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CLEAN COAL TECHNOLOGY

HEARING

BEFORE THE

SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND INNOVATION

OF THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION
UNITED STATES SENATE

ONE HUNDRED TENTH CONGRESS

FIRST SESSION

APRIL 26, 2007

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SENATE COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

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FIRST SESSION

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CLEAN COAL TECHNOLOGY

THURSDAY, APRIL 26, 2007

U.S. SENATE,
SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND INNOVATION,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, DC.

The Subcommittee met, pursuant to notice, at 10:02 a.m. in room SR–253, Russell Senate Office Building. Hon. John F. Kerry, Chairman of the Subcommittee, presiding.

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

Senator KERRY. The hearing will come to order. Thank you all very much, welcome to our witnesses, thank you, folks, for taking time to come in today.

I know that we have some other colleagues coming, but I also have a conflict. The Finance Committee is meeting now, and a number of members are caught up between them. We're going to just proceed ahead and we'll see who's here.

Obviously, the subject of climate change and emissions is increasing in its importance to the country and to the world as the evidence mounts regarding the impact of greenhouse gas emissions.

This is a subject that I've followed in this Committee since 1987, or slightly before, when Al Gore and I held the first hearings on global climate change. Subsequently we wound up going down to Rio for the Earth Summit where the voluntary Framework was entered into in 1992.

So, it's been a journey of 20 years or more, with a lot of evidence mounting and a lot of knowledge gained in the interim.

The science is pretty clear now, when you sit down with some of our top scientists from Jim Hansen to Ed Miles or John Holdren at Harvard or a bunch of folks. The feedback that we're getting from the climate, from Earth itself, is indicating a much more rapid, and much more consequential rate of change than had been predicted. The predictions are coming true, but in greater degree, and greater intensity.

Senator Stevens, welcome.

So the question we face is of how to deal with this? The scientists are telling us we have a 10-year window within which to try to get it right, and that 10-year window has now narrowed in the sense that the consensus of those scientists was 2 years ago. Two years ago the consensus was that we could afford a three-degree centigrade increase in the Earth's temperature, before you get to the

catastrophic tipping point, as they judge it, and that was deemed to be about 550 parts per million of greenhouse gases in the atmosphere.

They have now revised that, based on the rapidity and size of the feedback that they're getting. They now deem it to be a two-degree centigrade increase that we can tolerate, and a 450 parts per million level of greenhouse gases in the atmosphere.

So, we face an enormous challenge, and the question that we are all grappling with is how to do this responsibly, minimize economic dislocation, maximize economic output, growth, productivity, and lead the world, hopefully, in the creation of technologies that we can sell to India, to China, less developed countries, and others.

Obviously there's a lot of money that's already beginning to chase these technologies. Venture capital is moving in significant amounts into green technologies. But, at the same time leading industrialists, leading corporate chieftains, are telling us that they want the Government to create a certainty about the direction we're going, and not to have a patchwork of, California doing this, and New England Regional Compact doing that, and different states maneuvering. They believe that it's important to have a standard, and we need to wrestle with that.

I happen to believe that's true, I just came back from the Milken Conference out on the West Coast where this was one of the top topics of conversation with a lot of Wall Street folks and a lot of business people, all of whom believe that we probably need to move in that direction of having a cap and trade, some structure, with perhaps auctions, and create value and move in that direction.

The big question within that framework is, what's going to be the new mosaic of American energy sources? And to the greatest degree, most of us would like to let the marketplace decide that. I don't think the Government ought to pick the winner or loser in that effort, but I think we should create some strong incentives for people to move in certain directions.

Obviously, coal is a big deal to all of us. We have a lot of it, it's abundant, it's cheap, we know how to get it, and there's every indicator that it's going to be a significant part of the mix. But, to meet the challenge, we're going to have to find a way to burn it clean. Half of our electricity is currently generated from coal. That coal currently produces approximately 1.5 billion tons of carbon dioxide annually.

According to the National Energy Technology Laboratory at DOE, those numbers are going to get bigger, and get bigger fast.

Over 150 new coal-fired power plants are proposed for construction in our country alone. And China, we are told, is going to build one to two per week. Over their lifetime, those plants, the new plants that come online, are going to spew an additional 30 billion tons of carbon dioxide into the air.

We have witnesses today who will share with us their expertise and their views about what the prospects are as we go forward. In response to this challenge, today I am introducing the Clean Coal Act of 2007 which will seek to make certain that whatever plants we're going to build are going to be built with the new state-of-the-art technology that we're going to hear about today from our witnesses.

Recently, one of the world's top climate scientists, Jim Hansen, called for an end to building new coal-fired powered plants that use pulverized coal, without the new technologies, because of what they do with respect to global warming. Jim Hansen said, "Coal is the big amount. Until we have that clean coal power plant, we should not be building them, it is as clear as a bell."

The threat of those challenges, I've talked about a little bit, and I don't want to go on about it. Let me just say that we look forward to hearing from our 5 witnesses today, Joseph Chaisson, the Director of Research and Technology for the Clean Air Task Force, based in Boston; Roberto Denis, the Senior Vice President for Sierra Pacific Resources, a utility in the Pacific Northwest; Dr. Gregory McRae, the Bayer Professor of Chemical Engineering at MIT, and one of the authors of the recent MIT *Coal Study;* Michael Rencheck, the Senior Vice President for Engineering, Projects, and Field Services at American Electric Power; Mr. John Wilson, Chief Operating Officer for the Environmental Systems and Services Group at Siemens Corporation.

Before I introduce Senator Stevens and Senator Boxer, let me say that I have had a number of conversations in the recent weeks with Lou Hay at Florida Power and Light, and with AEP's CEO, and AEP is, as we will hear today, building two new plants with IGCC technology, in West Virginia and Ohio, and FPL is a powerful advocate for the notion that we need this cap, as are other major CEOs from the USCAP effort. They are growing in number in terms of the companies they represent in the country. So, there's a movement in this direction, but obviously time is of the essence, and we need to grab this baton and run with it.

Senator Stevens?

STATEMENT OF HON. TED STEVENS,
U.S. SENATOR FROM ALASKA

Senator STEVENS. Well, thank you very much, Mr. Chairman. I have a conflict and will have to leave soon. I did want to hear the witnesses if we could, but I ask that my statement appear in the record, if you will.

And, I want to add to it that most people don't realize that half of the coal in the United States is in Alaska. Access to it is denied because of a provision that was placed in Federal law back in the days when the projection was that we were entering into a new Ice Age, and the decision was made to prohibit the production of coal in Alaska unless the original contour of the land was restored. But, if you take out the coal, you have to melt the ice, and if you melt the ice, it would be hard to replace the act of God and freeze it back so that you had the same elevation and the same contour, so we haven't had a new coal operation in Alaska for a long time.

We are, now, proceeding with the coal gasification plant at Nikiski in the Kenai peninsula, that will allow the company known as Agrium to produce fertilizer and ammonia, and also clean diesel fuel. It is something that, as a project, we're all looking forward to see if it will work, it is one of the alternative energy technologies currently being partially financed by the Federal Government, and I really support that activity.

I do have some serious questions, however, about the role of carbon and CO_2 in the air, and I hope that one of these days we'll listen to the scientists from International Arctic Research Institute who have studied this, this process of change, now, for 20 years, and they do disagree with the current concepts that are being pursued by—in this Nation, and to a certain extent, in Britain, and I think it's time we took stock of looking at the accuracy of some of the comments that have been made in the past concerning the impact of global warming on our economy and its cause.

But, I do ask that my statement be put in the record, completely. Thank you.

Senator KERRY. Without objection, it will be put in the record.

[The prepared statement of Senator Stevens follows:]

PREPARED STATEMENT OF HON. TED STEVENS, U.S. SENATOR FROM ALASKA

Mr. Chairman, thank you for holding this hearing today on clean coal technologies.

In the United States alone, coal-fired power plants satisfy more than half of the Nation's energy needs and this percentage is likely to increase in the future. Coal is both abundant, inexpensive, and represents one of our most important natural resources.

It is a stable commodity and a key component in satisfying the United States' growing energy demands. Coal production is an important element to our national security. Without it, we would be increasingly reliant on unstable or unfriendly nations for our energy needs.

Most people don't realize that half the coal in the U.S. is located in Alaska. Access to it is denied because of a provision that was placed in Federal law back in the days when the projection was that we were entering into a new ice age. The decision was made to prohibit the extraction of coal in Alaska unless the original contour of the land was restored. But if you take out the coal you have to melt the ice, and if you melt the ice it is hard to replace the act of God and freeze it back so you have the same elevation and the same contours. We haven't had a new coal operation in Alaska for a long time.

Continued reliance on imported energy from volatile regions of the world is not a solution. We must increase our domestic production in order to remain globally competitive and we must do so in an environmentally responsible manner. New technologies to make this possible are on the horizon. Carbon capture and sequestration is just one of many processes already in development. Ground breaking research is being conducted to develop new ways to burn coal in order to maximize energy yield and employ cleaner and more efficient processes.

One of these processes, which we will hear about today, is called Integrated Gasification Combined Cycle or IGCC. The IGCC process is a promising new technology which has the potential to increase efficiency by 40 percent. However, this process is not conducive to all regions because of its limitations on the type of coal which can be used. Solutions must be found that will accommodate these differences and we must continue to research and develop other methods.

In my state, Agrium Incorporated is developing coal gasification at its Nikiski fertilizer plant. This process would allow the plant to switch from natural gas to coal as a chemical feedstock. This coal gasification project will allow Agrium to not only produce the fertilizer and ammonia currently in production but also clean diesel fuel. In addition, the excess energy produced by this project, estimated at 75 megawatts, could be injected into the existing power grid of the surrounding community. Agrium is also evaluating carbon sequestration, which can be utilized in existing oil and gas fields to yield additional energy supplies.

Like many of the alternative energy technologies currently in development, no one single solution will solve the problem of meeting energy needs in a responsible manner. However, we should continue to explore the benefits clean coal can continue to offer our economy. I look forward to hearing our witnesses' testimony and their response and their insight into how we can achieve this goal.

I do have some serious questions about the role of carbon and CO_2 in the air and I hope that one of these days we will listen to the scientists from the International Arctic Research Institute who have studied this process of change for twenty years. They do disagree with the current concepts that are being pursued in this Nation

and to a certain extent in Britain. I think it is time we took stock of looking at the accuracy of some of the comments that have been made in the past concerning the impact of global warming on our economy and its cause. Thank you.

Senator KERRY. And, Senator, I would be delighted, I think there's nothing more important than to get at the science, so I'd be happy to have those folks come in here, have a good dialogue here with them and with some others that have a different point of view, because I think we obviously need to proceed forward intelligently, and whatever theories are out there, we are all smart enough here to pick our way through them. So, I'd be delighted to have those scientists come in here, and we'll try to set that up as soon as we can.

Senator Boxer?

STATEMENT OF HON. BARBARA BOXER,
U.S. SENATOR FROM CALIFORNIA

Senator BOXER. Mr. Chairman, thank you so very much for your leadership, not only in this particular hearing this morning, but thank you for your leadership in general on global warming. We need that leadership from many people in the Senate and the House and the Administration, because as we know, we face a threat here that's pretty grave.

I'm going to speak, probably as long as Senator Stevens spoke, no longer than that.

We know that advanced cleaner coal can help us solve one of the—this, this great threat that is facing us. And, you know, we've had seven hearings in the Environment Committee, Senator Kerry, you've been part of a couple of those. The most disturbing thing, of course, is what could happen if we don't respond to this, and I won't go through it—it's in my statement—but what was stunning in new news, was that a scientist testified that 40 percent of the species on the planet could be at risk, if the worst predictions come true. We just can't abide by that.

Global warming puts the web of life that we take for granted in jeopardy. At current utilization rates we have more than 250 years worth of coal in the ground right here in the United States, we are the Saudi Arabia of coal. If we could figure this out, how to do this in a clean way, we'll be way on our way to energy independence in a very, I think, responsible way that will lead the way for the world.

Right now, 40 percent of our greenhouse gas emissions come from electricity generation. More than half of that comes from coal-fired power plants. Plans are on the books to build hundreds of new coal-fired power plants. That's why I think your legislation, we're analyzing it now, is a very important contribution to this, because if we don't deal with this we're going to keep going backward. We can't afford to go backward on global warming.

So, we have a big challenge, but I think it's doable. Some of the technologies are commercially available, some are in operation at pilot projects, others remain in early research. Some work on all kinds of coal, others do best with only one kind of coal, so this isn't a kind of a one-size-fits-all operation.

But, we need additional research. I've been one to say, we need a Manhattan Project on clean coal. We need to get very strongly

behind that effort, because all the countries in the world, I think, are looking to us. The Administration keeps saying, "We're not going to get anywhere unless China and India get involved," we can't wait. We never wait for other countries when it comes to the health and safety of our people, our planet, or our economy.

So, we need to move forward. If we do solve this problem, it will be exported across the world, we will create jobs, and our grandchildren will be able to have a similar experience living on this planet, as we have had.

So, thank you, again, Mr. Chairman for your leadership, I look forward to working with you continually as we solve this problem.

Senator KERRY. Thank you, Senator. I reciprocate—you've been terrific over in the Environment Committee and you're moving ahead and we're enjoying working together on this and we look forward to continuing to cooperate.

Folks, thank you, again, for taking time to be here, this is a very important topic, there's a lot of discussion here, as you know, about how to do this, so we anxiously look forward to your testimony.

Mr. Chaisson?

STATEMENT OF JOSEPH M. CHAISSON, TECHNICAL AND RESEARCH DIRECTOR, CLEAN AIR TASK FORCE

Mr. CHAISSON. Mr. Chairman and Members of the Subcommittee, my name is Joseph Chaisson, I'm the Technical and Research Director of the Clean Air Task Force, or CATF. Thank you for the opportunity to testify this morning about advanced coal technology and the environment.

Founded in 1996, CATF is the only national environmental advocacy organization with an exclusive focus on protecting the Earth's atmosphere and human health from air pollution and climate change.

A major CATF focus is working with state and regional environmental groups, state governments and private sector project developers to facilitate early domestic deployment of advanced coal gasification technology, including carbon capture and geologic storage, where feasible, today.

We're also exploring how to remove barriers to promising advanced coal technologies that have not yet entered the market.

Today, I will address why we need to deploy radically cleaner coal technology, highlight several recent advanced coal market developments, list key challenges to deploying cleaner coal technologies, and outline what I think the Federal Government could do to address these challenges.

Conventional coal combustion technology is responsible for some of the most important environmental problems on Earth, including air pollution that damages human health and ecosystems, land disruption, depletion of water resources, toxic solid waste production, and global warming.

Despite these problems, coal will continue to be widely used throughout the world for many decades, at least. Therefore, we must act to develop and commercially deploy much cleaner coal-using technologies, as soon as possible.

The good news is that much commercial activity, typically too recent to be reflected in available studies, is already underway in

both coal gasification power production, or IGCC, and in carbon capture and geologic storage.

Some key highlights include, first, the emergence of Siemens and Mitsubishi as full-systems IGCC vendors, offering coal gasifiers as well as combustion and steam turbines in an integrated package, with both of these gasifiers being well-suited to using low-rank subbituminous and lignite coals.

Second, we have several next-generation commercial IGCC plants under development, and these plants are driving important engineering design work, including serious exploration of options for adding carbon capture to these plants in the future.

Third, we see innovative hybrid coal gasification projects moving forward by independent power project developers that combine electricity and substitute natural gas production. These are very interesting projects.

We also see several promising advanced gas-fired technologies, moving into the process demonstration stage, it could be commercially available within the next 2 or 3 years.

And finally, projects using coal gasification, a new technology with significant implications, including the potential to avoid most adverse environmental impacts associated with coal mining, transportation and solid waste disposal, to significantly lower coal gasification project costs, and potentially to triple our economic coal reserves.

The first domestic underground coal gasification project is being developed in Wyoming by the Gas Tech Company.

However, several serious challenges exist to deploying these very clean coal technologies. First, proposed IGCC projects face the very significant global run-up in large energy project construction costs that is impacting and slowing down most proposed coal plants today.

Second, and very importantly, in the absence of a stringent cap on carbon dioxide emissions, there is no economic incentive today to incorporate carbon capture and geologic storage into most IGCC projects.

Third, Federal advanced coal research, development, and demonstration programs lack sufficient scope to help promptly develop and deploy the technologies we need.

And, fourth, and this is actually quite important, we do not yet have a low-cost practical technology for capturing carbon dioxide from conventional coal-plant combustion flue gas, which will be essential to substantially reducing CO_2 emissions from the existing global coal-powered plant fleet.

Several Federal policies could help overcome these challenges. First, a production tax credit, or some other form of equivalent financial incentives for new coal power plants that include full carbon capture and geologic storage.

Second, a carbon emissions performance standard for new fossil power plants that would require significant carbon capture and sequestration for all new coal-powered plants.

Third, an effective carbon emissions cap and trade system; and fourth, to expand and broaden DOE's advanced coal research, development and demonstration programs.

In summary, I believe the technology we need to transition coal to much more environmentally sustainable systems could be either deployed or developed promptly, if effective Federal advanced coal technology policies were implemented.

Thank you for this opportunity to testify, and I look forward to your questions.

[The prepared statement of Mr. Chaisson follows:]

PREPARED STATEMENT OF JOSEPH M. CHAISSON, TECHNICAL AND RESEARCH DIRECTOR, CLEAN AIR TASK FORCE

Introduction

Mr. Chairman and Members of the Subcommittee,

My name is Joseph Chaisson. I am Technical and Research Director of the Clean Air Task Force (CATF). Thank you for the opportunity to testify today on advanced coal technology and the environment.

Founded in 1996, CATF is the only major national environmental advocacy organization with an exclusive focus on protecting the Earth's atmosphere and human health from air pollution and climate change. This singular focus enables CATF to field deep analytic and strategic resources equal to the significant and complicated atmospheric challenges we face over the next fifty years.

