture with an ammonia-based solution. Powerspan has conducted extensive bench-scale testing to establish the effectiveness of the process for CO_2 capture, and has made improvements to the subject patent. The testing has also established the design parameters for the ECO_2 pilot unit in operation at FirstEnergy's R.E. Burger Plant in Shadyside, Ohio.

ECO_2 Pilot Project

Commissioning was completed and ECO_2 pilot testing began at FirstEnergy's Burger Plant in December 2008. The ECO_2 pilot processes a 1-MW slipstream drawn from the outlet of the 50-MW Burger Plant ECO unit. It is designed to produce approximately 20 tons of sequestration ready CO_2 per day while achieving a 90 percent capture rate. The pilot system is expected to run through 2009.

The ECO_2 pilot will demonstrate CO_2 capture through integration with the ECO multi-pollutant control process. Operation of the pilot will confirm process performance and energy requirements. The pilot program will also provide the basis for cost estimates while preparing the technology for the commercial scale CCS demonstrations planned to be online in 2012.

Scalability of ECO_2 to Commercial Scale Projects

Although the ECO_2 process is new and proprietary, the innovation is in its process chemistry. The equipment required for operation of commercial ECO_2 systems (e.g., large absorber, regenerator, heat exchangers, pumps, gas dryer, etc.) are commercially available at the required scale. Therefore, once the pilot scale demonstration of the ECO_2 process is completed, the scale up risk to commercial size systems is manageable. An independent engineering study focused on ECO_2 scaling risk determined that the ECO_2 pilot plant will provide sufficient design information to confidently build commercial scale systems up to 760-MW, supporting that ECO_2 technology scaling risk is manageable.

ECO_2 Commercial Demonstration Projects

Basin Electric Antelope Valley Station—In March 2008, Basin Electric Power Cooperative and Powerspan announced the selection of the ECO_2 process for a 120-MW commercial demonstration at Basin Electric's Antelope Valley Station located near Beulah, North Dakota. The selection of the ECO_2 process is the result of the first competitive solicitation process for a CO_2 capture demonstration at a coal-fired power plant in the U.S. The Antelope Valley project is designed to capture approximately one million tons of CO_2 annually which will be fed into an existing CO_2 compression and pipeline system owned by Basin Electric's wholly owned subsidiary, Dakota Gasification Company. Dakota Gasification Company is the only company in the U.S. that captures CO_2 from coal and delivers it for enhanced oil recovery operations. Since 2000, Dakota Gasification has been delivering CO_2 from its coal gasification facility, the Great Plains Synfuels Plant, to oil producers in Saskatchewan, Canada.

In June 2008, Powerspan successfully completed a feasibility study, which confirmed that there are no technical limitations in deploying the ECO_2 process at the plant. In January 2009, the project was approved for up to a $300 million loan from a USDA Rural Utilities Service program for early CCS demonstration. Based on successful completion of detailed engineering studies and obtaining of necessary permits, the Antelope Valley project is expected online in 2012.

NRG Energy WA Parish Plant—In November 2007, NRG Energy, Inc. and Powerspan announced their memorandum of understanding to commercially demonstrate the ECO_2 process at NRG's WA Parish plant near Sugar Land, Texas. The 125-MW equivalent CCS demonstration will be designed to capture and sequester about one million tons of CO_2 annually. The ECO_2 demonstration facility will be designed to capture 90 percent of incoming CO_2 and the captured CO_2 is expected to be used in enhanced oil recovery in the Houston area. The Parish plant is expected to be online in 2012.

About Powerspan and ECO Multi-Pollutant Control Technology

Powerspan Corp., based in New Hampshire, has been developing and commercializing advanced clean coal technology since its inception in 1994. Powerspan's most significant technology success to date has been the development and commercialization of its patented Electro-Catalytic Oxidation (ECO) technology, which is an advanced multi-pollutant control technology to reduce emissions of sulfur dioxide (SO_2), nitrogen oxides (NO_x), mercury (Hg), and fine particulate matter ($PM_{2.5}$) in a single system.

For over five years, Powerspan has successfully operated a 50-MW scale ECO commercial unit at FirstEnergy's R.E. Burger Plant in Ohio. This unit has demonstrated that the ECO process is capable of achieving outlet emissions below current Best Available Control Technology standards for coal-fired power plants. The ECO process also produces a valuable fertilizer product, avoiding the landfill disposal of flue gas desulfurization waste. Furthermore, the ECO system uses less water because it requires no wastewater treatment or disposal.

In June 2007, American Municipal Power-Ohio (AMP-Ohio) announced its commitment to install our ECO-SO_2 multi-pollutant control technology on its proposed 1,000-MW American Municipal Power Generating Station in southern Meigs County, Ohio. In January 2009, AMP-Ohio announced the selection of Bechtel as its engineering, procurement and construction firm, and granted the firm a limited notice to proceed on the project. AMP-Ohio will use our ECO-SO_2 technology as an SO_2, mercury, and fine particulate matter control option for its strong environmental performance and potential to add our ECO_2 carbon capture technology.

1. Competitive Award: CCS incentives should be awarded competitively based on a reverse auction (incentives awarded to the low cost bidders per ton of CO_2 captured and sequestered) for the following reasons:
   - This would preserve the primary objective of a cap and trade program, which is to minimize cost of compliance, while also providing a market signal on the real costs for early CCS installations.
   - Current climate legislation proposals, which arbitrarily set CCS incentive prices, would result in less cost-effective CCS technologies being subsidized, while plant owners/developers and regulators gain little or no information on what real CCS costs are.
   - Arbitrarily setting CCS incentive prices would distort the market and support technologies that may not otherwise survive in a non-subsidized market. It would also create a windfall profit opportunity for the lowest cost CCS solutions and unnecessarily increase the cost of CCS incentives to the government.
   - Knowing actual CCS costs is extremely important to plant owners, technology developers, investors, and regulators in evaluating future investment and regulatory decisions.
   - Competitively awarding CCS incentives is consistent with how renewable portfolio standards are normally administered. Market participants—power suppliers, regulated distribution companies, and state regulators—understand this process. States set a standard for the amount and type of renewable energy desired, and the potential suppliers respond to competitive solicitations to provide the renewable energy. The federal government could effectively implement the same type of approach for CCS projects/incentive awards.
2. Long-term Price Certainty, Factoring in CO_2 Emission Allowance Value: CCS incentives need to provide long-term price certainty and factor in the value of CO_2 emissions allowances because:
   - CCS projects will likely be financed over 15 to 30 years. Current climate legislation proposals award CCS incentives over a fixed period of time (i.e. 10 years) that is too short to finance most projects.
   - CCS incentives would be most economical for the government if they factor in the increasing value of CO_2 emission allowances over time.
     - For example, if the CCS project developer needs to assure a price of $40 per ton of CO_2 over 20 years to finance the project, the government could guarantee that price as an annual subsidy over the required term, after the value of avoided CO_2 emissions are subtracted. As the value of CO_2 emissions allowances rise, the amount of annual CCS subsidy the government is required to pay would decrease, while the project developer would still obtain the required price assurance to finance the project.

- As the value of CO_2 emission allowances rises over time, the percentage of allowance auction proceeds received by the government that are needed to support the CCS incentives will decrease.
- Current climate legislation proposals do not account for the added value of CO_2 emission allowances created by the CCS project or the fact that emission allowance values would be increasing over time. This approach creates a potential windfall profit opportunity for the early CCS adopters and unnecessarily increases the cost of CCS incentives to the government.

3. CCS Project Size: The primary objective of CCS incentives is to demonstrate CCS technology at commercial scale to accelerate market acceptance and deployment. In order to demonstrate CCS as commercially viable, a minimum project size criteria should be established:
   - Experts such as MIT, DOE, and EPRI have established a minimum size of 1,000,000 tons of CO_2 per year for CCS projects to be considered "commercial scale." Once the minimum CCS project size is met, preference should be given to larger projects.
4. CO_2 Capture Rate: In order to meet the objective of stabilizing GHG concentrations in the atmosphere, large stationary CO_2 sources will need to capture and sequester a high percentage of their CO_2 emissions (i.e. $\geq$ 90%). Therefore, CCS incentives should establish a minimum standard for CO_2 capture (e.g., 80%) and should favor projects that capture higher percentages of CO_2.
   - Available technology from leading suppliers has shown the ability to capture 90% CO_2. Therefore establishing a minimum CO_2 capture rate as high as 80-90% is technically feasible and commercially acceptable.
   - CCS projects will normally require 3-4 years to implement. An incentive program that encourages CCS to be demonstrated in sequential steps (e.g., 50% then 80%) would unnecessarily delay deployment of the high capture rate CCS projects needed to combat climate change and increase the cost of CCS incentives to the government.
5. Amount of CCS Incentives; Timing of Auctions; Technology Diversity: The amount of CCS incentives in tons of CO_2 should be based on the following factors:
   - The need to demonstrate CCS at commercial scale in a number of different configurations for both plant type and geological storage type. All large industrial sources of CO_2 should be considered equally. However, the government should not try to pick technology winners and losers. The primary driver in CCS incentive awards should be lowest cost per ton, with at least three different CO_2 capture technologies selected to promote technology diversity. This would facilitate the creation of a competitive supplier market of the most cost-effective technologies.
   - The need to avoid early market responses to a CO_2 emission cap, such as a rush to gas-fired power generation, which may not be sustainable after CCS is commercially proven and CO_2 allowance prices rise to where CCS would be deployed without incentives.

- The need to spread out incentives so that multiple CCS projects are awarded each year for at least five years as the current pace of technology evolution is great and the CCS incentive program should take advantage of and benefit from this rapid pace of improvement.
- The near-term need to stimulate the economy. CCS projects normally require 3-4 years to implement and create a great deal of economic activity over their entire duration. However the cost of the CCS incentive program does not begin until CO_2 sequestration is started upon project completion. For example, a 5,000,000-ton per year CCS project could cost $750 million in capital expense to implement over the first 4 years. However, with a $20 per ton net CCS incentive, it would only require government support of $100 million beginning in year 5 and decreasing annually from there.

6. Qualifying Criteria: Projects that apply for CCS incentives should meet certain qualifying criteria. Qualifying projects should:
   - Be new (existing projects that capture and sequester CO_2 should not qualify).
   - Certify that they have all required permits or will have within 12 months of award.
   - Certify that they have all required financing or will have within 12 months of award.
   - Certify that they are scheduled to break ground within 12 months of award and have scheduled project completion within 4 years after ground breaking.
     - Projects that receive CCS incentive awards but are not able to complete permitting, financing, and groundbreaking within 12 months of award should forfeit the CCS incentive (but may apply again).
   - Not be in any way disadvantaged by having received other types of government support such as loan guarantees, grants, and tax incentives.
7. Sequestration Issues: Existing CO_2 pipelines used for enhanced oil recovery (EOR) operations can support several new, large-scale CCS projects. The CCS incentives should be structured so as not to disadvantage these opportunities in any manner as they will likely be the lowest-cost and nearest-term projects available to demonstrate commercial scale CCS. However, in order to incentivize broader CCS deployment, the following sequestration issues need to be resolved:
   - Legal and permitting requirements for geological sequestration including standards for measurement, monitoring, and verification (MMV).
   - Long-term liability for sequestered CO_2.
   - Incentivizing CO_2 pipeline construction at optimum scale. CO_2 pipelines benefit from economies of scale up to about 24 inches in diameter. This size would provide CO_2 capacity for 3-4 large-scale CCS projects (nominally about 15 million tons per year; equivalent to ~2,000 MW capacity at 90% CO_2 capture). Therefore preference should be given to CCS projects that create extra capacity by constructing pipelines or other infrastructure that could be used by multiple CCS projects.

Mr. MARKEY. Thank you, Mr. Alix, very much. Our next witness is Mr. Hal Quinn, who is the President and CEO of the National Mining Association. The National Mining Association represents coal, metal, and industrial mineral producers, as well as equipment, manufacturers, and suppliers. We welcome you, sir.

STATEMENT OF HAROLD P. QUINN, JR.

Mr. QUINN. Thank you, Mr. Chairman, good morning, and good morning to the members of the subcommittee. I would just like to make several points this morning. Several of them have been well documented in your opening statements. The first point is coal is indispensable for meeting our energy needs here and worldwide for the foreseeable future. It is precisely because of the virtues of coal that were stated this morning in many of the opening statements, its abundance and affordability and it supplies over half the electricity in this country, and because of those virtues it also provides 125,000 high paying jobs for U.S. coal miners, as well as thousands of other jobs for many of the businesses and industries that depend on affordable and reliable electricity to remain competitive worldwide.

Globally coal has been the most rapidly growing fuel in the world. Countries such as China and India already rely upon coal to meet over 70 percent of their electricity needs. They, like us, depend on coal to sustain their economies and to raise their standard of living. The second point is as follows. Neither this Nation nor the global community can address climate effectively without advance clean coal technologies including, and most importantly, carbon capture and storage. Between 2007 and 2030 global energy demand is projected to increase by 50 percent. CO_2 emissions are projected to increase by 57 percent according to the International Energy Agency. Virtually all of this emissions growth will come from non-OECD nations, and the point being is if the United States and every OECD nation completely stopped using coal 75 percent of all CO_2 emissions would remain untouched and unaddressed.

In other words, without CCS, we deprive ourselves of the most effective tool for addressing climate change, particularly in the developing world. In other words, no climate policy will be successful without coal and CCS. This leads me to my third point. The United States must do much more to support accelerated development and deployment of CCS technologies. $3.4 billion including coal technologies including CCS provided for the American Recovery and Reinvestment Act is a good first step, but we need to push the technology as hard and fast as we can as noted by many members of the subcommittee this morning, and this will require further investment by the government and the industry.

As the World Resources Institute has pointed out, CCS technologies not only have to be tested and brought up to scale, but also have to be integrated on a series of electricity generation platforms. That is a challenge beyond the sole scope of first-adopters in the coal-based generation community. Similarly, as others have pointed out, a carbon price signal alone is insufficient. There has to be a push as well as a pull to get the job done. The Carbon Capture and Storage Early Deployment Act sponsored by Representatives Boucher, Barton, Upton, Whitfield, and Shimkus provide such

a push through mechanism for sustained funding to support development and deployment of the enabling CCS technology.

This brings me to my fourth point for your consideration. The solution we all seek requires that we harmonize the timing when controls are placed on emissions with the commercial availability of the critical CCS technologies needed to reduce them. The consequences of getting this policy wrong could be dire. The period of time between when promising technologies are developed and successful commercialization is often referred to as potential valley of death. By extension industries may confront a valley of death but they are trapped in the period between the mandate requiring a certain level of performance and availability of the technology enabling them to meet the requirement. The same fate could befall our economy if we impose harsh restrictions that jeopardize our ability to meet electricity demand before we have the necessary tools to meet future emissions requirements.

Our current economic crisis reminds us all the more the importance of structuring any actions responsibly so we can meet both our environmental and economic goals. In short, the solution must be sustainable in every respect, environmentally, economically, and politically. To sum up, Mr. Chairman, let me just make the following—sum up my points. First, coal is indispensable for meeting our energy needs domestically and globally. No climate policy will be successful without coal with CCS. We must accelerate the development and deployment of CCS, and the policy solutions must harmonize the expectations of commercial availability of enabling technology. Thank you very much for the invitation.

[The prepared statement of Mr. Quinn follows:]

Written Statement of

Hal Quinn
President & CEO, National Mining Association

Before the

United States House of Representatives
Committee on Energy and Commerce
Subcommittee on Energy and Environment

""The Future of Coal under Climate Legislation"

March 10, 2009

Mr. Chairman and members of the subcommittee, my name is Hal Quinn. I am president and CEO of the National Mining Association, the national trade association that represents U.S. producers of coal and minerals and their equipment and service providers. Thank you for the opportunity to discuss the future of coal under climate legislation.

There are five key points I hope to leave you with today. The first is quite simple: Coal is not merely important to the United States and the world, it is indispensable for meeting our energy needs for the foreseeable future—as you, Mr. Chairman, have wisely pointed out.

Coal is a prime energy source throughout the world, including here in the United States, where it generates half of our electricity. Worldwide, coal accounts for 27 percent of total energy use and its consumption is projected to grow about 2 percent annually. Because of its domestic abundance and affordability, coal not only provides 125,000 direct high-paying jobs for U.S. coal miners, it supports hundreds of thousands of additional jobs throughout the value chain and in companies and manufacturing operations that depend on reliable coal-based electricity to keep their energy costs down.

Coal has also been the world's most rapidly growing fuel for each of the last five years. It is available in every continent, totaling more than 930 billion tons of recoverable reserves in about 70 countries. Here in the United States our recoverable reserves are sufficient to last 250 years. Coal generates 41 percent of the world's electricity, twice as much as natural gas, the next most used fuel for electric power generation. Fast-growing countries such as China and India rely on coal to meet between 69 and 78 percent of their electricity demand. They, like us, depend on coal to sustain their economies and strengthen their energy security at a time of tremendous financial stress – when even today about 1.4 billion of the world's poorest people lack electricity.

My second point is equally simple: Neither this nation nor the global community can address climate concerns effectively without advanced clean coal technologies, including and most importantly, carbon capture and storage technologies (CCS).

Between 2007 and 2030, global energy demand is projected to increase by 50 percent. The International Energy Agency projects a 57 percent growth in emissions, virtually all of which will come from non-OECD (Organization for Economic Cooperation and Development) nations. Point being, if the United States and every OECD nation completely stopped using coal, most of the world's CO2 emissions sources would remain untouched. Without CCS, we deprive ourselves of the most effective tool for addressing CO2 emissions—particularly in developing economies.

As costly as CCS development and deployment will be, both here and abroad, the cost of not deploying this technology in a carbon-constrained economy will be higher still. The Intergovernmental Panel on Climate Change in its 2005 report found that CCS could reduce the costs of stabilizing CO2 concentrations in the atmosphere by 30 percent or more compared to non-deployment scenarios.

This leads me to my third point: The United States must do much more to support and accelerate the development and deployment of CCS technologies. The federal government's investments in research, development and demonstration of clean coal technology projects over the last 30 years have led to dramatic reductions in regulated emissions and nearly $100 billion in economic and environmental benefits to the nation, according to DOE analyses. The $3.4 billion in clean coal technologies, including CCS, provided for in the American Recovery and Reinvestment Act is a good first step. But we need to push technology as hard and as fast as we can, and that will require further investment by government and industry.

As the World Resources Institute pointed out, CCS technologies not only have to be tested and brought up to scale, but also integrated on a series of electricity generation platforms. That is a challenge beyond the sole scope of first-adopters in the coal-based generation community. To achieve commercially deployable CCS technology, the Electric Power Research Institute and the Coal Utilization Research Council estimate that a public-private partnership will require an investment of $10 billion to $12 billion in federal spending and $7 billion in private sector spending through 2025. Similarly, WRI and others have pointed out that a carbon price signal alone is insufficient to support CCS —there has to be a push as well as a pull to get the job done.

It follows therefore that our efforts to address greenhouse gas emissions must be technology-centric. And this is my fourth point for your consideration: Climate change policies must harmonize the timing when controls are placed on emissions with the availability of the critical CCS technologies needed to reduce them. Meanwhile, we must accelerate the deployment of these technologies both here and abroad.

The consequences of getting this policy wrong could be dire. The period of time between when promising technologies are developed and their successful commercialization is often referred to as "the valley of death." By extension, industries may confront a "valley of death" if they are trapped in the period between a mandate requiring a certain level of performance and the availability of the technology enabling them to meet that requirement.

Industries caught in this twilight zone may atrophy and spiral into a decline for which there is no realistic opportunity for rebuilding. For example, the Energy Information Administration estimated that under certain proposed carbon caps and timeframes considered by the Congress last year, coal use in the U.S. could decline by 65 percent by 2030. The same fate could befall our economy if we impose harsh restrictions on our ability to meet electricity demand before we have the necessary tools to meet future emissions requirements. Our current economic crisis reminds us all the more of the importance of structuring any actions responsibly so we can meet both our environmental and our economic goals. In short, the solution must be sustainable in every respect – environmentally, economically and politically.

To those who demand a moratorium on any new coal-based generating capacity until CCS is fully deployable, I offer two responses.

First, by depriving ourselves of much needed additional electric generating capacity in the near term, we veer closer to the crisis in electricity supply the North American Electric Reliability Corporation (NERC) has warned us about. NERC has cautioned us about falling reserves requirements for electric power to meet our growing electricity needs and, specifically, the consequences of switching to costlier fuels for base load power generation.

Second, a moratorium will stop CCS development dead in its tracks. Just as no one will ever build an IGCC plant with CCS if we don't first build several IGCC plants without it, likewise, we can't expect anyone to build a plant with 65 percent carbon capture if we don't first build plants with 20 percent capture. As with any technological advance we must walk before we can run. Toyota would not have developed the Prius if it had to await development of plug-in hybrid vehicles.

Finally, this undertaking is a task for Congress, not for EPA. The Clean Air Act precludes the public/private partnerships necessary to research, develop and deploy the technologies that will be needed. The act does not contemplate any strategy for achieving greater energy security, much less offer a way to minimize unproductive costs throughout our economy.

This is a responsibility of our elected representatives, and NMA has pledged to work with Congress and the administration to find solutions that result in the lowest cost to American families and businesses.

Thank you, again, for this opportunity.

Mr. MARKEY. Thank you, sir. And our final witness is Lindene Patton. She is the Chief Climate Product Officer with Zurich Financial Services. Ms. Patton works on developing insurance products that address the risk associated with climate change. We welcome you.

STATEMENT OF LINDENE PATTON

Ms. PATTON. Thank you. Chairman Markey, distinguished members of the Energy and Environment Subcommittee, my name is Lindene Patton and I serve as the Chief Climate Product Officer for Zurich Financial Services. Zurich is a global insurance company providing insurance and risk management solutions to customers in 170 countries. We have been serving customers in the United States since 1912. We are the third largest commercial property-casualty insurer in this country with over 20,000 employees in the U.S. I would like to begin my testimony by thanking you for holding this critical and timely hearing because immediate, concrete and responsible actions including the commercial-scale deployment of carbon capture and sequestration should be taken to reduce the risks associated with climate change.

Zurich is in the business of risk management. In 2008, Zurich announced as part of its climate initiative, that it would dedicate significant resources and apply its skills in the area of risk management to assist stakeholders in adapting to and mitigating the risks of climate change. Zurich has applied these skills specifically to commercial deployment of CCS. The focus of my testimony today will be identification of the essential risk management components of a legislative framework necessary to ensure the commercial deployment of CCS in an environmentally and economically sustainable manner. The role of an insurer in a CCS context is to assess risk, price risk, and create risk management best practices. Insurance imposes quality underwriting restrictions which are not only in the interest of the insurer but are in the interest of public good, reducing risk of property damage, bodily injury, environmental damage, and other economic loss.

Insurance performs a role like no other in society, sending price signals to incentivize risk-reducing behavior. To ensure that commercial deployment of CCS occurs in a sustainable manner with respect to natural resources, the environment, and public safety, the following four elements of a risk management framework are critical. First, estimating the expected. Appropriate analysis is needed to estimate the expected value of financial consequences that may arise from each individual CCS site. Specialty insurers are expert at estimating these low frequency, potentially catastrophic risks.

Second, proper identification and quantification must inform permitting, operation and maintenance requirements. No amount of insurance, trust fund, or other financial risk management system can overcome poor siting or inappropriate operating techniques. Third, establishment of a CCS safety board. With respect to siting, operational oversight and long-term stewardship of CCS facilities, a private/public government corporation should be chartered and vested with the authority to oversee the siting and design of CCS facilities and the management of CCS facilities in the event of conflict of law or resources.

Fourth, establishment of a CCS National Trust. A trust managed by the CCS safety board should be established to pay long-term stewardship costs only after the CCS facility is released from post-closure. Finally, it is critical that policymakers avoid the establishment of any liability scheme that would provide first dollar indemnity for liability during operational, closure or post-closure periods. No first dollar indemnity should be provided for sovereigns for risks manifesting from CCS activities during operational closure or post-closure periods because indemnity separates actions from consequences and masks risk price signals. Simply put, first dollar indemnity removes one of the greatest incentives to deploy CCS in an environmentally and economically sustainable manner.

With respect to international action and implication of commercial scale deployment of CCS in the U.S., I have a few observations. If we as a global community are to meet 2050 emissions reductions recommended by the IPCC scientists, the U.S., Europe, Australia, China and India must reduce emissions from coal-fired power plants. Ultimately, it may be necessary not only to export U.S. CCS technologies to China and India, but also our risk management frameworks and policies. Countries in the EU and Australia are moving forward with CCS deployment now.

In closing, Mr. Chairman, Zurich strongly believes private insurance has a critical role to play in the deployment of CCS, and we look forward to working with you, members of the committee, and your staffs to make this happen.

[The prepared statement of Ms. Patton follows:]

Congressional Testimony
of
Lindene E. Patton, Zurich

"The Future of Coal Under Climate Legislation:
The Importance of Risk Management in the
Commercial Deployment of CCS"

House Energy and Commerce Committee
Subcommittee on Energy and Environment

Tuesday, March 10, 2009

Chairman Markey, distinguished Members of the Energy and Environment Subcommittee, my name is Lindene Patton and I serve as the Chief Climate Product Officer for Zurich Financial Services (Zurich). Zurich is a global insurance company providing insurance and risk management solutions to customers in 170 countries. It has been serving customers in the United States since 1912, and today stands as the third largest commercial property-casualty insurer in the country, with over 20,000 employees nationwide.