Over the past several years, one of CATF's major activities has been to work with state and regional environmental groups, state governments and private project developers in several parts of the country to facilitate early domestic deployment of coal gasification technology—with carbon capture and geologic sequestration (storage) where currently feasible. We have briefed numerous Congressional offices—accompanied by state environmental partners—about the promise of coal gasification technology. Another related CATF focus has been exploring how to remove barriers to promising advanced coal gasification and carbon capture technologies that have not yet entered the market. This "hands on" project facilitation and market entry work provides us with a useful perspective on what is happening on the ground in today's marketplace.

In this testimony, I will briefly restate the importance of moving forward radically cleaner coal technology than is deployed today; highlight current market developments on the ground which the Subcommittee may not be aware of; and, finally, discuss key challenges to radically cleaner technology, and what the Federal Government might do to help tackle those challenges.

I. The Current and Projected Environmental "Footprint" of Coal

Coal-fired power generation is today one of the planet's most environmentally destructive activities. It is responsible for most of the Nation's sulfur dioxide emissions that, even after recent regulatory reductions, will still take 15,000 lives prematurely in the U.S. each year by EPA's own estimate. It contributes substantially to nitrogen oxides, which add to smog, haze, and crop and ecological damage. It emits most of the Nation's manmade mercury air pollution. Current coal mining practices have scarred land and threatened water and habitat. Coal power generation consumes and discharges enormous quantities of water, while generating nearly 100 million tons of toxic wastes each year, the disposal of which is not regulated by the Federal Government. Finally, coal power generation is responsible for nearly 40 percent of the planet's man-made emissions of carbon dioxide that contribute to global warming.

Despite these problems, coal-fired power generation is likely to be relied on for decades to come and is projected to expand dramatically. World electric demand is expected to triple by 2050, coming largely from developing countries like China and India. Most analyses agree that this underlying demand growth will substantially outpace even the most aggressive energy efficiency policies. Renewable energy, while it should and will be widely deployed, faces significant physical, environmental and economic challenges that will practically limit its share of total electrical supply for several decades. Natural gas is relatively expensive and its reserves are far more limited than coal. Finally, nuclear power faces considerable hurdles of scale, economics and environmental opposition. For these reasons among others, China is building as much new coal capacity each year as the entire U.K. power grid, and coal power generation in India is projected to grow rapidly—matching current U.S. coal consumption by 2020 and China's current coal consumption by about 2030. The United States faces both growing demand for electricity and an aging power plant

fleet; coal will remain economically attractive to meet some portion of electricity demand growth and to replace some existing power plants.

Turning to climate, numerous analyses performed or commissioned by such bodies as the Intergovernmental Panel on Climate Change, the European Union, the National Commission on Energy Policy, academic institutions such as Harvard, MIT, and Princeton University as well as environmental organizations such as Friends of the Earth-U.K. have concluded that, even with aggressive energy efficiency, renewable energy development and in some cases nuclear expansion, coal-fired power generation is likely to remain a significant part of any 2030–2050 global power supply. Accordingly, each of these studies has identified the critical importance of transitioning coal use to technologies that minimize health-related air emissions and allow for the removal and storage of carbon dioxide, and to begin to demonstrate and scale up those technologies on a commercial basis as soon as possible.

In short, the planet is unlikely to be able to live *without* coal for some time to come. But, at the same time, the planet, from an environmental standpoint, can't stand to live with coal as it is currently used to produce electricity. This leaves only one path forward: we need to change how we *use* it—and we need to do so as quickly as possible.

II. What Is to Be Done?

An environmentally responsible coal policy would do the following:

- Ban the construction of new coal combustion plants due to their inherently unacceptable air, water, solid waste and climate impacts.
- Rapidly commercialize the use of integrated coal gasification combined cycle (IGCC) for electric power generation, because it has a much smaller environmental footprint for air emissions and waste than does coal combustion.
- Rapidly demonstrate the feasibility of large-scale geologic storage of carbon dioxide and then require all new coal power plants to capture and sequester at least 90 percent of their coal carbon content.
- Demonstrate and deploy advancements such as underground coal gasification, that could further shrink IGCC's environmental footprint by substantially minimizing mining impacts and waste management.
- Reform coal mining practices worldwide, impose effective Federal regulation of coal plant solid waste disposal and reduce coal generation water use and associated impacts to the minimum practical levels.
- Increase the energy efficiency of IGCC power generation to the maximum practical levels over time.
- Establish effective carbon dioxide emissions controls.

Commercializing IGCC is of special importance. Because it is an inherently cleaner process—the gas it produces from coal must be free of most contaminants to power a gas turbine—IGCC reduces deadly sulfur and nitrogen oxide emissions to very low levels—approaching those achievable by natural gas combined cycle power plants. Gasification is the *only* coal power generation technology that can virtually eliminate mercury air emissions and capture most of the coal mercury content in a concentrated form that can potentially be sequestered from environmental release; IGCC is the only way we can continue to use coal to produce power without adding significantly to the global mercury burden. Total solid waste from gasification is typically half the volume generated by conventional coal plants, and gasification water use is substantially lower as well.

Underground coal gasification (UCG), a promising further advancement in IGCC would gasify the coal directly within the deep, unmineable coal seams. This process can potentially eliminate the environmental impacts of current coal mining and transportation practices, as well as significantly reduce the challenges of coal waste management.

Finally, IGCC is the key enabling technology for capture and storage of carbon dioxide from coal power generation and will be essential to meeting any reasonable climate stabilization target. While it is possible to retrofit a coal combustion plant with carbon capture technology, it is expensive and inefficient to do so today, costing twice as much for plants using bituminous coal as capturing carbon from an IGCC plant and reducing plant efficiency by as much as 40 percent. While development of more cost-effective coal-combustion carbon capture alternatives is important, current efforts are very early in the technology development stage, and it is unclear whether and when cost-effectiveness will be fully demonstrated for this technology. *If we are to turn the world coal tide to a near-zero carbon footprint in the next 20 years, IGCC power generation is likely to be the most availing path forward based on current information*.

III. Recent Market Developments

The good news about cleaner coal power and carbon capture is the many recent coal gasification market developments, nearly all of which are too new to be reflected in academic studies and many of which are being conducted by companies not well represented by Washington trade groups or research organizations. When we "look out the window" at these market developments, we see a substantially different situation than is typically presented in available studies or by traditional institutions.

Key highlights include the areas listed below. It should be noted that the coal gasification market developments described below do not reflect a complete survey of recent developments, but rather are intended to illustrate the contrast between the relatively static and out-of-date study characterizations of coal gasification technology with today's rapid pace of market development.

Emergence of New "Full System" IGCC Vendors

Prior to last summer, GE was the sole "full systems" IGCC vendor capable of offering all major IGCC components (that is, gasifier, combustion turbines and steam turbines) in a single package. Since that time, Siemens and Mitsubishi have developed full system commercial IGGC offerings, significantly expanding vendor choice for potential IGCC project developers. Siemens emerged as a full systems vendor last summer when the company acquired the Future Energy gasifier. NRG's recent selection of Mitsubishi as the technology supplier for their proposed domestic IGCC plants introduced the entry of Mitsubishi as a full systems vendor.

Emergence of New Coal Gasifiers

Up until last summer, there were only three serious commercial coal gasifier offerings: the GE (Texaco technology), ConocoPhillips (E-Gas technology) and Shell gasifiers. These gasifiers have different characteristics that affect their suitability for various coal types, with Shell appearing most suited to low-rank coals (sub-bituminous and lignite). These gasifiers are also estimated to vary significantly in cost. Nearly all IGCC studies and academic literature have been restricted to analysis of these gasifiers.

Several additional coal gasifiers have moved into the marketplace over the past year:

- The *Future Energy* gasifier, developed in the former East Germany and recently acquired by Siemens, should be well suited to low rank coals and shows promise of being quite economically competitive.
- The *British Gas Lurgi* (BGL) gasifier is an evolution of the Lurgi gasifiers used extensively in South Africa and at the Dakota Gasification plant in the U.S. This gasifier should also be well suited to low-rank coals.
- The *Mitsubishi* gasifier is partially oxygen blown, should also be well suited to low-rank coals and shows promise of being quite economically competitive.

As all three of these gasifiers are well suited to low-rank coals, they provide a much more competitive set of market offerings for projects using these coals and should reduce pre-inflation low-rank coal IGCC project costs. This point is particularly important as some critics have suggested that some conventional gasifiers are not well-suited to low rank coals, and that there may not be an economic path for low-rank coal use.

"Next Generation" IGCC Plant Development

At least four "next-generation" IGCC projects are moving forward in the U.S., in addition to the "hybrid" coal gasification plants described below. These projects are AEP's Meigs plant in Ohio and Mountaineer plant in West Virginia, Duke Energy's Edwardsport plant in Indiana and BP's Carson Refinery Hydrogen project in California.

These projects all use the most advanced available combustion turbine (for example, GE's 7FB) and are a major "scale-up" from the several IGCC plants built at refineries in Europe about 5 years ago. They are also much larger than the two early demonstration plants built in the U.S. (Wabash Station in Indiana and Polk Station in Florida) about a decade ago. These projects will typically have about 600 MW of generating capacity. The BP Carson project will use petroleum coke (a coal-like refinery waste product) and will include 90 percent carbon capture, which reduces plant output to about 500 MW. The BP Carson project will be the first commercial project in the U.S. to include and demonstrate "full" carbon capture.

Several additional "next-generation" plants may also be moving forward, but at a slower pace, including additional AEP-proposed plants in Kentucky and NRG's proposed Huntley plant in New York State.

These "next generation" plants are important for several reasons, including lower inflation adjusted costs and higher operating efficiencies. They also are driving significant detailed engineering design work, including in the case of Duke and AEP, serious engineering analysis of options for adding carbon capture to these plants at some future time, and provisions that can economically be built into the initial plant to facilitate carbon capture retrofit. The good news is that this very significant amount of engineering work will provide much more detail than is currently available on next generation costs, performance and carbon capture retrofit feasibility. The bad news is that this information remains proprietary and is not yet available in open literature.

"Hybrid" Projects

Some independent IGCC project developers like the ERORA Group and Summit Power are developing coal gasification projects that produce both electric power and substitute natural gas, typically allocating about 50 percent of the project coal syngas to each of these products. The ERORA group is developing projects in Illinois (Taylorville) and Kentucky (Cash Creek) and Summit Power is developing projects in Oregon and Texas.

These developers are pursing "hybrid" projects because they have economic advantages over next-generation "power only" IGCC plants, including reduced overall project cost, high availability—particularly in projects using several of the new Siemens gasifiers—and attractive overall project economics for power generating companies that have existing natural gas power plants by allowing them to have coal-based fuel pricing for both their new coal generation and some portion of their existing natural gas generation.

Some of these projects are close to final permitting and full financing. Several projects plan to include some carbon capture and will initially use the captured carbon for enhanced oil recovery (EOR). At least one project is exploring full carbon capture and sequestration. In many respects these projects reflect efforts by project developers to overcome current economic barriers to stand-alone IGCC plants.

Advanced Coal Gasifiers

Several innovative coal gasification technologies are conducting process demonstrations and could be commercially available within the next 2 years. Two examples among several such systems being developed include Great Point Energy's catalytic coal gasifier (a technology originally explored in the 1970s) and Texas Syngas' molten metal bath gasifier. Both technologies can potentially be produced modularly in a factory and both appear to have potential to reduce gasification costs compared with traditional gasifier designs.

Underground Coal Gasification

Underground coal gasification ("UCG") is just beginning to be recognized as a potential option for utilizing coal. UCG is a gasification process conducted in deep coal seams. Injection and production wells are drilled into the coal seam and are then linked together. Once linked, air and/or oxygen is injected and the coal is ignited in a controlled manner to produce hot, combustible coal syngas that is captured by the production wells, brought to the surface and cleaned for power generation and/or production of liquid hydrocarbon fuels or substitute natural gas. This technology has been used at a minor level since the early 2000s and DOE conducted many pilot UCG projects in the 1970s.

A successful modern pilot project was conducted about 6 years ago in Chinchilla, Australia by the Ergo Exergy Technologies, Inc. and the first modern commercial UCG electric power production project started up this January in Mpumalanga, South Africa. I understand that two commercial UCG projects producing hydrogen for chemical plants have been developed in China. The GasTech Company is developing the first North American pilot UCG project in Wyoming. The initial GasTech project will be conducted in the Powder River basin and will use a coal seam 950 feet deep. Current estimates are that the *pre-clean-up* syngas will be produced for about $1.90/mmbtu (as compared with current U.S. gas forward prices of about $8.00/mmbtu for the next several years).

UCG technology is potentially quite significant for several reasons:

1. It can avoid most of the adverse environmental impacts associated with coal mining and transportation;
2. It leaves coal residuals (ash and some other constituents) underground;
3. It can potentially reduce coal gasification costs—perhaps significantly; and

4. It can open up large amounts of deep coal reserves that are currently not economic to mine. Lawrence Livermore National Laboratory (LLNL) estimates that UCG could potentially triple domestic economic coal reserves.

5. Carbon capture costs may be somewhat lower than with above-ground gasification and a significant fraction of captured carbon can potentially be stored in the underground gasification cavities created by a UCG project.

Once this technology emerges from the pilot/demonstration stage, which will be necessary to clarify technology costs, it may be deployed rapidly if it proves to be more economic than conventional pulverized coal plants or advanced above-ground gasification system IGCC's. LLNL has recently produced a summary of current UCG knowledge that is available at *https://eed.llnl.gov/co2/11.php*.

IV. A Key Technology Gap

Developing a practical and very-low cost method of capturing carbon dioxide from existing power plant flue gases would be an enormous boost to global efforts to reduce carbon dioxide emissions and may be the only practical opportunity to significantly reduce future carbon dioxide emissions from the rapidly developing coal power plant "fleet" in China and India. Current technologies that can accomplish this task are too expensive and consume far too much energy to be practical to apply broadly throughout the world. While current research in this area is focused primarily on what are essentially incremental improvements in existing technology systems, a "break through" technology is needed. Potential "high-risk/high-reward" breakthrough technologies, like structured fluids, have been identified (in this case by MIT researchers) but there appear to be no relevant sources of Federal support for such research.

V. Challenges to Advanced Technology Deployment

Several problems are constraining rapid deployment of advanced coal gasification technologies and associated carbon capture, including the recent substantial increase in large energy project costs; the lack of an economic incentive to build IGCC projects with full carbon capture today; and Federal advanced coal research, development and deployment programs that are not adequately funded or sufficiently broad.

Recent Large Energy-Project Cost Inflation

For several reasons, including massive infrastructure development in China and very large investments in Persian Gulf oil and gas projects, the construction cost of large energy projects has significantly increased over the past two to three years. In some cases, this cost inflation may have *doubled* project costs—including some domestic proposed coal plants. While it is not clear how long costs will continue to rise or for how long they will remain inflated, it does not appear that this cost-inflation period will be short.

The current cost-inflation environment will also affect the economics of carbon capture and sequestration for new coal projects, raising the estimated costs from roughly 1.5 cents/kwh to about 2.5 cents/kWh. This suggests that if this cost environment prevails, carbon capture will begin to be economic at a carbon emissions price of about $40 per ton of CO_2, at least initially.

No Economic Incentive To Build New Coal Plants With Full Carbon Capture Today

While the technology exists to develop new coal IGCC plants with full carbon capture and sequestration today, as is being demonstrated by BP's Carson project, there is no economic basis to do so except possibly in the very few cases (like BP's Carson project) where all captured carbon can be used for enhanced oil recovery. This disincentive to adding CCS to new coal plants will continue until captured and sequestered carbon is worth roughly $40/ton of carbon dioxide.

Limitations of Federal Advanced Coal Research, Development and Demonstration Programs

We have not conducted a serious review of the relevant Federal "clean coal" research, development and demonstration programs, but we have observed several "disconnects" between such programs and both promising market activity and needed "breakthrough" technology. We note that all EPAct financial support for new IGCC projects has been awarded to next-generation commercial IGCC projects, which in nearly all cases are being proposed by large investor-owned utilities. In contrast, no innovative "hybrid" IGCC/SNG projects being developed by independent project development companies were awarded financial support. We also note that none of the promising advanced coal gasifiers being developed that we are aware of are receiving significant DOE support nor are these advanced gasifier concepts

listed in the various technology evolution "road maps" developed by DOE and others. And as we noted above, no Federal programs exist today that would provide financial support for new IGCC project developers seeking to include full carbon capture and sequestration in their projects.

MIT's Future of Coal Study reviewed current DOE clean coal research, development and demonstration programs and outlines one approach to expanding and better targeting these programs. We see MIT's proposals as a good starting point for discussion, but believe they would not be sufficient to address all research, development and demonstration gaps or "disconnects" we have observed.

VI. What Can the Federal Government Do to Accelerate Deployment of Needed Technology?

Several Federal actions could accelerate development and deployment of the advanced coal technology needed to address climate change and dramatically reduce coal's environmental impacts:

1. Establish a production tax credit or some other form of equivalent financial incentives for new coal power plants with full carbon capture and sequestration. These incentives would be in effect until a national carbon emissions reduction program has been established that creates a carbon emissions allowance price sufficient to offset carbon capture and sequestration costs. At current energy project prices, such a production tax credit would likely need to be at least 2.5 cents per kWh.

2. Establish a carbon emissions performance standard at some future date for new fossil power plants that would require significant carbon capture and sequestration for new coal power plants.

3. Establish effective carbon emissions controls.

4. Significantly expand and broaden DOE's advanced coal research development and demonstration programs.

The recent MIT Future of Coal Study outlines one approach for expanding DOE's advanced coal programs and suggests that such programs need to be funded at levels as high as $800–$900 million per year. Beyond MIT's recommendations, it would be useful to review current research and market activity in this field to identify promising technologies that are slipping through the cracks in current DOE programs to help develop more effective programs. It is also critically important that appropriate support be established for developing "breakthrough" technology in critical areas like practical, low cost carbon capture at existing power plants.

In summary, I believe that the technology we need to transition coal use to much more environmentally sustainable systems could be either deployed or developed promptly if effective Federal advanced coal technology policies were implemented.

Senator KERRY. Thank you, sir, we look forward to it.

Mr. Denis?

STATEMENT OF ROBERTO R. DENIS, SENIOR VICE PRESIDENT, SIERRA PACIFIC RESOURCES

Mr. DENIS. Thank you very much, Chairman Kerry, Members of the Committee. I'm Roberto Denis, I'm Senior Vice President of Sierra Pacific Resources, a holding company that serves the electrical needs of 1.2 million customers throughout most of Nevada.

Our company has been taking significant steps to lessen our carbon footprint, while at the same time, investing in new technologies to meet our ever-increasing demand for energy.

Nevada is a high-growth state. We have been adding about 55,000 new customers per year, at an annual growth of 5 percent, an envy in the industry.

Over the next several years, we intend to invest more than $1 billion annually to add new generating capacity, and transmission infrastructure.

In 1997, Nevada enacted one of the Nation's first renewable portfolio standard laws. As a state and as a company, we are committed to renewable energy. As evidence of this commitment, by

year-end, Sierra Pacific Resources will lead the Nation in generation of solar and geothermal energy in relation to the total electric energy sold to consumers, even exceeding California.

However, Sierra Pacific Resources cannot meet our future energy demands solely from renewable projects. We are building over 2,800 megawatts of new, efficient natural gas generation. This will cause our company to become about 75 percent dependent on natural gas for the electricity that we deliver.

Last year, we announced that we were pursuing the development of the Ely Energy Center, a four-unit coal-powered complex totaling 2,500 megawatts. The first two units will utilize the newest, commercially available, supercritical generation, highly efficient and emissions controls technology. These two units will be followed by two more Integrated Gasification Combined Cycle, or IGCC units, once those units become commercially viable.

Ely will also be the catalyst for the development of wind-to-energy in the mountains of eastern Nevada. Ely will make a $600 million, 250-mile transmission line economically possible, providing the means for wind energy to reach consumers.

It is also important to point out, as new generation is developed, Sierra Pacific Resources is decommissioning older, less efficient coal and natural gas units, a move that mitigates our CO_2 emissions. These combined actions will ensure that even when the first two coal units of the Ely Energy Center are completed, our company's carbon footprint will mirror that of a utility that burns 100 percent natural gas.

We particularly urge Congress to be mindful that the most knowledgeable source of our collective ability to capture and store CO_2, the Electric Power Research Institute, estimates that even with the most aggressive technology development actions that can be realistically contemplated, we will not have the ability to capture and sequester carbon on a commercial scale until 2020. Thus, a policy—any policy choices should recognize that our economically viable generation strategies must include clean supercritical coal generation, and when viable, IGCC.

As recognized in the recent MIT study, instead of excluding the most viable domestic energy source, we must focus on seeking technological solutions to mitigate the adverse effect of the current and future use of coal. In such regards, we're working with EPRI and 25 other utilities to fund a pilot-scale demonstration project in Wisconsin of a promising new CO_2 capture technology for pulverized coal. While integrated gasification combined cycle technology offers promise in the near-term, it has been shown to be more economic using eastern bituminous coals.

The use of IGCC with eestern sub-bituminous coals, which have different characteristics and contain higher moisture, has not yet been proven commercially viable, particularly at the higher altitude sites available in our State.

I would like to quote Dr. Bryan Hannegan's recent testimony before the Senate Energy and Natural Resources Committee. "EPRI stresses that no single advanced coal generating technology . . . has clear-cut economic advantages across the range of U.S. applications. The best strategy for meeting future electricity needs while addressing climate change concerns and economic impacts lies in

developing multiple technologies from which power producers—and their regulators—can choose the best, when suited, to local conditions and preferences."

In conclusion, innovative technological advances must be supported and encouraged to the maximum extent feasible. But, in the meantime, we should not curtail the construction of new generation needed to serve our customers. Walking away from coal-powered generation altogether would mean higher prices for consumers, and even a greater national reliance on energy imports.

We must be careful to avoid arbitrary efforts to pre-ordain winners in the race to develop new generation technologies. Our industry is large, and geographically diverse, and winners must be market-driven if we are to serve our customers well.

Thank you.

[The prepared statement of Mr. Denis follows:]

PREPARED STATEMENT OF ROBERTO R. DENIS, SENIOR VICE PRESIDENT, SIERRA PACIFIC RESOURCES

Introduction

Chairman Kerry, Senator Ensign, Members of the Committee, thank you very much for the opportunity to be with you today. My name is Roberto Denis and I'm Senior Vice President of Energy Supply for Sierra Pacific Resources, a holding company that serves most of the electrical energy needs of Nevada. Our company has been taking significant steps to lessen our carbon footprint while at the same time meeting the ever increasing demand for energy in one of fastest growing regions of the country. There are many factors that make this an especially difficult task. These involve managing the tradeoffs between renewable energy and fossil fuel plants, different fuel types, self generation versus market purchases, the commercial application of current and emerging technologies and of course, the cost of energy to our customers.

Company Profile

Sierra Pacific Resources is the holding company for two utility subsidiaries, Nevada Power Company and Sierra Pacific Power Company that provide electricity to 1.2 million electricity customers in Nevada and around the Lake Tahoe area of California. We are interconnected to the western transmission grid and are significant participants in the western power markets since we currently purchase about half the energy we deliver. It is noteworthy that Nevada was a major victim of the meltdown in the western markets several years ago when Enron and others were found to be illegally manipulating the power purchase market in California.

Our state's high growth rate is also a very important consideration. We have been adding about 55,000 new customers per year, an annual growth rate of 5 percent, which is much higher than the electric industry as a whole. Investing to meet this growth is a constant challenge. Our company owns nine power plants with a diverse mix of fuels including coal and natural gas. For 10 years, Nevada has had a renewable portfolio standard in place and we have been contracting for geothermal, wind and solar energy and expect to be making direct investments in renewable energy projects as well for years to come. Because of our state's rapid economic growth plus the hard lessons learned from being over reliant on the power purchase markets during the Enron years, Sierra Pacific Resources is committed to delivering a diverse power portfolio that protects against the volatility of fluctuating fuel costs and swings in the purchased power markets. Over the next several years we intend to invest more than $1 billion annually to add to our generating capacity and build the infrastructure necessary to support the strong growth.

Renewable Energy: An Important Source of Power

Our utility in northern Nevada, Sierra Pacific Power Company leads the Nation in use of renewable energy as a percentage of total energy consumed. In 1997, Nevada enacted one of the Nation's first Renewable Portfolio Standard (RPS) laws. It required all electric providers in the state to acquire renewable electric generation or purchase renewable energy credits so that 1 percent of the energy consumption of each utility was produced from renewable sources.

In 2001, the state amended the RPS law to become the country's most aggressive renewable portfolio standard. The law then required that 15 percent of all electricity consumed in Nevada be derived from new renewables by the year 2013, with 5 percent of that amount coming from solar energy. In June 2005, the Nevada legislature extended the deadlines and raised the requirements of the RPS to 20 percent of sales by 2015. The bill also allows utilities to receive credits toward meeting the state's RPS by investing in certain energy efficiency measures capped at one-quarter of the total standard in any particular year. The law phases in the renewable energy commitment over time as follows: 9 percent by 2007, increasing to 12 percent by 2009, 15 percent by 2011, 18 percent by 2013 and 20 percent by 2015.

We are committed to renewable energy and believe that such investment needs to be stimulated; in that regard, we call upon Congress to extend the Investment Tax Credit (ITC) and the Production Tax Credit (PTC) for all types of renewable energy for at least 8 years and to remove the outdated provision which excludes utilities from participating in the ITC for renewables. This nation needs the financial strength of the Nation's utility industry if we are to substantially attract the investment of large sums of capital to renewable energy.

This year, state regulators approved three new geothermal contracts that will bring an additional 73 megawatts of renewable energy to our customers. Two major Nevada solar projects, including the largest solar thermal plant built anywhere in the past 15 years, will this year begin delivering a total of 74 megawatts of power. Just this past Monday, I attended an event at Nellis Air Force Base in Las Vegas celebrating the beginning of construction for the largest solar photovoltaic system ever to be built in North America. I can assure that our company, in cooperation with our state leaders, is doing everything possible to be at the forefront of renewables development. By year end, Sierra Pacific Resources will lead the Nation in the generation of solar and geothermal energy in relation to total electric energy consumed.

Energy Conservation Programs

Sierra Pacific Resources places a high priority on helping our customers conserve energy. It is our goal to achieve 50 percent of our energy savings from our residential customers. Our demand side management (DSM) program will result in the installation of 2 million compact fluorescent light bulbs each year. This is accomplished through a buy down subsidy we provide local retailers who sell these energy saving light bulbs. We perform energy efficiency audits for our customers and help almost 23,000 per year to improve the efficiency of residential AC units. We continue to work with the gaming properties to convert the bright lights along the famous Las Vegas strip to efficient lighting. We have a program to improve energy efficiency of swimming pools and outdoor water features. One-quarter of the RPS goal of 20 percent by 2015 may come from DSM programs. Below is a projection of our DSM goals by company.

Includes Both Sierra Pacific Power Company and Nevada Power Company

	2007	2008	2009
Budget	36,553,000	45,265,000	44,886,000
MWh Saved	205,220	242,417	233,750
Sales MWh	28,771,765	29,639,965	30,756,233
Customers	1,127,132	1,160,946	1,195,774
$/Customer	$32.43	$38.99	$37.53
kWh Save as % of Sales	0.71%	0.82%	0.76%

Fossil Fueled Generation

Despite years of experience coupled with one of the most aggressive renewable energy programs in the nation, it must be noted that Sierra Pacific Resources cannot meet our future energy demands solely from new wind, solar or geothermal. By 2008, we expect to be about 75 percent reliant on natural gas as the source of fuel for the power we sell. This dependence is due to the addition of more than 2,800 megawatts of new, efficient combined cycle natural gas generation. We are concerned however about the price stability of natural gas which was the fuel choice for the majority of new power plant additions during the past decade.

Ely Energy Center

Last year we announced that we were pursuing the development of the Ely Energy Center, a four unit coal power complex totaling 2,500 megawatt in eastern Nevada. This facility will utilize the newest high efficiency, supercritical boilers, water

saving dry cooling and the latest emission-control technologies. The first two, 750-megawatt units located near Ely, Nevada will not be completed until 2011 and 2013, respectively. The project is an important part of our company's ongoing strategy to maintain a balanced energy portfolio that is in the best interests of the state. Ely will also be the catalyst for the development of more renewable energy resources (particularly wind energy in the mountains of eastern Nevada) by providing transmission access to northern and southern Nevada via a proposed 250-mile transmission line between our two companies. This transmission line that would not be economically justifiable to serve a stand alone renewable energy project. Therefore, this project and its associated transmission should provide the opportunity to develop additional renewable projects that would not otherwise be developed in Nevada.

It also is important to point out that, as new generation is developed, Sierra Pacific Resources is decommissioning older, less-efficient coal and natural gas plants, a move that conserves the use of natural resources and mitigates our CO_2 emissions. After the Ely facility is built, we are planning to retire three aging coal units at the Reid Gardner Station in southern Nevada. And, with the anticipation of Ely, Nevada Power will not participate in efforts to restart the coal-fired Mohave power plant that was shuttered in 2006. These actions combined with the aggressive development of renewables will insure that even when the first two units of the Ely Energy Center are completed, our company's carbon footprint will mirror that of a utility that burns 100 percent natural gas.

Climate Change Legislation

As you can tell, we at Sierra Pacific Resources have not been waiting for Congress to impose carbon controls before we developed our own carbon mitigation and reduction program. In addition to striving to meet a 20 percent RPS goal and replacing our older natural gas units with highly efficient combined cycle plants and building new state-of-the-art supercritical coal units, we have also implemented aggressive energy conservation programs. All of these measures will be needed if we are to face the challenge. Like Sierra Pacific Resources, many other utilities in the Nation are also moving to implement carbon reduction strategies.

Should Congress eventually conclude however that these voluntary efforts are not sufficient; we would favor Federal legislation which imposes an economy-wide approach to carbon control with trading mechanisms for allowance distribution. Should Congress impose a cap and trade regime as is reflected in most of the legislation that has been introduced, we believe that caps must be applied with great care to avoid inequitable distribution of carbon allowances.

As the fastest growing state for nineteen of the past twenty years and with expected high growth anticipated far into the future, a simple cap would, relative to other states, severely and unfairly disadvantage Nevada's economy. Additionally, Nevada has for many years imported a large proportion of its electricity. After the serious market disaster created by the California energy crisis and with all western states growing far faster than the electric supply can accommodate, it is clear that consideration must be given in any capping mechanism to both the historic use of carbon by a utility (really by a group of customers) (whether self generated or not) and the growth of the state's economy. If Congress adopts a cap and trade system, it must allocate carbon emission allowances for growth states (as was done for SO_2 allowances in the 1990 Clean Air Act Amendments) and for power purchased and not just self generated. CO_2 emission allowances must be distributed taking into account both historic and projected use of carbon.

CO_2 Capture and Sequestration and IGCC Technologies

We particularly urge the Congress to be mindful that the most knowledgeable source about our collective ability to capture and store CO_2, the Electric Power Research Institute (EPRI), estimates that even with the most aggressive technology development actions that can be realistically contemplated, there will be *no* ability to effectively capture and sequester carbon until at least 2020.

Thus, any policy choices that may be made by the Congress should recognize that *every* economically viable set of generation strategies to serve the electric needs of the U.S. economy until then must include coal, clean supercritical coal or when viable, IGCC. As recognized in the recent MIT study, instead of excluding the most viable domestic energy source, we must focus on seeking technological solutions to mitigate any adverse effect of the current and future use of coal.

Much has been said of the recent MIT study on the future of generation in a carbon constrained world. It is important to remember that the MIT study did *not* recommend that the United States should stop building coal-fired generation. Its conclusion, with which we agree, was that new coal units must utilize the best commer-

cially available technologies and must be built to accommodate retrofits when new large scale carbon capture and sequestration (CCS) technologies are demonstrated feasible. Our new Ely coal complex will do just that. The first two units are being designed so that when CCS is available we will have a physical facility that can be retrofitted to enable us to capture the CO_2 and identified the land for a CO_2 storage site. Additionally, we are working with the Electric Power Research Institute (EPRI) and 25 other utilities to fund a pilot-scale demonstration project in Wisconsin of a promising new CO_2 capture technology for pulverized coal units. American Electric Power has already announced plans for scale-up of this technology at two of its coal-fired plants in West Virginia and Oklahoma. We hope we will be able to deploy these emerging technologies by the time the final two units of our Ely complex are scheduled to be constructed.

While integrated gasification combined cycle (IGCC) offers promise in the near term, it has been shown to be more economic using eastern bituminous coals. The use of IGCC with western subbituminous coals which have different characteristics and contain higher moisture has not yet been proven commercially viable. Quoting from recent testimony given by EPRI's Mr. Stuart Dalton:

> "The COE cost premiums . . . vary in real-world applications, depending on available coals and their physical-chemical properties, desired plant size, the CO_2 capture process and its degree of integration with other plant processes, plant elevation, the value of plant co-products, and other factors. Nonetheless, IGCC with CO_2 capture generally shows an economic advantage in studies based on low-moisture bituminous coals. For coals with high moisture and low heating value, such as subbituminous and lignite coals, a recent EPRI study shows PC with CO_2 capture being competitive with or having an advantage over IGCC." [1]

The Piñon Pine Clean Coal Technology Project

Indeed, Sierra Pacific has a history with gasification of coal. In 1992, near Reno, we partnered with U.S. Department of Energy in one of the few western Clean Coal Technology Projects. The Piñon Pine Project attempted to extract synthetic gas from coal under pressure and burn the synthetic gas stream in gas fired turbines. Because of significant challenges, the Piñon Pine Project was not completed until late 2001 and at a cost of $335 million. It was never able to operate commercially because of problems we encountered with the first-of-a-kind technologies used in the plant. Ultimately, the plant was abandoned and converted to a pure natural gas facility. Our company ventured and lost millions of dollars on this experiment.

I would like to quote from Dr. Bryan Hannegan's recent restimony before the Senate Energy and Natural Resources Committee given on March 22, 2007. In expressing EPRI's view on the MIT report he said:

> "EPRI stresses that no single advanced coal generating technology (or any generating technology) has clear-cut economic advantages across the range of U.S. applications. The best strategy for meeting future electricity needs while addressing climate change concerns and economic impact lies in developing multiple technologies from which power producers (and their regulators) can choose the one best suited to local conditions and preferences."

I would also like to submit with my testimony a copy of the EPRI report entitled "Technologies for a Carbon Constrained World" that was first released to the public in February 2007.

[This information is being retained in Committee files.]

Conclusion

Clearly, innovative technological advances must be supported and encouraged and successful outcomes must be embraced, but in the meantime we should not stop the development of new generation needed to serve customers today and in the immediate future. Walking away from coal-powered generation altogether would mean higher prices for consumers and an even greater national reliance on energy imports. Our nation's energy independence must include the use of coal, our most plentiful energy resource, in the production of new, environmentally responsible electric generation. We must be careful to avoid arbitrary efforts to pre-ordain winners in the race to develop new generation technologies. Ours is a large and geographically diverse industry and winners must be market driven if we are to best serve our customers. We believe this is an appropriate and responsible approach to addressing

[1] EPRI House Testimony Carbon Capture and Sequestration, March 6, 2007 (Subcommittee on Energy and Air Quality).

environmental concerns while keeping our commitment to deliver reliable power to our customers. Thank you.

Senator KERRY. Thank you very much, Mr. Denis.
Dr. McRae?

STATEMENT OF GREGORY J. MCRAE, HOYT C. HOTTEL PROFESSOR OF CHEMICAL ENGINEERING, DEPARTMENT OF CHEMICAL ENGINEERING MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Dr. MCRAE. Senator Kerry and members of the Committee, thank you very much for this opportunity to address you on this important topic.