I would like to begin my testimony by thanking you for holding this critical and timely hearing. Immediate, concrete and responsible actions, including the commercial-scale deployment of Carbon Capture and Sequestration (CCS) should be taken to reduce the risks associated with climate change.

Zurich is in the business of risk management.

In 2008, Zurich announced, as part of its climate initiative, that it would dedicate significant resources and apply its skills in the area of risk management to assist stakeholders in adapting to and mitigating the risks of climate change.

Zurich has applied these skills specifically to assess risk, price risk and develop risk management approaches for the commercial deployment of CCS. On January 19, 2009, we announced the availability of CCS Liability Insurance and Geologic Sequestration Financial Assurance policies, which we are today prepared to underwrite. In fact, we have released one premium indication for a project in the US, and we are in the process of receiving additional applications for coverage.

The focus of my testimony today will be what – based upon our evaluation of the property, casualty and environmental risks associated with the commercial deployment of CCS – are the essential risk management components of a legislative framework necessary to ensure the commercial deployment of CCS in an environmentally and economically sustainable manner. In other words, I will focus on what conditions are required before Zurich is willing to commit insurance capital to risks at CCS projects.

Insurance policies are a contract. The insurance contract can be configured to address certain liabilities that may emerge under a common law scheme, where no legislative or statutory framework yet applies. To foster full scale commercial deployment of CCS, substantial capital will be required, as well as additional safeguards with respect to siting and long-term stewardship. As an insurer, Zurich is only willing to commit risk capital today for CCS projects with appropriate geology, geochemistry, and operating and maintenance plans; and closure / post-closure plans. Specifically, insurance capital is available to CCS project developers to address pollution, transportation, well control, geo-mechanical events and business interruption costs during periods of facility operation, closure and post-closure.

The role of an insurer in the CCS context is to assess risk, price risk and create risk management best practices. Insurance imposes quality operating restrictions as a condition of continuing to receive insurance. Quality operations which seek to achieve sustainability are not only in the interest of the insurer, but are in the interest of the public good, reducing risk to property damage, bodily injury, environmental damage and other economic loss. Targeted underwriting criteria that foster sound risk management benefit both short term insured risks, and risk manifesting over the long term. In addition, strong underwriting criteria will beneficially influence the site's risk profile, thereby minimizing the potential for loss events and maximizing the characteristics which will best ensure long-term sequestration of CO2.

Insurance performs a role like no other in society, sending price signals to incentivize risk-reducing behavior. This is particularly important in managing risks arising from the deployment of new technologies. The insurance industry has substantial experience in sending price signals to assure the sustainable deployment of new and important technologies relevant to safety and the environment.[1]

In the case of CCS, at Zurich we consider the risks in three phases of the project – the operational phase, the closure phase and the post closure phase. In the CCS operational phase, insurance capital is available to address pollution, transportation, out of control wells, geomechanical events and business interruptions costs. In the closure and post-closure phases insurance capital can be deployed for the risks of increased implementation costs, accelerated closure, and, in some cases, cost over-runs. The challenges for committing capital during the post-closure period are more material as it is more difficult to anticipate risk decades from now.

The benefits that insurance brings to the risk management process – the price signaling, incentivizing best risk management practices and the pre-funding of potential financial losses – makes it critical that insurance be used to its fullest extent when it can be deployed.

[1] Consider boiler and machinery coverage, mandatory sprinklers from the Hotel and Motel Safety Act 40 C.F.R. § 264.140-146 (2007); Price Anderson Act, Price-Anderson Act, 42 USC 2011 et seq.

To ensure that commercial deployment of CCS occurs in a sustainable manner with respect to natural resources, the environment and public safety, the following elements of a risk management framework are critical:

1. **Estimating the Expected Cost of Risk:** Appropriate analysis is needed to estimate the expected value of financial consequences that may arise from each individual CCS site,[2] as well as from an applicable portfolio of sites, which may develop over time with commercial scale deployment of CCS. Complete actuarial data is neither always required, nor often available in circumstances involving the deployment of a new technology. As such, alternative, sophisticated processes must be applied which are the province of the specialty insurance business – addressing risks where the frequency of losses occurring is low, but can be severe if a rare event manifests.

2. **Proper Risk Identification and Quantification to Inform Permitting, Operation and Maintenance Requirements:** No amount of insurance, trust fund or other financial risk management system can overcome poor siting or inappropriate operating techniques. True environmental sustainability of CCS sites depends squarely on the chemistry and geochemistry of the sites, and the sound operations of the facility itself. Feedstocks, industrial processes and geology at a given gas generation and sequestration operation will vary. As such, underwriting requirements will vary by site, but may include testing and pre-treatment prior to injection to assure quality and sustainability of reservoir conditions. To ensure that a CCS site has the highest likelihood of ultimately sequestering the CO2 without causing ancillary damages, operational injection criteria must consider and be based upon the goal of achieving long-term sequestration and should not be compromised to accommodate less restrictive injection criteria for other operational reasons. If the operator is not the party ultimately responsible for the long term stewardship, it is important to require operating criteria which impose quality restrictions on the operations, and which take into consideration the long term stewardship impacts of current operations. A pure business model based solely on owner / operator responsibility only up and through the post-closure care period may not consider such impacts.

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[2] Expected value must incorporate the probability of adverse events occurring and the severity (financial consequences / costs) of such events. Expected financial consequences in a given year for each site are calculated as the product of potential financial consequences multiplied for a particular event by the annual probability of occurrence for that event, summed over all identified events, adjusted for interactive, additive or exclusive loss scenario characteristics, as applicable (in other words, one loss may lead to another; one type of loss may preclude the occurrence of another; etc.) Potential financial consequences are defined by taking each potential cause of loss, assigning a fixed financial consequence to same, which might include one or more of the following: property damage costs, bodily injury costs, business interruption costs, other environmental damages or economic losses. Results for each year are summed over the relevant time period and discounted to generate an expected value of financial consequences for an individual site or for a pool of sites.

3. **Establishment of a CCS Safety Board To Address Conflict of Laws and Resources:** With respect to siting, operational oversight and long-term stewardship of CCS facilities, a private / public government (mixed ownership) corporation ('CCS Safety Board' or 'CCSSB') should be chartered and vested with the authority to oversee the siting and design of CCS facilities and the management of CCS facilities in the event of conflict of laws or resources. Although the insurance industry can operate without a CCS Safety Board, if no such Board is created to address these conflicts of law, scarce and valuable economic resources[3] could be diverted to transactional costs – such as negotiating access issues or dispute resolution – making new common law – where no statutory law exists. Addressing this issue as soon as possible will ensure that scarce economic resources are used to manage public good directly with a unified public purpose to achieve climate and energy security goals, avoiding unintended diversion of scarce public resources to address conflict of law or dispute resolution expenses.

4. **Establishment of A Trust Fund ('CCS National Trust') for Long Term Stewardship Only:** A Long Term Stewardship CCS National Trust, managed by the CCSSB, should be established to pay long-term stewardship expenses and delimited compensatory damages resulting after the CCS facility is released from post-closure (not for financial assurance during the revenue generating operating period). Contributions to the Trust must map to the expected value of expenses / damages likely to be incurred over the long-term. Failure to map appropriately would mean there is little financial assurance that the balance of funds remaining at the time of site transfer will be appropriate to the long-term need for funds. This Trust would be best structured as a "revolving fund" to assure funding is appropriately reflective of the low likelihood (frequency) of a catastrophic event, relying on regulatory and private methods (insurance underwriting criteria) during operational, closure and post-closure periods to minimize the potential for an event later in the lifecycle of the site. By its nature, a revolving fund can be replenished, as required, after an event. A revolving fund is designed to have a minimum and a maximum balance.

With respect to the board and trust fund, the above recommendations are not dissimilar to current provisions governing the Oil Spill Liability Trust Fund (OSLTF) and the National Pollution Funds Center (NPFC) mandated by the Oil Pollution Act of 1990,[4] or the Presidio Trust, established by Congress in 1996 as an independent management entity to preserve the Presidio's natural resources.[5] In each of these cases, new and independent entities were established to address unique risks, where conflicts of laws would present in addressing the public goal of the subject

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[3] Scarce economic resources that could be used to manage climate risk or deploy more climate friendly or energy securing technology.

[4] Oil Pollution Act, P.L. 101-380, August 18, 1990. Oil Pollution, 33 USC 2701 et seq.

[5] 16 U.S.C. § 460bb appendix (enacted as Title I of H.R. 4236, P.L. 104-333, 110 Stat. 4097, on November 12, 1996)

legislation, where one or more agencies had conflicting and overlapping authority, and where no existing governmental agency was authorized or properly positioned to address the issues necessary to achieve the public policy goals.

Finally, it is critical that policymakers avoid the establishment of any liability scheme that would provide first dollar indemnity for liability during operational, closure or post-closure periods: No first dollar indemnity should be provided by sovereigns for risks manifesting from CCS activities during operational, closure or post-closure periods because indemnity separates actions from consequences and masks price signals. The financial risk management framework should align with the CCS project lifecycle. As such, the CCS facility operator should remain financially responsible for consequences arising during the operational phase – from capture through a defined period of post-closure, either time-delimited or based on site stabilization criteria. This does not mean that an operator cannot and should not be able to recoup reasonable and necessary costs to effectuate proper risk management of CO2 through its business model. In fact, such recoupment of cost may be essential to the sustainability of the commercial deployment of CCS. In other words, operators must have sufficient funds to operate CCS facilities and such costs must be recognized as part of the business model.

However, operators must remain responsible for both the consequences of not doing what is reasonable and necessary and as otherwise set forth in their operating permit. Specifically, the operator should demonstrate the ability to manage site risks, technically and financially, using well tested first party assurances based upon their financial capacity or through third party mechanisms, such as annually renewable insurance policies.

CCS is what the financial services sector calls a specialty (non-standard) risk. As such, only a small part of the insurance sector is equipped and qualified to analyze the risks and place capital at risk thereon. The initial volume of CCS sites is anticipated to be small, when compared to the volume of other insured risks, such as number of automobiles or homes. The small number of participants should not be of concern for capital purposes because a small number of participants does not mean small amounts of capital . That said, other legal restrictions, such as anti-trust, may pose a barrier to immediate participation and capital commitment for immediate commercial scale deployment from the financial services sector (through insurance, etc) and the operating industry. A process similar to that followed with the advent of nuclear power risk management, e.g., anti-trust waivers for participating parties, may be necessary.

With respect to international action and implications of commercial scale deployment of CCS in the US, I have a few observations.

If we as a global community are to meet the 2050 emissions reductions recommended by the IPCC scientists, the US, Europe, Australia, China and India must reduce emissions from coal fired power plants. As you know, China and India continue to expand their use of coal without significant emissions controls, further increasing the importance of establishing a well working CCS program in the United States. Ultimately, it may be

necessary to not only export U.S. CCS technologies to China and India, but also our risk management frameworks and policies.

Further, despite the fact that CCS is not recognized under the trading schemes for certain credit generation purposes, other countries in the EU and Australia, are moving forward with CCS deployment.

In conclusion, after significant study, we at Zurich believe that commercial deployment of CCS is necessary today if we are to meet the recommended 2050 emissions reductions. We are willing to put substantial capital at risk, today, to insure the commercial deployment of CCS. If the recommendations outlined in my testimony are followed, Zurich believes that CCS can be deployed in a manner protective of natural resources and environmental health and safety, while achieving essential climate risk reductions. Zurich encourages Congress to move expeditiously, enacting legislation to support the commercial scale deployment of CCS. Zurich looks forward to continuing to work closely with the committee and Congress to assure the successful and timely commercial deployment of CCS.

Mr. MARKEY. Thank you, Ms. Patton. The Chair will now recognize himself for a round of questions. Mr. Crane, Mr. Hawkins outlined the USCAP proposal for a package of incentives and regulations to drive deployment of CCS. Do you believe that that package can work?

Mr. CRANE. Yes, Mr. Chairman. I do believe it works. I think the real—would work. I mean I think the real focus is how you get the 5 gigawatts, in particular what we call the rapid demonstration projects how to get them up and running. Certainly the idea is to get up enough scale so that some of the costs of these projects come down because I think everyone on the panel probably has their view on how much carbon capture and sequestration is going to cost, but until we do a few of these projects it is all guesswork.

Mr. MARKEY. Thank you, Mr. Crane. Under the Obama Administration, there is an expectation that the EPA finally will follow the law and move forward with regulating CO_2 emissions from coal-fired power plants under the Clean Air Act. Given those facts, it seems to me that coal is only going to have a future in the United States if we enact comprehensive climate legislation that provides the financial incentives and regulatory drivers to make CCS technology a reality. Would each of you respond to whether you agree with that assessment? Mr. Hawkins.

Mr. HAWKINS. Yes.

Mr. MARKEY. Mr. Crane.

Mr. CRANE. Yes.

Mr. MARKEY. Mr. Duncan.

Mr. DUNCAN. Not really my field, I am afraid.

Mr. MARKEY. OK, fine. Mr. Alix.

Mr. ALIX. Yes.

Mr. MARKEY. Mr. Quinn.

Mr. QUINN. Yes. It is in our interest to get this issue resolved.

Mr. MARKEY. OK. Thank you. Ms. Patton.

Ms. PATTON. From an insurer's perspective insurance can accommodate the legal scheme of choice that is supplied.

Mr. MARKEY. Mr. Alix, how significant is the potential of CCS technology to create jobs here in the United States? Are we at risk of losing this market to Europeans and others if we fail to follow it aggressively?

Mr. ALIX. I think that technology is being developed in many nations. When we competed in Canada, we competed against Japanese companies, French companies, Canadian companies, and certainly an individual project probably creates 500 jobs at its peak in construction and another 100 to operate the system so certainly a danger that if others moved before us that they will develop technology that will create jobs abroad instead of in the U.S.

Mr. MARKEY. Now I heard you describe your technology, Mr. Alix. I met recently with Brent Constantz, who is a Stanford scientist who is the founder of Calera Corporation. Calera proposes to use CO_2 capture from power plants and other sources to make cement simultaneously sequestering the CO_2 and reducing cement's carbon footprint. I was very impressed with that technology's potential. Are you familiar with that technology, Mr. Crane?

Mr. CRANE. Yes, Mr. Chairman. In fact, the application that Calera has in front of the DOE for a loan guarantee is actually

with our company at one of our coal plants. And, you know, we wouldn't be doing that if we weren't impressed with the technology but I just want to caution the chairman that Mr. Alix's technology needs to be scaled up from 1 megawatt to probably 100 megawatts. I will let him speak for himself but the Calera technology is almost at the test tube stage. They don't even have a continuous process going. They are mixing it in batches right now. So when you think of the millions of tons of carbon that come out of a 500 megawatt power plant, it is a great promising technology that the government should support, but scaling up to utility size power plants is not around the corner when it comes to the Calera technology.

Mr. MARKEY. But if we had a cap placed upon carbon, would that not create a lot of market incentives for the development of technologies like that that might completely surpass anything that we are now contemplating?

Mr. CRANE. I agree with you completely, Mr. Chairman, that putting a cap on a cap and trade system, I mean, yes, to stimulate all sorts of innovation and disruptive technologies, you are exactly right.

Mr. MARKEY. What do you think the likelihood of that happening, Mr. Crane, that a disruptive technology would in fact emerge as it did—You Tube and Google only have emerged because we changed from a narrow band to a broad band policy. If we move to a cap and trade system, do you think that that would encourage the private sector——

Mr. CRANE. Mr. Chairman, I am not a probability analysis guy. I am just a poor businessman, but Dr. Duncan may have a better view on that, but I would say that over 20, 30 years, I would be pretty confident that there would be disruptive technologies. I would not be confident over the next 5 to 10 years. I think the next 5 to 10 years we are going to be slogging forward with what we have and demonstrating at scale.

Mr. MARKEY. Mr. Hawkins, would you like to comment on that briefly?

Mr. HAWKINS. I would agree completely with Mr. Crane that adoption of the economic signal from a cap and trade program will unleash all sorts of interest in exploring technologies and systems that will keep greenhouse gases out of the atmosphere, and in the next 5 or 10 years we have lots of tools we can work with. The challenge is to get them deployed and create the market conditions. After that, we are going to see ideas coming out of the woodwork, and the regime for controlling global warming pollution 25 years from now is probably going to look very different than any analysis today would suggest.

Mr. MARKEY. Thank you, Mr. Hawkins. My time has expired. The Chair recognizes the gentleman from Michigan, Mr. Upton.

Mr. UPTON. Thank you, Mr. Chairman. It has been noted that I think since 1990 we have built about or we have put on line about 12 plants, 12 coal plants, which is slightly more than one per year. At the same time, China is bringing on a new coal plant virtually every single week. Wall Street is not financing any of the projects unless they have carbon capture as part of the long-term goal. And I would just like to comment on the last question that the chairman asked, and that is as I look at cap and trade, I am a very

strong supporter of CCS. We need legislation to do that. But the last thing that we want to do is embark on cap and trade without knowing whether in fact it is going to work for sure and it is in place or not as those years commence.

Mr. Crane, you made the comment that nuclear would be a lot easier than clean coal from your experience in New York, and I know that as you were embarking on a project in New York State your CCS project virtually collapsed. The question that I have is you said that this technology is promising carbon capture but it is not around the corner. How long do you think it is until it can be in place whether it is using Mr. Alix's technology, when is the date that we can look at it——

Mr. CRANE. Well, I am actually not a technology—I think we are ready to go forward with scale demonstration projects right now. I think every element of the CCS chain is ready to go at scale whether it is with Frank's technology, and we have carbon pipelines down on the Gulf Coast in Mississippi and up in the Big Sky country. So, no, I am a big believer that it is ready to go, but in New York State it wasn't that we didn't think that we knew how to do it. It was just too expensive. And, you know, keep in mind that the greatest stimulant in the electric industry to doing other things apart from having money available from Wall Street, which there is none for anything, is high natural gas prices.

So in a low natural gas price environment the trouble that you see with clean coal, solar, wind, everything, is that the price of natural gas is now so low that that is by far the cheapest way of producing electricity.

Mr. UPTON. Were there liability concerns in New York as well?

Mr. CRANE. Yes. Yes. Liability with the carbon migrate underground, and we had the geological studies to show that it would stay very contained and it did not propose a threat, but there is a big difference between having that in a study and making people comfortable. And we didn't even get out into the public with that. That is just making the public policymakers comfortable.

Mr. UPTON. Dr. Duncan, I know that Texas is not a Great Lake state. How do you get away with or how do you proceed with liability issues in Texas as it relates to ground water and the whole NIMBY factor? Is there a special law that Texas has that other states or Oklahoma may have that we don't have in places like New York and Michigan?

Mr. DUNCAN. Well, there are some differences in the common law tradition in Texas that are different than other states. I think that the attitude in Texas was portrayed when the Texas legislature voted unanimously to take on the liability related to FutureGen CO_2. So I think there is a high degree of comfort in Texas both amongst the general public and legislators as to the safety and efficacy of CO_2 injections, which comes from the long record that we have there. During the FutureGen project, I was out in the communities where we were considering FutureGen sites, and I think that there was a large degree of public acceptance. We found that there was a negative reaction towards new coal power plants that didn't have CCS, but there was a high degree of acceptance of carbon capture and storage.

Mr. UPTON. Last year there were certainly a lot of us that were encouraged that we would actually move the CCS legislation that Mr. Boucher and many of us were co-sponsors of. Have each of you had a chance to look at that legislation and what comments would you have as we look to have it moved this year in terms of changes that we might want to make to that legislation. Does anybody have a suggestion? Mr. Hawkins?

Mr. HAWKINS. We did review Mr. Boucher's legislation and commented favorably on it last year. This year we think it would be a good contributor to what we would call a two track proposal on CCS. Deployment is the top priority. Some of the concepts that are in the Boucher legislation would provide additional resources for research that could be done along with that deployment to advance some of the technologies that are further behind.

Mr. UPTON. I know my time has expired so I will ask my last question which may not require an affirmative answer. Is anyone on the panel against our legislation? That is a good answer. I yield back.

Mr. MARKEY. The gentleman's time has expired. The Chair recognizes the gentleman from Pennsylvania Mr. Doyle.

Mr. DOYLE. Thank you, Mr. Chairman. I want to for all the panelists just first given the power makeup of the United States today and for the near future and given the prior makeup for developing countries like China and India, is there anybody here on the panel that thinks we can meet our greenhouse gas reduction goals without widespread development of CCS technology? Is there a way to do this without CCS? Does anybody think that? So it is critical that this technology be developed and deployed if we are going to have any chance of meeting these targets.

Now here is my question for all of you. I heard Mr. Hawkins said that this technology is ready to go today. I have seen television commercials that says it is a complete myth and doesn't exist and won't be ready for 50 years, and I heard all of you talk a little bit about it, but I still don't have a clear—could each of you tell me in your opinions how long you think, how many years are we talking about until we have widespread deployment where we can go to our coal-fired utility plants here in this country and start to export this technology to countries like China and that. Are we 10 years away from that? Are we 20 years away from that? Is it ready today or is it a myth? Could each of you just tell me what your opinion of that is? Yes, go ahead.

Mr. HAWKINS. Yes. Mr. Doyle, I think what I would say is that with respect to the question of readiness it is ready today. My view is that if the comprehensive climate legislation were enacted, we would see contracts of the first commercial scale projects being firmed up within months, less than a year from enactment. That is my view. In terms of widespread deployment, that is more difficult to predict, but in terms of—you know, we build power plants one at a time, and the first ones could be on line within the normal construction time path of a power plant without carbon capture and disposal if you get the legislation and the economic conditions to support it.

Mr. DOYLE. Mr. Crane.

Mr. CRANE. My view is that the quickest way to go forward, and I agree with David's time table, is to split the carbon capture and the sequestration, prove carbon capture and combine it with enhanced oil recovery. You can do that now. Frank's technology is one of the leaders scaled up to the 100 megawatt size. Prove up sequestration sides by just putting off the shelf gasifiers from the chemical industry on top of the geological formations that you want to prove it in. And if you do that, you can be going within a year and you prove it up over the next 5 years, and you can be exporting at scale within a decade.

Mr. DOYLE. In a decade you think we can be to scale and deploy these things?

Mr. CRANE. Yes. And the huge market here obviously is all the newer coal plants, not the 50-year-old coal plants in the United States, which are reaching the end of their useful life anyway.

Mr. DOYLE. Mr. Duncan.

Mr. DUNCAN. I believe from a technical viewpoint and a technological viewpoint we are ready to start now. I think there are some policy issues and regulatory issues that need to be worked out.

Mr. ALIX. Assuming the policy and regulatory issues are worked out, I think 3 to 4 years in a build cycle is about right, and as both Mr. Hawkins and Mr. Crane said, we are ready to go, so really the financial incentives have to be in place and we can see commercial units come on line 2012, 2013, then I would think a year or two on line is sufficient to demonstrate that it is commercially ready at any scale so I am a little bit more optimistic. I would say by 2015 we should be ready to do this everywhere at whatever scale is needed if we get going in the next year with the incentives needed to get commercial scale units deployed.

Mr. DOYLE. Very good.

Mr. QUINN. My understanding of the consensus would be that a widespread deployment, commercial deployment, is 2020, 2025 for CCS. That is not to say there can't be breakthroughs that some of the panel just mentioned that can accelerate that even——

Mr. DOYLE. You are saying the year 2020. You are not saying 20 to 25 years.

Mr. QUINN. No, the year 2020, between the year 2020 and 2025 with widespread commercial deployment.

Ms. PATTON. I think the time frames which have been outlined are consistent with our understanding from the insurance industry perspective. At Zurich in January of this year we announced the availability of insurance capital that is immediately deployable in this context. And, in fact, we have been asked to and have provided an indication for coverage already so from my perspective not only is this technology technically ready to go but there are indications in the marketplace that the business is ready to go.

Mr. DOYLE. Very good. So basically the consensus is certainly within the decade or shortly thereafter we would be ready for widespread deployment of this technology. Is that what I am hearing? OK. Thank you very much. I think that is important to have on the record. Thank you.

Mr. MARKEY. We thank the gentleman. The Chair recognizes the gentleman from Texas, Mr. Barton.

Mr. BARTON. Thank you, Mr. Chairman. I would ask unanimous consent to put two documents in the record for this hearing. Both are from the Energy Information Administration. One is the last updated price of coal per short ton in the United States. It is February of 2009. The other is a chart of coal prices per kilowatt hour by state that is from the EIA, and it is January of 2007.

Mr. MARKEY. Without objection, it will be included.

[The information appears at the conclusion of the hearing.]

Mr. BARTON. Thank you, Mr. Chairman. The reason I put those two documents in the record is because we are having a nice warm touchy feely discussion about CCS and all that, and I am on the Boucher bill. I am supportive of it. But consumers make decisions based on price and utilities make decisions on what kind of plants to build based on the price of the fuel. If I heard Mr. Alix correctly, he said that his technology is going to cost $40 a ton of CO_2, which is the equivalent of $120 a ton of coal, so he is going to—the base load price of coal in the United States according to the EIA is around between $26 and $30 a ton. So he has just added 400 percent to the cost of coal if I understand him correctly. Now Mr. Doyle asked the question, and it is a good question, does anybody think that we can meet all of our environmental challenges without using CCS technology for coal, and you all answered no.