My name is Greg McRae, I am a Professor of Chemical Engineering at MIT, and I'm one of the co-authors of the recent MIT report on the future of coal, where we set out to address what are the issues about how we might burn this fuel in an environmentally responsible way.

Our study involved many colleagues from across MIT, as well as advisory groups from outside of MIT, in fact, our first panelist Joe Chaisson was, in fact, a member of one of our advisory committees.

The key premise that drove our report was, in fact, the need to think about global climate, and warming, and the need to think about—by mid-century—that we're going to have to sequester several gigatons of carbon, or carbon dioxide. The size of the problem is enormous, and one of the things that we were interested in is how do we actually go about developing a strategy for coping with these problems.

A key conclusion, and you touched on it in your introduction, is that coal is an important part of this problem. And while we fully support and are actively involved in a lot of developments associated with solar and wind and biomass conversion, the key issue is that in order to meet our energy demands today, in fact, there are very few other fuel sources that we can supply at scale, other than coal. And so the key question is, how do we use this important fuel in an environmentally friendly way?

And so, we believe that there are two crucial issues that need to be addressed in order to use coal as a fuel in the future. The first is the issue of sequestration. Our belief is that there's a critical need for demonstration projects at scale to show that you can safety store and capture CO_2 in a way that imposes no risk to the community. We believe that most of the technology that's available to do this exists already, what's missing is the opportunity to do it at scale.

And just to give you a sense of the size of the problem, a typical 500 megawatt coal-fired power plant will produce about ten to twelve thousand tons a day of carbon dioxide, that's roughly 4 million tons a year. There are about, roughly, 500 power plants of this size in the United States. The biggest sequestration experiment that's going on right now is less than 1 million tons a year. And so, in order to be able to develop the regulatory framework, the monitoring framework, and to build public confidence that you can safely mitigate and store carbon, we believe that it's crucial that we immediately start to look at three or four demonstration projects at scale, in the order of a million tons per year.

We view this as an important investment—almost as an insurance policy—because this provides us with the information and data that we will need to build these systems at scale over the longer time period.

The second part associated with sequestration is the issue of capture of CO_2 in the first place. And again, while we believe that many of the existing technology exists to be able to do that, and there are exciting developments taking place on a daily basis, again, we believe that these should be done at scale. We do not believe that focusing on IGCC *per se* is the right way to go.

We, in fact, think that we need to look at a spectrum of technologies from pressurized oxified combustion processes, chemical looping combustion systems—there are many, many other technologies that are potentially out there that could significantly lower the cost of CO_2 capture, but the issue is how to do it at scale. And, we believe that, again, that you need demonstration projects to show that you can, in fact, capture CO_2 at that scale.

The third point is that we basically need to put the two pieces of the problem together—how do you actually capture CO_2 at scale, and how do you sequester it at scale? And, again, our belief is that the demonstration project should be supported with adequate monitoring, so that the data that's going to be available to help, builds public confidence that this is a viable option for mitigating carbon in the future.

We believe that there are many opportunities for the United States to become leaders in the supply of this important technology to the rest of the world. These, and many other, topics are discussed in our report, and I thank you very much for the opportunity to discuss these this morning. Thank you.

[The prepared statement of Dr. McRae follows:]

PREPARED STATEMENT OF GREGORY J. MCRAE, HOYT C. HOTTEL PROFESSOR OF CHEMICAL ENGINEERING, DEPARTMENT OF CHEMICAL ENGINEERING, MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Senator Kerry and Members of the Committee, good morning and thank you for the opportunity to address you on this important topic. My name is Gregory McRae and I am a professor of chemical engineering at the Massachusetts Institute of Technology. In addition to my research and teaching on energy and environmental issues I am also one of the co-authors of the recent MIT Report called the *Future of Coal—Options for a Carbon Constrained World*.[1] This study involved eleven colleagues from various disciplines at MIT as well as an external advisory group that represented diverse perspectives on the problem. This morning I would like to draw your attention to a few of the key recommendations from the report related to clean coal technology.

Four key premises drove our study:

1. There is a pressing need to address the global warming problem. The risks are real and the United States and other governments should take action to restrict the emissions of carbon dioxide (CO_2) and other greenhouse gases (GHG).[1,2]

2. Our second and equally important premise is that coal will continue to play a large and indispensable role in a greenhouse gas constrained world because it is cheap, abundant, and in the short term one of the fuel sources that can meet, at scale, the growing demands for electricity.

3. We believe that CO_2 capture and sequestration (CCS) are the critical enabling technologies that would significantly reduce CO_2 emissions associated with coal combustion. Much of the needed technology exists (CO_2 capture, transport and storage) but there is a critical need for several large scale demonstra-

tion projects to give policymakers and the public confidence that a practical carbon mitigation control option exits.

4. A key conclusion based on experience in other RD&D programs is that the government should not pick a "technology winner" *per se,* but rather create an environment that will enable the development of a diverse range of cost effective options to reduce green house gas emissions.

These and other issues are discussed in much more detail in.[1] In this morning's testimony I will focus on two key technical recommendations related to the future use of coal.

The Driving Force for Change

The risk of adverse climate change from global warming is serious forced in part by growing greenhouse gas emissions. While projections vary, there is now wide acceptance among the scientific community that global warming is occurring, that the human contribution is important, and that the effects may impose significant costs on the world economy. As a result, governments are likely to adopt carbon mitigation policies that will restrict CO_2 emissions; many developed countries have taken the first steps in this direction. For such carbon control policies to work efficiently, national economies will need to have many options available for reducing greenhouse gas emissions. *The Future of Coal* [1] addresses one option, the continuing use of coal with reduced CO_2 emissions.

Coal is an especially crucial fuel in this uncertain world of future constraint on CO_2 emissions. Because coal is abundant and relatively cheap ($1–$2 per million Btu, compared to $6–$12 per million Btu for natural gas and oil)—it is often the fuel of choice for electricity generation, and perhaps for extensive synthetic liquids production in the future in many parts of the world. Its low cost and wide availability make it especially attractive in major developing economies for meeting their pressing energy needs. On the other hand, coal faces significant environmental challenges in mining, air pollution (including both criteria pollutants and mercury) and importantly, emissions of carbon dioxide (CO_2). Indeed coal is the largest contributor to global CO_2 emissions from energy use (41 percent), and its share is projected to increase.

The U.S. has 27 percent of the total global recoverable coal reserves, enough for about 250 years at current consumption. Over 50 percent of U.S. electricity was generated from coal last year. It is important to understand the magnitude of CO_2 emissions associated with power generation. A single 1,000 MW_e coal-based power plant emits between 5 and 8 million tonnes of CO_2 per year. A few statistics give a sense of the enormity of the challenge.[4]

- There are the equivalent of more than five hundred 500 megawatt, coal-fired power plants in the United States with an average age of 35 years.
- China is currently constructing the equivalent of two 500 megawatt, coal-fired power plants per week, a capacity comparable to the entire U.K. power grid each year.
- At present the largest sequestration project is injecting one million tons/year of carbon dioxide (CO_2) from the Sleipner gas field into a saline aquifer under the North Sea.

By mid-century, given the expectation that coal use will grow substantially, the annual sequestration of several gigatonnes of carbon dioxide is the scale needed for a major impact on climate change mitigation,. This translates into sequestration of the CO_2 emissions from many hundreds of utility scale plants worldwide. Each plant will need to capture millions of metric tonnes of CO_2 each year. Over a fifty-year lifetime, one such plant would inject about a billion barrels of compressed CO_2 for sequestration [5,6]

Recommendation 1—Large Scale Demonstration of Carbon Dioxide Capture and Storage (CCS)

Carbon dioxide capture and sequestration (CCS) is the critical enabling technology that would reduce CO_2 emissions significantly, while also allowing coal to meet the world's pressing energy needs. What is needed is a successful large-scale demonstration of the technical, economic, and environmental performance of the technologies that make up all of the major components of a large-scale integrated CCS system—capture, transportation, and storage.

We have confidence that megatonne scale injection at multiple well-characterized sites can start safely now, but an extensive program is needed to establish public confidence in the practical operation of large scale sequestration facilities over ex-

tended periods, and to demonstrate the technical and economic characteristics of the sequestration activity.[1,6]

An important additional objective of the demonstration program is to create an explicit and rigorous regulatory process that gives the public and political leaders confidence in effective implementation of very large scale sequestration. A regulatory framework needs to be defined for sequestration projects, including site selection, injection operation, and eventual transfer of custody to public authorities after a period of successful operation.

Present government and private sector sequestration projects are inadequate to demonstrate the practical implementation of large scale sequestration on a timely basis.

Thus, we believe that the highest priority should be given to a program that for demonstrating CO_2 sequestration at megatonne scale in several geologies, following "bottom-up" site characterization. For the United States, this means about three megatonne/year projects with appropriate modeling, monitoring and verification (MMV), focusing on deep saline aquifers. Each demonstration project should last about eight to 10 years. We estimate the cost for the total program to be about $500M over a decade, not including the cost of CO_2 acquisition. The CO_2 costs are likely to be considerable and highly variable depending on the acquisition strategy (natural reservoirs, capture from existing plants, supply from large scale demonstrations of new coal combustion and conversion plants).[1,6]

We estimate that for new plant construction, a CO_2 emission price of approximately $30/tonne (about $110/tonne C) would make CCS cost competitive with coal combustion and conversion systems without CCS. This would be sufficient to off set the cost of CO_2 capture and pressurization (about $25/tonne) and CO_2 transportation and storage (about $5/tonne). This estimate of CCS cost is uncertain; it might be larger and with new technology, perhaps smaller.

The pace of deployment of coal-fired power plants with CCS depends both on the timing and level of CO_2 emission prices and on the technical readiness and successful commercial demonstration of CCS technologies. The timing and the level of CO_2 emission prices is uncertain. However, there should be no delay in undertaking a program that would establish the option to utilize CCS at large scale in response to a carbon emission control policy that would make CCS technology economic. Sequestration rates of one to two gigatonnes of carbon (nearly four to eight gigatonnes of CO_2) per year by mid-century will enable appreciably enhanced coal use and significantly reduced CO_2 emissions.

In addition to the value of the scientific and engineering data that will emerge from this sequestration demonstration program, we should not underestimate the value of demonstrating the ability to successfully manage the program over an extended time. Such practical implementation experience will be important for public confidence in committing to very large sequestration over many decades.

Our highest priority recommendation is that as soon as possible the Congress, the Department of Energy, and other private and public sector entities work to launch a sequestration demonstration program with the characteristics identified above, including those associated with development of the regulatory system. A sense of urgency has been absent and this needs to change.

Recommendation 2—Avoid Picking "Technology Winners"

Our second recommendation is for the U.S. Government to provide incentives to several alternative coal combustion and conversion technologies that employ CCS. At present, integrated gasification combined cycle (IGCC) is the leading candidate for electricity production with CO_2 capture because it is estimated to have lower cost than pulverized coal with capture. For lower rank coals this choice may not be so clear, particularly as the traditional CO_2 capture technology continues to improve.

Thus, it is too early to declare IGCC the winner for all situations at this time.[1,5] History teaches us that one single technology is almost never the winner in every situation. However, neither IGCC nor other coal technologies have been demonstrated with CCS at large scale. CO_2 capture will add significantly to the Cost of Electricity (COE), independent of which approach is taken.

It is critical that the government RD&D program not pick a technology "winner" especially at a time when there is great coal combustion and conversion development activity underway in the private sector in both the United States and abroad. Approaches with capture other than IGCC could prove as attractive with further technology development for example, oxygen-fired pulverized coal combustion, especially with lower quality coals. Of course, there will be improvements in IGCC as well. R&D is needed on sub-systems, for example on improved CO_2 separation techniques for both oxygen and air driven power systems and for oxygen separation from air. The technology program would benefit from an extensive modeling and simula-

tion effort in order to compare alternative technologies and integrated systems as well as to guide development. Novel separation schemes such as chemical looping should continue to be pursued at the process development unit (PDU) scale. The reality is that the diversity of coal type, *e.g.,* heat, sulfur, water, and ash content, imply different operating conditions for any application and multiple technologies will likely be deployed.

The U.S. Department of Energy (DOE) program needs considerable strengthening and diversification in looking at a range of basic enabling technologies that can have major impact in the years ahead, particularly in lowering the cost of coal use in a carbon-constrained world. This work needs to be done at laboratory or process development unit scale, not as part of large integrated system demonstrations. A significant increase in the DOE coal RD&D program is called for, as well as some restructuring.

Government assistance is needed for a portfolio of coal combustion and conversion demonstration projects with CO_2 capture—IGCC, oxyfuel retrofits, new combustion technologies, coal to synthetic natural gas, chemicals and fuels are examples. Given the technical uncertainty and the current absence of a carbon dioxide emissions charge, there is no economic incentive for private firms to undertake such projects at any appreciable scale. The DOE coal program is not on a path to address our priority recommendations namely—enabling technology, sequestration demonstrations, coal combustion and conversion demonstrations with capture. The level of funding falls far short of what is required and perhaps as a result the program is imbalanced.

The flagship project FutureGen is consistent with our priority recommendation to initiate integrated demonstration projects at scale. However, we are concerned that the project needs more clarity in its objectives. Specifically, a project of this scale and complex system integration should be viewed as a demonstration of commercial viability at a future time when a meaningful carbon policy is in place. Its principal call on taxpayer dollars is to provide information on such commercial viability to multiple constituencies, including the investment community. To provide high fidelity information, it needs to have freedom to operate in a commercial environment.

We believe that the Congress should work with the Administration to clarify that the project objectives are commercial demonstration, not research, and reach an understanding on cost-sharing that is grounded in project realities and not in arbitrary historical formulas. In thinking about a broader set of coal technology demonstrations, including the acquisition of the CO_2 needed for the sequestration demonstration projects, we suggest that a new quasi-government corporation should be considered.

The 2005 Energy Policy Act contains provisions that authorize Federal Government assistance for coal plants containing advanced technology projects with or without CCS. We believe this assistance should be directed only to plants with CCS, both new plants and retrofit applications on existing plants.

Recommendation 3—Regulatory Action

Success at capping CO_2 emissions ultimately depends upon adherence to CO_2 mitigation policies by large developed and developing economies. We see little progress to moving toward the necessary international arrangements. Although the European Union has implemented a cap-and-trade program covering approximately half of its CO_2 emissions, the United States has not yet adopted mandatory policies at the Federal level. U.S. leadership in emissions reduction is a likely prerequisite to substantial action by emerging economies. Recent developments in the American business sector and in Congress are encouraging.

A more aggressive U.S. policy appears in line with developing public attitudes. Our study has polled the American public, following a similar poll conducted for the earlier MIT study on nuclear power. Americans now rank global warming as the number one environmental problem facing the country, and seventy percent of the American public think that the U.S. Government needs to do more to reduce greenhouse gas emissions. Willingness to pay to solve this problem has grown 50 percent over the past 3 years.

Conclusion

In conclusion the central message of the MIT study on the *Future of Coal* is that demonstration of technical, economic, and institutional features of carbon capture and sequestration at commercial scale coal combustion and conversion plants, will (1) give policymakers and the public confidence that a practical carbon mitigation control option exists, (2) shorten the deployment time and reduce the cost for carbon capture and sequestration should a carbon emission control policy be adopted, and (3) maintain opportunities for the lowest cost and most widely available energy form

to be used to meet the world's pressing energy needs in an environmentally acceptable manner.

Mr. Chairman, thank you again for inviting my testimony on this important topic.

References

1. *The Future of Coal—Options for a Carbon Constrained World,* Massachusetts Institute of technology, 2007. (See the website *http://web.mit.edu/coal* for the report and the executive summary).

2. Ernest J. Moniz and John M. Deutch, *Hearing on the MIT Interdisciplinary Study: The Future of Coal, Options for a Carbon-Constrained World,* Comments made to the Senate Committee on Energy and Natural Resources, 22 March 2007, Washington, D.C.

3. *Intergovernmental Panel on Climate Change, Climate Change 2007: The physical science basis, Summary for Policy makers, http://www.ipcc.ch/.*

4. A few statistics from [1] that illustrate the scale of the problem.

- 50 percent of the electricity generated in the U.S. is from coal.
- Today fossil sources account for 80 percent of energy demand: Coal (25 percent), natural gas (21 percent), petroleum (34 percent), nuclear (6.5 percent), hydro (2.2 percent), and biomass and waste (11 percent). Only 0.4 percent of global energy demand is met by geothermal, solar and wind.
- There are the equivalent of more than five hundred, 500 megawatt, coal-fired power plants in the United States with an average age of 35 years.
- China is currently constructing the equivalent of two, 500 megawatt, coal-fired power plants per week and a capacity comparable to the entire U.K. power grid each year.
- One 500 megawatt coal-fired power plant produces approximately 3 million tons/year of carbon dioxide (CO_2).
- The United States produces about 1.5 billion tons per year of CO_2 from coal-burning power plants.
- At present the largest sequestration project is injecting one million tons/year of carbon dioxide (CO_2) from the Sleipner gas field into a saline aquifer under the North Sea.

5. James R. Katzer, *Coal-Based Power Generation with CO_2 Capture and Sequestration,* Comments made to the Senate Committee, on Commerce, Science, and Transportation, Science, Energy, and Innovation Subcommittee, March 20, 2007, Washington, D.C.

6. Julio Friedmann, *Technical Feasibility of Rapid Deployment of Geological Carbon Sequestration,* Comments made to the House Energy and Commerce Committee, Energy and Air Quality Subcommittee. 2007: Washington, D.C.

Senator KERRY. Well, we welcome it. Thank you very much.

Mr. Rencheck?

STATEMENT OF MICHAEL W. RENCHECK, SENIOR VICE PRESIDENT—ENGINEERING, PROJECTS, AND FIELD SERVICES, AMERICAN ELECTRIC POWER

Mr. RENCHECK. Good morning, Mr. Chairman and Members of the Committee. Thank you for inviting me to participate in this hearing.

I am Mike Rencheck, Senior Vice President of Engineering, Projects, and Field Services for American Electric Power.

American Electric Power is one of our nation's largest utilities with more than 5 million customers in 11 states. We are also one of the Nation's largest power generators, with more than 38,000 megawatts of generating capacity from a diverse fleet.

But of particular note for today, AEP is one of the largest coal-fired generators in the U.S., and we have implemented a portfolio of voluntary actions to reduce and avoid and offset greenhouse gases during the past decade.

Coal generates over 50 percent of the electricity used in the U.S., and is extensively used worldwide. As the demand for electricity increases significantly, coal use will increase as well. In the future, coal-fired electric generation must be zero emission, or near-zero emission. This will be achieved through new technologies that are being developed today, and are not yet commercially proven, or commercially available. Like most companies in our sector, AEP needs new generation. We are investing in a new clean coal technology that will enable AEP, and our industry, to meet the challenge of reducing greenhouse gases in the near-term, and for the long-term. This includes plans to build new, integrated gasification combined cycle plants, IGCC plants, and two state-of-the-art, ultra supercritical coal units. These will be the first of the new generation of ultra supercritical plants in the U.S.

AEP is also taking the lead in commercializing carbon capture technology for use on new generation, and more importantly, for retrofitting the existing generation fleet.

We signed a Memorandum of Understanding with Alstom for post-carbon capture combustion technology, using Alstom's chilled ammonia system. Starting with a commercial performance verification project in mid- to late-2008 in West Virginia—a project that will also include storage and capture of carbon dioxide in a saline aquifer, we will move then—after that's completed—to the first commercial-size project at one of our 450-megawatt coal plants, our Northeastern plant, in Oklahoma, in 2011.

This would capture about 1.5 million metric tons of CO_2 a year, which will be used for enhanced oil recovery. We are also working with Babcock & Wilcox to take its oxy-coal combustion technology from the drawing board, to a commercial-scale application in the next decade.

AEP is very comfortable leading the way on technology. We have had a long and impressive list of technological firsts during our first 100 years, being in existence. But, we have identified one very important caveat during our century of technological achievement, and engineering excellence—providing a technology to be commercially viable, and having that technology ready for widespread commercial use, are two very different things. It takes time to develop off-the-shelf commercial offerings for technology to be widely deployed.

AEP is not calling for an indefinite delay in the enactment of mandatory climate change legislation until advanced technology, such as carbon capture and storage is developed, however, as the requirements become more stringent during the next 10 to 20 years, and we move beyond the ability of current technology to deliver those reductions, it is essential that requirements for deeper reductions allow sufficient time for the demonstration and commercialization of technologies.

How can you help? It is also important to establish specific public funding, as well as incentives for private funding, for the development of commercially viable technology solutions, as well as providing the legal and regulatory structures to facilitate development.

AEP believes that IGCC and carbon capture technology need to be advanced, but the building of IGCC and the timely development

of commercially viable carbon capture technologies will require additional public funding.

AEP and others in our sector have already invested heavily in the research and early development of the technologies that may eventually be commercially viable solutions to address greenhouse gases. For this reason, separate investment tax credits are needed to facilitate both construction of IGCC plants now, and the development of carbon capture technologies for future use.

Of significance here, the final decider on the type of power generation that can be built in many states is the public utility commission of that state. That commission determines how, or if, a utility can recover the cost of new generation, or retrofits of existing generation.

How do you reconcile a Federal mandate for expensive greenhouse gas mitigation with states that desire to cap energy costs? The utilities and their shareholders remain caught in the middle, and need your help to research, develop, and build this type of generation.

American industry has long been staffed by excellent problem solvers, I am confident that we will be able to develop technologies to efficiently address emissions of greenhouse gases, in an increasingly cost-effective manner. We have the brain power, we need time, funding assistance, and legal and regulatory support.

Thank you very much.

[The prepared statement of Mr. Rencheck follows:]

PREPARED STATEMENT OF MICHAEL W. RENCHECK, SENIOR VICE PRESIDENT—ENGINEERING, PROJECTS, AND FIELD SERVICES, AMERICAN ELECTRIC POWER

Good morning, Mr. Chairman and distinguished Members of the Senate Subcommittee on Science, Technology, and Innovation.

Thank you for inviting me here today. Thank you for this opportunity to offer the views of American Electric Power (AEP) and for soliciting the views of our industry and others on climate change technologies.

My name is Mike Rencheck, Senior Vice President—Engineering, Projects and Field Services of American Electric Power (AEP). Headquartered in Columbus, Ohio, we are one of the Nation's largest electricity generators—with over 36,000 megawatts of generating capacity—and serve more than five million retail consumers in 11 states in the Midwest and south central regions of our Nation. AEP's generating fleet employs diverse sources of fuel—including coal, nuclear, hydroelectric, natural gas, and oil and wind power. But of particular importance for the Committee members here today, AEP uses more coal than any other electricity generator in the Western hemisphere.

AEP's Technology Development

Over the last 100 years, AEP has been an industry leader in developing and deploying new technologies beginning with the first high voltage transmission lines at 345 kilovolt (kV) and 765 kV to new and more efficient coal power plants starting with the large central station power plant progressing to supercritical and ultrasupercritical powers plants. We are continuing that today. We implemented over 11 selective catalytic reactors (SCRs), 9 Flue Gas Desulphurization units with others currently under construction, and we are a leader in developing and deploying mercury capture and monitoring technology. In addition, we continue to invest in new clean coal technology plants and R&D that will enable AEP and our industry to meet the challenge of significantly reducing GHG emissions in future years. For example, AEP is working to build two new generating plants using integrated gasification combined cycle (IGCC) technology in Ohio and West Virginia, as well as two highly efficient new generating plants using the most advanced (*e.g.,* ultrasupercritical) pulverized coal combustion technology in Arkansas and Oklahoma. We are also supporting a leading role in the FutureGen project, which once completed, will be the world's first near-zero CO_2 emitting commercial scale coal-

fueled power plant. We are also working to progress specific carbon capture and storage technology.

AEP's Major New Initiative to Reduce GHG Emissions

Just this past month, AEP announced several major new initiatives to reduce AEP's GHG emissions and to advance the commercial application of carbon capture and storage technology and oxy-coal combustion. Our company has been advancing technology for the electric utility industry for more than 100 years. AEP's recent announcement continues to build upon this heritage. Technology development needs are often cited as an excuse for inaction. We see these needs as opportunities for action.

AEP has signed a memorandum of understanding (MOU) with Alstom, a worldwide leader in equipment and services for power generation, for post-combustion carbon capture technology using Alstom's chilled ammonia system. It will be installed at our 1,300-megawatt Mountaineer Plant in New Haven, W.Va. as a "30-megawatt (thermal) commercial performance verification" project in mid to late 2008 and it will capture up to 100,000 metric tons of carbon dioxide (CO_2) per year. Once the CO_2 is captured we will store it. The Mountaineer site has an existing deep saline aquifer injection well previously developed in conjunction with DOE and Battelle. Working with Battelle and with continued DOE support, we will use this well (and develop others) to store and further study CO_2 injection into deep geological formations.

Following the completion of commercial verification at Mountaineer, AEP plans to install Alstom's system on one of the 450-megawatt coal-fired units at its Northeastern Plant in Oologah, Oklahoma, as a first-of-a-kind commercial demonstration. The system is expected to be operational at Northeastern Plant in late 2011, capturing about 1.5 million metric tons of CO_2 a year. The CO_2 captured at Northeastern Plant will also be used for enhanced oil recovery.

AEP has also signed an MOU with Babcock and Wilcox to pursue the development of oxy-coal combustion that uses oxygen in lieu of air for combustion, which forms a concentrated CO_2 post combustion gas that can be stored without additional post combustion capture processes. AEP will work with B&W on a "30-megawatt (thermal) pilot project in mid-2007 then use the results to study the feasibility of a scale 100–200 Mw demonstration." The CO_2 from the demonstration project would be captured and stored in a deep saline or enhanced oil recovery application.

Just last month, AEP voluntarily committed to achieve an additional five million tons of GHG reductions annually beginning in 2011. We will accomplish these reductions through a new AEP initiative that will add another 1,000 Mw of purchased wind power into our system, substantially increase our forestry investments (in addition to the 62 million trees we have planted to date), as well as invest in domestic offsets, such as methane capture from agriculture, mines and landfills.

AEP Perspectives on a Federal GHG Reduction Program

While AEP has done much, and will do much more, to mitigate GHG emissions from its existing sources, we also support the adoption of an economy-wide cap-and-trade type GHG reduction program that is well thought-out, achievable, and reasonable. Although today I intend to focus on the need for the development and deployment of commercially viable technologies to address climate change and not on the specific policies issues that must be addressed, AEP believes that legislation can be crafted that does not impede AEP's ability to provide reliable, reasonably priced electricity to support the economic well-being of our customers, and includes mechanisms that foster international participation and avoid creating inequities and competitive issues that would harm the U.S. economy. AEP supports reasonable legislation, and is not calling for an indefinite delay until advanced technology such as carbon capture and storage (CCS) is developed. However, as the requirements become more stringent during the next ten to twenty years, and we move beyond the ability of current technology to deliver those reductions, it is essential that requirements for deeper reductions coincide with the commercialization of advanced technologies.

Phased-in Timing and Gradually Increasing Level of Reductions Consistent with Technology Development that is facilitated by Public Funding

As a practical matter, implementing climate legislation is a complex undertaking that will require procedures for measuring, verifying, and accounting for GHG emissions, as well as for designing efficient administration and enforcement procedures applicable to all sectors of our economy. Only a pragmatic approach with achievable targets, supported by commercial technology, and reasonable timetables—that does not require too many reductions within too short a time period—will succeed. Past experience with the Clean Air Act Amendments of 1990 (which involved a vastly simpler SO_2 allowance trading system for just the electric power sector), strongly

suggests that a minimum of 5 years will be necessary to have the administrative mechanisms in place for full implementation of the initial GHG emission targets.

AEP also believes that the level of emissions reductions and timing of those reductions under a Federal mandate must keep pace with developing technologies for reducing GHG emissions from new and existing sources. The technologies for effective carbon capture and storage from coal-fired facilities are developing, but are not commercially engineered to meet production needs, and cannot be artificially accelerated through unrealistic reduction mandates.

While AEP and other companies have successfully lowered their average emissions and emission rates during this decade, further substantial reductions will require the wide-scale commercial availability of new clean coal technologies. AEP believes that the electric power industry can potentially manage much of the expected economic (and CO_2 emissions) growth over the course of the next decade (2010–2020) through aggressively deploying renewable energy, further gains in supply and demand-side energy efficiency, and new emission offset projects. As stated above, AEP supports reasonable legislation, and is not calling for an indefinite delay of GHG reduction obligations until advanced clean coal technology is developed. However, as the reduction requirements become more stringent, and move beyond the ability of current technologies to deliver those reductions, it is important that those stringent requirements coincide with the commercialization of advanced technology. This includes the next generation of low- and zero-emitting technologies. In the case of coal, this means demonstration and full-scale deployment of new IGCC units with carbon capture, new ultrasupercritical or oxy-coal plants with carbon capture and storage, as well as broad deployment of retrofit technologies for carbon capture and storage at existing coal plants. The next generation of nuclear technology will also play an important role in meeting significant reduction targets.

However, today's costs of new clean coal technologies with carbon capture and storage are much more expensive than current coal-fired technologies. For example, carbon capture and storage using current inhibited monoethanolamine (MEA) technology is expected to increase the cost of electricity from a new coal-fired power plant by about 60–70 percent and even the newer chilled ammonia carbon capture technology we plan to deploy on a commercial sized scale by 2012 at one of our existing coal-fired units will result in significantly higher costs. It is only through the steady and judicious advancement of these applications during the course of the next decade that we can start to bring these costs down, in order to avoid substantial electricity rate shocks and undue harm to the U.S. economy.

Simply put, our Nation cannot wait a decade or longer to begin the development and commercialization of IGCC and carbon capture and sequestration technologies. The need for new electric generating capacity is upon us now. The need is real and it is pressing. Unfortunately, the deployment of advanced coal electric generation technology, such as IGCC, is expensive now and will only become more so if development is postponed.

AEP believes that IGCC is the best commercially-ready technology for the future inclusion of CCS but that the timely development of commercially viable CCS technologies will require additional public funding. Our IGCC plants will incorporate the space and layout for the addition of components to capture CO_2 for sequestration, but AEP does not plan to incorporate CCS equipment until after the plants are operating and the technology is demonstrated and proven.

Our IGCC plants will be among the earliest, if not the first, deployments of large-scale IGCC technology. The cost of constructing these plants will be high, resulting in a cost of generated electricity that would be at least twenty percent greater than that from conventional pulverized coal (PC) combustion technology. As more plants are built, the costs of construction are expected to come into line with the cost of PC plants.

To help bridge the cost gap and move IGCC technology down the cost curve, there is a need for continuation and expansion of the advanced coal project tax credits that were introduced by the Energy Policy Act of 2005. All of the available tax credits for IGCC projects using bituminous coal were allocated to only two projects during the initial allocation round in 2006. More IGCC plants are needed to facilitate this technology. AEP believes an additional one billion dollars of section 48A (of the Internal Revenue Code) tax credits are needed, with the bulk of that dedicated to IGCC projects without regard to coal type.

Along with an increase in the amount of the credits, changes are needed in the manner in which the credits are allocated. Advanced coal project credits should be allocated based on net generating capacity and *not* based upon the estimated gross nameplate generating capacity of projects. Allocation based upon gross, rather than net, generating capacity potentially rewards less efficient projects, which is antithetical to the purpose of advanced coal project tax incentives. AEP also believes that

the Secretary of Energy should be delegated a significant role in the selection of IGCC projects that will receive tax credits.

On a critical note, the inclusion of carbon capture and sequestration equipment must not be a prerequisite for the allocation of these additional tax credits due to the urgent need for new electric generating capacity in the U.S. AEP also believes that this requirement is premature and self-defeating, since the technology to capture and sequester a significant portion of an IGCC project's CO_2 does not currently exist. The addition of yet-to-be-developed carbon capture and sequestration technology to an IGCC project would cause the projected cost of a project to increase significantly, making it that much more difficult for a public utility commission to approve.

AEP also believes that additional tax incentives are needed to spur the development and deployment of greenhouse gas capture and sequestration equipment for all types of coal-fired generation. We suggest that additional tax credits be established to offset a significant portion of the incremental cost of capturing and sequestering CO_2. These incentives could be structured partly as an investment tax credit, similar to that in section 48A (of the Internal Revenue Code), to cover the upfront capital cost, and partly as a production tax credit to cover the associated operating costs.

In summary, AEP recommends a pragmatic approach for phasing in GHG reductions through a cap-and-trade program coincident with developing technologies to support these reductions. The emissions cap should be reasonable and achievable. In the early years of the program, the cap should be set at levels that slow the increase in GHG emissions. Allowing for moderate emissions increases over the first decade is critical due to limitations on currently available GHG control options and technologies. The stringency of the cap would increase over time—first stabilizing emissions and then requiring a gradual, long-term decline in emissions levels. The cap levels should be set to reflect projected advances in new carbon-saving technologies, which advances AEP believes can be facilitated by Federal incentives. In the case of the electric power sector, additional time is necessary to allow for the deployment of new nuclear plants as well as the demonstration and deployment of commercial-scale gasification and advanced combustion facilities fully integrated with technologies for CO_2 capture and storage. Substantial GHG reductions should not be required until after the 2020 time-frame.

Requiring much deeper reductions sooner would very likely harm the U.S. economy. For AEP and the electric sector, the only currently available strategy to achieve substantial absolute CO_2 reductions prior to 2020 without the full-scale deployment of new technologies will inevitably require much greater use of natural gas, in lieu of coal-fueled electricity, with the undesirable effects of higher natural gas prices and even tighter supplies.

Technology is the Answer to Climate Change

The primary human-induced cause of global warming is the emission of CO_2 arising from the burning of fossil fuels. Put simply, our primary contribution to climate change is also what drives the global economic engine.

Changing consumer behavior by buying efficient appliances and cars, by driving less, and by similar steps, is helping to reduce the growth of GHG emissions. However, these steps will never be nearly enough to significantly reduce CO_2 emissions from the burning of coal, oil and natural gas. Such incremental steps, while important, will never be sufficient to stabilize greenhouse gases concentrations in the atmosphere at a level that is believed to be capable of preventing dangerous human-induced interference with the climate system, as called for in the U.S.-approved U.N. Framework Convention on Climate Change (Rio agreement).

For that, we need major technological advances to effectively capture and store CO_2. The Congress and indeed all Americans must come to recognize the gigantic undertaking and significant sacrifices that this enterprise is likely to require. It is unrealistic to assume, and wrong to argue, that the market will magically respond simply by the imposition of severe caps on CO_2 emissions. The result will not be a positive response by the market, but rather a severe impact on the economy. Not when what we are talking about, on a large scale, is the capture and geologic storage of billions and billions of tons of CO_2 with technologies that have not yet been proven anywhere in the world.

CCS should not be mandated until and unless it has been demonstrated to be effective and the costs have significantly dropped so that it becomes commercially engineered and available on a widespread basis. Until that threshold is met, it would be technologically unrealistic and economically unacceptable to require the widespread installation of carbon capture equipment. The use of deep saline geologic formations as the primary long-term geologic formations for CO_2 storage has not yet

been sufficiently demonstrated. There are no national standards for permitting such storage reservoirs; there are no widely accepted monitoring protocols; and the standards for liability are unknown (and whether Federal or state laws would apply), as well as who owns the rights to these deep geologic reservoirs remains a question. Underscoring these realities, industrial insurance companies point to a lack of scientific data on CO_2 storage as one reason they are disinclined to insure early projects. In a nutshell, the institutional infrastructure to support CO_2 storage does not yet exist and will require years to develop. In addition, application of today's CO_2 capture technology would significantly increase the cost of an IGCC or a new efficient pulverized coal plant, calling into serious question regulatory approval for the costs of such a plant by state regulators. Further, recent studies sponsored by the Electric Power Research Institute (EPRI) suggest that application of today's CO_2 capture technology would increase the cost of electricity from an IGCC plant by up to 50 percent, and boost the cost of electricity from a conventional pulverized coal plant by up to 60–70 percent, which would again jeopardize state regulatory approval for the costs of such plants.