But the real answer is yes. You don't use coal. You use natural gas or you use nuclear or you use some other alternative. Natural gas prices are falling like a rock. Last month in Texas in the Barnett Shale, which is partially in my district, you could buy all the natural gas you wanted at about between $4 and $5 a thousand cubic feet. Now there is a formation up through Pennsylvania and New York called the Marcellus Shale. It is estimated that it has so much natural—it could have 500 trillion cubic feet of natural gas. Now to put that in perspective, we use about 22 trillion cubic feet of natural gas a year. The Barnett Shale, which is the largest new producing formation of natural gas in the world last year produced about a trillion cubic feet.

So we have this formation up in Pennsylvania and New York that has so much natural gas potentially that we can't even estimate how much we have, so there is a way to do this without using coal, but having said that I think we need to use coal. Now my question to Mr. Crane and to Mr. Alix if we really, really, really study this CCS under Mr. Boucher's bill, what is a reasonable expectation of how much lower you can get the cost of this technology so that it really is cost competitive with natural gas and nuclear? Mr. Crane.

Mr. CRANE. Congressman, it is not clear to us that the house load of post-combustion carbon capture, it is difficult to see from an engineering perspective how it ever gets below sort of taking up 20 percent of the production of the power plant itself, so while we expect——

Mr. BARTON. It takes that much electricity just to run the technology?

Mr. CRANE. Yes.

Mr. BARTON. Twenty percent of the output?

Mr. CRANE. Yes.

Mr. BARTON. OK.

Mr. CRANE. So our view is that Mr. Alix's $40 a ton, I mean can it get down to $30 a ton? Maybe it can. We don't believe it will ever go——

Mr. BARTON. That is per ton of CO_2?

Mr. CRANE. Yes, per ton of CO_2. We don't believe it will ever get to—the economy is such that we don't believe it ever gets to $5 a ton or $10 a ton, so it becomes an inconsequential portion of the whole. When you talk about the cost of carbon for a coal-fired power plant on a deliberate basis $40 a ton is a little bit more than doubling the cost of coal because the $8 a ton of coal that you are talking about of course is up in Wyoming. You still have to get it to where you are using it. So it is a big adder but maybe not quite as large as you said.

But the issue with gas is that if it turns out that the country has an infinite amount of gas in these shell formations then probably the future for coal isn't that great anyway. I think all of us in the power generation industry remember what happened the last time the power industry plunged wholesale at the gas which was that the price of gas went from $3 per million BTU to 15 last June, so I think we really think there needs to be a balance. I know that you agree with that.

Mr. BARTON. I agree with it. My time has—could I let Mr. Alix answer?

Mr. MARKEY. Yes.

Mr. BARTON. How low can you bring the cost of your technology if you really refine it and expand it?

Mr. ALIX. I think we are looking at between $20 and $30 a ton as a reasonable goal based on what we know today for an advanced coal plant. I think that adds about 2 to 3 cents per kilowatt hour if you look at advanced coal plants. I think it is important to note that natural gas plants have about half CO_2 of a coal plant, so CO_2 emissions from natural gas plants would not be free under a cap and trade bill and they would increase as well, so under many scenarios we have seen even adding that 2 to 3 cents per kilowatt hour to coal, if you look at gas historically more in the 8 to 10 per million BTU and the CO_2 emissions of gas coal still remains quite competitive.

Mr. BARTON. Thank you, Mr. Chairman.

Mr. MARKEY. The gentleman's time has expired. The Chair recognizes the gentleman from Utah, Mr. Matheson.

Mr. MATHESON. Thank you, Mr. Chairman. I thank the panel as well. We may have covered this a little bit in Mr. Barton's questioning. I just want to say one of my concerns about moving too quickly on climate change in terms of whether the key technologies are really developed or not, you have heard in fact a lot of the members on the panel ask you questions about when is this going to be ready, when are we going to be viable. But beyond being viable, I guess the question is how much is it really going to cost? You know, 2 years ago a witness before this subcommittee noted the new technologies at that point predicted the total cost of a new coal-fired plant would increase by 60 to 70 percent.

Do these new costs—what level of concern do you have about the potential cost impacts if we are going to employ carbon capture and

sequestration? I just ask that to the panel in general. How much do these new costs concern you?

Mr. HAWKINS. Well, I pay electricity bills and so I can certainly relate to the concerns about cost. What I would say is that the first generation of these plants is likely to cost more and the percentage increase that you are describing is what is called the production cost of electricity. That is not going to translate into that kind of a price rise in retail electricity prices for several reasons. First, coal is half of the power production in the U.S. Second, production cost is about 60 percent of the electricity bill you pay, but most importantly we are not going to deploy this technology on all 330 gigawatts of coal-fired power plants overnight. It is going to happen gradually. The first ones are going to be somewhat clunky. I remember the first portable computer that I had. It was about the size of a carry on bag on an airline, and it had a lot less computing power than this cell phone. So we are going to get better at this, and we are going to get better faster if we start right away.

Mr. MATHESON. Do people think cap and trade legislation, that there is going to be a way to provide cost mitigation to consumers that feel this? Is that a piece of this equation as well?

Mr. CRANE. Well, yes, at least that is part of the USCAP Blueprint is to provide cost mitigation through some of the proceeds from the auction to the hard-pressed consumers.

Mr. MATHESON. I would suggest that doing so is more complicated than it sounds. About half the states in this country have primary reliance on coal as their electric and fuel source, about half the states don't, and one of the concerns I have coming from one of those states that about 90 percent of its electricity comes from coal is we are going to have a regional wealth transfer, if you will, in this country based on who pays more on the utility bills and how the cost mitigation funds are directed to consumers who are affected by it. So I don't know if anyone on the panel has expertise on that issue but I would just suggest to you that this is a lot more complicated than people are making it out to be I think in terms of how you do cost mitigation in a fair and equitable way.

Let me move to—I mentioned that mid-term action—I mentioned that quote earlier. The witness in the 2007 hearing was Jeff Sterba, who is the CEO of PNM Resources. I know he can't be here today but at that same hearing in 2007 he said that it is only through the steady and judicious advancement of these applications during the course of the next decade we can start to bring the costs down. It seems to me we have a long way to go in terms of making the advances we need to make between 2007 and 2017. We thought we made some progress in the bill, the legislation that passed Congress in 2007, the Energy Independence and Security Act, but from the policymaker's side of the equation what more do we need to be doing?

I am a co-sponsor of last Congress—the Boucher bill, as you heard before. Is that the approach we need to take? What are your suggestions policy wise for how we can move this technology along?

Mr. CRANE. Well, just even on your regional wealth transfer point, I agree with you that there is the potential for that, and right now absent support for clean coal in particular, but also for nuclear there will be a wealth transfer to the parts of the country

that have more solar, wind resources or more gas-fired generation than ones that depend on coal and nuclear, and we think all of those technologies, solar, wind, gas, nuclear, and clean coal need to be supported, so I would say to answer your last question what you can be doing is exactly what you are talking about which is early funding to get clean coal going because that is definitely the laggard of all those technologies right now in terms of, you know, ready for commercial deployment. So to prevent that regional wealth transfer, I think pushing forward the way you are is the way to go.

Mr. HAWKINS. And I would add we would recommend this USCP Blueprint, which has a series of proposals to address all the concerns that you mentioned, both in terms of regional impacts and in terms of the serious program to deploy carbon capture and disposal.

Mr. MATHESON. Thank you, Mr. Chairman.

Mr. MARKEY. The gentleman's time has expired. The chair recognizes the gentleman from Kentucky, Mr. Whitfield.

Mr. WHITFIELD. Thank you, Mr. Chairman. I guess after hearing all this testimony and reading it, I am not particularly optimistic about carbon capture and sequestration myself, but I noticed recently, Mr. Hawkins, that the NRDC in partnership with Alliance for Climate Protection produced some TV ads, and they focused on an employee of a plant using coal, and basically the commercial ends with a caption stating in reality there is no such thing as clean coat. Now does that ad, does that apply to a plant using CCS or not?

Mr. HAWKINS. Unfortunately, it does today, and that is the reason that we co-sponsored these ads. Today we don't have a commercial scale electric power plant in the United States that is using carbon capture and disposal.

Mr. WHITFIELD. But you would be supportive of the coal industry if it did have CCS in a commercial——

Mr. HAWKINS. As I have testified, NRDC is a strong supporter of CCS deployment and we have supported it for a number of years now and continue to support it. We would like to be able to run an ad very soon saying in reality there is such a thing as coal with carbon capture.

Mr. WHITFIELD. Now say by the year 2030 just from the NRDC's perspective, what would you like to see the fuel mix used worldwide to produce electricity, say about 2030?

Mr. HAWKINS. We don't think that it is appropriate for Congress or for an organization like ours to dictate the fuel mix. We think it is important for the Congress to set criteria for environmental performance, and we think the environmental performance of the global power sector has to be a lot better in terms of carbon dioxide pollution than it is today. You say by 2030? Globally, we should be trying to reduce emissions on the order of 30 percent or more. In the United States, we would like to see reductions on the order of 40 percent or more reflecting our large historic contributions to the CO_2 in the atmosphere.

Mr. WHITFIELD. Ms. Patton, one of the issues relating to commercial use of carbon capture and storage certainly relates to liability issues, and you touched on insurance policies in your testimony,

but from the liability side of this companies that are first using commercial grade CCS and storing this the post-injection liability issue, is that something that you all are willing to cover?

Ms. PATTON. Absolutely. Our customers came to us and asked us for some assistance specifically in managing risk associated with carbon sequestration, especially the post-injection issues. From our perspective, we evaluated the existing suite of technologies in this case, and as I indicated in my written testimony we announced the availability in January of two policies that are designed to provide liability coverage during the operational closure and post-closure periods. The first policy addressed is the core risks were identified to us as unique for the sequestration activity, so clearly existing in the insurance industry already there was capital available to address construction liability associated with constructing capture ready facilities.

With respect to the injection component our customers identified five areas which we developed a policy around. They were concerned about pollution liability for underground sequestration activities so what would happen, as Dr. Duncan noted, if there was a migration of stored CO_2 into ground water. Our policy does respond to that. They were concerned about liabilities associated with transportation, whether that was a short distance or a long distance. Our policies respond to that. With respect to injection activities itself potentially that a well could go out of control, we were able to respond to that. There was concern about a geo-mechanical event so basically the active putting the gas into the ground causing a geo-mechanical event, a seismic event. We are able to respond and provide coverage for that.

And, finally, there were concerns about business interruption. What would happen if after this project was constructed there were circumstances where the plant had to—had a business interruption and they might have to buy carbon credits or some other equivalent in that process. We are prepared to extend coverage to address that during that period. The second area of policy looks at the specified activities that may be imposed by a permitting system if one is implemented, which will dictate the terms under which those facilities will be closed and released in a post-closure context. So what must an operator do to prove that that site is stable enough for a long-term stewardship, and we have a second policy which addresses those issues. So, yes, we stand ready today to commit capital now for those applications.

Mr. MARKEY. The gentleman's time has expired. The chair recognizes the gentleman from Washington State, Mr. Inslee.

Mr. INSLEE. Thank you. My compliments to the panel too. This has been one of the best panels. We have had about two dozen hearings and this has just been a great panel. I have 1,000 questions. I will start with one to the whole panel. Does anyone believe that the coal industry has an ownership right in the atmosphere that gives it right to use the atmosphere? Does anybody believe that? No one said yes so far. OK. Does anybody believe that the coal industry should have the right to put unlimited amounts of carbon dioxide at zero cost into the atmosphere? Does anybody believe that?

Mr. QUINN. Congressman, I am not sure of the point of your questions whether the coal industry has that right. Aren't we just talking about whether society in terms of how——

Mr. INSLEE. Yes, that is a good point. Let me rephrase the question. Does anybody at the table believe that anyone, any industrial group, utility or coal-based using industry have the right to put unlimited amounts of carbon dioxide which is causing global warming into the atmosphere at zero cost? Does anybody believe that? So far nobody——

Mr. QUINN. Well, again I just think the question is a little narrow. It keeps invoking the coal industry, and we are talking about society and economic activity, and there is a lot of different activity that has carbon contribution.

Mr. INSLEE. Do you think a utility that has a coal plant that is spewing tons of CO_2 into the atmosphere that is causing global warming, do you think that utility has a property right to put that CO_2 into the atmosphere in unlimited amounts at zero cost? Does anybody believe that? OK. Nobody believes that, so there is a consensus that we should have a legal framework that does not allow that to happen so now here is my next question on how to form that consensus. Does anybody believe that the cost of developing this technology that I think there is broad consensus in this room needs to be developed to figure out a way to sequester carbon dioxide, does anybody believe that the cost of developing that technology should fall exclusively on the public as opposed to those industrial entities that are using the coal that are putting the CO_2 into the atmosphere? In other words, does anybody believe that cost should be exclusively on the taxpayers who would have to fund that research?

OK. Now one has said yes to that question, so that means there is someone else going to have to fund this research, so now I want to ask for your opinions about that. I have suggested, others on this committee have suggested, that we have a cap and trade system that auctions off the right to put carbon dioxide in the atmosphere and uses at least a substantial portion of the auction revenues to go to research and development activities, some of which would be through the utilities of actually doing this work. Some of this would be through the companies developing this coal-generating technology. Some would be from academic institutions but basically this fund would help fund this new technology.

How many people think that at least in part is a good idea that we fund this new technological development at least in part to the auction revenues of a cap and trade system? I see a bunch of heads nodding. Why don't we just go down the table? How many people think that is a good idea in general?

Ms. PATTON. I think there are multiple methods for doing funding. I think the critical issue is that there needs to be funding.

Mr. QUINN. I think in part an auction would assist in providing the push to funding, but I think it is also important that we allocate any allowances properly to protect any economic dislocation because after all we are talking about businesses that are going to have to adjust their cost structures to increase energy supplies, and if you are going to make them pay more some of their factories in your districts could be their last in the United States.

Mr. ALIX. I would support in part funding CCS technology with auction revenue.

Mr. DUNCAN. This issue is outside my field of expertise, but I am in favor of funding.

Mr. CRANE. Yes, we agree in part auction but we know the government has many different uses for funds and that often they don't end up in the place where we would agree with you.

Mr. HAWKINS. We support funding for deployment of this technology. It could be done either through an auction or it could be done through direct allocation of allowances, which would then be turned into money, so you can turn the allowances into money at the start of the process or one step down the chain but it is important to get the funds there.

Mr. INSLEE. Thank you. And I just note Mr. Doyle and I are working on a provision that would allow a partial distribution of permits to energy intensive industries that compete in international commodities that would otherwise might have a difficulty of competing so at least I am proposing the bulk of these auction revenues to go to develop this new technology but that there be some assistance, if you will, to these energy intensive industries. Thank you very much to all the panelists.

Mr. MARKEY. The gentleman's time has expired. The chair recognizes the gentleman from Louisiana, Mr. Scalise.

Mr. SCALISE. Thank you, Mr. Chairman. Mr. Crane, I think you had said your company, NRG, is the only company that is actually seeking a permit right now for nuclear plants?

Mr. CRANE. Well, no, I was just expressing a high level of confidence that we would be the first to build, but I think there are something like 24 companies that have filed permits. There are 14 that asked for the Department of Energy loan guarantees, and I think the Department of Energy is down to considering five and they will pick two to three.

Mr. SCALISE. So you are close enough to where you think you—do you have any time table when you think you would——

Mr. CRANE. Well, close enough in the nuclear world.

Mr. SCALISE. When do you think you would get that——

Mr. CRANE. Well, the Nuclear Regulatory Commission has published a schedule for our permit which would qualify for us getting the permit in 2011, and then if we proceed to build immediately we first would be on line in 2016.

Mr. SCALISE. Now how long has this process been going on for your company to try to get—and how much does it cost?

Mr. CRANE. We were a late start and we moved fast so it has been only 3 years for us so far but keep in mind we are permitting a nuclear design that has been previously designed certified by the NRC at a site that has been previously approved for four units and has two there now so——

Mr. SCALISE. It is not a new plant. It is not a new site or it is not a new model that you are using.

Mr. CRANE. Well, it is advanced. It is far newer than any other nuclear plant currently existing in the United States thanks to the 30-year lag, but it is not new by international standards.

Mr. SCALISE. And how much have you spent so far?

Mr. CRANE. The application process has cost us close to $200 million.

Mr. SCALISE. What do you think the reasons are for that high cost? There are a lot of barriers to entry——

Mr. CRANE. Nuclear plants are complicated, and the NRC takes their safety mission exceedingly seriously as they should. We have no criticism of the NRC in the way that they have been dealing with our application.

Mr. SCALISE. I don't want to put you on the spot because you are waiting for them to approve this but you have seen this across——

Mr. CRANE. Good point.

Mr. SCALISE. There are many people, not mentioning you, but there are many companies that want to pursue nuclear but consider barriers to entry, not just cost but regulatory burdens in a proven technology. This is not something new. This is something that has been perfected. It is very widely used in Europe. They sure don't put those same types of barrier to entry and have been able to get a carbon free energy product much more readily. It is much more widely used in other parts of the world.

Mr. CRANE. I think the biggest barrier to entry to nuclear as a macro-economic or solution in the U.S. is that I don't think in my life time there will be a nuclear plant developed in the United States that is not at an existing site, and since there are roughly 60 some existing sites and probably half of them they can't have expansion for various reasons, it limits—the limiting factor for nuclear as a solution is siting long term.

Mr. SCALISE. Mr. Hawkins, I think you have talked about, and I will let you explain your real feelings on it, but in terms of coal, I think you have called for a moratorium on coal facilities, if you could expand on that.

Mr. HAWKINS. Nuclear plants should be built with carbon capture and disposal.

Mr. SCALISE. And so you are saying that that technology is not available today though, right?

Mr. HAWKINS. No, we are saying the technology is available but the policies are not there to require it or to create an economic incentive for it.

Mr. SCALISE. When would you foresee being in place where a facility could be built that would have that technology?

Mr. HAWKINS. Well, Chairman Waxman has said he wants to get a bill out of his committee by Memorial Day. If that happens and if the Senate moves it could be before the end of this year.

Mr. SCALISE. And how long would it take then to get those facilities built if, and assuming a lot of things, but——

Mr. HAWKINS. Well, the coal-fired power plant takes 3, 4, and 5 years to build and as soon as the policy signals are straight, I think, as I said before, you would see contracts written, and 3, 4, 5 years after that you would see projects that could come on line with this technology.

Mr. SCALISE. We have had hearings on a number of renewables. I think we all support the continued development of those renewables to get them at a place where they could be even more reliable. I think the estimates I have seen on wind and solar is you could maybe get 20 on the high end, 30 percent of your grid in elec-

tricity generated through those methods, and everybody acknowledges that even then it is not a continuous source and so you would need backup power supplies and another method of providing continuous power because when we turn on our lights of course we are not going to just have the lights be on when the wind is blowing, and so you have to have that backup. Even if under those scenarios you laid out, how would you suggest solving that problem of the fact that you don't have a continuous source just by using renewables?

Mr. HAWKINS. As I said, we don't propose a system that is 100 percent renewables. We think that the most likely electricity system in the U.S. in the next several decades is going to be a mix of renewables.

Mr. SCALISE. Nuclear, gas?

Mr. HAWKINS. A mix of the technologies that we have today. With respect to renewables, I think we will see the development of storage technologies which will make renewables and the intermittent nature of renewables much less of an issue than it is today.

Mr. MARKEY. The gentleman's time has expired. The chair recognizes the gentleman from Virginia, Mr. Boucher.

Mr. BOUCHER. Thank you very much, Mr. Chairman, and I want to commend you on organizing our discussion this morning on the future of coal. It is a critically important conversation for us to have as we consider cap and trade legislation direct funding legislation for carbon capture and sequestration and other measures that are related to climate change. And I agree with Mr. Inslee. This has been one of the more productive conversations we have had in this subcommittee very recently. The Electric Power Research Institute widely regarded for its expertise in energy technology tell us that if we had a dedicated funding stream of approximately $1 billion per year for a 10-year period that at the end of that 10-year period by approximately 2020 we would have available, reliable, and affordable carbon capture and sequestration technology available. And very shortly within a matter now of just a couple of days, as has been mentioned in the course of our discussion today, bipartisan legislation that would achieve that funding schedule and put those dollars in place for research development and demonstration for carbon capture and sequestration will be introduced.

I have heard some interesting testimony today from a number of the members about perhaps there being carbon capture and sequestration technologies available in the nearer term, and I would like to explore that for just a moment, and I would ask for relatively brief answers to these questions because I have another train of questions I would also like to ask. My sense, and I would like your reaction to this, is that it is possible certainly today for a CO_2 emitting facility to install carbon capture and sequestration technology. That would be possible, for example, if you were sitting on top of an oil field and you are using a gasification technology which is well understood, and as Mr. Crane indicated has been a commercial application in the chemical industry now for a number of years, and you are simply injecting that carbon dioxide directly into the gas or oil field. In fact, that is happening today in Canada at Wayburn with natural gas that is—with CO_2 that is being gen-

erated from a coal-fired power plant, I think it is in one of our Great Plains northern states.

But there are some challenges, and that is what the funding is designed to address. First of all, we really don't have storage caverns other than oil and gas fields, well characterized for CO_2 sequestration. Secondly, we don't have post-combustion technologies that are at hand for CO_2 separation. There is an older technology but improvements are on the way that will yield a larger suite of technologies including chilled ammonia, including oxygen firing, and other processes that will make far more reliable, available, and affordable that full suite of CCS technologies, and it is the need for that, the characterization of fields other than oil and gas, that being, saw caverns or perhaps unmountable coal seams. It is the need for these next generation technologies for CO_2 capture that it is essential we provide this funding for.

So let me just ask if there is general agreement with the statement I have just made about the need for this legislation directed towards those objectives. Mr. Crane.

Mr. CRANE. Well, Congressman, I agree with you completely. I would just be careful if you get the money, who is dispensing it because you are going to need someone with a bit of an entrepreneurial event, and the DOE has traditionally been exceedingly conservative in the way that they have——

Mr. BOUCHER. Thank you. I appreciate the answer that we need to do it. We do have in our legislation a comprehensive mechanism involving broad participation in the policy making about how it would be distributed. Mr. Hawkins, would you care to comment?

Mr. HAWKINS. My view, Mr. Boucher, is that you would get a lot more bang for your buck if your legislation were incorporated into climate legislation that will make sure that the private sector is motivated to spend this money as effectively as possible to deliver results as quickly as possible.

Mr. BOUCHER. Thank you very much, Mr. Hawkins. Mr. Quinn, would you care to comment?

Mr. QUINN. Congressman, I agree totally with your statement, and we are supportive of your legislation.

Mr. BOUCHER. All right. Does anyone have a different view? OK. I will take that as essentially unanimous agreement from the group. Mr. Hawkins, I would welcome your advice on the fundamental difference between research development and demonstration on the one hand which government typically funds because these are large scale projects often times beyond the scope of private industry in order to finance and the deployment of that technology once it is developed on the other hand. And my sense about how that division should be drawn is that a larger scale, longer term projects are deserving of government funding perhaps through a mechanism such as the legislation we are about to introduce that would speed those dollars to it. And then when it comes to deployment that should be a shared responsibility between the polluting—well, I don't want to use that word, between the emitting sector, the industry that is emitting, and the government perhaps through a mechanism in our cap and trade legislation that would devote revenues from whatever share of the allowances we

decide to auction toward that purpose. Would that be essentially the right division?

Mr. HAWKINS. Yes, sir. The U.S. has supported deployment of critical technologies in the past. The interstate highway system is one such example, and I think that one can say that with respect to the electricity sector support for deployment is a reasonable thing to do for energy security reasons and to attack this critical problem of climate change.

Mr. BOUCHER. Thank you very much, Mr. Hawkins. Ms. Patton, one question for you as my time expires. I am very encouraged to see that the insurance industry is now offering products to insure against liabilities, short term, long term, operation closure, post-closure, for those who inject carbon dioxide for sequestration purposes. And that tends to resolve some of the issues that we have discussed over the last several years about that liability and who is going to bear it. Now the industry potentially can bear it because they will have insurance against it.

What I think is absent from this conversation is the cost of that insurance, and can you give us a sense of what the premium is on the policy that you are now offering perhaps in terms of the unit of dollars or sense, I suppose, per ton of carbon dioxide that is stored?

Ms. PATTON. In short, the answer is in the absence of a specific submission unfortunately, no, not in the amount of time that I have available.

Mr. BOUCHER. So, in other words, you have a product available, price to be determined?

Ms. PATTON. It is price based on the geologic conditions that are present and to the extent that we provided indications to customers, they have indicated that they can absorb that within their business model.

Mr. BOUCHER. All right. So they have found it to be affordable?

Ms. PATTON. Affirmative.

Mr. BOUCHER. All right. Thank you very much. Thank you, Mr. Chairman.

Mr. MARKEY. The gentleman's time has expired. The chair recognizes the gentleman from Illinois, Mr. Shimkus.

Mr. SHIMKUS. Thank you, Mr. Chairman. I apologize. We have a health subcommittee meeting going on. We met with local county officials, so you know I would rather be here 100 percent of the time, so I apologize for not being here.