Despite these uncertainties, I believe that we must aggressively explore the viability of this technology in several first-of-a-kind commercial projects. AEP is committed to help lead the way, and to show how this can be done. For example, as described earlier in this testimony, AEP will install carbon capture controls on two existing coal-fired power plants, the first commercial use of this technology, as part of our comprehensive strategy to reduce, avoid or offset GHG emissions.

AEP is also building two state-of-the-art advanced ultrasupercritical power plants in Oklahoma and Arkansas. These will be the first of the new generation of ultrasupercritical plants in the U.S.

AEP is also advancing the development of IGCC technology. IGCC represents a major breakthrough in our work to improve the environmental performance of coal-based electric power generation. AEP is in the process of permitting and designing two of the earliest commercial scale IGCC plants in the Nation. Construction of the IGCC plants will start once traditional rate recovery is approved.

IGCC technology integrates two proven processes—coal gasification and combined cycle power generation—to convert coal into electricity more efficiently and cleanly than any existing uncontrolled power plants can. Not only is it cleaner and more efficient than today's installed power plants, but IGCC has the potential to be retrofitted in the future for carbon capture at a lower capital cost and with less of an energy penalty than traditional power plant technologies, but only after the technology has been developed and proven.

AEP is also a founding member of FutureGen, a groundbreaking public-private collaboration that aims squarely at making near-zero-emissions coal-based energy a reality. FutureGen is a $1.5 billion, 10-year research and demonstration project. It is on track to create the world's first coal-fueled, near-zero emission electricity and hydrogen plant with the capability to capture and sequester at least 90 percent of its carbon dioxide emissions.

As an R&D plant, FutureGen will stretch—and indeed create—the technology envelope. Within the context of our fight to combat global climate change, FutureGen has a truly profound mission—to validate the cost and performance baselines of a fully integrated, near zero-emission coal-fueled power plant.

The design of the FutureGen plant is already underway, and we are making great progress. The plant will be on-line early in the next decade. By the latter part of that decade, following on the advancements demonstrated by AEP, FutureGen and other projects, CCS technology should become a commercial reality.

It is when these technologies are commercially demonstrated, and only then, that commercial orders will be placed on a widespread basis to implement CCS at coal-fueled power plants. That is, roughly around 2020. Widespread deployment assumes that a host of other important issues have been resolved, and there is governmental and public acceptance of CCS as the proven and safe technology that we now believe it to be. AEP supports rapid action on climate change including the enactment of well thought-out and achievable legislation so that our Nation can get started on dealing with climate change. However, the complete transformation of the U.S. electricity system will take time, and we can't put policy ahead of the availability of cost-effective technology. The development of technology must coincide with any increase in the stringency of the program.

What will happen if the Congress does the opposite, and mandates deep reductions in the absence of a proven, viable technology? It is the proverbial road of good intentions, and only dangerous consequences can follow. The most immediate would be a dramatic—and very likely costly—increase in the use and price of natural gas by the utility sector, since there would be no other identifiable alternative. This would have significant adverse impacts on consumers and workers by driving up the

cost of gas for home heating and cooking, and would further increase costs to any industry dependent upon natural gas as a feedstock, such as chemicals and agriculture with a further exporting of jobs overseas.

A huge challenge that our society faces over the remainder of this century is how we will reduce the release of GHG emissions from fossil fuels. This will require nothing less than the complete reengineering of the entire global energy system over the next century. The magnitude of this task is comparable to the industrial revolution, but for this revolution to be successful, it must stimulate new technologies and new behaviors in all major sectors of the economy. The benefits of projects like FutureGen and the ones AEP is pursuing will apply to all countries blessed with an abundance of coal, not only the United States, but also nations like China and India.

In the end, the only sure path to stabilizing GHG concentrations over the long term is through the development and utilization of advanced technologies. And we must do more than simply call for it. Our nation must prepare, inspire, guide, and support our citizens and the very best and the brightest of our engineers and scientists; private industry must step up and start to construct the first commercial plants; and our country must devote adequate financial and technological resources to this enormous challenge. AEP is committed to being a part of this important process, and to helping you achieve the best outcome at the most reasonable cost and timelines possible. Thank you again for this opportunity to share these views with you.

NEWS from AEP

Media Contact:
PAT D. HEMLEPP
Director, Corporate Media Relations

Analysts Contact:
JULIE SLOAT
Vice President, Investor Relations

For Immediate Release

AEP to Install Carbon Capture on Two Existing Power Plants; Company Will Be First to Move Technology to Commercial Scale

As climate policy advances, "it's time to advance technology for commercial use," CEO says Columbus, Ohio, March 15, 2007—American Electric Power (NYSE:AEP) will install carbon capture on two coal-fired power plants, the first commercial use of technologies to significantly reduce carbon dioxide emissions from existing plants.

The first project is expected to complete its product validation phase in 2008 and begin commercial operation in 2011.

"AEP has been the company advancing technology for the electric utility industry for more than 100 years," said Michael G. Morris, AEP chairman, president and chief executive officer. "This long heritage, the backbone of our company's success, makes us very comfortable taking action on carbon emissions and accelerating advancement of the technology. Technology development needs are often cited as an excuse for inaction. We see these needs as an opportunity for action."

"With Congress expected to take action on greenhouse gas issues in climate legislation, it's time to advance this technology for commercial use," Morris said. "And we will continue working with Congress as it crafts climate policy. It is important that the U.S. climate policy be well thought out, establish reasonable targets and timetables, and include mechanisms to prevent trade imbalances that would damage the U.S. economy."

Morris will discuss AEP's plans for carbon capture during a presentation today at the Morgan Stanley Global Electricity & Energy Conference in New York. A live webcast of the presentation to an audience of investors will begin at 12:10 p.m. EDT and can be accessed through the Internet at *http://www.aep.com/go/webcast*. The webcast will also be available after the event. Visuals used in the presentation will be available at *http://ww.aep.com/investors/present*.

AEP has signed a memorandum of understanding (MOU) with Alstom, a worldwide leader in equipment and services for power generation and clean coal, for post-combustion carbon capture technology using Alstom's Chilled Ammonia Process. This technology, which is being piloted this summer by Alstom on a 5-megawatt (thermal) slipstream from a plant in Wisconsin, will first be installed on AEP's 1,300-megawatt Mountaineer Plant in New Haven, W.Va., as a 30-megawatt (thermal) product validation in mid-2008 where up to 100,000 metric tons of carbon dioxide (CO_2) will be captured per year. The captured CO_2 will be designated for geological storage in deep saline aquifers at the site. Battelle Memorial Institute will serve as consultants for AEP on geological storage.

Following the completion of product validation at Mountaineer, AEP will install Alstom's system on one of the 450-megawatt (electric) coal-fired units at its North-

eastern Station in Oologah, Okla. Plans are for the commercial-scale system to be operational at Northeastern Station in late 2011. It is expected to capture about 1.5 million metric tons of CO_2 a year. The CO_2 captured at Northeastern Station will be used for enhanced oil recovery.

Alstom's system captures CO_2 by isolating the gas from the power plant's other flue gases and can significantly increase the efficiency of the CO_2 capture process. The system chills the flue gas, recovering large quantities of water for recycle, and then utilizes a CO_2 absorber in a similar way to absorbers used in systems that reduce sulfur dioxide emissions. The remaining low concentration of ammonia in the clean flue gas is captured by cold-water wash and returned to the absorber. The CO_2 is compressed to be sent to enhanced oil recovery or storage.

In laboratory testing sponsored by Alstom, EPRI and others, the process has demonstrated the potential to capture more than 90 percent of CO_2 at a cost that is far less expensive than other carbon capture technologies. It is applicable for use on new power plants as well as for the retrofit of existing coal-fired power plants.

AEP has signed an MOU with The Babcock & Wilcox Company (B&W), a world leader in steam generation and pollution control equipment design, supply and service since 1867, for a feasibility study of oxy-coal combustion technology. B&W, a subsidiary of McDermott International, Inc. (NYSE:MDR), will complete a pilot demonstration of the technology this summer at its 30-megawatt (thermal) Clean Environment Development Facility in Alliance, Ohio.

Following this demonstration, AEP and B&W will conduct a retrofit feasibility study that will include selection of an existing AEP plant site for commercial-scale installation of the technology and cost estimates to complete that work. Once the retrofit feasibility study is completed, detailed design engineering and construction estimates to retrofit an existing AEP plant for commercial-scale CO_2 capture will begin. At the commercial scale, the captured CO_2 will likely be stored in deep geologic formations. The plant, with oxy-coal combustion technology, is expected to be in service in the 2012–2015 time-frame.

B&W, in collaboration with American Air Liquide Inc., has been developing oxy-coal combustion, a technology that utilizes pure oxygen for the combustion of coal. Current generation technologies use air, which contains nitrogen that is not utilized in the combustion process and is emitted with the flue gas. By using pure oxygen, oxy-coal combustion excludes nitrogen and leaves a flue gas that is a relatively pure stream of carbon dioxide that is ready for capture and storage. B&W's and Air Liquide's collaborative work on oxy-coal combustion began in the late 1990s and included pilot-scale development at B&W's facilities with encouraging results, burning both bituminous and sub-bituminous coals.

The oxy-coal combustion process, as envisioned, uses a standard, cryogenic air separation unit to provide relatively pure oxygen to the combustion process. This oxygen is mixed with recycled flue gas in a proprietary mixing device to replicate air, which may then be used to operate a boiler designed for regular air firing. The exhaust gas, consisting primarily of carbon dioxide, is first cleaned of traditional pollutants, then compressed and purified before storage. B&W, working with Air Liquide, can supply the equipment, technology and control systems to construct this new value chain, either as a new application or as a retrofit to an existing unit.

The Alstom technology provides a post-combustion carbon capture system that is suitable for use in new plants as well as for retrofitting to existing plants. It requires significantly less energy to capture CO_2 than other technologies currently being tested.

The B&W technology provides a pre-combustion boiler conversion option for existing plants that promotes the creation of a pure CO_2 stream in the flue gas.

Both pre- and post-combustion technologies will be important for companies facing decisions on carbon reduction from the wide variety of coal-fired boiler designs currently in use.

AEP anticipates seeking funding from the U.S. Department of Energy to help offset some of the costs of advancing these technologies for commercial use. The company will also work with utility commissions, environmental regulators and other key constituencies in states that have jurisdiction over the plants selected for retrofit to determine appropriate cost recovery and the impact on customers.

"We recognize that these projects represent a significant commitment of resources for AEP, but they are projects that will pay important dividends in the future for our customers and shareholders," Morris said. "Coal is the fuel used to generate half of the Nation's electricity; it fuels about 75 percent of AEP's generating fleet. By advancing carbon capture technologies into commercial use, we are taking an important step to ensure the continued and long-term viability of our existing generation, just as we did when we were the first to begin a comprehensive, system-wide retrofit program for sulfur dioxide and nitrogen oxide emissions controls. We have com-

pleted the sulfur dioxide and nitrogen oxide retrofits on more than two-thirds of the capacity included in the program and we are on schedule to complete all retrofits by shortly after the end of the decade."

"By being the first to advance carbon capture technology, we will be well-positioned to quickly and efficiently retrofit additional plants in our fleet with carbon capture systems while avoiding a potentially significant learning curve."

AEP has led the U.S. electric utility industry in taking action to reduce its greenhouse gas emissions. AEP was the first and largest U.S. utility to join the Chicago Climate Exchange (CCX), the world's first and North America's only voluntary, legally binding greenhouse gas emissions reduction and trading program. As a member of CCX, AEP committed to gradually reduce, avoid or offset its greenhouse gas emissions to 6 percent below the average of its 1998 to 2001 emission levels by 2010. Through this commitment, AEP will reduce or offset approximately 46 million metric tons of greenhouse gas emissions by the end of the decade.

AEP is achieving its greenhouse gas reductions through a broad portfolio of actions, including power plant efficiency improvements, renewable generation such as wind and biomass co-firing, off-system greenhouse gas reduction projects, reforestation projects and the potential purchase of emission credits through CCX.

American Electric Power is one of the largest electric utilities in the United States, delivering electricity to more than 5 million customers in 11 states. AEP ranks among the Nation's largest generators of electricity, owning nearly 36,000 megawatts of generating capacity in the U.S. AEP also owns the Nation's largest electricity transmission system, a nearly 39,000-mile network that includes more 765 kilovolt extra-high voltage transmission lines than all other U.S. transmission systems combined. AEP's utility units operate as AEP Ohio, AEP Texas, Appalachian Power (in Virginia and West Virginia), AEP Appalachian Power (in Tennessee), Indiana Michigan Power, Kentucky Power, Public Service Company of Oklahoma, and Southwestern Electric Power Company (in Arkansas, Louisiana and east Texas). AEP's headquarters are in Columbus, Ohio.

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This report made by AEP and its Registrant Subsidiaries contains forward-Looking statements within the meaning of Section 21E of the Securities Exchange Act of 1934. Although AEP and each of its Registrant Subsidiaries believe that their expectations are based on reasonable assumptions, any such statements may be influenced by factors that could cause actual outcomes and results to be materially different from those projected. Among the factors that could cause actual results to differ materially from those in the forward-looking statements are: electric load and customer growth; weather conditions, including storms; available sources and costs of, and transportation for, fuels and the creditworthiness of fuel suppliers and transporters; availability of generating capacity and the performance of AEP's generating plants; AEP's ability to recover regulatory assets and stranded costs in connection with deregulation; AEP's ability to recover increases in fuel and other energy costs through regulated or competitive electric rates; AEP's ability to build or acquire generating capacity when needed at acceptable prices and terms and to recover those costs through applicable rate cases or competitive rates; new legislation, litigation and government regulation including requirements for reduced emissions of sulfur, nitrogen, mercury, carbon, soot or particulate matter and other substances; timing and resolution of pending and future rate cases, negotiations and other regulatory decisions (including rate or other recovery for new investments, transmission service and environmental compliance); resolution of litigation (including pending Clean Air Act enforcement actions and disputes arising from the bankruptcy of Enron Corp. and related matters); AEP's ability to constrain operation and maintenance costs; the economic climate and growth in AEP's service territory and changes in market demand and demographic patterns; inflationary and interest rate trends; AEP's ability to develop and execute a strategy based on a view regarding prices of electricity, natural gas and other energy-related commodities; changes in the creditworthiness of the counterparties with whom AEP has contractual arrangements, including participants in the energy trading market; actions of rating agencies, including changes in the ratings of debt; volatility and changes in markets for electricity, natural gas and other energy-related commodities; changes in utility regulation, including the potential for new legislation or regulation in Ohio and/or Virginia and membership in and integration into regional transmission organizations; accounting pronouncements periodically issued by accounting standard-setting bodies; the performance of AEP's pension and other post-retirement benefit plans; prices for power that AEP generates and sell at wholesale; changes in technology, particularly with respect to new, developing or alternative sources of generation; other risks and unforeseen

events, including wars, the effects of terrorism (including increased security costs), embargoes and other catastrophic events.

Background: American Electric Power's Actions to Address Climate

Change GHG Reduction Commitment

American Electric Power (AEP) was the first and largest U.S. utility to join the Chicago Climate Exchange (CCX) and make a legally binding commitment to gradually reduce or offset its greenhouse gas emissions to 6 percent below the average of 1998–2001 emission levels by 2010.

As a founding member of CCX, AEP committed in 2003 to reduce or offset its emissions gradually to 4 percent below the average of 1998–2001 emission levels by 2006 (1 percent reduction in 2003, 2 percent in 2004, 3 percent in 2005 and 4 percent in 2006). In August 2005, AEP expanded and extended its commitment to a 6 percent reduction below the same baseline by 2010 (4.25 percent in 2007, 4.5 percent in 2008, 5 percent in 2009 and 6 percent in 2010). Through this commitment, AEP expects to reduce or offset approximately 46 million metric tons of greenhouse gas emissions.

Operational Improvements

AEP has been able to reduce its carbon dioxide (CO_2) emissions by improving plant efficiency for its fossil-fueled plants through routine maintenance and investments like turbine blade enhancements (installing new turbine blades) and steam path replacements that improve the overall heat rate of a plant and, in turn, reduce CO_2 emissions. A one-percent improvement in AEP's overall fleet efficiency can reduce the company's greenhouse gas emissions by 2 million metric tons per year.

AEP has also reduced its CO_2 emissions by improving the performance and availability of its nuclear generation. AEP's D.C. Cook Nuclear Plant in Michigan set plant records for generation and capacity factor in 2005. The plant had a capacity factor (energy generated as compared to the maximum possible) of 96.8 percent in 2005 and generated 17,471 gigawatt-hours (GWH) of electricity. Additionally, AEP will invest $45 million to replace turbine motors in one unit at D.C. Cook in 2006, which will increase that unit's output by 41 megawatts.

As a member of the U.S. EPA's Sulfur Hexafluoride (SF6) Emissions Reduction Partnership for Electric Power Systems, AEP has significantly reduced emissions of SF6, an extremely potent greenhouse gas, from 1999 levels of 19,778 pounds (a leakage rate of 10 percent) to 2004 emissions of 1,962 pounds (a leakage rate of 0.5 percent).

Managing Forests and Agricultural Lands for Carbon Sequestration

To reduce carbon dioxide (CO_2) concentrations in the global atmosphere, AEP has invested more than $27 million in terrestrial sequestration projects designed to conserve and reforest sensitive areas and offset more than 20 million metric tons of CO_2 over the next 40 years. These projects include protecting nearly 4 million acres of threatened rainforest in Bolivia, restoring and protecting 20,000 acres of degraded or deforested tropical Atlantic rainforest in Brazil, reforesting nearly 10,000 acres of the Mississippi River Valley in Louisiana with bottomland hardwoods, restoring and protecting forest areas in the Sierra Madres of Guatemala, and planting trees on 23,000 acres of company-owned land.

Deploying Technology for Clean Coal Generation

AEP is focused on developing and deploying new technology that will reduce the emissions, including greenhouse gas emissions, of future coal-based power generation. AEP announced in August 2004 its plans to build commercial-scale integrated gasification combined cycle (IGCC) plants to demonstrate the viability of this technology for future use of coal in generating electricity. AEP has filed for regulatory approval in Ohio and West Virginia to build a 629-megawatt IGCC plant in each of these states. The plants are scheduled to be operational in the 2010 to 2011 timeframe and will be designed to accommodate retrofit of technology to capture and sequester CO_2 emissions.

Developing Technology for CO_2 Capture and Storage

AEP's Mountaineer Plant in New Haven, W.Va., is the site of a $4.2 million carbon sequestration research project funded by the U.S. Department of Energy, the Ohio Coal Development Office, and a consortium of public and private sector participants. Scientists from Battelle Memorial Institute lead this climate change mitigation research project, which is designed to obtain data required to better understand

and test the capability of deep saline aquifers for storage of carbon dioxide emissions from power plants.

AEP is a member of the FutureGen Alliance, who, along with the Department of Energy, will build "FutureGen," a $1 billion, near-zero emission plant to produce electricity and hydrogen from coal while capturing and disposing of carbon dioxide in geologic formations.

Additionally, AEP funds research coordinated by the Massachusetts Institute of Technology Energy Laboratory and the Electric Power Research Institute that is evaluating the environmental impacts, technological approaches, and economic issues associated with carbon sequestration. The MIT research specifically focuses on efforts to better understand and reduce the cost of carbon separation and sequestration.

Renewable Energy and Clean Power

AEP strongly supports increased renewable energy sources to help meet our Nation's energy needs. AEP is one of the larger generators and distributors of wind energy in the United States, operating 311 megawatts (MW) of wind generation in Texas. The company also purchases and distributes an additional 373.5 megawatts of wind generation from wind facilities in Oklahoma and Texas. Additionally, AEP operates 2,285 megawatts of nuclear generation and 884 megawatts of hydro and pumped storage generation.

More than 125 schools participate in AEP's "Learning From Light" and "Watts on Schools" programs. Through these programs, AEP partners with learning institutions to install 1 kW solar photovoltaic systems, and uses these systems to track energy use and demonstrate how solar energy is a part of the total energy mix. Similarly, AEP's "Learning From Wind" program installs small-scale wind turbines to provide wind power education and renewable energy research at educational institutions.

Biomass Energy

Until the company sold the plants in 2004, AEP co-fired biomass in 4,000 MW of coal-based power generation in the United Kingdom (Fiddler's Ferry and Ferry Bridge). AEP has been evaluating and testing biomass co-firing for its smaller coal-fired power plants in the United States to evaluate potential reductions in CO_2 emission levels.

Energy Conservation and Energy Efficiency

AEP is implementing "Energy Efficiency Plans" to offset 10 percent of the annual energy demand growth in its Texas service territory. In 2003 alone, AEP invested more than $8 million to achieve over 47 million kilowatt-hours (kWh) of reductions from installation of energy efficiency measures in customers' homes and businesses. Total investments for the four-year program will exceed $43 million, achieving more than 247 million kWh of energy efficiency gains.

2005 EPA Climate Protection Award

In May 2005, the EPA selected AEP to receive a 2005 Climate Protection Award for demonstrating ingenuity, leadership and public purpose in its efforts to reduce greenhouse gases. EPA began the Climate Protection Awards program in 1998 to recognize outstanding efforts to protect the Earth's climate.

Senator KERRY. Thank you very much, Mr. Rencheck, we appreciate that.

Mr. Wilson?

STATEMENT OF JOHN M. WILSON, CHIEF OPERATING OFFICER, SIEMENS ENVIRONMENTAL SYSTEMS AND SERVICES

Mr. WILSON. Thank you very much. Greetings, Chairman Kerry, and the Committee.

My name is John Wilson, I am the Chief Operating Officer for Siemens Environmental Systems and Services. It's a company created out of a 90-year-old air pollution control business.

I'm really pleased to be able to give the overall presentation from the practical side for air pollution control here for clean coal.

Today I'm speaking on behalf of Siemens power generation, it's a $10 billion organization, part of the $100 billion global infrastruc-

ture supplier. And, what I'd like to do, is really like to let you know about Siemens Power Generation first.

We've basically grown by consolidating many of the well-known companies out in the industry—Westinghouse, Wheelabrator, Bonus Energy, as well as the industrial turbine business of Alstom. And what we invest right now, every year, is about $600 million a year in R&D in the energy sector, so we're fully vested in this energy sector.

Siemens recognizes that clean coal doesn't have to be an oxymoron, either, because that's our business. We basically focus on the safe environmental use of coal today, and in the future.

So, what we've done, is we basically participate with DOE and bring our expertise to funding on clean coal technology programs like the hydrogen fuel gas turbine, like CO_2 separation technologies, membrane technologies, oxy-fuel combustion, and ultra supercritical steam turbines. So we participate in that, all of these efforts because we believe that coal is going to be a part of our global future. As you mentioned, it's 50 percent today, in terms of electricity generation, growing to 60 percent by 2030, according to the Energy Administration.

So, that's 325,000 megawatts, essentially, of installed base out there that's already operating—it's not going to go away—that's basically going to be there in providing our needs. It take decades, essentially for these plants to amortize their value, and my business is actually focused on cleaning up the emissions at these plants.

We fundamentally are now in a boom, where we have State regulatory commissions, with consent decrees that are forcing higher levels of emissions controls on the existing plants. And so, what we see today, is that with the appropriate engineering design, we're able to design emissions control systems that basically are on par with the proposed IGCC plants that are out there today.

There's a real potential for improvement, essentially, out there today in the existing fleet, because we see the opportunity and capability to retrofit these plants with additional controls that aren't deployed today. If you want to permit a new plant today, you have to have a full suite of environmental controls for a new source review, but fundamentally, the existing plants that are out there are not necessarily all compliant with that, and they're just now being upgraded.

So, with the fact that there's a lot of technology out there, we also focus—as we've said—across the whole technology spectrum—gasification and gas-turbine technology for IGCC, emissions control, and ultra supercritical combustion based technologies. So, we provide essentially whatever the market asks for in terms of technology.

But clearly efficiency, or CO_2 avoidance, is superior to CO_2 capture—either post-combustion or pre-combustion. So, we see the efficiency improvements in the existing fleet as one of the areas that we could look at. Because, clearly, with the average fleet efficiency of 33 percent—and now plant technologies that are in excess of 40 percent efficient—there's a great deal of improvement potential for the existing fleet, both in emissions and also in efficiency.

Gasification is a real option, too. Basically, Siemens has over 320,000 hours of operation on gasification (or integrated gasification combined cycle) plants around the world. We've also recently acquired one of the leading gasification technologies. This technology is very favorable and works very well on Western coals, higher moisture coals and lower-quality coals. So, we're also part of the overall gasification technology business.

But clearly the CO_2 policy issue not only involves important advanced technology questions but also the ultimate cost to the consumer and the economy. For example, current estimates suggest that CO_2 capture and storage will add several cents a kilowatt to existing utility bills.

So, fundamentally, Siemens believes that the long-term storage of carbon, is one of the critical areas—that we have to focus on in the regulatory environment.

So, in closing, I want to make it clear that there are existing technologies out there today to make the coal, much cleaner coal and that we are providers of most of these technologies. In addition, we'd like to see further R&D development across the suite of technologies because there is no clear "winner" technology today. We need investment and demonstration programs in all of these technologies because it takes years to prove out the right technology and the right application. We also support the development of industry-wide performance-based/efficiency-based standards as well as a reevaluation of the new source rules. These changes would facilitate the deployment of newer, more advanced coal-based technologies which would result in improved environmental performance, including CO_2.

Thank you very much.

[The prepared statement of Mr. Wilson follows:]

PREPARED STATEMENT OF JOHN M. WILSON, CHIEF OPERATING OFFICER, SIEMENS ENVIRONMENTAL SYSTEMS AND SERVICES

Greetings, Chairman Kerry and Ranking Member Ensign and Subcommittee members. My name is John Wilson; I am the Chief Operating Officer of Siemens' Environmental Systems and Services business unit which was created out of a company with over 90 years of experience in air pollution control technology. I am honored to be here today to discuss the current state of clean coal technology from an infrastructure suppliers' perspective.

Today I am speaking primarily on behalf of the power generation business at Siemens. For the last several years, I was the vice president of strategy for the Power Generation Group, headquartered in Orlando, Florida, and Erlangen Germany, which is a 10 billion dollar segment of Siemens 100 billion dollar global infrastructure business.

Before I speak specifically to clean coal issues, I'd like to direct the Subcommittee's attention to a unique global project and recently published report entitled "Megacity Challenges" that is based upon research conducted by two independent organizations with the support of Siemens. The goal of the project was to carry out research at the megacity level to gather data as well as perspectives from mayors, city administrators and other experts on infrastructure challenges, like energy supply and delivery systems, in which this Subcommittee takes great interest. Over 500 public and private sector experts from 25 cities were interviewed. The results were fascinating, including the projection that by 2030 over 60 percent of the world's population will live in cities. The key megatrends identified in this report that are guiding Siemens' priorities are: healthcare challenges, urbanization and associated mobility challenges, scarcity of clean and reliable natural resources such as clean air and water, and reliable energy supplies. Siemens has been investing in the technologies that address these massive shifts that are driving the current and future needs of society. In addition to the energy infrastructure technologies that I will

focus upon today, other examples of our forward-looking technologies include efficient lighting, automation and controls, intelligent traffic controls, water purification and efficient technologies for buildings and rapid transit.

Siemens' power generation business has grown to its current size by consolidating some of the best known names in the power generation industry, such as Westinghouse, KWU, Parsons, Wheelabrator, Bonus Energy, and the Alstom industrial turbine business. Our technology portfolio in this business sector is comprehensive, and we will invest over $600 million in research and development in the next fiscal year in technology enhancements that will improve both efficiency and overall performance.

Siemens recognizes that clean coal does not have to be an oxymoron, because there are many technologies that can facilitate the safe environmental use of coal, both today, and into the future, as an integral part of a balanced energy supply portfolio. As part of our strategy, we have been working jointly with the Department of Energy on several key efficiency and CO_2 capture technologies which will play a role in the continued use of coal. Areas of cooperative research include:

- Development of hydrogen fueled gas turbines for gasification plants, possibly one approach for reducing the carbon footprint of power generation (FutureGen Alliance);
- Ion Transport Membrane (ITM) for improved efficiency in gas separation.[1] Efficient, low cost gas separation is a key enabling technology as part of a CO_2 mitigation strategy;
- Oxy-Fuel Turbine: This is a new turbine design that capitalizes on advances in gas separation and hydrogen turbine design, providing a unique pathway for CO_2 separation, and ultimately, CO_2 sequestration;
- USC (ultra supercritical) steam turbine materials—developing better materials for more efficient, higher temperature and pressure steam turbines.

The continued usage of coal will be an integral part of any solution in power generation in our lifetimes, because coal currently provides 50 percent of the United States' generation needs. According to the Energy Information Agency, this usage will grow to almost 60 percent by 2030. Compare this demand trend to that for renewable energy, which, excluding hydropower, makes up a little more than 2 percent of capacity in the United States. For some of the world's largest economies, coal represents the dominant domestic energy resource. Today, Siemens' generating equipment provides over 25 percent of electricity worldwide, and we also provide services to our customers to maintain and upgrade their equipment.

The United States' fleet of 325,000 megawatts of coal-fired generating capacity was built over generations, and cannot be replaced quickly. Unlike commodities or consumer goods, power plants are massive in scale, take years to build, and require decades to recover their costs. Economics and regulatory requirements demand that we efficiently extract the most energy from this installed base. Currently, in the United States, the average age of a coal-fired power plant exceeds 40 years (and is increasing).

SO_X, Mercury, NO_X and Particulate Matter

Today with appropriate engineering design, we can routinely reduce criteria pollutants from these existing power plants by 90 percent compared to an uncontrolled power plant; for some pollutants 99 percent reduction is the norm. Modern air pollution control technologies that are *readily available today, with no substantial investment in research and development,* can reduce emissions of criteria pollutants from any coal-fired plant to levels that are projected to be achieved by integrated gasification combined cycle (IGCC) plants. The attached table in Appendix One compares the performance of retrofit air pollution controls to IGCC performance. Even though the performance is basically the same at this point, Siemens recognizes the need to invest in multiple technological pathways, and so Siemens not only provides the technology for the world's highest efficiency supercritical steam power plants, along with total emissions controls, it also has gas turbines and gasification technology for IGCC plants (to be discussed later herein).

Although substantial fossil fuel plant upgrades are available, in fact very little of the fleet has the emissions control that would be required for a new power plant. For example, while most units have particulate controls, about one-third of capacity has SO_2 scrubbers, most have low-NO_X burners, and only one-third of the capacity in the Eastern United States has advanced NO_X controls.[2] Our business in retro-

[1] A cooperative venture with Air Products, Inc.
[2] Recent communication with U.S. EPA

fitting SO_2 air pollution controls to existing plants has recently boomed in the U.S., with many states regulating existing units under consent decrees.

Today, all new plants will include either wet or dry flue gas desulphurization as required by the Clean Air Act Amendments. Trading in SO_2 credits is an incentive for the implementation of new, high efficiency flue gas desulphurization (FGD) systems. FGD systems also efficiently recycle the sulfates extracted from the process streams. Over 90 percent of the sulfates extracted from FGDs are recycled for use as wallboard in the construction industry. The largest single-stage FGD system in the United States utilizes Siemens technology, and was installed at the Big Bend Plant near Tampa, Florida.

In addition to sulfur, burning coal can generate a great deal of particulate matter, or dust. The technology of capturing dust has been available for decades as electrostatic precipitators—or bag houses—that have been widely applied in the power generation sector. According to the American Coal Ash Association, nearly 71 million tons of fly ash is collected today, with over 40 percent of this is recycled for uses in concrete products, cement, and agriculture.

More recently, small particulate matter and aerosols less than 2.5 microns in size have been identified as serious health hazards, and therefore, to meet even tighter ambient air quality standards, there has been a renewed interest in improving the performance of these emission control devices. Siemens emissions control technology products include wet electrostatic precipitator (WESP) designs that can meet the most stringent requirements. WESPs and bag house filtration systems can yield greater than 99 percent particulate capture and achieve compliance with the most stringent air quality requirements.

Mercury is a unique chemical element exhibiting no health benefits at any concentration (lead is another); mercury can damage the central nervous system, endocrine system, kidneys, and other organs. In the United States, mercury has been identified as a hazardous air pollutant to be regulated. Today, coal plants in the United States emit between 30 and 50 tons of mercury per year. Siemens provides technology to capture mercury, incorporating some of the same design features for particulate capture.

NO_X, which contributes to visible smog and is a respiratory health concern, is also emitted from automobiles and is one of the more challenging pollutants to control because it is formed from the nitrogen and oxygen in the atmosphere at high heat. Several technologies are now available for NO_X control, including third- and fourth-generation low NO_X burners that minimize the creation of NO_X, and selective catalytic reduction technologies, or multi-pollutant technologies, that convert NO_X back to stable nitrogen and water vapor. Siemens offers new, advanced burner designs to reach 75 percent NO_X reduction compared to uncontrolled emissions, and can provide advanced catalysts, or multi-pollutant technology, to reduce NO_X by over 95 percent.

Carbon Dioxide and Other Greenhouse Gases

Any fossil fuel used in any application will have CO_2 emissions associated with the process. Because of CO_2's potential role in global warming, reducing or mitigating emissions is a central strategy for Siemens. Siemens offer the tools to manage all the emissions from power plants. And while emissions of CO_2 are linked to climate change, other emissions including methane and particulates are also factors of concern for climate change. The technology to address emissions of criteria pollutants that impact climate change (NO_X, CH_4, particulates) are available as described above.

Carbon dioxide, however, is radically different. None of the current capture technologies that are used for the priority pollutants can be directly applied to CO_2 capture. The best way today to address the reduction of CO_2 in the power generation fleet is the same as for automobiles, by essentially increasing the output of the fleet without increasing the fuel used. The current United States fossil fleet operates at approximately 33 percent efficiency (with the remainder of that energy lost as heat to the environment). If we could improve that fleet efficiency by even just 1 percentage point, we could reduce CO_2 emissions by 50 million tons per year, with no loss in net generation. The most efficient coal plants today can reach well over 40 percent efficiency, and if the entire United States fleet were operating at that efficiency, nearly one-quarter of the CO_2 emissions from power generation would be eliminated.[3] Siemens offers advanced technology to improve the efficiency of any

[3] Approximately 500 million tons of CO_2 reduction if the fossil fleet were to operate at 42.5 percent efficiency.

power plant, thus indirectly reducing the CO_2 generated for each unit of electricity produced.

Integrated Gasification Combined Cycle (IGCC)

As an alternative to the discussed technologies to capture emissions post-combustion, some of the next generation of clean coal power plants are proposing pre-combustion coal gasification to capture these same pollutants during the fuel processing steps. The most desirable part of the fuel is the energy content in the form of CO and hydrogen, which is extracted in gasification, leaving behind most of the pollutants. Siemens offers gasification for applications such as power generation (IGCC) as well as for production of synthetic fuels.

Siemens has demonstrated 320,000 hours of gas turbine operation with gasification processes at scales ranging from 8 MW to over 300 MW. Our current product strategy is to provide a 630 MW IGCC plant here in the United States. To broaden its portfolio in this sector, Siemens recently acquired one of the longest demonstrated and commercially offered technologies for gasification for the production of petrochemical liquids or for conversion to synthetic natural gas, and for power generation applications.