A couple of things. One is part of the memo from committee staff talks about, and I think, Mr. Hawkins, you referenced the fact that there is no really movement on fossil fuel in the capital market section. I would submit that it is more a fear of politics than the fear of—that fear is putting a high risk on raising capital for this because we are uncertain and we are not moving in the direction. In fact, I would talk about the new appointee to the Secretary of Health and Human Services, Governor Sebelius, who 3 times vetoed legislation for a coal-fired power plant in the State of Kansas.

That is the signals that are going out there in the community that—and added by, I know Mr. Whitfield talked about your ads that there is no clean coal, and I would add based upon your web site you say there is no such thing as clean coal even with carbon

capture and sequestration. That uncertainty provides exactly what you all want is fear in the markets to move products. Now, fortunately, in Illinois we haven't fallen to those fears.

I just talked about the mechanical refinery expansion. I got the Prairie State campus that is employing thousands of workers. In fact, it is taking the jobs of laid off steelworkers because of this economy and putting the work in the power plant now in my district. We have Taylorville, Illinois. We have Decatur, Illinois. So I would say that we need to get this right and we need to bring certainty, and it is the politicians who are doing this. Mr. Chairman, I would like to for the record also submit the Wall Street Journal editorial from yesterday which raises the issue of who pays for cap and trade. And you know who pays? The Midwest. Mr. Doyle, it is going to be Pennsylvania. It is going to be Virginia. It is going to be Louisiana. It is going to be Illinois. It is going to be those fossil fuel states who are going to be paying to really transfer wealth from the Midwest to the coastal states.

And if you allow it to be submitted, Mr. Chairman, I would appreciate it. I think it adds to this debate on the whole cap and trade regime.

Mr. MARKEY. Without objection, the Wall Street editorial mentioning my name will be included in the record.

[The information was unavailable at the time of printing.]

Mr. SHIMKUS. You are on here. I didn't know that. I didn't read that far down, Mr. Chairman. You are always one step ahead of me. I want to go—Mr. Crane, I think you made a critical point on the nuclear power and expansion, so I agree with you 100 percent that site selection is a limiting factor. I wish the environmental community would get on board with helping us expand nuclear power. Let me address this current question as far as Yucca Mountain and the high level nuclear storage. If we don't address the nuclear storage issue, does that inhibit the ability of expansion on site for nuclear power?

Mr. CRANE. I don't think so. I mean whether Yucca Mountain goes forward or not is a decision you all make. That is above my pay scale. We proceeded with nuclear development on the view that dry cast storage——

Mr. SHIMKUS. On site.

Mr. CRANE. On site would be good for one or two centuries.

Mr. SHIMKUS. But you would have to get permission to expand. There are nuclear power plants right now that in the current siting they are almost at capacity.

Mr. CRANE. And I hate to be colloquial but that is someone's else problem. Our nuclear power plant is on 15,000 acres.

Mr. SHIMKUS. OK, but if you are talking about the expansion of nuclear power so what is not good for your competitors but nuclear power, which is important for the country to meet these caps, I hope that in this you would think better of the country than just your shareholders.

Mr. CRANE. Well, no, certainly as an American I am a huge proponent of nuclear power and I think it ties directly with the electric car which is I think a service that nuclear power is tied to. The siting question though and the nuclear storage question, again that is more of a political public policy issue.

Mr. SHIMKUS. And, guess what, you are in front of politicians and the debate on public policy, and the Yucca Mountain debate is a current debate on how we deal with this, and there are nuclear power plants that are at capacity that will either have to expand their on site storage, and of course the State of Illinois is a big nuclear power state with 11 reactors in suburbia. My colleague who chairs this talks about the threat and the risk. However, we never seem to address a threat and risk of major metropolitan areas that have nuclear power facilities while we keep high level nuclear waste right in the backyards of suburbia. Mr. Chairman, I could go on for more but my time is up and I don't want to push the limits. I yield back.

Mr. MARKEY. Thank you. I thank the gentleman very much, and just a brief correction here that unless something has gone terribly, terribly wrong in the private sector, Mr. Crane, that decision on nuclear waste storage is actually way below your pay grade. We will make that note for the record. Let me turn now and recognize the gentleman from Florida, Mr. Stearns.

Mr. STEARNS. Thank you, Mr. Chairman. Well, let me see if I can get through this and perhaps speak a little louder. I had the opportunity to have dialogue with the European Union and I get a lot of information from those meetings over in Europe and then they come over here to the United States. And recently I read that the European commissioners for energy last November said that coal with CCS, carbon capture sequestration, is the low cost, low carbon alternative. Reports published by the European Commission and the IEA, which is the International Energy Agency, last year made the direct statements that, A, the cost of achieving European climate goals could be 40 percent higher without CCS, the European EC, and, B, the cost of mitigation without CCS is 71 percent greater than coal with CCS. Given that position, is there an opportunity for large scale cooperation with the EU on large public-private CCS partnerships? Mr. Quinn and Mr. Hawkins.

Mr. QUINN. Congressman, I think so, and I think it was the IEA that actually made the statement that in the long term that coal with CCS will be the most affordable, low carbon energy source for the world. Perhaps some of the panelists have better information than I do but there are sequestration demonstration projects currently proceeding in Europe. There are some American companies participating in Asia with carbon capture and storage projects in China, so there are opportunities on those I think that are underway in terms of those types of partnerships.

Mr. STEARNS. Mr. Hawkins.

Mr. HAWKINS. I would agree that there is great potential in these partnerships. Actually I am going to Europe on Saturday to have conversations in Brussels with European legislators about this very thing in addition to Europe, China, Australia or other places where this kind of work could pay off big benefits.

Mr. STEARNS. Anyone else like to comment on it? Yes.

Mr. ALIX. We have also been to Europe and asked to compete for projects in Europe and Australia, so I think the initiatives are in the national scope in terms of trying to bring the best technology to bear on the problem.

Mr. STEARNS. A study by a collaboration of both unions and industry leaders published last month estimate that 5 to 7 million jobs would be created during the construction process of CCS facilities, and that a quarter of a million permanent jobs would be needed in order to operate these facilities. With that said, in your opinion what is needed to jump start the CCS technology industry to ensure widespread commercial deployment of the technology and what can Congress do to make these jobs a reality? The same two individuals perhaps. Mr. Quinn.

Mr. QUINN. Well, Congressman, I think what we have heard today is two things. We need a push. Congressman Boucher's legislation provides part of that push in terms of sustained funding source for this technology. Probably also what we have heard today is that there needs to be a framework that establishes some certainty, a balanced framework in terms of carbon management. It provides a certainty we need to build out our existing coal-based generation source. Part of the discussion today has been about some of that uncertainty. Mr. Shimkus raised it. Uncertainty in terms of technology, operational uncertainty and policy uncertainty are all the enemy of investment and capital investment.

Mr. STEARNS. What do you think are the biggest hurdles to reaching CCS commercialization?

Mr. QUINN. We have three pieces there. We have the technology in terms of capture and use, and from what I have heard today it sounds like we have very promising demo projects and pilot projects underway or close on their way. Scaling those up and to be applied and integrated into commercially available electricity generation platforms, still there is a way to go on that particularly in terms of the economics. The transportation segment, transporting that to a storage facility and then the siting for storage and what is suitable for siting, and I think on the last part there is quite a bit of studying underway that sounds very promising, but I am not—I will defer to Dr. Duncan in terms of the status of that.

And there is probably the issue that Ms. Patton talked about in terms of how we underwrite the risk for long term for that type of storage. So there are a number of different hurdles there we have to get through but I am very confident that in the time horizons we talked about today that we will overcome those.

Mr. STEARNS. Mr. Hawkins.

Mr. HAWKINS. In terms of what Congress can do again I would hold up for the cameras the USCAP Blueprint. It provides a cap on emissions and it provides a very structured program to get carbon capture and disposal systems into the market, emission standards and financial incentives to make sure that these first projects are economically affordable to build and fold into our power system.

Mr. STEARNS. Mr. Duncan, is there anything you would like to add to this before I close?

Mr. DUNCAN. Yes, thanks. I think that a number of the statements being made about cost of CCS and gas prices are a little misleading. First, all of the prices with regard to carbon capture are referred to retrofits of post-combustion capture. Capture can be much cheaper if you do it through an IGC plant or through oxy firing through new builds rather than just retrofitting. Another thing, if I might add just quickly, is the comments on natural gas prices

and the Barnett Shale and so on were very misleading because those gas productions will not continue under gas prices, and the average life time of the Barnett on the shale well is about 9 months in terms of its productivity so gas prices are going to go higher.

Mr. STEARNS. Good point. Thank you.

Mr. MARKEY. The gentleman's time has expired. The chair recognizes the gentleman from Texas, Mr. Hall.

Mr. HALL. Mr. Chairman, can you hear me?

Mr. MARKEY. Unfortunately, yes, very clearly.

Mr. HALL. I just didn't want you to cut me off like you did my friend from Florida. I am from a fossil fuel state, and I realize the importance of technology to address CCS, and I support nuclear power totally and completely, clean coal, of course. But I also recognize the presence of a thing that some of you seem to forget, and that is the presence of a cash register. You know, China doesn't really want to go by the cash register.

And you can, Mr. Hawkins, hold up all the periodicals that you have there in your whole briefcase and you can't force China to change their mind. They are not only refusing to participate financially in the clean up but they are deteriorating daily and weekly as has been testified to here and none of you objected to that or disagreed with it. And about the same thing can be said for Russia, Mexico, India, and go right on down the line. They just don't want to talk about the cash register. That is too plain. That is something that the American people can understand.

I am a little bit sick of all the self-serving, worn out determination to push and rush to judgment when, you know, you don't even say global warming anymore. You are saying global change. And of course we have to have global change, and we ought to have technology. We ought to be addressing it. And this young lady over here can give you a quick policy of insurance, the whole line, legal reserve, non-cancellable on global change. Now I wonder if that would also include global freezing. Sometimes up here I am about as afraid of global freezing as I am global warming, but you all don't seem to notice that.

I guess in the question by Mr. Inslee from Washington about unlimited amount of carbon dioxide, who has the right to do all that into the atmosphere and whether or not—I would really like to ask Ms. Patton a question but I think it would take too long to answer about your policy and how you arrive at a policy to insure against and what do you insure against on global warming, an occasion? Just yes or no. You insure the happening or the non-happening of an occasion, right?

Ms. PATTON. We insure the happening of the triggering event.

Mr. HALL. OK. I think you might have meant mechanical event, and would that to get to be more plain that something an American, that I could understand, does that mean devastating—is there something in the small print that describes what your mechanical might be?

Ms. PATTON. A geo-mechanical——

Mr. HALL. Let me ask you, would that be when the Statue of Liberty is under water or the Sahara Desert becomes Sahara Ocean or what mechanical event has to happen before it triggers your pay off?

Ms. PATTON. Mr. Hall, in response to what coverage we are providing for the geo-mechanical issues, the covered event would be a resultant earthquake from the injection of gas.

Mr. HALL. You have a board that can insure against earthquakes?

Ms. PATTON. If, in fact, the CCS injection, the injection of the carbon dioxide, does cause that event, we are prepared to pay in response for any consequential——

Mr. HALL. I am pleased to know that it does exist, and do you sell many policies in China?

Ms. PATTON. We do offer coverage in China. However, this particular coverage is——

Mr. HALL. I will get to my question before Mr. Markey turns me off like he did the guy from Florida here. I like Mr. Markey. Don't misunderstand me. I just don't like the way he votes. He has killed my vote for 28 years up here. Mr. Quinn, in your testimony you state that coal is not merely important to the United States and the world, it is indispensable for meeting our energy needs for the foreseeable future, and I sure agree with you to that effect. I am big on coal. Now only that, but coal could provide 125,000 direct high-paying jobs to the U.S. coal miners and support hundreds of thousands of additional jobs throughout the value chain and then companies and manufacturing operations that depend on reliable coal-based electricity to keep their energy costs down, and Mr. Barton alluded to that.

What will happen to these jobs if we stop using coal-fired generation or we arbitrarily raise the price of coal-fired generation through cap and trade?

Mr. QUINN. Well, if the wrong policy is chosen and coal is adversely impacted then those jobs would be gone. Those jobs happen to be the highest paying jobs in many of those regions including in your State of Texas as well.

Mr. HALL. Do any of the other of you four who said yes, yes, yes, yes, have a different answer to that? I presume that you don't. I yield back my time, Mr. Chairman.

Mr. MARKEY. The gentleman's time has expired. By unanimous consent, Mr. Terry, who is not a member of this subcommittee, will be recognized to ask questions.

Mr. TERRY. I appreciate it. Mr. Hawkins, in your booklet, the plan, does it state where the cap should be placed on CO_2 emissions, at what level?

Mr. HAWKINS. It does.

Mr. TERRY. And what is that?

Mr. HAWKINS. There are targets for 2012, for 2020, for 2030, and for 2050.

Mr. TERRY. Just for 2012, what would that be?

Mr. HAWKINS. It is a range of between 97 percent of 20205 levels to 102 percent of 2005 levels, so basically bracketing 2005 levels.

Mr. TERRY. Very good. Then the follow-up question would be to Mr. Crane and Mr. Alix, for a coal-fired plant in Omaha, Nebraska sitting on the Missouri River, 500 megawatts, does technology exist that allows them to comply to the cap by 2012?

Mr. CRANE. To take the carbon—to comply by not emitting the carbon as opposed to——

Mr. TERRY. Right, that plant, starting up a new one and shutting down the current one.

Mr. CRANE. My opinion is that the technology will not be ready so that by 2012 a 500 megawatt flue gas stream could all be 90 percent carbon captured but Mr. Alix may have a different point.

Mr. ALIX. I would agree with that. I would say it is available to confidently predict you can deploy it by that time frame. I would say it is not ready yet. It is available to demonstrate. It is not commercially proven.

Mr. TERRY. And by 2012, will it be commercially proven in your opinion?

Mr. ALIX. The current commercial demonstration project we have on track should be running in 2012. Generally, people want a year of operation to say it is commercially proven so I would say on that track by 2013 you might suggest it is commercially proven at that point.

Mr. TERRY. So perhaps maybe part of our discussion is not only what the level of the cap should be in a cap and trade, but also what year it should take effect. Would any of you support or feel that a trigger that the technology exists before the cap would be enforced is a reasonable position? Any of you have an opinion on that?

Mr. CRANE. Well, I have an opinion. I think it is a classic chicken and egg situation that you cannot wait for the technology to be proven or to put the cap and trade system in place or else it will never happen. Certainly that has been our history of progress over the last 10 years is there has been actually very little progress made in that regard, so I think you have to set the target out there and then set the private sector working with the government out there to get after it.

Mr. TERRY. I am curious—I am sorry. You wanted to say something?

Mr. QUINN. I just would add that I think Mr. Crane makes some good points. I think it is important to know you shouldn't be picking a time frame that is arbitrary and then saying hopefully the technology catches up so somehow there has got to be integration in terms of figuring out what the time frame is based on what we know right now or in the near future about when that will be commercially available, and that is different than commercially—it has been commercially tested. I mean why leave available commercially is a whole different animal.

Mr. TERRY. I think that is an excellent point. Do any of you, again probably Mr. Crane or Mr. Alix, have any idea or opinion about what the cost to the utility would be around 2012 to retrofit their coal-fired plant to be able to meet the requirements of the cap, what those costs would be, ballpark? We are guessing here but give me an educated ballpark.

Mr. ALIX. We have done a number of studies both for retrofitting new at commercial scale 500 to 760 megawatts and they indicate capture costs in the vicinity at large scale plants of $30 a ton. When you add in sequestration if it is enhanced oil recovery you may recoup some of those costs. If you pay to inject it in general people——

Mr. TERRY. Now is that the operating cost to do that or the upfront cost of the technology?

Mr. ALIX. That includes capital and operating with some assumption of financing costs which today is a big assumption because current markets are not widely open as Mr. Crane pointed out.

Mr. CRANE. I would agree with Frank. Normally you would express in our industry in dollars per megawatt, but in this market where you can't get the money to fund a 500 megawatt power plant would be looking at $500 million or more in upfront cost.

Mr. MARKEY. The gentleman's time has expired. All time for questions has expired. What I am going to do now is ask each one of you to give us your 1-minute summation of what you want us to remember about your testimony as we move forward in drafting climate change legislation. We will begin with you, Ms. Patton.

Ms. PATTON. Thank you very much. In closing, Zurich believes that commercial scale deployment of CCS must be achieved soon to meet the 2050 emission reduction goals. Zurich encourages this committee to proceed with legislation of whatever form you see fit that would provide the necessary funding and support to study and generate data that is necessary for us as an industry to properly underwrite risk and send price signals in the form of insurance premiums and otherwise support risk mitigating technologies. The more data that we have available, the better sites we can select and the lower fees that we can charge in terms of deploying our capital.

Mr. MARKEY. Thank you, Ms. Patton. Mr. Quinn.

Mr. QUINN. Thank you, Mr. Chairman. I say again several points I would like to leave you with are that coal is indispensable for meeting our energy needs here in the United States, as well as globally. No climate policy will be successful without coal with CCS. We must accelerate the development and deployment, widespread deployment, of carbon capture and storage. And, finally, the policy solutions to meet those needs must be harmonized so that expectations are harmonized with commercial availability of the enabling technology.

Mr. MARKEY. Thank you, Mr. Quinn. Mr. Alix.

Mr. ALIX. Thank you, Mr. Chairman. My point is that CO_2 capture technology is commercially available today from several vendors with commercial guarantees. Studies suggest that they have a high likelihood of success upon deployment. To get those projects deployed, we need some type of financial incentive offered from the government either as part of a comprehensive climate bill or separately, and we suggest that those incentives be competitively awarded so we get the lowest cost solutions moving first at the best sites. Thank you.

Mr. MARKEY. Thank you. Dr. Duncan.

Mr. DUNCAN. I believe that CO_2 sequestration and deep brine reservoirs and oil reservoirs can be done safely and effectively. I think that in order to do this, I think that Congress should develop some sort of regulatory mechanism that encourages the best sites to be selected, just not oK sites. I also think that they should encourage the development of regulations for CO_2 sequestration in association with enhanced oil recovery.

Mr. MARKEY. Thank you, Dr. Duncan. Mr. Crane.

Mr. CRANE. Thank you, Chairman Markey. What I would try and focus the committee on is as we go forward with looking at energy policy to not get distracted by wind, solar, smart grids, conservation efficiency. All those things are great, but what your focus on today, this is central, coal is central, carbon capture and sequestration is central, and as you turn to how to incent that focus on what we can do now. We need to get dirt turned. We have been studying this for so long. We need to get some metal in the ground to see what works and what is the cost of these various technological options.

Mr. MARKEY. Thank you, Mr. Crane. Mr. Hawkins.

Mr. HAWKINS. Yes, Mr. Chairman. Carbon capture and dispose technology is ready for commercial use today. The industry is waiting for a signal, and that signal has to come starting with this subcommittee. If you consider and adopt legislation that applies a cap to global warming emissions that applies, emission standards for new coal power investments, and that couples that with a financial incentive program to promote the early use of carbon capture and storage, you will make that happen. Thank you.

Mr. MARKEY. Thank you, Mr. Hawkins. We thank each of you, and I couldn't agree with all of your testimony more. This is——

Mr. HALL. Mr. Chairman.

Mr. MARKEY. The gentleman from Texas.

Mr. HALL. Since you are telling them that you agree with them, do I have the right to tell them that I am disappointed that none of them mentioned the taxpayers and how much it would cost and how soon we would know that it would help, whether it be 10 years or 50 years, whether we would know that we had had any—and why they didn't mention China's inability or unwillingness to come forward and participate, Mexico, India, and the others. I think they ought to take those into consideration when they go to recommend what the taxpayers of this country have to pay for something they will never receive.

Mr. MARKEY. I think they assume that one of the members would mention all those facts and that they could keep their testimony on the subject that was at hand which is that we have to find a solution to the burning of coal not only here but around the world and only if we find the solution here can we export that solution to China and India and other countries, and so the burden is on our shoulders. We are the technological giants on the planet. The world is looking to us. We have to put in place the incentives to find the solution to these problems. Thank you. We thank each of the witnesses for being here today.

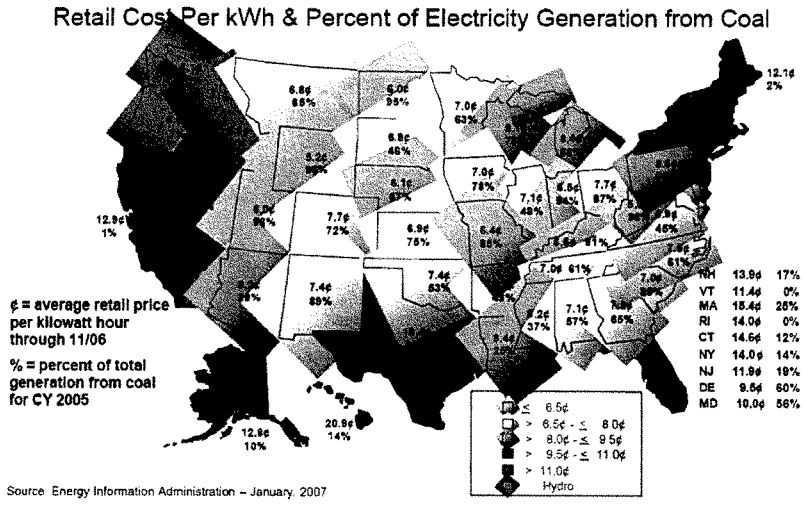
[Whereupon, at 12:15 p.m., the subcommittee was adjourned.]

[Material submitted for inclusion in the record follows:]

Average Weekly Coal Commodity Spot Prices
(Dollars per Short Ton)

Week Ended	Central Appalachia 12,500 Btu, 1.2 SO2	Northern Appalachia 13,000 Btu, <3.0 SO2	Illinois Basin 11,800 Btu, 5.0 SO2	Powder River Basin 8,800 Btu, 0.8 SO2	Uinta Basin 11,700 Btu, 0.8 SO2
1/16/09	$66.45	$76.00	$60.00	$13.00	$73.00
1/23/09	$66.45	$69.00	$60.00	$13.00	$73.00
1/30/09	$66.45	$69.00	$55.00	$13.00	$73.00
2/06/09	$66.45	$66.00	$55.00	$13.00	$73.00
2/13/09	$68.20	$66.00	$55.00	$13.00	$73.00
2/20/09	$68.20	$66.00	$55.00	$13.00	$73.00
2/27/09	$68.20	$66.00	$55.00	$13.00	$73.00
3/6/09	$68.20	$58.00	$55.00	$13.00	$73.00

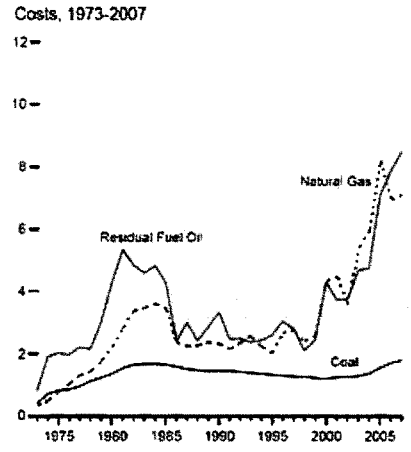
Source: Energy Information Administration



Source: Coal Utilization Research Council

Energy Information Administration
Official Energy Statistics from the U.S. Government

Cost of Fossil-Fuel Receipts at Electric Generating Plants
(Dollars per million Btu, Including Taxes)



Source: Energy Information Administration

Average Open Market Mine Price of U.S. Coal 1995-2007	
Year	**Dollars per Short Ton**
1995	18.83
1996	18.50
1997	18.14
1998	17.67
1999	16.63
2000	16.78
2001	17.38
2002	17.98
2003	17.85
2004	19.93
2005	23.59
2006	25.16
2007	26.20
Source: Energy Information Administration, Annual Coal Report, Annual Energy Review	

Since 1976, coal has been the least expensive fossil fuel used to generate electricity. During the early 1970s, natural gas was the least expensive fuel used to generate electricity. In 1973 electric utilities paid on the average, about 34 cents per million Btu of natural gas, 41 cents per million Btu of coal, and 80 cents per million Btu of petroleum.[1]

However, by 2007, on a dollars-per-million-Btu basis, petroleum was the most expensive fossil fuel ($7.40), natural gas was second ($7.10), and coal was least expensive ($1.78). Although the cost of generating electricity from coal has increased, it is still lower than the cost of generating electricity from either natural gas or petroleum.

For 2007, coal prices rose across every consuming sector. In particular, the delivered price of coal at electric utilities (a subset of the electric power sector) increased for a seventh consecutive year, to $36.11 per short ton (1.78 dollars per million Btu), up 5.7 percent from the prior year.

Another important use of coal is to produce coke, which is used in smelting iron ore to make steel. The tight specifications needed for coal to produce coke limit the availability of the coal. Thus, as the world market for metallurgical coal remained tight over the course in 2007, the delivered coal price at U.S. coke plants climbed 2.3 percent, reaching $94.97 per short ton in 2007.

The average mine price of coal increased 4.1 percent over 2006. The average open market mine price, which excludes any transportation and insurance costs, increased in 2007 to $26.20

per ton. Open market coal is sold to companies other than the mining company's parent company or an operating subsidiary of the parent company.

The average U.S. coal export price for 2007 was $70.25 per short ton down slightly from 2006. Coal exports in 2007 totaled 59.2 million short tons, up 19.2 percent from a year earlier.[2]

The average coal import price for 2007 was $47.64 per short ton, a 3.0 percent decrease from 2006. Total coal imports for 2007 rose to 36.3 million short tons, a slight increase over 2006 but a 19.0 percent increase over 2005.

What is the outlook through 2030? The average mine prices reported in the *Annual Energy Outlook* include prices for both open market and captive mines.[3] According to the *Annual Energy Outlook 2009 Early Release*, the average mine price of coal, in constant 2007 dollars, rises from $25.82 per short ton ($1.27 per million Btu) in 2007 to an early peak of $30.01 per short ton ($1.47 per million Btu) in 2009. This increase is primarily due to the rising prices of fuel, equipment, and parts and supplies at U.S. coa mines. Following this initial run-up, however, prices are expected to moderate, with a price of $28.94 per short ton ($1.45 per million Btu) projected for 2030.

1. To make meaningful comparisons of different energy sources, you must convert physical units of measure (such as weight or volume) into a common unit of measurement based on the energy content of each fuel. One practical way to compare different fuels is to convert them into British thermal units (Btu). The Btu is a precise measure of energy--the amount of energy required to raise the temperature of 1 pound of water 1 degree Fahrenheit.

2. Coal exports and imports. Source: Exports: Bureau of the Census, U.S. Department of Commerce, "Monthly Report EM 545;" and Imports: Bureau of the Census, U.S. Department of Commerce, "Monthly Report IM 145."

3. Captive coal: Coal produced to satisfy the needs of the mine owner, or of a parent, subsidiary, or other affiliate of the mine owner (for example, steel companies and electricity generators), rather than for open market sale.

Source: Energy Information Administration

NATURAL RESOURCES DEFENSE COUNCIL

April 21, 2009

Honorable Joe Barton
Ranking Member
House Committee on Energy and Commerce

Dear Ranking Member Barton:

Enclosed please find my response to the questions you asked me following on my March 10, 2009 testimony to the Subcommittee on Energy and Environment.

Please do not hesitate to contact me if I can be of further assistance.

Sincerely,

David Hawkins
Director, Climate Programs
Natural Resources Defense Council

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Responses of David G. Hawkins, NRDC, to questions from Representatives Barton and Upton Hearing on March 10, 2009 Hearing of the Subcommittee on Energy and Environment

1. You state in your written testimony "Well designed measures can phase in CCD on new coal plants with only very modest impacts on retail electricity prices." What constitutes a "well-designed measure" and what do you characterize as a "modest impact" on consumer's energy rates?

A. NRDC believes a well-designed program to deploy carbon capture and disposal (CCD) systems for new coal plants would combine an emissions standard for CO_2 to provide regulatory clarity and a financial incentives program to spread the cost of deploying the early versions of CCD broadly over electricity consumers. This approach is contained in the March 31, 2009 Waxman-Markey discussion draft, "American Clean Energy and Security Act of 2009." The benefit of such a cost-sharing approach is that the impacts of the additional costs of these initial systems would not fall exclusively on the customers of the power firm that is the first to build and operate such systems. We believe that such a program could be implemented with a cost of less than a 5% change in average retail electricity rates.

2. Is NRDC's position that it opposes any new coal power plant without CCS technology?

A. Yes. NRDC's position is that new coal power plants should install and operate systems to capture and safely dispose of their CO_2 emissions. Our assessment of publicly available information is that use of such CCS or CCD systems is technically feasible for new coal plants today. The earliest versions of these systems will be expensive, which is why we support a program of financial incentives that will share those costs broadly across the electric power sector as I discuss in the answer to question one.

3. Of the estimated 3,000 new coal plants in the world planned to be built by 2030, how many would be built in the United States? Would enacting a cap-and-trade regime on our economy stop other countries from building these 3,000 plants?

A. The global estimate of 3,000 new coal plants in my testimony is based on the World Energy Outlook published by the International Energy Agency (IEA). In IEA's forecast, about 7% of the global new coal plants, or about 210 medium-sized plants, are forecast to be built in the U.S. The purpose of enacting legislation to cap and reduce U.S. emissions is not to stop the building of new coal plants (or other energy production facilities), either in the U.S. or in other countries; nor do we believe the legislation would have such an effect. Rather, the legislation is intended to spur investments in electric power plants (and other projects) that emit little or no greenhouse gas emissions. While of course U.S.

law only direct affects what is done within the U.S., we have numerous examples in the environmental policy arena where U.S. action has been followed by similar action in other countries. For example, pollution controls on new cars began in the U.S. and is now standard practice in countries around the world, including countries like China. Similarly, elimination of lead in gasoline and use of scrubbers on power plants began in the U.S. and both have been adopted around the world, including in China. Electric power generating technology is to a great degree standardized internationally. A new power plant built in China today is very similar technologically to one built today in the U.S. If the U.S. leads the way with policies that speed the use of CCD systems on coal-based power, we believe that leadership will hasten the day when that technology too becomes international standard practice.

Natural Resources Defense Council

April 21, 2009

Honorable Fred Upton
Ranking Member
Subcommittee on Energy and Environment
House Committee on Energy and Commerce

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Responses of David G. Hawkins, NRDC, to questions from Representatives Barton and Upton Hearing on March 10, 2009 Hearing of the Subcommittee on Energy and Environment

1. You state in your written testimony "Well designed measures can phase in CCD on new coal plants with only very modest impacts on retail electricity prices." What constitutes a "well-designed measure" and what do you characterize as a "modest impact" on consumer's energy rates?

A. NRDC believes a well-designed program to deploy carbon capture and disposal (CCD) systems for new coal plants would combine an emissions standard for CO_2 to provide regulatory clarity and a financial incentives program to spread the cost of deploying the early versions of CCD broadly over electricity consumers. This approach is contained in the March 31, 2009 Waxman-Markey discussion draft, "American Clean Energy and Security Act of 2009." The benefit of such a cost-sharing approach is that the impacts of the additional costs of these initial systems would not fall exclusively on the customers of the power firm that is the first to build and operate such systems. We believe that such a program could be implemented with a cost of less than a 5% change in average retail electricity rates.

2. Is NRDC's position that it opposes any new coal power plant without CCS technology?

A. Yes. NRDC's position is that new coal power plants should install and operate systems to capture and safely dispose of their CO_2 emissions. Our assessment of publicly available information is that use of such CCS or CCD systems is technically feasible for new coal plants today. The earliest versions of these systems will be expensive, which is why we support a program of financial incentives that will share those costs broadly across the electric power sector as I discuss in the answer to question one.

3. Of the estimated 3,000 new coal plants in the world planned to be built by 2030, how many would be built in the United States? Would enacting a cap-and-trade regime on our economy stop other countries from building these 3,000 plants?

A. The global estimate of 3,000 new coal plants in my testimony is based on the World Energy Outlook published by the International Energy Agency (IEA). In IEA's forecast, about 7% of the global new coal plants, or about 210 medium-sized plants, are forecast to be built in the U.S. The purpose of enacting legislation to cap and reduce U.S. emissions is not to stop the building of new coal plants (or other energy production facilities), either in the U.S. or in other countries; nor do we believe the legislation would have such an effect. Rather, the legislation is intended to spur investments in electric power plants (and other projects) that emit little or no greenhouse gas emissions. While of course U.S.

law only direct affects what is done within the U.S., we have numerous examples in the environmental policy arena where U.S. action has been followed by similar action in other countries. For example, pollution controls on new cars began in the U.S. and is now standard practice in countries around the world, including countries like China. Similarly, elimination of lead in gasoline and use of scrubbers on power plants began in the U.S. and both have been adopted around the world, including in China. Electric power generating technology is to a great degree standardized internationally. A new power plant built in China today is very similar technologically to one built today in the U.S. If the U.S. leads the way with policies that speed the use of CCD systems on coal-based power, we believe that leadership will hasten the day when that technology too becomes international standard practice.

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April 21, 2009

The Honorable Henry Waxman
Chairman, House Energy and Commerce Committee
2125 Rayburn House Office Building
Washington, DC 20515 - 6115

Dear Chairman Waxman:

Attached please find NRG Energy's responses to the questions raised by members of your committee, which you forwarded to my attention on March 31st. I appreciate the opportunity to testify before your committee.

Sincerely,

David Crane
President & CEO

cc: Early Green, Chief Clerk, Energy and Commerce Committee

NRG answers to questions from the Honorable Joe Barton and the Honorable Fred Upton

1. *NRG is a member of the US Climate Action Partnership. In your testimony you reference the need for government incentives that will 'rapidly lead to lots of orders for CCS technology that will allow companies like PowerSpan, GE, Siemens, and Fluor, to scale up their factories and assembly lines' GE, Siemens, and Fluor are also USCAP members. In the Blueprint to which you are signatory, do you connect the dots between government incentives for companies like yours to then be spent on your USCAP partners' technology?*

The only connection we see is the emergence of a robustly competitive market for new low carbon technology developers and manufactures in the US, which will allow technology deployers like our company to lower our cost and that of consumers. Our policy recommendations, including those of the USCAP *Blueprint*, are structured to create the most competition as quickly as possible among the largest possible number of technology manufacturers, construction firms, and others in the upstream value chain. This is essential to the value proposition we offer our shareholders and our customers, and is firmly embedded in our approach to developing new power plants in our core markets, notably in Texas, where we have what we believe to be the most competitive new nuclear project in the US under development. We would note this project is using Toshiba North America, who is not a USCAP member, as the primary equipment vendor and EPC contractor. Also, we would respectfully note that Fluor is not a USCAP member.

2. *You mention that the USCAP Blueprint that encourages a cap and trade scheme will result in a great increase in demand for CCS technology. This demand increase will allow companies like GE and Siemens to scale up their factories and – according to you – 'buy lots of concrete and steel.' We have already seen a sharp drop in domestically produced cement and steel because of increasing energy costs. Is it your idea that we should import all of this steel and cement from overseas workers to support technology companies propped up by government subsidies? How can you reconcile increased energy costs with competitive domestic steel and cement industries?*

We support the USCAP *Blueprint* approach to allocating a reasonable share of allowances to energy intensive manufacturers, such as concrete and steel companies, in order to help level the playing field with other countries, to the extent that a price on carbon initially tilts the playing field away from US companies. We also support the Blueprint's allocations of a share of allowances to electric distribution companies, who would use them to buffer the energy cost impact to consumers and businesses, which would further level the carbon playing field. These measures should significantly mitigate job losses and offshoring, to the extent it might actually be driven by a US price on carbon until other countries agree to their own emission limits. In addition, NRG would not oppose a provision in climate legislation that would allow the US to impose border adjustments on imported goods from other countries if they fail to adopt their own greenhouse gas emission limits in a timely manner.

When it comes to subsidies, we support competitive and market-oriented incentives wherever possible, so that emerging technologies have both the opportunity and the incentive to quickly achieve competitive cost structures that can work without subsidies when there is a market-based price on carbon.

3. *You mention that several new international coal plants are being built every month. Is it possible some countries may decide, despite action by the U.S., to continue business as usual? What effect will this have on reducing CO_2 emissions?*

It is possible, but we think it is much more likely that a concerted effort by the US to lead by example and, in parallel, engage in serious diplomatic efforts, will lead to other countries taking on an appropriate commitment to reduce their own emissions. We also think there is already a low carbon technology race among countries, and that if the US does not undertake the suite of policies called for in the *Blueprint*, US industries run the very real risk of permanently ending up on the buying end rather than the selling end of the new, low carbon technologies.

US House of Representatives; Subcommittee on Energy and Environment; March 10, 2009 hearing entitled "The Future of Coal Under Climate Legislation"

Follow-up Questions for Frank Alix, Chief Executive Officer, Powerspan Corp. from The Honorable Joe Barton and the Honorable Fred Upton:

1. How do you feel about technology transfers to China, India, and other foreign countries? Does Powerspan support a patent pool, which might hasten commercialization of CCS technologies?

Powerspan Response
Technology transfer to any country that does not respect and defend intellectual property (IP) rights is a significant concern for Powerspan. As a technology company, we derive most of our corporate value from our IP and patents. Prior to transferring our CCS technology to a country such as China, we would need to have confidence that our IP rights would be respected and could be defended, if necessary.

Patent pools are most useful when a consortium of at least two companies agree to cross-license patents relating to a particular technology. The creation of a patent pool can save patentees and licensees time and money, and, in the case of blocking patents, it may also be the only reasonable method for making the invention available to the public. As a key innovator and owner or licensee of relevant CCS patents, Powerspan would be concerned about being adequately compensated in a patent pool. We believe a patent pool operates best when the members have somewhat equal patent contributions, or contributions from several parties' patents are necessary to deploy the most cost-effective CCS technology. Since the CCS technology space is still quite new and very few patents have been granted, it is not clear whether patent pools could be of any benefit at this time.

2. Based on the historic delays surrounding the FutureGen project, do you think the U.S. government is fully committed to the development of CCS?

Powerspan Response
CO_2 capture technology is commercially available from several qualified vendors for different types of plants, including IGCC plants like FutureGen. In order to develop and demonstrate CCS at commercial scale, the government will either need to legislate a requirement to install CCS on new or existing coal plants, or provide sufficient financial incentives to fund early CCS installations. Experts such as EPRI have suggested that a financial commitment of at least $1 billion per year will be required over 10 years to commercially demonstrate CCS.

The FutureGen project, as a single example of CCS on an IGCC plant, is not as important to the future of CCS in general since only three IGCC plants exist worldwide and very few others are being built. However, a broad commitment to CCS funding will be needed to commercially demonstrate the technology on new and existing coal-fired plants. CCS funding provisions provided in Section 114 - CARBON CAPTURE AND

SEQUESTRATION DEMONSTRATION AND EARLY DEPLOYMENT PROGRAM and Section 115 - COMMERCIAL DEPLOYMENT OF CARBON CAPTURE AND SEQUESTRATION TECHNOLOGIES of the Waxman-Markey American Clean Energy and Security Act of 2009 released on March 31, 2009 would represent a full commitment of the U.S. government to CCS development and would be adequate to ensure CCS was commercially available to support CO_2 emission reductions called for in the proposed legislation without significant impact on coal-fired electricity generation.

3. Can nuclear energy provide clean, predictable baseload power that is as reliable and cost-competitive as coal? How about wind and solar?

Powerspan Response

Nuclear energy has a track record of providing clean, predictable baseload power in the US that is as reliable and cost-competitive as coal. However, there are legitimate concerns about nuclear waste disposal and nuclear proliferation that many informed observers believe require further action to address. Costs for the next generation of nuclear power plants are also uncertain as the supply base is constrained and construction risk is considered quite high.

Wind and solar power are useful energy sources to supplement, but normally not replace, baseload power generation. These power sources suffer from dependence on local resources (sun and wind), which vary greatly across the U.S., and from intermittency of sunshine and wind. They also have costs that are substantially higher than coal-fired electricity generation, even when the projected costs of CCS are added.

HAL QUINN
President & CEO

April 21, 2009

The Honorable Joe Barton
Ranking Member, Energy and Commerce Committee
United States House of Representatives
2322-A Rayburn House Office Building
Washington, DC 20515

The Honorable Fred Upton
United States House of Representatives
2183 Rayburn House Office Building
Washington, DC 20515

Dear Ranking Member Barton and Representative Upton:

Please find attached my responses to your questions regarding the testimony I presented to the Subcommittee on Energy and the Environment on March 10, 2009.

If you have any questions please feel free to contact me at (202)463-2601.

Sincerely,

Hal Quinn

1. *You cite in your written testimony the dire economic impact that poor climate policy may have on the U.S. coal community. How many states and how much employment would be likely impacted?*

An analysis of S. 2191, the Lieberman-Warner Climate Security Act of 2007, conducted by CRA International concluded that the U.S. economy would suffer millions of lost jobs as a result of the legislation.

Job Losses (thousands of jobs)

Year	2015	2020	2025	2030	2035	2040	2045	2050
Lost Jobs	3,774	3,269	1,914	2,393	3,054	3,864	5,535	7,154

The analysis did not estimate specifically the number of coal mining jobs that would be lost. However, we do know that the impact on coal and coal jobs would be devastating as a result of the substantial decrease in coal demand. The CRA International analysis found that the use of coal in electricity generation would fall from 22.6 quadrillion BTUs in 2010 to 8.3 quadrillion BTUs in 2035.

In 2007, coal mines in twenty eight states employed a total of 122,940 men and women with an average wage of over $66,000. The largest states for coal mining employment were West Virginia (31,700), Kentucky (22,760), Pennsylvania (11,170), Virginia (9,270) and Wyoming (8,600). Other states with at least 3,000 coal mining jobs include, Alabama, Colorado, Illinois, Indiana, Ohio, Texas, Utah, and Virginia. For each job in coal mining, an *additional* 3.5 jobs are created elsewhere in the economy. Coal mining in the U.S. generated a total of 554,650 jobs during 2007.

2. What time frame do you foresee for the development of CCS technologies, how much will it cost, and where will the funding come from?

It is expected that Carbon Capture and Storage (CCS) technologies will be developed and deployed through a series of stages characterized by the increasing confidence in the cost and performance of the technology. These phases include:

1) Iintial stand-alone CO_2 storage tests of CO_2 injection and post-injection monitoring. This phase is underway in the Department of Energy's Regional Carbon Sequestration Partnership program, but needs additional funding to expand the scope and number of tests;
2) CCS "Pioneer Plants" in which electricity generation (or some other industrial use of coal) and CO_2 capture and storage are at least partially integrated. It is anticipated that 7-15 GW-equivalent of CCS capacity[1] (approximately 20 – 30 installations) will need to be built and operated with approximately four years of operation and monitoring before potential CCS vendors and adopters will have sufficient understanding and confidence in the technology and its costs to allow widespread deployment. If the Pioneer Plant phase were to begin now, and all installations follow a typical seven-year power plant construction schedule, the Pioneer Plants would achieve four years of operation by approximately 2020;
3) CCS "Early Adopters." Following the successful operation of a sufficient amount of Pioneer Plant capacity, generators will be able to add CCS capacity on a more routine basis, with the initial Early Adopter plants coming on line in the 2025 time frame. It is anticipated that CCS will be accepted as technically proven at this point, but it likely will require substantial financial assistance. There is a consensus view within the industrial community that approximately 60 GW of cumulative capacity in the Pioneer Plant and Early Adopter phases is necessary to bring the cost of the technology down to acceptable commercial levels. If the highest historical rates in the United States of coal-fueled power plant capacity addition[2] could be achieved for CCS, this level of installation could be achieved in the 2030-2035 timeframe, and perhaps a few years earlier if a significant amount of CCS coupled with enhanced oil/gas recovery is installed to generate additional revenue from oil/gas production.
4) CCS Capacity Addition. Following the Early Adopter phase, CCS will be deployed based on demand, economic competition with other electricity generating technologies, and regulatory and public policy measures that facilitate or impede it.

[1] "Equivalent CCS capacity" refers to the likelihood that plants in the Pioneer Plant phase may not treat 100% of their gas stream to minimize technical and cost risk. The equivalent capacity refers to the amount of gas treated. For example, a 600 MW plant that treated half its flue gas would represent 300 MW-equivalent of CCS capacity.
[2] As a point of reference, in the 1970s and 1980s, the US added ~12 GW/yr of coal-fueled power plant capacity, with a maximum of ~16 GW in any year. Of course, what was built at the time was much simpler than a current coal plant with CCS.

Cost of CCS Deployment

Various organizations have estimated the capital and operating costs of CCS. While estimates vary, the Electric Power Research Institute (EPRI) analyzed various carbon capture scenarios based on a variety of electricity generating technologies (pre- and post-combustion) in greenfield and retrofit applications, for bituminous and subbituminous coals. If the Pioneer Plant phase were to consist of 5 GW of retrofit capacity and 10 GW of greenfield capacity, the total capital cost, using EPRI's estimate, would be on the order of approximately $49 billion. If the Early Adopter phase were to consist of 15 GW of retrofit capacity and 30 GW of greenfield capacity, the capital cost would be on the order of approximately $132 billion. These estimates represent the total for electricity generation and CCS.

3. What will happen if we demand a moratorium on any new coal-based generating capacity until CCS is fully deployable?

This would pose grave problems for meeting growing demand for electricity as well as meeting requirements arising from retirements of existing electric generating units without coal, our most plentiful and affordable fuel for electric generation. According to the Energy Information Administration, electricity demand is expected to increase 26 percent by 2030. Clearly, such a policy would result in substantial upward pressures on the electricity prices and would have implications for the reliability of the system.

Responses of Lindene E. Patton, Chief Climate Product Officer, Zurich Financial Services to Questions Submitted by Honorable Joe Barton and the Honorable Fred Upton
April 21, 2009

1. **If a liability framework is not fully developed, can CCS expect enough private capital investment to reach commercialization ?**

Summary Answer: No.
Why: Under the appropriate liability framework, insurance can provide a significant amount of certainty for investors in CCS that there will be asset protection from first and third party property damage, bodily injury, business interruption and other insured loss. However, neither the insurance mechanism, nor other available third-party financial instruments, can provide protection against (i) certain long term liability risks; (ii) the broad array of political risks; or (iii) many risks associated with conflicts of law. These latter three risks are a remaining source of uncertainty that may deter sustainable commercial investment, which insurance cannot address, and which a fully developed liability framework must mitigate to create sufficient predictability to incentivize capital investment.

So, while insurance provides a significant piece of the puzzle to promote commercial scale deployment of CCS, insurance alone may not be sufficient, and public policy makers will need to take action to resolve certain conflicts of law and long term liability issues to provide sufficient certainty to investors to allow commercial deployment of CCS.

Discussion:
Insurance generally provides indemnity for covered loss and liabilities arising out of fortuitous events arising from CCS operations, and can further provide financial assurance for closure and post-closure activities. However, insurance cannot provide indemnity for risks and liabilities arising out of certain conflict of laws and political risks which exist under the current patchwork of laws applicable to CCS and which, in their current framework, could result in stranded assets for a project developer, operator and / or investor. Further, insurance cannot address liability

today for risks associated with long term stewardship after operations have ceased and closure and post closure obligations have been satisfied. Generally, insurance is a contract designed to protect private assets, providing indemnity for bodily injury, property damage and / or some other special damages, such as business interruption, arising out of fortuitous events of covered operations or locations. Insurance does not generally act to guarantee asset values.[1] Today Zurich makes available insurance which is designed, subject to its terms and conditions, to address first and third party liability resulting from CCS operations, and specified obligations for closure or post closure activities. However, insurance does not substitute for governmental decision making in the event that it results in conflicts of law resulting in unsolvable legal conflicts in the deployment of CCS. In this emerging area insurance will not accept these types of political risks. Further, while insurance will pay for loss or provide indemnity for damages, insurance will not pay for loss or provide indemnity for damages arising out of knowing, ongoing and intentional acts which perpetuate or exacerbate such damages or loss when mitigation is possible.

In the case of CCS deployment under the current patchwork of laws, it is quite easy to imagine a loss scenario where a triggering event occurs and a conflict of laws situation ensues. As one such example, injected gas could migrate outside of the boundaries of the intended reservoir and into a potable drinking water source, causing damage to said drinking water. If certain applicable law requires that groundwater remediation occur and that injection cease, while other applicable law prohibited discharge to air and no alternative injection site or other mitigation scenario were part of the applicable law, then the operator would be faced with several unpalatable scenarios. First, the operator could continue to inject to the reservoir; however, this ongoing damage to groundwater would no longer be resultant from a fortuitous act, and, as such, resultant ongoing (additional) damages to such groundwater would thus unlikely be insured. This is because while insurance, when properly triggered would (pursuant to the terms and conditions of the policy) pay for covered damages, the terms of the insurance coverage would also require that mitigative actions be taken, as insurance is not designed to pay for damages caused by ongoing knowingly intentional wrongful acts, even if such is caused by this conflict of law. So the operator could continue, but

[1] Although in some cases policies can be designed to address loss arising out of specified events.

would be at risk for fines and costs of remediation without insurance. The second unpalatable option: the operator could stop injecting into the reservoir and instead discharge to air and violate other laws and likely face uninsured fines and penalties. Or, for the third unpalatable option, the operator could simply shut down the plant; however, this would both strand an asset and potentially destabilize continuous power delivery to customers and thereby violate some other law designed to protect the public – not to mention destroy invested capital.

In short, while CCS may be deployed in support of delivery of an essential service, power delivery, the technology could – under certain scenarios – potentially impact other resources of either a public or private nature, which other unrelated laws are designed to protect.

Conflicts of law may arise when statutory requirements underpinning environmental media collide with those underpinning delivery of essential services. If not addressed prior to CCS deployment through a viable, rational liability framework, investors will be wary of placing financing capital behind CCS projects for fear of losing their return on investment. In other words, if either this scenario, or one of several others, were to manifest, an investment would be at risk in a manner solvable only by liability framework structure and conflict of law resolution – not through the tool of insurance.

Relevant Precedent: Waste Water Treatment and Nuclear Power

The potential conflict of laws presented by CCS deployment is significant but not unprecedented. Mining rights, oil and gas rights, and environmental legislation of many types have all, with varying degrees of success and failure, addressed prior conflicts of laws experienced with prior deployment of "new technologies" and in response to science.

In the case of waste water treatment, in high rain events, waste water treatment plants can overflow and discharge untreated waste water into streams, rivers or oceans. In these cases, the government does not generally order the shut down of the plant and order its users to stop generating waste water (e.g., flushing toilets, using their taps and drains, etc.). Rather, the government, through permitting and liability systems designed to address such conflicts, may fine or otherwise penalize the operator; may direct the operator to increase treatment capacity; or may find a different treatment and discharge method or location. If this simple

concept of advanced risk management and mitigation plans, including conflict of law resolutions as necessary, were addressed as part of the legislation and regulation affecting deployment of CCS, commercial deployment could be supported.

In the case of nuclear power generation, a decision to design a pre-emption based scheme to address conflict of laws was taken to provide enough certainty to operators and investors to allow commercial deployment. Other decisions were taken to address insuring risk; however, the nuclear liability framework is not wholly applicable to the CCS case as the magnitude of risk is likely different and the willingness and the capacity of the insurance industry to address CCS risk is different than that presented during the commercialization of nuclear power because the severity of risk from any single event with proper risk management involving CCS is anticipated to be less than that from a critical nuclear event, even with proper risk management. So, while the specific types of risks at issue were quite different in many technical ways, there are some analogies which should be considered.

2. What are the essential risk management components of a legislative framework necessary to ensure the commercial deployment of CCS in an environmentally and economically sustainable manner ?

Discussion:

a. To ensure that commercial deployment of CCS occurs in a sustainable manner with respect to natural resources, the environment and public safety, the following four (4) elements of a risk management framework are critical:

1. **First, Estimating the Expected:** Appropriate analysis is needed to estimate the expected value of financial consequences that may arise from each individual CCS site. **(See discussion in response to question 4 below for critical characteristics of such actions).**

Specialty insurers are expert at estimating these low frequency, potentially catastrophic risks.

2. **Second, Proper Risk Identification and Quantification Must Inform Permitting, Operation and Maintenance Requirements:** No amount of insurance, trust fund or other financial risk management system can overcome poor siting or inappropriate operating techniques.

3. **Third, Establishment of a CCS Safety Board:** With respect to siting, operational oversight, and long-term stewardship of CCS facilities, a private / public government corporation should be chartered and vested with the authority to oversee the siting and design of CCS facilities and the management of CCS facilities in the event of conflict of laws or resources. A uniform baseline standard for siting decisions is critical to the effectiveness of the insurance tool and to the economically and environmentally sustainable deployment of CCS. Some governmental bodies may have substantial economic and political conflicts that could lead to the siting of CCS facilities in areas with inappropriate geology which would make such site uninsurable and untilmately make the deployment of CCS environmentally or economically unsustainable, or both..

4. **Establishment of A 'CCS National Trust':** A revolving Trust, managed by the CCS Safety Board, should be established to pay long-term stewardship costs after the CCS facility is released from post-closure. This Trust should be designed to manage only residual, low frequency risks over the long-term stewardship duration of the site. As such, the permitting and operational scheme which manages the sites before the transfer of liability for long-term stewardship into the trust must be geared toward leaving ONLY residual risk. **(See discussion in response to question 4 for detail of this concept).**

b. Finally, it is critical that policymakers avoid the establishment of any liability scheme that would provide first dollar indemnity for liability during operational, closure or post-closure periods: No first dollar indemnity should be provided by sovereigns for risks manifesting

from CCS activities during operational, closure, or post-closure periods because indemnity separates actions from consequences and masks price signals. Simply put, first dollar indemnity removes one of the greatest incentives to deploy CCS in an environmentally and economically sustainable manner.

Fines and penalties, to the extent they are designed to achieve penal public policy goals, are generally uninsurable.[2] As such, regulatory schemes based solely on fines and penalties may not present a meaningful role for insurance, as contrasted with a regulatory scheme which defines damages in a compensable manner.

3. You explain that insurance sends price signals to incentivize risk reducing behavior. This is particularly important in managing risks arising from deployment of new technologies. How can Congress encourage new technologies without taking on excess risk ?

Discussion:

Insurance performs a role like no other in society, sending price signals to incentivize risk-reducing behavior. These signals are sent in the form of premium charges, deductibles, co-payment obligations, and in the most severe risk circumstances, declinations to provide any insurance at all. Parties who conduct insured operations or whose sites have characteristics that either have a greater likelihood of causing or experiencing a loss relative to another, or for which the loss costs likely will be much more severe in the event of loss, will pay more than a party whose potential frequency or severity of loss is less.

For example, in the case of car insurance, the value of the insured vehicle, the location of the car, the behavior of the driver, other factors, and the political jurisdiction itself may affect the potential frequency and severity of loss and will be (subject to applicable law) reflected in the premium. Such auto premium signals induce many drivers to drive more

[2] Exceptions may be applied to this criterion where a penalty attaches regardless of fault. In those "no fault" cases, insurance may be possible, provided that providing insurance does not violate local public policy or law.

safely as the consequence of an unlawful or loss causing driving event may be financial in the form of increased premium costs.

To leverage the same type of risk-mitigation behavior, Congress should refrain from providing indemnity to site developers, operators, or parties who can affect the risk profile of the CCS site risk because such an indemnity sends a zero dollar price signal in the event of loss. In other words, there is no immediate financial consequence to choosing to operate a site of greater risk than a site of lesser risk – and such indemnity may inadvertently cause a race to the bottom. Responsible site operators want responsible competitors. As such, risk management, and tools like insurance, can be used for competitive advantage to support good risk management, assuming that other regulatory action does not interfere with price signals (e.g., price caps, prohibitions on cost pass-throughs for certain environmental risk management costs, etc.).

Premiums are generally calculated as a function of the potential frequency and severity of loss assumed, and include allocable underwriting and anticipated loss adjustment expenses.

As such, critical characteristics of the site, operations and environs which are drivers of insured loss and administration of loss expense (e.g., certain technical conditions, conflict of laws, etc.) are identified. Some of those characteristics will drive the likelihood of an event of loss occurring (the expected frequency of the event), while others will drive the potential magnitude of the costs of loss (e.g., severity). Each site and associated operation will have a consequential risk profile (e.g., projected loss content over a specified period). To manage and reduce risk, it may be possible to identify certain operational changes which could substantially adjust the risk profile, thereby increasing or decreasing the premium charge or price signal. At some point, the premium or price signal makes the project economically sustainable or not.

To avoid taking excess risk, Congress must structure legislation in a manner which fosters effective underwriting and pricing of risk, and which agrees that some risks are simply unacceptable and should not be taken – or in this case should not be permitted to operate. **(See Discussion in response to question (4) below for more detail on this critical issue of risk management structure).**

Unfortunately, this is deceptively simplistic advice for a complex public policy challenge. To "underwrite," risks of interest and concern must be identified. In the case of an insurer, underwriting focus is placed upon protection of private assets; in the case of Congress, this focus must be expanded to include definition and underwriting of the desired public good.

Fortunately, socially we have some history with analogous circumstances involving the deployment of energy resources, new technologies or response to developments in science designed to further a public good: Price Anderson, CERCLA, RCRA, Uninsured Motorists Coverage, and TAPAA. That said, the regulatory framework designed in each case has succeeded in part and failed in part, and none is directly applicable in its full structure to the risks, risk profiles, and/or societal issues presented by the deployment of CCS. As such, Congress should learn from past successes and failures and design a novel system for the unique needs presented by climate change and CCS deployment.

There is precedent for insuring some common goods in the insurance industry, but only where the applicable regulatory framework defines the risk as a private asset or liability to be insured. For example, in some jurisdictions, damage to soil and groundwater is considered property damage and the liability for cleaning up the contamination is similarly considered property damage. When the definition of a performance endpoint for the environmental liability, like a clean-up level, is sufficiently defined under law, an insurer can identify, assess, quantify, and accept transfer of the environmental risk under an insurance product. The environmental insurance market, while a specialty, non-standard liability market, is a robust market with significant history and durability in jurisdictions where liability is defined.

Please see the articles appended for your review for additional conceptual detail. A coordinated public and private solution will be required to deploy CCS and other new technologies in an economically and environmentally sustainable manner.

4. **The testimony from Dr. Duncan, a geologist, indicates that although large scale CO_2 sequestration in deep brine reservoirs can be done safely and effectively, the likelihood of leakage, leakage rate, and the consequences of leakage in terms of possible**

damages to the drinking water vary greatly between sites. How can his liability best be addressed ?

Short Answer: Liability due to site variability must be addressed by assuring that site specific and proper site selection criteria and management requirements are applied in such a way to leave only residual fortuitous risks for management using financial instruments. This risk management process must be designed to accept the fact that some sites will simply be unsuitable for use – no matter what – and that some sites will be far more expensive to run than others. No amount of insurance or other financial instrument can make a bad or unsuitable site a good or suitable site. Further, the liability framework must recognize both the underwriting value and temporal limitations of insurance; and the negative risk management impacts of governmental indemnity during operational phases. Additionally, to reduce long term stewardship risks, the risk management framework must consider temporal aspects of environmental risk profiles (e.g., could the risk occur immediately, in one year, 5 years or only in 100 years or more) and design the site selection criteria and management requirement to minimize BOTH short term and long term risks. And, finally, the risk management system and framework must recognize that each potential CCS site is unique, as it is natural resource dependent. As such, a "one size" approach is neither feasible nor appropriate, given current scientific understanding, to manage liability in an environmentally and economically sustainable manner.

Discussion:
The economic and environmental suitability / viability of a particular site for CCS is completely dependent upon the individual geologic characteristics of the site and how those characteristics will interact with the gas stream intended for injection. **As such, proper site selection and proper site operations management are critical to the creation and stewardship of economically and environmentally sustainable CCS.** The key is to find both an acceptable site and to design operations in such a way so as to minimize the potential for leakage or loss to the greatest extent possible, given environmental consequences and costs of impacts. Only when the risk of both an event and consequences of the event are managed can one proceed to responsibly manage the liability. In other words, in the case of CCS, site risks must be technically managed to a residual environmental risk status, for both near term and long term events, and then the residual liability can be managed through an

economically sustainable system using first and third party methods (e.g., insurance, trust funds, surety, self-insurance through a corporate financial test, etc.) for operational, closure, and post-closure periods, and then some type of governmental assumption of responsibility may be required after post-closure.

The risk assessment must consider (1) possible events; (2) likely frequency of such events; and (3) consequences of such events, where such consequences could impact one or more types or numbers of private assets, persons, natural resources or public goods. (1) and (2) determine the frequency of the liability that must be managed, while (3) determines the potential severity of such events if they were to manifest. To make deployment of CCS viable, the key will be to reduce the actual number of (1) possible events that could ever occur at any site – which is primarily done by site selection, but pre-treatment and other operational criteria may also impact frequency; and to (2) minimize the potential frequency of any such events – which can be accomplished primarily by specifying operational criteria; (3) by reducing the severity potential – which can be done either through site selection (e.g., eliminate very risky sites with lots of impact potential) or through loss mitigation and emergency response criteria.

To accomplish desired liability management, risks must be assessed and managed from a technical perspective which considers temporal characteristics. Why? Because both technical and financial risks can change over time – and the party bearing the responsibility for risk may change over time.

Because CCS is wholly dependent upon characteristics of a natural resource, that is the subsurface geology, like other natural resources (e.g., oil extraction), some will be easier and less costly to manage (extract in the oil analogy), while others might be very costly and present challenging safety and environment conditions (e.g., deep sea drilling), while others may simply not be feasible given current science, technology and costs structures.

No amount of insurance, indemnity, or other financial tool can make an unsuitable site good. In fact, financial instruments without proper underwriting will send a distorted price signal and pool for or accrue for the anticipated costs of the consequence of a failure or an insured

event. To properly manage the risk and associated liability, the key is to use underwriting criteria as a method for both managing (controlling) the actual risk itself and pricing that acceptably managed risk. Insurers are motivated to assure that proper risk assessment and pricing occurs, up to their exposed limit of assumed liability, because they bear the costs of insured loss.

Permitting is inherently a political government function, and as such, permitting entities do not bear the ultimate cost of risk, even if other parts of government may ultimately bear some of the consequential costs – the cost bearers are not often linked to the permit issuers. Even if the permitting entity can issue fines or have other enforcement powers, the incentives for government are different from those of the private sector. Further, if governmental indemnity is injected into the risk management system, the government indemnity both interferes with underwriting, because it disincentivizes underwriting, and also sends a zero dollar price signal for the risk, causing a disconnect between the creation of risk and the cost of risk.

In some cases, the geology may simply be unsuitable for any type of CCS injection due to geologic instability or mineral characteristics for environmental reasons.

In other cases, a site may be well suited for a particular type of gas stream injection at a specific rate and volume, but not for others. For example, in such a case if the gas stream were changed in its make-up (e.g., to have variable co-contaminants due to coal feedstock flow changes), then the consequential geochemistry (subsurface chemistry) might make the site unsuitable because of increased risk of leakage or because of increased consequence of such leakage (e.g., if the gas leaked into groundwater, no remedial action would be feasible). In this second type of case, a site acceptable only under limited conditions, pre-treatment of the gas might be required prior to injection. Obviously, pre-treatment will increase costs up front, but will in some cases substantially reduce the environmental risk – both the risk of leakage and the consequence thereof, that is the overall liability.

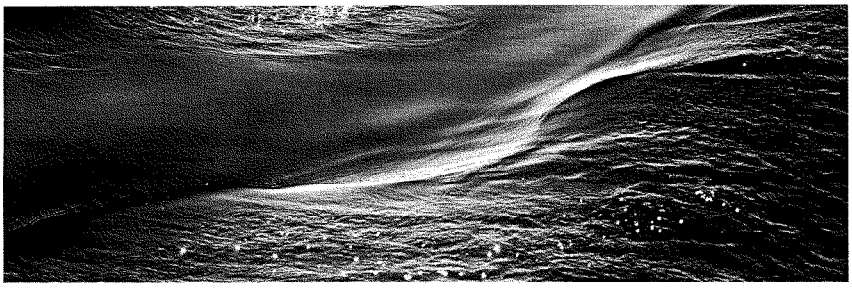
In sum, liability must be managed through careful site selection, permitting, and operational management using a liability framework which recognizes and requires integration of environmental externalities

(risk of loss and damage to the environment) directly into the business model of the operator, at least through the operational phase, including closure and post-closure obligations.

Attachments
EBR Article 1
EBR Article 2
WCCR Article

Beyond Rising Sea Levels: *Using the Insurance Asset to Manage Risk and Maximize Opportunity in the "Green" Economic Paradigm Shift*

By Lindene Patton, Chief Climate Product Officer, Zurich



The Green Paradigm Shift:

Climate change is causing much more than just rising sea levels. Climate change is changing the way we power a society that depends more heavily on power everyday; the way we transport ourselves; how we evaluate where we live and work; the way we interact with the environment; and the risk to which we are exposed in both our personal lives and in our businesses[1]. In other words, climate change is causing an inexorable change in the way we live, work and play by adding a new dimension of risk to our already complex environment. We need to re-think the ways we manage risk and leverage our assets to respond to these changes – including insurance.

Climate change has already begun to cause global changes in public policy, consumer demand, technology and other stakeholder demands, forcing businesses to become more ecologically and climate focused. The Kyoto protocol, the European Union Environmental Liability Directive, the California Global Warming Solution Act and Greenhouse Gases Emissions Performance Standard for Baseload Electrical Generating Resources are merely a select few of many such public policy actions. The physical reality of climate change is causing what looks to be a macro-economic shift and consequential micro-economic changes around the globe affecting a multitude of industries and business sectors.

Climate change creates both risk and opportunity. Business leaders are paying attention but not all are taking action[2]. Some see property risks; some see liability risks; some see opportunities for economic gain. To take advantage of the opportunities and respond to risk attendant to climate change, certain sectors of the economy must adapt or reinvent their business models. Proper enterprise risk management dictates a re-evaluation of existing risk management tools in response to this "green" paradigm shift. Insurance is one of those tools that can be used to both achieve competitive advantage and corporate social responsibility – if properly leveraged.

Insurance is an integral, if often overlooked, cornerstone of our lives that enables all of us to manage risk – and is an asset which we must leverage to the maximum extent to mitigate and manage the risks of climate change. The insurance asset is not merely a financial one: insurance is an industry which thrives on risk and which possesses the intellectual capital to do so.

The purpose of this article and its companion[3] is to explore the use of insurance as a risk management tool in helping businesses and public policy makers adapt to the reality of climate change and attendant business model and risk profile changes.

[1] A recent European example of the far-ranging risks associated with climate change is the reported migration of exotic and deadly communicable diseases into Italy as disease-carrying insect populations historically unknown there are enabled by climate shifts to move northward.

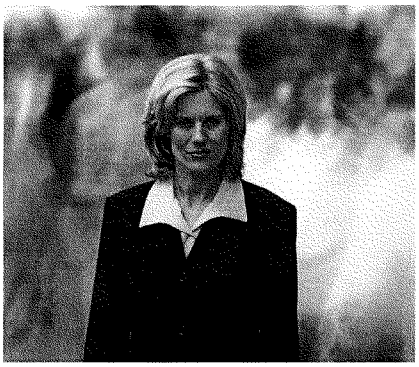
[2] "How companies think about global climate change: a McKinsey Global Survey, February 2008.

[3] This is the first of two articles designed to address the use of insurance as a means to manage risk and maximize opportunity in a changing climate. A companion article which focuses on specific applications of insurance will follow in EBR's next issue.

The Impact to Business and People and the Insurance Asset:
Business depends upon stability[4] to attract investment capital; individuals depend upon financial and other predictabilities to go about living their lives. Risks, such as those posed by climate change, must be addressed on an enterprise basis to assure investor and consumer confidence for business and on a specific risk basis to address individual needs. Insurance is one of the most common tools applied to address risk and assure stability in the face of fortuity.

Some look at climate change and see property risk; others see liability; still others see pure economic gain and loss potential. In fact, each perspective is correct. However, all of the risks described and more arise out of climate change. As such a suite of risks must be managed to address new and exacerbated risks created by climate change and our societal response to that change.

Today, a variety of operational risk management techniques are used to address systematic risks. Such tools are being developed and modified across industries as our understanding of climate change evolves and improves. Insurance is one of the key risk management tools used to manage non-systematic risk, e.g. fortuitous risks, reasonable system exceedences and other residual risks. When business models and public policies change, so must the risk management tools and solutions which support the affected businesses and individuals, including insurance.



The Unique Insurance Asset – Financial Tool and Intellectual Property Repository:
Like other businesses operating in today's environment, insurers must evaluate changes to their own risk profiles arising out of climate change. Insurance must also examine how its core business can respond effectively to the environmental and social challenges presented by climate change. What is unique to insurance and other financial services industries is that their risk profiles are affected by the risk profiles of their customers. Further, with respect to insurance, risk is their core business. As such, insurers find themselves in a unique position. The proper use of technology and underwriting can be combined to better match risk and price, mitigating climate risk to the extent that price is sensitive to such risk[5]. Properly designed insurance products can also be adapted and created to facilitate public policy goals designed to create or confirm a value for a "public good" of common ownership – such as those aimed at reducing carbon emissions and controlling ecological damage. Insurers collect, manage and analyze vast quantities of data. Insurers possess the know-how to understand the complex business structures of a multitude of industries and their interactive effects, as well as the multiple effects of public policy and societal shifts on those industries impacted by the physical realties of climate change and public policy regulation of conditions deemed by such policy to be related to climate change.

Unfortunately, only hindsight is 20/20, and insurers did not always collect data in a manner which systematically anticipated the effects of climate change. The essential raw data, however, often exists. That gold mine of data can be tapped and interpreted using the vast amount of professional experience in the industry to develop unique risk management solutions to assist its stakeholders to adapt to the effects of climate change. But this raises one of the key problems of developing sound climate change policy: various stakeholders too often look to insurance as the residual risk manager, after all their business models or public policies have been developed and public policy has been implemented. This lessens insurers' incentives to participate in solving climate change issues by identifying and quantifying new risks in ways designed to set price signals which public policy makers and businesses can use to determine whether insurance or other risk mitigation techniques are the most efficient solution to lessen the risks posed by the effects of climate change. Insurance should instead be viewed as an integral business and societal partner in the development of public policy and business solutions designed to mitigate climate risk in the most efficient manner by providing accurate risk pricing signals, not just to respond by compensating for the damage climate change has caused. While insurance cannot ever substitute for leadership on public policy, insurers can certainly serve by meeting their corporate responsibilities and also serve their stakeholders by participating in partnerships in which the insurance asset is used to maximize shareholder value – which should in turn mitigate climate risk to the extent pricing signals are functioning with respect to this "public good".

[4]Stability with respect to conditions that impact the specific business model. Such conditions of importance could be political, financial, social and / or legal.
[5]The challenge created by climate change is that the "asset" at issue is a natural or ecological resource (e.g., the stability of the global climate) and, as such, is a "public good" with common ownership rather than a private asset. Economic theory is often challenged when applied to the pricing of a "public good" or "global resource" of common ownership. Typical pricing indicators may not be reliable with respect to such assets. Therefore, some are motivated to set public policy that creates a price either directly or indirectly through regulation.

What Insurance Can Do – Facilitate Public Policy and Responsive Business Models:
Properly designed risk management solutions can facilitate public policy goals designed to reduce the effects of climate change as well as facilitate market entrance and sustainability for a business directed at achieving these same public policy goals by increasing investor confidence with respect to disaster planning and other risk exposures; and mitigating actual business interruption and other consequential risks attendant to climate change[6,7]. Certain risk management tools can both facilitate the implementation of new business models and execution of specified policy goals. As such, insurance is both an essential advisor and partner in helping its customers and stakeholders take advantage of the opportunities presented by and mitigate the risks of climate change.

I. The "Green Business" Frontier: How Climate Change is Changing Consumer Behavior, Business Models, Expectations and Risk Finance

The Changing Physical and Business Climate:
People and businesses can expect that climate change will have a substantial impact on all aspects of their lives. Leading scientists[8] tell us that **over the past 100 years:**

- Average mean global temperature has increased by 0.74°C
- Average sea level has risen by 0.17m
- Artic sea ice has melted by 8 percent since 1978
- Green house gas concentration has increased by more than 30 percent since 1750
- The frequency and severity of weather events has increased.
- Population patterns have changed, increasing concentrations at coastlines and rivers edge.

Over the next 100 years these same scientists expect:

- Global surface temperatures are projected to increase by 1.4-5.8°C
- Average sea level is predicted to rise by 0.18-0.59m
- Artic sea ice is projected to melt entirely during summer months
- Hot extremes (heat waves) and heavy rain events are predicted to be more frequent
- Intensity of tropical cyclones is projected to increase
- Weather patterns are predicted to become more volatile

The physical conditions listed above all create new and exacerbated risks in our lives and businesses. As noted above, these risks can also include risks to human health as communicable disease vectors alter. Insurance provides risk solutions for the fortuitous risks such as those listed above. However, when the frequency or likelihood of such an event is determined solely by actions which are under the direct control of the insured, fortuity is lost and insurance is ill-equipped to transfer, mitigate and manage such risks. As such, insurance must work hand-in-hand with good public policy makers and stakeholders to avoid this limitation in order to drive a suite of risk management solutions to manage the climate change risk.

[6]Examples of products that are both good business and facilitate public policy goals to reduce GHG emissions, include pay-as-you-go car insurance. Pay-as-you-go car insurance is predicated on historical loss experience which indicates that miles driven is one of the key indicators of risk, and thus drives pricing. The pay-as-you-go car insurance structure should result in lower customer costs for fewer miles driven. As such, customers should be encouraged to drive only when necessary because they will save money by eliminating unnecessary trips; fewer trips and fewer miles driven should translate into GHG emission reductions.

[7]An example of unique business risks associated with new business opportunity created by climate change in which insurance can play a facilitating role involves the creation and development of "green(er)" and "clean(er)" power technologies and business models, including wind, solar, geothermal, biomass and other emerging technologies. Concerns related to the predictability of these business model risks abound. These risks can include a legal system which does not recognize ownership rights to the "source" of the power or which does not recognize the necessary rights for storage – because the legal systems currently only address right derivative or attendant to fossil fuel driven programs, such as mineral rights. However, insurance underwriting experience from analogous exposures is being applied to extend and adapt insurance products to respond to these new and improved technologies to accept risk that would otherwise restrict development of or the operational stability and sustainability of these "green(er)" and "clean(er)" power sources.

[8]IPCC 2007. It is not the author's intention to endorse IPCC's scientific analysis, but it is to suggest that prudent businesses will take the data and predictions very seriously.

However, focusing merely on the physical risks misses a host of risks created by public policy and societal changes driven by climate change. As noted, much of our legal systems in respect to natural resource rights assume that fossil fuels, certain foodstuffs, water and a modest amount of ecologic diversity is essential. Much of the law is silent with respect to rights associated with ownership, access and use of natural resources essential to some alternative energy and "clean(er)" energy business models. Regulatory schemes focused on business regulation and consumer protection are similarly designed around business models driven by our current energy and transportation economic structure and models. As such, there are regulatory uncertainties surrounding issues such as advertising claims. What will a regulator agree is truly "recycled" or "environmentally friendly" or "sustainable" and what claims will the regulator decide are tantamount to deceptive and false advertising – creating other tort liability? The aforementioned are but a few of the potentially unaddressed liability issues impacting the willingness of business to invest in and develop climate friendly activities. Uncertainty with respect to these natural resource rights and other legal system dynamics can result in new tort exposures and other uncertainties. Insurance can be used to mitigate these new liabilities, as well as making it possible for people and businesses to engage in activities desired by the public policy and consumer shifts. In other words, insurance, through proper matching of price and risk associated with climate change, can be used to encourage activities that reduce GHG emission,thereby reducing the risks of climate change and improving ecological stability.

Effects on Energy Technology

In light of the fact that many sovereigns and multi-lateral organizations have imposed carbon constraints and ecological standards under their law and / or in their contracts, the availability of insurance to manage risks for the new business models which are needed to comply with these new laws and expectations is essential. Further, carbon limits may well require the creation and development of "green(er)" and "clean(er)" power technologies and related business models, including wind, solar, geothermal, biomass and other emerging technologies. Concerns related to the predictability of business model risks for these technologies abound. However, insurance underwriting experience from analogous exposures is being applied to extend and adapt insurance products to respond to these new and improved technologies to accept risk that would otherwise restrict development of, or the operational stability and sustainability of, these "green(er)" and "clean(er)" power sources As such, insurance is available for all types of alternative power generation and for many modifications necessary to make fossil fuel power generation more climate friendly. But, if a company currently operating in a fossil fuel environment simply extends their business model without a deep review of its existing insurance structures to assure adaptation, unfortunate gaps in coverage are possible on a wide variety of fronts – business interruption, supply chain management, advertising exposure – just to name a few. Given that International Energy Agency (IEA) scientists tell us that to cut global GHG emissions in half by 2050[9] we should focus on restructuring our approach to power, perhaps with the following recipe[10], we need to assure that our risk management tools contemplate these businesses and their unique risks:

- Start with 30 new nuclear power plants around the world;
- Add 17,000 wind turbines, 400 biomass power plants, two hydroelectric dams the size of China's Three Gorges Dam, and 42 coal or natural-gas power plants using CCS technology;
- Build everything by 2013; and
- Repeat every year until 2030.

Basic Property and Casualty Coverages:

Traditional energy insurance operations focus on fossil fuel driven activities: exploration, production, transportation, generation and transmission. When new business types are implemented, such as solar or wind power, unique and new supply chain challenges are presented. These new underwriting exposures must be evaluated and changes to insurance policies may be required to respond to the unique damage potential created by these alternative energy sources, technologies and delivery systems. Both first and third party damages in these environments are different from those of the fossil fuel chain.

Business Interruption Extensions and Complex Claims Consequences:

The supply chain risks for the new business models are exacerbated when catastrophic weather events (anticipated to increase in frequency with climate change) occur because such events cause surge demand on the supply chains. The resultant business interruption risk is heightened. Developing unique insurance products which mitigate the demand surge risk is critical. Further, when carbon constraints are added to the mix, the shutdown of a "green(er)" power source may mean that the only way to run the business will be to use not so "clean" power, resulting in an additional exposure to requirements to purchase offsets if the insureds' allowances have been exceeded.

The above discussions are narrow and are limited to the fossil fuels chain, but the same types of discussions can be had for building materials, essential goods supplies – water and food chains, and the like – because each of those industries is affected by climate change, as are their customers and stakeholders.

[9]The need to cut GHG emissions in half by 2050 was articulated and posited as a "tipping point that could lead to intolerable impacts on human well-being…", by "Confronting Climate Change: Avoiding the Unmanageable and Managing the Unavoidable", United Nations Foundation, Sigma Xi, the Scientific Research Society report February 2007; see www.unfoundation.org/files/pdf/2007/SEG_ExecSumm.pdf http://www.usatoday.com/tech/science/2007-02-27-global-warming_x.htm and http://www.theaustralian.news.com.au/story/0,20867,21102081-601,00.html. It is not the author's intention to endorse these scientific analyses, but it is to suggest that prudent businesses will take the data and predictions very seriously.

[10]International Energy Agency, as reported by the Los Angeles Times 12/13/07. It is not the author's intention to endorse these scientific analyses, but it is to suggest that prudent businesses will take the data and predictions very seriously.

Energy Efficiency Opportunity, Risk and Insurance:
Other scientists suggest that if we are to reduce the risks of climate change, we must become more efficient in the use of what we have. To that end, products which use electricity must be reconfigured to be more efficient and / or innovative new products developed which achieve the same desired performance characteristic in an alternate way (much like alternative energy is to fossil fuel power). Underwriting insurance for existing products which have efficiency characteristics will require adjustment to risk analyses and underwriting criteria, but in an adaptive form. Thus, the extension of insurance underwriting to adapted products should be a predictable exercise, unless extreme loss potential arises from the adaptation. By contrast, underwriting innovative or new products requires the underwriter to become familiar with the new product's characteristics when it functions properly and its failure characteristics and frequency. That said, analogies are often possible based upon insurance industry experience with other risks – and such analogies are being used today to provide insurance to these new and more efficient technologies.

Transportation and Insurance:
Others note we need to change the way we transport ourselves; and either where we live or how we live in that location. Insurance can be applied in this context to facilitate public policy goals, too. Insurance for hybrid cars has been available for many years[11].

Summary
Thus, to continue to live the way we desire and mitigate climate risk, we must explore the best ways to change the way we power ourselves, transport ourselves and house ourselves. We may also need to consider how to best evaluate new ways to protect our foodstuffs, including our water; our health and our environment.

The Point:
To mitigate risks posed by climate change – all means are required…there is no silver bullet …

The Concern:
The actual work is beyond what today's technology and policy can achieve.

The Risk Management Climate Challenge:
Devising appropriate risk management tools that will assist stakeholders to adapt to the fact of climate change and to succeed in harnessing the opportunities climate change presents a challenge, but a challenge that falls squarely within the comfort zone of qualified insurers.

The Path and Insurance:
To change the way society powers itself, transports itself and protects its assets from the physical realities of climate change, new business models and technologies must be developed, tested and deployed. Each of these activities creates new risks and new natural advantages.

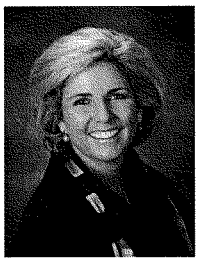
In the energy area, clean(er) power may depend upon certain natural assets – sun, wind, rain and steam. In the transportation area, the feasibility of fleet conversion depends upon current electrical supply systems or other biomass management needs and structures.

As we try to implement the changes, public policy makers, businesses and their stakeholders are quickly finding that our social and economic systems are quite interdependent and that each change to reduce climate and ecological risk involves a choice -- generally a very hard economic choice that necessarily requires tradeoffs. There is no "free lunch" in climate change.

[11]Farmers Insurance has offered a hybrid car discount since 2005 and offers such coverage in 37 states in the United States. Many European insurers offer motor coverage tailored to hybrid and other flex fuel or alternative fuel vehicle. See **Ceres: 'From Risk to Opportunity: 2007 – Insurer Responses to Climate Change'**October 2007. Source: http://www.ceres.org/pub/docs/Risk-to-Opportunity-2007.pdf

To date we have seen pursuit of the "low hanging fruit" -- wind power, some efficiency oriented consumer products and the like. But to make our next ecological advances to reduce climate risk, we must now look to the harder activities, and we must make equally hard decisions. Included in the list are choices for approaches to clean(er) coal technologies such as Integrated Gasification Combined Cycle ("IGCC") generation and Carbon Capture and Sequestration (CCS), off-grid power generation and storage, transportation options and controls, new communication technologies, and the list goes on. But nothing on the list is free and most of the list contains products and services that cost more than those which perform, albeit in an unsustainable manner, the same function today.

Part of the hesitancy to move forward is the economic "price" placed on certain risks that can be born most efficiently by the insurance industry, rather than be engineered out to a zero risk of occurrence value. In other words, the public dialogue to date has focused on the technology and has not yet focused on the business and risk models in a disciplined way because not all the correct stakeholders are at the table. And the cost to engineer out the occurrence potential for a specific risk is quite high in many cases in return for little economic or social value. To determine which risks can be most efficiently assumed and managed by insurance to facilitate achieving the next level of climate risk management, a multi-disciplinary dialogue must proceed. Engineers, economists, underwriters, lawyers and public policy professionals must figure out how to speak the same language to define what risks each party can bear and then move onto the business of reducing climate risk. A very public example of this dialogue is being played out with respect to IGCC and CCS. However, actually implementing the theory of multi-disciplinary dialogue is encountering the reality of inconsistent public policy, competitive forces associated with natural asset advantage and unequal information and knowledge distribution -- exposing the great challenges we face in determining how to best address specific stakeholder's needs and get to the goal of climate risk mitigation[12]. But that dialogue, and many others going on in much smaller venues involving risks and liabilities perceived to be of a lesser magnitude with respect to "greener" technologies, is proceeding every day and insurance knowledge and tools are being used to manage much of that new risk in each case. To get to this next step, we all must focus on and articulate what risks exist and determine how to best manage same with insurance and other enterprise risk management tools.



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She is an advisory board member for the University of California at Santa Barbara's Bren School of Environmental Science and Management. Patton also serves on numerous government and non-governmental advisory boards, including the U.S. Environmental Protection Agency (EPA) Environmental Financial Advisory Board, the Bureau of National Affairs' monthly publication, the Environmental Due Diligence Guide, and the Environmental Technology Verification Program.

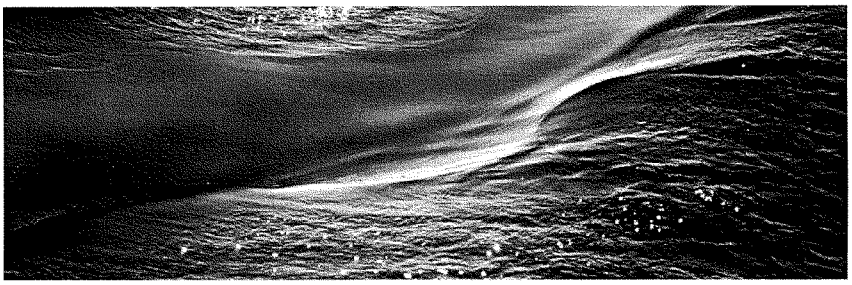
Patton is an attorney licensed in California and the District of Columbia and an American Board of Industrial Hygiene Certified Industrial Hygienist. She holds a Bachelor of Science in biochemistry from the University of California, Davis, a Master of Public Health from the University of California, Berkeley, and a Juris Doctor from Santa Clara University School of Law.

[12]The dialogue with respect to IGCC and CCS has focused on the physical and tort liability risks associated therewith as part of an overall dialogue regarding the financial risks associated with developing and implementing IGCC and CCS. So far in the process, we have learned that CCS is not appropriately addressed as a monolithic risk. In fact, the actual geologic structure of choice for sequestration may have a huge impact on the willingness of the insurance industry to assume liability for damages. Because some types of geologic structures have a long-standing history of being able to retain gases in a stable manner, such structures may be immediately insurable, where other underwriting criteria are satisfied. The insurance industry has a long history of insuring enhanced oil recovery (EOR) activities to which both technology and geological / physical asset analogies can be drawn for risk-profiling purposes. By contrast, other types of geologic structures may not have -- at least the data is not publicly available at this time -- the history of successful operation as a sequestration structure. Consequently, while the engineers may have considered both processes as CCS, the underwriters do not. The implications for insurance availability and natural advantage based upon physical asset ownership could be significant in determining the feasibility of the further development and implementation of the CCS technologies. The availability of insurance and other risk management tools for both short-term and long-term liability for CCS is critical to the determination of the willingness of stakeholders to support development and implementation of this technology as a climate risk mitigation tool.

Beyond Rising Sea Levels

The Importance of the Insurance Asset in the Process of Accelerating Delivery of New Technology to Market to Combat Climate Change

By Lindene Patton, Chief Climate Product Officer, Zurich



Climate Change Challenge – Insurance and New Technology

Climate change is causing much more than just rising sea levels. As noted in the companion to this article[1], climate change is changing the way we power a society that depends more heavily on power everyday; the way we transport ourselves; how we evaluate where we live and work; the way we interact with the environment; and the risk to which we are exposed in both our personal lives and in our businesses.[2] New and emerging technologies will support how we, as a society, adapt to much of this change.

Climate change adds a new dimension of risk to our already complex environment. Many experts suggest that new technology will be essential to the ability of humankind for adapting to climate change.[3] However, much of this technology has limited tenure and limited testing. In other words, the technology itself presents unique risks – including risks which the insurance industry is uniquely suited to evaluate, price and manage. To successfully adapt to climate change, we must reconsider the ways we manage risk, especially new technology risk, and leverage our capabilities – including insurance – to respond to these changes.

Risk management is the core competency of the insurance business. Insurers are experts in financing and hedging risk; the insurance sector is conditioned to anticipate the unexpected. In so doing, insurers deal with real events and their expected probabilities and frequencies. They have the professional resources and capacities to evaluate physical, technical, operational, legal, financial and other business risks, because they do so every day as part of the underwriting and risk management

[1] "Beyond Rising Sea Levels: Using the Insurance Asset to Manage Risk and Maximize Opportunity in the "Green" Economic Paradigm Shift," by Lindene Patton, European Business Review March / April 2008.

[2] A recent European example of the far-ranging risks associated with climate change is the reported migration of exotic and deadly communicable diseases into Italy as disease-carrying insect populations historically unknown there are enabled by climate shifts to move northward.

[3] Stern Review Final Report: The Economics of Climate Change. http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/stern_review_report.cfm; CERES 'From Risk to Opportunity: 2007 – Insurer Responses to Climate Change'October 2007. Source: http://www.ceres.org/pub/docs/Risk-to-Opportunity-2007.pdf, IPCC 2007. It is not the author's intention to endorse Stern's economic analysis, CERES' assessment of insurer response or IPCC's scientific analysis, but to suggest that prudent businesses will take the data and predictions very seriously.

process.

Insurance is best used as a preventative risk management tool. Yet many stakeholders tend to focus on insurance only in reaction to events that have occurred and resulted in conditions that exceed societal abilities to manage e.g., Hurricane Katrina and flood insurance, the anthrax scare and bioterrorism insurance, Enron and D&O warranties, etc. Such events may be infrequent and may not affect individuals directly – but in the aggregate, the frequency and severity can be substantial.[4] When such events occur is the point-in-time when an insured needs coverage, and when insurance must deliver. The application of insurance in general, and the inclusion of appropriately qualified insurers with necessary specialty skills, only on an ex post (after-the-fact) basis, tend to result in market distortions and adverse policy decisions. Insurance should be included in the public policy dialogue at the outset as part of the multidisciplinary group evaluating the risk and sustainability of policy choices designed to ensure an economically efficient recourse on climate change technologies. These policies must appropriately weigh costs and benefits within a comprehensive framework that accounts for economic and financial market implications, as well as the welfare of societies.[5]

While often taken for granted, insurance is the tool upon which business and individuals implicitly rely to mitigate their risk exposures. Insurance is an important economic shock absorber.

Insurance has a unique role to play in mitigating the risks of climate change. Insurers, like nowhere else in the public or private sector, have the data and professional skills necessary to evaluate and price risk. Insurers have the ability to help stakeholders navigate the unknown – areas of low-frequency but high-severity risks, such as those posed by climate change e.g., naturally occurring events (hurricane, flood, wildfire) potentially aggravated by human activity. Moreover, insurers have the ability to send price signals that inform policyholders and investors about the opportunity when the likely risk occurrence of a particular event is so high as to make other actions – such as change of building codes, land use restrictions or operational controls, in combination with or in lieu of pure risk transfer insurance – the most cost effective and economically viable solutions.

Insurers have a history of success in providing data to support the prove up of the appropriate use and deployment of life-saving, life-enhancing and environmentally protective technologies.[6] Climate change presents the same opportunity to leverage the insurance industry's capabilities, especially in the deployment of new technologies. **To ignore price signals sent by the insurance industry is to risk deployment of unsustainable or inefficient technologies in an effort to adapt to climate change.**

This article will discuss the current public dialogue with respect to the need for new technology to adapt to climate change, articulate the role of insurance in the process to improve efficacy and efficiency, and distill an underwriter's approach to, or considerations in evaluation of such technologies. Specific examples of an underwriter's approach to the insurability analysis for such new technologies will also be provided.

Current Public Dialogue About New Technology and Climate Change

The Need

The current public dialogue about climate change emphasizes the importance of getting new technology deployed to reduce greenhouse gas (GHG) emissions. The Stern final report[7], the Intergovernmental Panel on Climate Change report[8], the Electric Power Research Institute[9] and the International Energy Agency[10] all identify the importance of new technology in meeting the climate change challenge of bringing the Earth back from the "tipping point."[11]

[4] Insurance Information Institution states incurred losses for the P/C industry of $275 billion on average and $2.2 trillion in aggregate from 2000-2007, see "A Firm Foundation: The Insurance Industry and Its Contribution to Society" presented at St. Johns University, New York, New York, April 10, 2008..

[5] "Beyond Rising Sea Levels: Using the Insurance Asset to Manage Risk and Maximize Opportunity in the "Green" Economic Paradigm Shift", European Business Review March / April 2008.

[6] The Hotel Motel Fire Safety Act is fine example of how insurance and insurance premiums can play a critical role in advancing public policy, in this case improving public safety. Hotel and motel owners who installed sprinklers in response to the aforementioned law realized a savings in insurance premiums that fully offset the cost of installing sprinklers. The installation of sprinklers ultimately saves lives and money for the insured. Further, the insurance industry has developed products to insure a wide variety of environmental remediation technologies, and as environmental financial assurance pursuant to 40 C.F.R. § 264.140-146 (2007). Many other examples exist.

[7] http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/stern_review_report.cfm
It is not the author's intention to endorse Stern's economic analysis, but to suggest that prudent businesses will take the data and predictions very seriously.

[8] IPCC 2007. It is not the author's intention to endorse IPCC's scientific analysis, but to suggest that prudent businesses will take the data and predictions very seriously.

[9] "The Power to Reduce CO2 Emissions: The Full Portfolio", discussion paper prepared for the EPRI 2007 Summer Seminar Series, prepared by Evan Mill, Ph.D. for the EPRI Energy Technology Assessment Center.

[10] Statement to the 13th Conference of Parties to the UNFCCC, Mr. Nobuo Tanaka, Executive Director, International Energy Agency, December 2007.

[11] The need to cut GHG emissions in half by 2050 was articulated and posited as a "tipping point that could lead to intolerable impacts on human well-being…." by a "Confronting Climate Change: Avoiding the Unmanageable and Managing the Unavoidable," United Nations Foundation, Sigma Xi, the Scientific Research Society report. February 2007; see www.unfoundation.org/files/pdf/2007/SEG_ExecSumm.pdf http://www.usatoday.com/tech/science/2007-02-27-global-warming_x.htm and http://www.theaustralian.news.com.au/story/0,20867,21102081-601,00.html. It is not the author's intention to endorse these scientific analyses, but to suggest that prudent businesses will take the data and predictions very seriously.

The Risks

The public dialogue about risks of new technology tends to be superficial – overly simplistic and lacking in specificity. To assure efficiency and sustainability, the dialogue about the risks associated with new technologies must be improved and conducted at a more granular level. Only when sufficient granularity in the discussion of risks related to each new technology is achieved can appropriate risk management solutions and appropriate public policies (where necessary) be devised. Risks must be identified, categorized and analyzed with respect to the cause of loss in developing economically efficient solutions that are also reasonable, responsible and responsive.

If risk is not appropriately characterized, inappropriate policy solutions result, which ignore relevant market forces, create the potential for long-term dependency, foster economic inefficiency and aggravate the risk of environmental harm – all of which are unsustainable conditions. A possible framework for approaching such analyses might be to categorize risks by the damages which emerge if such events were to manifest:

1. Third-party bodily injury
2. Third-party property damage
3. First-party property damage
4. First-party economic loss

However, such a framework tends to be overly legal and not easily translated or linked to reality in terms of operational activities, experiential data or risk mitigation options. An alternate approach might be to organize risks with respect to operational activities:

1. Design risks
2. Supply-chain risks
3. Performance failure
4. Operational exceedances and failures
5. Operational interruptions (first-party property damages due to fire, wind, flood, earthquake and the like)
6. Financing risk / investment risk
7. Credit risk
8. Counter-party risk
9. Cross-border political risk
10. Regulatory / in country political risk

The above approach focuses on the operational aspects of risk but not on the cause of loss. Yet another approach to risk analysis might be to identify the exposed assets and the risk of loss. In fact, there are a multitude of options for approaching risk analysis, many of which are beyond the scope of this article.
Many approaches to risk analysis are possible. The key is to assure that the appropriate analysis is used for the technology under discussion, and the analysis itself is comprehensive and granular. Only when risks are parsed and defined appropriately can one determine what mechanisms are most effective and economically efficient to manage such risks. In the specific case of climate change, an objective of risk analysis should be to inform the policy debate and promote appropriate, sustainable technologies to reduce GHG emissions.

Insurability Analysis: Underwriting of New Technology

Many risks can be insured, for a price. At issue, however, is whether all risks warrant insurance. Sustainability dictates that the use of insurance as a risk management technique must be weighed carefully. Insurers should be careful not to assume risks aggravated by moral hazard (the incentive to act in a manner that created a risk of loss to gain the insured benefit or failure to act in a manner to mitigate such risk to gain the insured benefit).[12] As an example, one generally cannot insure a building for more than its value – as doing so may create the potential for the insured to gain as the result of a total loss and puts in place a moral hazard.

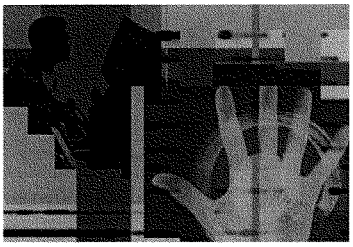
Proper risk analysis must focus on all relevant conditions – including activities under the control of the potential insured – as well as those externalities that are immutable and those imposed by the rule of law or the marketplace. As such, proper risk analysis of a new technology focuses not just on the technology itself, but upon the environmental and societal system into which it will be deployed.

[12] The insurance policy should not be structured in a manner such that the insured is in a better position in the event of loss than the insured would have been in the absence of loss, especially where the insured is in control of activities and conditions that could mitigate the risk of loss.

Issues of feasibility range from concept to execution – from the overall business plan, financing and pro forma cash flow to the dependence upon subsidies, any applicable regulatory environment and market analysis. Collectively, these considerations underpin the functionality of and life-cycle issues attendant to the technology itself.

Technology Risk

An underwriter will look to the fundamentals of the technology itself when undertaking risk analysis. Technical specialists are assigned (such as engineers, geologists, chemists or the like) to develop an understanding of the technology's functionality and its potential failure points.



The underwriter will ask for testing and performance data, including the conditions of performance – especially scale. In the area of technology, scalability presents substantial risk for many reasons, including – but not limited to – basic theory extensions, specific chemical or physical behavioral changes associated with volume or environmental factors (such as temperature or humidity) and supply-chain risks, to name a few.

Consideration must be given to what will happen if the technology does not perform as expected. Questions to consider include:

- Who might be injured or damaged if a performance failure occurs?
- What could be done to mitigate that injury or damage?
- What if the technology is used for an activity differing from its intended purpose?
- Is such an alternate use likely?
- Does the alternate use create risk – more or less risk than its originally intended purpose?
- Is there a warning against such use?

And, ultimately, with respect to the analysis of this technology in isolation, does the underwriter believe it is sufficiently reliable to put capital at risk on the technology? Specifically, are the risks associated with the technology truly fortuitous? Have reasonable risk mitigants been integrated within the technology process (including areas as simple as having sufficient cash flow to make adjustments in the technology to respond to local conditions or induced-performance issues), or are the risks associated with the technology and its performance so significant that the risks attendant therewith are, in fact, not fortuitous – but rather are certain.

Representation: Advertising and Warranty Risks

After the underwriter has a fundamental understanding of the technology, consideration must be given to the relationship between the technology and associated representations and warranties – to determine what part, if any, of that risk may be insured. Generally, warranty risks remain with the business,[13] while risks of advertising injury or misrepresentation may be insured to one degree or another. That said, risk transfer insurance is designed to respond to fortuitous events, not to known losses. As such, if the representations or warranties are overzealous or inconsistent with what the underwriter understands to be true about the technology or believes such verities are inconsistent, the underwriter will decline to insure the risk.

Supply Chain / Capacity and Surge Demand Concerns

The underwriter also must consider risks that could interrupt production and delivery – commonly referred to as business interruption – to the degree such risks are assumed by the insurance contract. In addition, the supply-chain risk may also manifest in a claim circumstance, when the new technology must be repaired or replaced after a policy-triggering event (such as a fire or storm).

The underwriter must look at the sales plan and the capacity of those in the supply chain and repair chain to determine what is possible under various scenarios. Key questions to be considered include:

- How can the technology be repaired?
- How many suppliers exist?
- How many pieces could be repaired or delivered new in the event of a catastrophic storm event?
- Can the insurer rely on the existing chain? Is any redundancy built in?
- Do special steps need to be addressed in the process of the applicant business or persons or by the insurer to mitigate this risk?
- To make the technology supply-chain risk worthy, what expense will be required and by whom should it be incurred?
- Is such mitigation possible with sufficient certainty to argue for putting capital at risk for this technology by the insurer?

[13] Warranties are generally contractual liabilities. Limited warranties provide specified remedies in the event of failure. Performance failure, which is the most prevalent risk associated with warranty, is the province of surety or financial guarantee – a core risk of the business itself; a contract liability, credit risk and / or investment risk – and is not the business of insurance.

Life-Cycle Issues

Disposal. Trash. Waste.

No one likes to think about their new technology generating waste, becoming trash or requiring disposal, but such considerations are critical to an underwriter. Further, in some jurisdictions and for particular types of technologies such considerations are mandatory.[14] The underwriter must determine if there is a challenge with the disposal:

- Can a damaged item be recycled?
- Where can disposal occur?
- During the process of damage or disposal, is pollution possible? Probable?
- Can that risk be insured, or must it be excluded?
- Can the insurance include coverage relevant to liabilities to recycling and disposal? Must an exclusion or other limitation be applied?

Risks Posed by Existing Laws: Risks of Consumer Protections, Prohibitions, Unrecognized Rights, Subsidy and Indemnity

Certain laws may create special standards of care or liability for delivery of specific products or services.[15] Similarly, in certain cases, the law may limit the liability for delivery of specified products or services.[16] Some laws may prohibit certain actions.[17] Much regulation and law is focused on the delivery of what are deemed "essential services" –including power, water and transit systems. They are deemed essential services precisely because the constant and consistent delivery of such services is essential to preserve the normal working order of advanced economies and social order.

In fact, most essential service delivery paradigms (business models) were designed around:

(a) the weather patterns prevalent at the time of design, including predictable changes at the time for 100-year periods; and
(b) continued reliance on fossil fuel.

Because many of the effects of climate change impact weather patterns, and because much of the new technology that is the focus of attempts to reduce GHG emissions is focused on alternative energy, essential services are impacted, and the current policy and regulatory structure present critical considerations of underwriting risk.

Many of the laws applicable to essential services are directed to consumer protection, especially pricing protection and safety. In the power area, fossil fuel pricing is the default basis (reference point) in most developed economies for these laws. Many of the new technologies are more expensive on a per-kilowatt-hour basis than the equivalent fossil fuel source. As a consequence, deployment of the new technologies may not be permissible under the rate approval process without legal change or subsidy. However, ill-crafted or overly broad subsidy structures can do more than merely provide price supports; they can unwittingly mask highly risky and / or unsustainable technologies.

Furthermore, because these essential services assume that fossil fuels – and the materials associated with that raw material chain – are central commodities of great importance for governments, businesses and citizens, the allocation of rights related to the energy services product chain is focused thusly. Rights related to mining of fossil fuels, related mineral rights and right-of-ways are well defined. The law currently does not address many rights related to other energy products and service supply and delivery chains. As such, the sustainability of a new technology dependent upon access to, or ownership of physical quasi-commodities – like sunlight, wind or wave action that are not now reliably defined as property rights - may be impacted by interference as others attempt to access these quasi-commodities under the laudable guise of mitigating the effects of climate change – with questionable redress. For example:

- A wind farm off the coast of waterfront property that clouds an otherwise unobstructed natural view may have the unintended consequence of devaluing the individual property asset, while fostering macro-societal benefits of mitigating climate change impacts.
- If a business places a turbine in front of another party's turbine and takes or alters the wind in front of the first turbine, has a right been violated?

[14] EU Directives 2002/95/EC and 2002/96/EC, Waste Electrical and Electronic Equipment.
[15] See generally, "Restatement of Law Third, Torts: Products Liability," American Law Institute, 1998.
[16] See specific municipal utility codes in the United States in general. See also "Utility Provider Liability for Electrical Power Failure: Implications for Interdependent Critical Infrastructure," Brown, Chang and McDaniels, The Electricity Journal, Vol 19, Issue 5, June 2006. However, limitations are not universal.
[17] Some utilities may be prohibited by their charter or other authorizing documents from providing services outside a specified geographic area. In the event of water scarcity, such restrictions could impede the ability to share resources in a way which is different from the sharing possible under the national power grid systems.

Subsidy will not mitigate either of these risks; only recognitions of the actual quasi-commodity as a property right in and of itself will mitigate this risk. Thus, the underwriter faced with these risks must determine what would happen to the business if such interference were to occur, claims for damages were lodged, and how such claims might impact the insured liability or property risks. In fact, much of the risk posed by the lack of property rights may be more important as an uninsurable first-party investment risk, with relevance only to consequential risks to insured first- and third-party risks.

Upon analysis of the types of legal conditions set forth above, the underwriter can decide whether to support the initial financing decision and put capital at risk.

Risks Posed by Public Policy Demands and New Laws

To address the unique challenges posed by the deployment of new and emerging technologies designed to reduce GHG emissions, the law in most jurisdictions must be amended to address the rights relevant to each technology. As noted above, property rights issues may require address, as may many other issues.

Much of the public debate surrounding the issue of technological advancements to mitigate the adverse impacts of climate change focuses on a single word: liability. Yet, few are willing to define what is meant by liability in the context of climate change. In fact, many technology purveyors and potential users assert that indemnity for third-party liability protection is essential before they can move forward. However, the dialogue fails to identify protection for what type of event or cause of loss must be addressed by insurance. Or, if the dialogue does focus on protection, the request is often for broad-form third-party liability protection with intimations of concern related to unlimited environmental liability that is, as yet, not clearly defined.

In fact, the discussion about needs for legal change would be much more valuable, and would result in a much greater likelihood of the promotion and success of sustainable new technology, if the discussion were more granular and involved appropriately qualified insurers to assist with such risk qualification. Without inclusion of the insurance community in these dialogues, the potential for price and liability supports (possibly in the form of subsidies) may yield the development and deployment of unsustainable technologies that likely will fail in the long-run or exist only at very high social and economic costs.

As an example, much is being said about "cleaner coal" technologies, such as carbon capture and sequestration (CCS), requiring governmental subsidy to move forward. The dialogue has proceeded as if all CCS are risk neutral on a relative basis – meaning that all CCS processes are the same and produce the same risk profile. In fact, not all CCS are created equal. Risk parsing can help identify which processes have substantial data available to evaluate environmental health and safety risks – and which have incomplete or unsubstantiated information. Some CCS approaches have substantial scale data through modeling and analogy, while others have little or none. Risk mitigation requirements to qualify for insurability may be different as a result of the specific technology and the specific physical conditions. Insurance premiums will reflect those costs – e.g., risk price indications. As such, the risks associated with certain types of CCS may make it more expensive than other types. Only when the granular analysis is done can a public-policy maker determine what, if any, type of incentive or subsidy is truly required to make delivery of this technology to the consumer most like the fossil-fuel baseline – not just in short-term kilowatt-hour pricing terms, but in terms of overall long-term risk.

The eventual structure and value of a price subsidy is also of concern to the underwriter. In theory, underwriters will generally find production tax credits to create less operational risk and greater sustainability than investment tax credits. Why? Production tax credits create incentives for owners to fix modest problems to assure the "lights stay on" so to speak – thus keeping the production operations going. By contrast, investment tax credits – depending upon their absolute monetary value – may disincline investors to infuse cash to fix modest operational problems and continue operations. In specific cases, the underwriter may find investment and production tax credits have no effect on risk profiles for the project. The devil is in the details, and to date the dialogues have been sorely lacking details.

Indemnity structures[18] generally send zero-dollar price signals to the indemnified party with respect to risk. In other words, the indemnified party is told to ignore the risk for which it is indemnified within the scheme and not to account for it or apply money to it in its business planning. As such, underwriters are very wary of indemnities, and generally do not like to put capital at risk where an indemnity could increase the risk or void economic incentive to mitigate such risk.

In all cases, subsidies may result in odd effects involving anything ranging from basic facility construction quality to safety to supply-chain risks, due to market forces and other externalities. As such, underwriters must decide whether to put capital at risk for the new technology in a subsidized environment.

In the case of new technologies designed to reduce GHG emissions, even those that are sustainable from an underwriting perspective may require some level of high attachment point, oftentimes very high attachment point, excess indemnity structures due to capacity or tenor limitations of the insurance industry. However, great care should be taken in the development of laws with indemnity, because such laws may result in the promotion of socially or economically unsustainable or inefficient technologies.

The above dialogue can be repeated for most new technologies in the climate change area. Risk must be considered in the development of supporting public policy, especially subsidies, to assure promotion of the most sustainable technologies – scientifically and economically speaking. The insurance industry has data and unique professional skills that should be included in the dialogue to ensure the most efficient, practical and effective result.

[18] Where no charge is made for the indemnity – or where the charge is artificially capped or bears no actuarially quantified relationship to the risk indemnified.

Practical Applications and Examples of Insurance for New / Green Technologies

Insurance is being used today, quietly in most cases, to actively facilitate delivery of so-called "green" technologies – those focused broadly on environmental sustainability, as well as those specifically focused on GHG emission reductions. The discussion below provides insight into the underwriting structure of selected technologies and processes.

Green Buildings – LEED Certifications

Insurers have been supporting the design and development of materials and the design and construction of buildings that have sustainability characteristics, and which foster "green" development. Specifically, the insurance community has evaluated risk and extended coverage for:

- Errors and omissions / professional liability for architects and engineers
- General liability
- Builder's risk
- Workers' compensation coverage for associated projects.

In fact, although these coverages have been offered as long as green buildings have been around[19] (because financiers of such projects and buyers will not loan funds or purchase the building without insurance coverage for the design and construction activities). The public has not made the link between these efforts and climate change until recently – with the associated frenzied interest in green buildings. With the recent public spotlight focused on green buildings, several insurers have announced the availability of coverages for related projects – in some cases, for the second time – because the time is now ripe and stakeholders are paying attention.

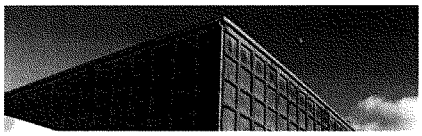
The insurance industry is moving toward green building wrap-up programs, which are analogues to traditional wrap-up programs. Essentially, wrap-up programs permit all parties to collectively procure insurance on a construction site and thereby derive associated risk management benefits (alignment of interests) and concomitant price efficiencies in the form of reduced premiums – as compared with likely higher premiums for independently procured insurance for each party.

The insurance industry works closely with design and construction industry professionals and building trades to evaluate the risks of each new design and associated materials, and agree upon risk mitigation techniques that are a predicate to coverage. To that end, the role of the insurance industry as a market-based tool to provide price indicators for risk is evident, and continues working today.

As an example, green roofs have been touted as a means for reducing storm water run-off, thus increasing energy efficiencies and creating urban wildlife refuges. While underwriters see all these benefits, they also realize the weight of such structures is significant and must be addressed during building design. Before insuring the projects, underwriters will confirm that structural compatibility has been evaluated and deemed safe.

The integrity of the roof is also dependent upon liners to keep moisture from seeping into the building. This structural component is also of interest to the underwriter. Why? Because liners leak. Experience with landfills confirms this fact. Even the best-lined systems have the potential to leak under fortuitous circumstances. As such, the underwriter may require certain construction components (secondary containment and / or collection systems) to be included in the structure as a risk-mitigation technique.

The underwriter recognizes that urban wildlife may populate the roof, but what some consider wildlife, others consider pests – whether plant or animal. As such, the underwriter must consider the possibility that someone operating the roof may at some point in time think about applying, or actually apply, herbicides or pesticides to the roof – risking pollution of storm water that escapes the system. To mitigate such risk, operating instructions to direct against use of such pesticides / herbicides might be appropriate and a condition to insurability, or the underwriter may choose to exclude pollution liability coverage altogether.



Where green buildings seek to incorporate alternative energy sources, subsidies are generally involved. As a result, adoption of such technology has been slow – due to price and business-model complexity resulting from the subsidies. (See following alternative energy section.)

The insurance industry is now moving toward and executing on green re-build extensions – products that permit rebuilding of, and payment for, damaged structures using building techniques and materials that would qualify for point award under the United States Green Building Council (USGBC) Leadership in Energy and Environmental Design (LEED) certification program. Some carriers have formally announced such coverage, while others have simply offered it without fanfare. In each case, great care is taken in evaluation of the associated techniques and technologies to assure the suite of sustainability and business risks are appropriately managed and addressed in deployment of such green programs.

Disaster Resilience – the Sleeping Giant of Sustainability

Disaster-resilient characteristics of building and community construction (and operation) are crucial in the context of climate change. In fact, disaster resilience confers the ultimate sustainability characteristic in the context of climate change – that is, better protection against the physical manifestations of increased frequency and severity of storms: high winds and lots of water. Disaster resilience includes activities as diverse as emergency preparedness, specialized roof attachment

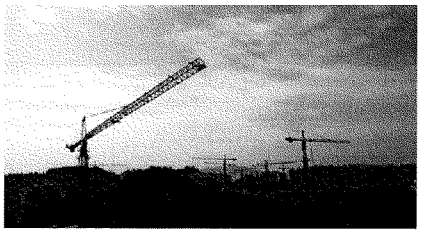
[19] CERES 'From Risk to Opportunity: 2007 – Insurer Responses to Climate Change'October 2007. Source: http://www.ceres.org/pub/docs/Risk-to-Opportunity-2007.pdf

techniques and missile-resistant window coatings. Disaster resilience minimizes, and in some instances eliminates, property damage and tends to reduce morbidity, mortality and economic disruption.

Unfortunately, disaster resilience is not generally associated with being green, and has not been integrated to any great extent in the sustainability dialogue. However, it should be.

Disaster-resilient structures and communities survive stronger storms. Furthermore, in the event of disaster, emergency-preparedness plans strive to make recovery more organized and efficient, thus reducing the incident and materiality of damage claims and reducing the loss of life. If structures and communities are damaged less often, they are, by definition, more sustainable. They require fewer building materials (less to re-build) and fewer relocations, and benefit from lower morbidity and mortality rates. Such savings translate not only into less disruptive and more humane practices but also into true dollar savings –which the insurance industry can transmit as price signals in reduced premium charges. Greater disaster resilience should equate to lower premiums . . . which equates to financial savings for use in additional sustainability improvement efforts. The challenge is that disaster resilience is expensive. Infrastructure and building changes are costly. Community organization is expensive. Insurers are not the only beneficiaries of the risk reduction achieved by disaster resilience; the public and many uninsured activities are also protected. Thus because insurers are but one affected party and insurance cannot provide price reductions that cover the entire cost of the disaster resilience – because more than insured risks benefit.

The insurance industry is now working with non-governmental organizations to try to get disaster resilience recognized formally as a sustainability characteristic. But, what is really needed, because of the public benefit, is for public-policy makers to continue implementing changes to building codes and land-use plans to achieve true sustainability[20] – preferably in a manner that permits market forces to establish economic incentives without precluding such through regulation. Further research on the links between disaster resilience, energy savings and off-grid power systems might also help solve this conundrum with the most market-driven participation possible.



Alternative Energy

Energy systems and technologies using fuel sources other than fossil fuels have been around for decades – some much longer.

Wind power, solar power, hydropower, geothermal and biomass systems are being insured as this article is being written. Each alternative energy power process has different experience in the competitive market with fossil fuels. Some of these power systems have been the subject of subsidies of various types during various governmental administrations and under various sovereigns. The viability of each process has tracked directly with its competitiveness vis-à-vis fossil fuel, and the functionality of proffered price supports or subsidies.

Many challenges exist when evaluating risks for alternative energy. Generally, the technologies themselves perform the function of producing power. The core issues of risk and concern tend to be associated with subsidies, the price competitiveness of the technology as compared with fossil fuel options and the laws defining associated rights.

Today, wind power project commitments blow with the wind of tax subsidy. When subsidies near their legal term and require re-up, new project starts halt. Underwriters must weigh the possible risks of stoppage carefully with respect to consequential covered first- and third-party damages that can occur when disuse occurs. Wind rights are an emerging issue:

- What if someone builds a structure that blocks the wind necessary to run the turbine? Is that actionable?
- How can the underwriter assure that the risk of stoppage is mitigated and / or understood with respect to insured damages associated therewith?

Like wind, solar power benefits from a subsidy. Solar power remains more expensive than fossil fuel generated power. Risks are different, however, as most subsidies are investment tax credit-based (see earlier section). Solar rights present certain issues:

- What if someone or something blocks the sun necessary to drive the power system? Is that actionable?

[20] See www.disastersafety.org for information about the work of the Institute for Business and Home Safety.

• How can the underwriter assure that the risk of stoppage is mitigated and / or understood with respect to insured damages associated therewith?

Such questions must be answered before the underwriter will put capital at risk.[21]

That said, it is fair to say that the insurance industry is quite prepared to underwrite and is actually insuring these technologies today. Moreover, the insurance sector is well-prepared to support decentralization efforts that are considered of importance in the energy area – that is, supporting off-grid decentralized power to improve capacity, disaster resilience and sustainability.

In the area of alternative energy, decisions to decline specific types of technology are often driven by concerns related to the stability of the business model with respect to physical, legal and public policy externalities, rather than the technology itself.

Water Scarcity

The availability of plentiful water near existing population centers is a significant concern. The availability of clean and plentiful water is typically a highly regulated essential service in developed economies. Most developed economies choose to centrally manage water in areas of concentrated population using a public, quasi-public or highly regulated private utility.

Much of the technology response to water scarcity involves local management and treatment – e.g., storm water recovery and re-use, treatment at the tap, etc. These technologies are being insured now.

The risks of greatest challenge in this area are not the technology, but the regulation. Regulation may prevent transport of water outside of that respective authority's geographic boundary. In other words, water operates on a theory exactly reverse to that of a power grid. Furthermore, there are very real public health concerns related to letting individuals decide whether to treat locally – because a decision not to treat could have significant morbidity and / or mortality consequences that are both socially and economically disruptive.

Thus, although insurers are willing and able to insure storm water recovery and reuse programs with existing specialty products (primarily through pollution coverage products), the feasibility of implementation is affected by public-policy externalities. The underwriting qualifications for such programs are likely to be similar to those requirements that might be imposed by a regulator in controlling public-health risks.

Insurability of water treatment for potable water uses is also possible, and such technology is insured now under the currently centralized schemes in developed economies. Extension of such coverage to local and at-the-tap treatments systems in developed economies creates both technology and legal challenges. Water treatment technologies for use immediately prior to consumption exist and are insured today. Issues are present with respect to immediate scalability for deployment. Public policy decisions related to water scarcity and water management may well be a central component of our society's response to climate change. Experts note that drought is one of the most prominent features of past climatic changes. New technologies such as water reclamation at wastewater treatment facilities and desalinization projects will be critical in meeting these new water challenges, and insurance can and should play a role in sorting out the application of these technologies.

Cleaner Coal: Carbon Capture and Sequestration

Many see the continued use of coal as an economic reality and, in the light of climate change, believe it is important to focus on technologies that can reduce GHG emissions associated therewith. CCS is one of those technologies. However, as noted earlier, CCS is not one technology – it is a family of field practices employing certain technologies for underground injection of CO2 as a supercritical fluid derived from coal-fired power plant operations.

First and foremost, for underwriting purposes, one must understand the composition of the gas stream at the capture point, which varies by power plant production process. Then, the underwriter must understand the transportation risk, if any. Next, an understanding of the injection process, the locus of injection and placement, and eventual sequestration into a subsurface confinement zone are essential.

Some subsurface injection processes have substantial data available to evaluate environmental health and safety risks – while others have little information. Some CCS approaches have substantial scale data through analogy, while others have little or none.

[21] A full discussion of the risks associated with all types of alternative energy is far beyond the scope of this paper.

Much data exists as to the behavior of injected supercritical gases used in the enhanced oil recovery process (EOR). Such injections are made into petroleum reserves and have been made on moderate scale when compared with demand that will arise when used for sequestration of CO2 emissions streams from coal-fired power plants. Petroleum reserves present specific geo-chemical and strategraphic characteristics and behaviors.

However, for logistical and other reasons, use of other types of subsurface sequestration geology may be desirable for purposes of CCS – namely deep saline structures and unmineable coal seams. Unfortunately, little if any real, practical data is publicly available with respect to the performance of the latter two types of sequestration subsurface structures. As such, data that is not currently public must be made available to underwriters for analysis and / or publicly available data must be generated to permit a credible insurability analysis. However, if analogous systems behavior can be demonstrated, insurability qualification may be achieved.

As noted earlier, risk mitigation requirements to qualify for insurability may be different as a result of the specific technology and the specific physical conditions – and insurance premiums will reflect those costs – e.g., risk price indications.

Because public data is lacking and little or no loss analysis modeling has been performed with respect to specific emissions streams, some of the public is quite concerned about plans to store this supercritical CO2 underground. Many stakeholders discuss concerns about the potential pollution of groundwater and / or release of large volumes of CO2 above ground – which could cause asphyxiation or result in other natural disasters. These concerns lead to calls for assurances about safety. That dialogue has quickly turned to demands for financial assurance – in a non-specific form – for extensively long periods of time. It is unclear that demands for financial assurance bear any reasonable relationship to the actual risks presented by this technology. Further, the demands have escalated to terms of up to 1,000 or more years in tenor – essentially in perpetuity. These demands have quickly led to countervailing demands for indemnity of the designers, constructors and operators of such sequestration facilities. Proper risk analysis and market-driven risk management solutions should be used to break the impasse in a manner likely to result in the most efficient solution.

The dialogue with respect to IGCC and CCS has focused on the physical and tort liability risks associated therewith as part of an overall dialogue regarding the financial risks associated with developing and implementing IGCC and CCS. So far, in the process, we have learned that CCS is not appropriately addressed as a monolithic risk.

In fact, the actual geologic structure of choice for sequestration may result in a huge impact on the insurance industry's willingness to assume liability for damages. Because some types of geologic structures have a long-standing history of being able to retain gases in a stable manner, such structures may be immediately insurable, where other underwriting criteria are satisfied. The insurance industry has a proven history of insuring enhanced oil recovery (EOR) activities to which both technology and geological / physical asset analogies can be drawn for risk profiling purposes. By contrast, other types of geologic structures may not have such backgrounds; at least the data is not publicly available at this time for the history of successful operation as a sequestration structure. Consequently, while engineers may have considered both processes as viable opportunities for CCS, the underwriters cannot. The implications for insurance availability and natural advantage based upon physical asset ownership could be significant in determining the feasibility of further developments and implementing CCS technologies. The availability of insurance and other risk management tools for both CCS short- and long-term liability is essential in determining stakeholders' willingness to support development and implementation of this technology as a climate risk-mitigation tool.

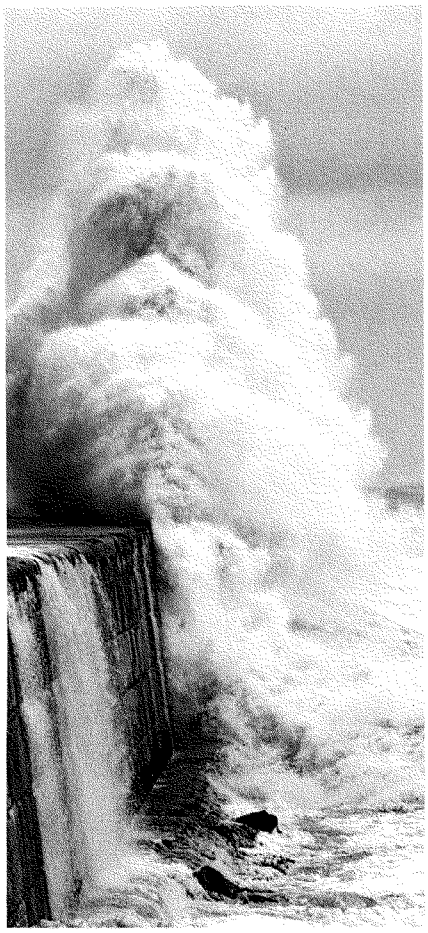
Unfortunately, the demands for first-dollar indemnity could send a zero-dollar price risk signal to the purveyors and operators of such technologies and disincent innovation. If probabilistic risk analysis reveals liability risks with extreme tenor, then a combination of risk-transfer insurance, alternative risk management solutions and indemnity, or limitation of liability may be required – in addition to price subsidy to incent the responsible and sustainable deployment of CCS.

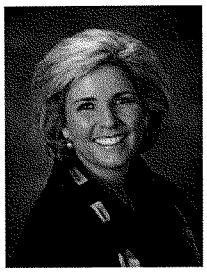
Conclusion

Insurance at its core is a risk-management tool. The insurance underwriting process is designed to analyze risks. To the extent that such risks are insurable, in part or in full, the insurance sector sends price signals about that risk in the form of premium charges. The underwriting process consequently allows for a risk-based differentiation of new technologies.

The provision of risk management solutions by private insurers is also firmly embedded in the structure of our market economy. Insurers deploy labor and capital to underwrite risks. They have to be mindful that the resources of production are scarce and must be allocated to their most efficient use. It would be economically wasteful – and ultimately not sustainable – to use insurance to foster excessive investments in new climate technologies. Insurance is a business. The profitability of insurance is the benchmark for its service to society –including when used to support new climate technologies through the process of underwriting.

Public-policy makers should endeavor to consider solutions that accelerate deployment of new technologies to combat climate change in a manner embracing the use of insurance and allowing insurance practitioners to send relevant signals regarding price and risk management options. Public-policy makers should consider insurance as a tool to accelerate responsible deployment of GHG emission reduction technologies. Public-policy makers should avoid subsidies that mask risk and can otherwise be parsed and managed effectively by private insurance. In so doing, society is assured of maximum true economic and technological sustainability in an environment of rising seas, increasing storm frequency and severity, and increasing water-distribution challenges – thus permitting and promoting efficient, effective technologies to mitigate the effects of climate change.





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