The DOE clean coal initiative has focused on pre-combustion capture of emissions, along with CO_2 capture. The debate on pre-combustion versus post-combustion capture has now fully developed, with the industry planning demonstration projects for both technologies underway. One feature of gasification is that carbon can be effectively extracted from the concentrated high pressure gas stream leaving the gasifier, resulting in reduced energy losses and less adverse impact on the cost of electricity. Post-combustion capture operates similarly using solvents, like an amine, or ammonia, to capture the CO_2 from the exhaust gases at much lower pressures, after they have had all the other pollutants removed. Neither of these processes has been commercially demonstrated on a full-scale power generation facility, however we are working to demonstrate this application on existing power plants.

Nearly every scenario we have explored reveals that all CO_2 recovery comes at a cost of energy, sometimes substantial amounts of energy. Increased research, along with demonstration projects are needed to find ways to reduce the energy intensity of CO_2 capture and removal for both pre-combustion and post-combustion capture. Equally important, we must also resolve the issue of carbon storage, because if there is no long-term storage for the carbon, then CO_2 capture and recovery is moot. We agree with the MIT study, *The Future of Coal,* that CO_2 Capture and Storage (CCS) is *"the critical enabling technology that would reduce CO_2 emissions significantly while also allowing coal to meet the world's pressing energy needs"*.

As an Original Equipment Manufacturer (OEM), we are also aware that our customers and end-users are sometimes reluctant to upgrade or repair facilities to improve plant efficiency which may trigger new reviews. Output-based efficiency standards could be used as a tool to encourage upgrades and to improve environmental and output performance. Such an approach has been used for gas turbine emission regulations in the recent New Source Performance Standards updated in February 2005.

To close, Siemens believes that there are currently many technologies to provide the Nation with cleaner coal power generation, and that what is needed is a meaningful commitment from the Government to encourage greater efficiencies. We urge increased support for research, development and deployment of more efficient end-use technologies, low or zero-emitting technologies, and cost effective carbon capture and storage technologies. We also urge support for incentives to encourage private sector risk taking for the development and deployment of these technologies.

APPENDIX ONE

Comparison of Retrofit Projects and IGCC

Parameter	Units	Recent AQCS	IGCC
SO_2	% Removal	95–99	99
SO_2	Lb/MMBtu	0.03–0.18	0.03
PM	Lb/MMBtu	0.010–0.015	0.011
PM_{10}	Lb/MMBtu	0.015–0.03	0.011
HCL	Lb/MMBtu	0.00001–0.003	0.0006
HCL	% Removal	97–98	95
HF	Lb/MMBtu	0.00001–0.00026	N/A
Mercury	Lb/TBTu	0.28–2.2	0.56–0.74
Lead	Lb/TBTu	0.9–16.2	10.2

Senator KERRY. Thank you, Mr. Wilson, very, very much. I appreciate that. I want to follow up with you on some of the tech notions that you just put forward.

But, before I do, let me try to get the big picture here a little bit if we can. I thought one of the most important points put forward, you've all talked about the technology that's out there, we've got technology, but the big question is, how to sequester? Big question—how to capture carbon? And what we can do to do that rapidly.

The date, 2020, rang a bell. This is an issue where you kind of can't be half-pregnant. If you believe the scientists, I assume you all accept, you're all accepting the science, or are you simply doing this because you see it coming? Let me just establish that as a front line. Do you accept the science on global climate change, Mr. Chaisson?

Mr. CHAISSON. Yes.

Senator KERRY. Mr. Denis?

Mr. DENIS. Yes.

Senator KERRY. Dr. McRae?

Dr. MCRAE. Yes.

Senator KERRY. Mr. Rencheck?

Mr. RENCHECK. Yes.

Mr. WILSON. Yes.

Senator KERRY. OK. So, if you accept the science, and you have 2,000-plus scientists from around the globe, including some of, what we consider to be our smart folks, from Jim Hansen and John Holdren, Ed Miles, Bob Correll, others, all coming together, and if those scientists are telling us, with alarm, that the indicators that they see are moving more rapidly, and with greater impact, species movement already showing up, millions of acres of forest with bug infestation that didn't used to exist because they'd die, because of the cold, now they don't. No ducks for hunting in South Carolina or Arkansas, because migratory patterns have changed—I mean, you run the list. All of the feedback is coming back faster, ice melting, et cetera, et cetera, et cetera. Question marks about oceans currents' impact on climate, all of these things.

So, here you are, you've got the science, and those same scientists are telling us, "You've got a 10-year window," to get on the track where you're able to get the 3.2 reduction you need going out to 2050, or if you don't get 3.2 percent, you're going to have to get a much higher percentage faster in out-years.

To know whether or not we can capture or have capture online by 2020 or sometime seems unacceptable when measured against the 10-year window. Can you speak to that? Let me throw one other ingredient out there. Back when we negotiated the Clean Air Act in 1990, I was part of those negotiations and we were working to put the SO_2, acid rain provisions in. The industry came in, and everybody said, "Oh, we can't do this, it's going to take us 10 years, it's going to cost eight billion bucks, don't make us do it, you'll kill the industry." The environmental community said, "No, no, no, it's not going to take 8 years, it's going to take 4 years, it'll cost about $4 billion, and we must do it, we can afford it."

To the credit of George Herbert Walker Bush, Bill Reilly, and John Sununu, we did it. They bought the science, they said, "We

have to do it." Guess what? It took half the time that the environmental community thought it would, and half the money. Why? Because nobody was capable of predicting what happens once you make the Federal commitment, once you create the standard, once you have moved all of these industries toward a now-existing marketplace. And nobody is able to predict the rapidity with which the technology then takes over and provides you with something.

Aren't we in that kind of situation here, folks? Where we've got to put up whatever we think it takes for those demonstration projects, for the tax credit, for the science, and guarantee we're setting a goal, and we've got to get this done within 10 years. I'd like everybody to comment.

Mr. CHAISSON. Certainly. I mean, I think that from our perspective, the issue here is, how do you transition from where we are today, to where you need to be in 2020? And I guess, our view would be that you need a suite of policies, no one policy will do it.

On a national scale, requiring that all new coal plants have carbon capture and sequestration wherever they might be located, and having the knowledge to do nationwide geologic sequestration is probably something that's going to take 10 years—perhaps 2018.

There has been a lot of expert testimony presented in the Energy Committee or whatever, about the geologic demonstration projects. In the short-term, you have a lot of companies like BP and others, I'm sure several of the folks pursuing IGCC projects today would be perfectly happy to do carbon capture early, in carefully selected situations, with financial incentives to, to support the cost of doing that. Given the recent run-up in energy project costs, we're going to need to see CO_2 allowance prices somewhere in the $40 a ton range to actually offset the cost of adding carbon capture and storage, so the third piece we need is an effective carbon cap and trade system, but it's going to take awhile for that to ramp up to $40.

So, from our view, the complementary policies would be, first of all, financial incentives for the companies willing to move right now—and I think we'd find that many would be willing to move right now—that would cover the cost of carbon capture and storage between their plants starting up, and us eventually getting to, say, $40 a ton of CO_2 with a cap and trade system.

A second piece would be something along the lines of your proposed legislation, Senator Kerry—an absolute date by which all new coal plants will simply have to have carbon capture and storage—that puts people on notice today, their behavior will change based on that, and that will be a date certain, rather than a questionable date as to when, when we might reach $40 a ton. But behind all that, I think the foundation is, an effective carbon cap and trade system, which will eventually drive prices sufficient to offset any need for financial support.

Senator KERRY. Anybody else?

Mr. DENIS. Certainly, Senator.

Certainly, like yourself, I wish we could have this tomorrow, and not 10 years from now. But, I believe that we do have to be realistic in the timeframe that it takes to develop—not only the technology, but to be able to establish the framework under which we can store the carbon that is going to be sequestered.

I have to observe that, really, the focus really should be on the development of technology—whether it's 1 year, 2 years, 10 years or twelve years. You know, yesterday, the DOE even said it was 2045, which I believe it's a date that's unacceptable to everybody. Nevertheless, the development of technology really needs to move forward. And the reason I say——

Senator KERRY. What if we can't capture it? What if we can't store it? What if you can't find a sufficient storage capacity, it leaks, or it's just too costly or geologically problematic?

Mr. DENIS. That is problematical, and that is a quandary that we have. However, I do believe that current research has it that there can be found some geological structures where the carbon, the CO_2 can be stored.

It is not in all parts of the country. There are some parts of the country that are unsuitable for this, so we need to talk about infrastructure that may be needed to transport such CO_2 to those areas that are geologically safe.

Senator KERRY. Obviously we can't store it in some places, because we're using it now to push fuel. We actually tap into naturally produced CO_2 in order to improve our capture of oil out of old wells and things, so I assume, I don't know what the amount is, but I know there's a sufficient capacity.

Mr. DENIS. And we have to deal with the liability loss associated with such capture, and Congress needs to address that, also.

But, one of the reasons I say we really need to address the technology is, because the focus, and our discussion centers around coal. But we really can't overlook the fact that a modern gas plant produces 50 percent of the carbon dioxide that a coal plant does. So, the problem is wider than just coal, the problem is carbon dioxide. So, the technology that gets developed for coal, hopefully is some technology that's also applicable to some of the gas generation that exists, because even if we replace all the coal units with, or do away with coal units, and have just gas units, we will still have half of the problem, and that half of the problem is still a large problem.

Senator KERRY. Senator Boxer's asked for some time, and I have no problem with that, I can come back.

Senator BOXER. I don't have to leave until eleven.

Senator KERRY. No, that's OK, I'll let you do it now, and I'll come back afterwards and follow up, make sure we do.

So, Senator Boxer?

Senator BOXER. Mr. Chairman, thank you so much, I wish I could stay all morning, but I have another Committee I need to go to.

Again, Senator Kerry, thank you for doing this.

I don't know if you share my view, but Mr. Denis, you said that you don't believe we'll have the ability to capture and sequester carbon till at least 2020, that was your initial——

Mr. DENIS. That, we will have the viable commercial means to do so in a large scale.

Senator BOXER. OK, but you said at least 2020.

Mr. DENIS. Yes, ma'am.

Senator BOXER. Now, I just have to say to my Chairman, that's 3 years after scientists tell us we've reached a tipping point. So,

just speaking for myself, I can't speak for anybody else, we need a better attitude about this. It's just not realistic. I mean, really.

And I don't, in any way want to minimize what we're facing. We've done a lot in this country when we've put our mind to it. I want to see what it is you think we can do as policymakers to help.

And, I guess I'll ask Mr. Wilson, since he's out there now, already, putting out some technologies that are helpful. Do you think we need a Manhattan-like Project? To do more model projects, to help us find the way here? Because I don't see how we wait until at least—at least—2020.

Mr. WILSON. Clearly, a more intensive effort would be highly valuable in terms of demonstrating these technologies at the commercial scale.

Here is the challenge we face. All of these plants, are basically massive in scale; they take years to build and years to prove out their operational efficiency and their performance. At the same time, these facilities must demonstrate economic viability within the regulatory climates, (*i.e.,* a guaranteed rate of return), along with all of the other elements associated with business investments. Without significant Federal guarantees, in many cases, these projects will not move ahead. If you're talking about a Manhattan-type Project, then we have to have a Manhattan-type Project, not a business as usual scenario which is how most of these plants have to operate today.

Senator BOXER. Would you support a Manhattan-like Project in this area?

Mr. WILSON. Of course, we would support—I mean, we're a technology provider, and we will provide to any, any need that was identified in terms of what our customers want.

Senator BOXER. Mr. Rencheck, you were a bit more optimistic than Mr. Denis, I think, trying to find some out here, because in your statement you said, "Over the last 100 years, AEP has been an industry leader in developing and deploying new projects." You said that you have a Memorandum of Understanding for post-carbon capture using Alstom's chilled ammonia system, it will be installed at your 1,300 megawatt plant in New Haven, West Virginia as a "commercial performance verification project in mid- to late-2008, it will capture up to 100,000 metric tons of carbon dioxide." Once the CO_2 is captured, you'll store it. So, you hope to do that by 2008.

Mr. RENCHECK. Yes, ma'am.

Senator BOXER. So, are you a little bit more optimistic than is Mr. Denis on future of the sequestration issue?

Mr. RENCHECK. We believe technology is the answer, and AEP is pushing technology on several fronts, we talk about an IGCC plant being constructed, new, more efficient coal plants, being the ultra supercritical coal plant, the oxy-coal plant for combustion, and we also are looking at back-end retrofit technologies, like carbon capture and sequestration using the chilled ammonia process.

Senator BOXER. So, are you more optimistic than is Mr. Denis, that we could solve this before 2020? He said at least, at the earliest 2020.

Mr. RENCHECK. We are working to solve it very quickly.

Senator BOXER. Good, good.

Mr. RENCHECK. Technology will evolve, and in R&D efforts, sometimes you take a few steps forward, and it stalls, and you have to take a few steps back. So, we are working to make that reality at AEP——

Senator BOXER. Could you use more incentives?

Mr. RENCHECK. We definitely need incentives from the Government. We could use additional investments up to $1 billion a year in the R&D program for DOE. We could use investments in areas for understanding geological sequestration.

At our Mountaineer Facility, for example, in 2004, we have drilled a well, a 9,200-foot well, where we have studied the geological structure underneath the plant, looking for saline aquifers that could store carbon. We've done that with the DOE and Battelle, and we believe we've identified porosity of the geological structure that would enable carbon capture to take place there. We want to test that out with these projects. We're going to need help, we're going to need additional funding to study that.

Senator BOXER. Well, I appreciate your work, your attitude, it's very helpful. I have one last question if I might?

Senator KERRY. Yes, absolutely.

Senator BOXER. And then I'll leave.

Mr. Wilson, you say that you are working every day, your company is, to get cleaner coal going, and you have success. I'm trying to understand where we are right now, with the technologies you're using. So, you say you have cleaner coal, does this mean, you're not only dealing with carbon, but NO_X, SO_X and mercury, as well?

Mr. WILSON. We're dealing predominantly with NO_X, SO_X and mercury, because we—all of the technologies we have, basically, are capture technologies, filtration technologies, which are able to clean all of the pollutants out of the exhaust stream to where you'd have—you basically have no, negligible pollutants left.

Senator BOXER. OK.

Mr. WILSON. With respect to CO_2, the only real option available is to improve the overall efficiency of the plant so that it uses less fuel, therefore produces less kilowatts per unit output. The capture and sequestration objective is clearly the issue that the whole panel was talking about——

Senator BOXER. OK.

Mr. WILSON.—which does need additional work, and a lot of additional work, to get——

Senator BOXER. So, you're not doing any of the work of carbon capture?

Mr. WILSON. Not predominantly, not yet.

Senator BOXER. So, you're doing cleanup of NO_X, SO_X and mercury, and not to minimize that, that's absolutely crucial under the Clean Air Act, and it's important to our families, but——

Mr. Chairman, I think what you've identified today is really critical, here. And I think this panel is so interesting, because you really do have, I believe, different attitudes on how we can move forward.

I hope we can get bipartisan support to really move forward on this. Because, without solving this problem, it's going to create obstacles for us. I've learned a lot, and I thank you so much for your

leadership, and I'm sure we will be doing more of this together. Thank you.

Senator KERRY. We will, indeed, thank you very, very much.

I'll let the others ask some questions, and then I'll come back afterwards. Who was next? I think, yes, Senator Dorgan?

STATEMENT OF HON. BYRON L. DORGAN,
U.S. SENATOR FROM NORTH DAKOTA

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

We have, in my State, lignite coal, something around 800 years worth of lignite coal reserves, and my guess is that we are going to continue to use coal—the question isn't whether, I mean, I don't think we have much choice—but the question is how do we use it, and do we use it in a way—especially combined with new technology, to make it much, much less difficult for our environment.

In, I would say to the Chairman, we have—I believe—the only coal gasification plant in the country, in North Dakota, it produces synthetic natural gas from lignite coal. And the production of synthetic natural gas from lignite coal is a—it's using old technology, the plant was built about 25 years ago, but it's an unbelievable plant, very productive, and we take CO_2 from that plant, put it in a pipe in the world's—I believe—the world's largest application of CO_2 sequestration. We put it in a pipe, and move it to the oil fields of Alberta, Canada, invest it in the ground, to make more productive marginal oil wells in Canada. So, you have beneficial use of CO_2, even as you sequester.

Now, that obviously is not a solution for all of that which we have to deal with, but it's a demonstration that there are some things you can do that make some sense.

I'd just like to ask a couple of questions, because I—I think we're going to use coal. The question is, can we—in a robust way—invest in technology to get to the point where we have zero emissions coal-fired electric generating plants? Do we do it by capturing and storing CO_2? Or do we do it by, hopefully, with some technology that is an avoidance technology, with the production of CO_2? I don't know what the technology will give us.

But, here's the situation, what I want to ask you about. The President and the Administration says, "Let's go with FutureGen," big old project, really a big project. In fact, in Fiscal Year 2008, the Fossil Energy and Coal Request is $426 million, by the President, that's a $1 million increased over the previous year. So, essentially, flat funding for fossil energy and coal—which is mostly research. And flat funding for that at a time—it seems to me—when we ought to be saying, "Wait a second, we can't hardly run fast enough to catch up to this, we need to be really aggressive." Flat funding for that, and then we have $108 million for FutureGen, which is 20—fully 25 percent of that which we're going to put into fossil energy and coal research.

So, tell me your thoughts on that, is that what we ought to be doing? Or, is that kind of a slow motion approach to finding our top speed, using technology to address these questions?

Yes, sir?

Mr. CHAISSON. Senator, a couple of responses. First all, on the DOE program funding, I think the MIT report does a pretty good

job of reviewing that, and I think—for all practical purposes—they're talking about something like $1 billion a year being, sort of minimum. And I think both Professors Deutsch and Moniz testified, or have stated that, when they both have been at DOE, running those programs, you know, many years ago, at least Professor Deutsch, in those-year dollars, the program was actually larger than that. So, it's just sort of getting it back to what it used to be.

I think, in addition, as far as near-term carbon capture, whether it be in North Dakota, or Indiana, we're going to—it costs two and a half cents a kilowatt hour to add carbon capture to a plant today. And, as I said, you're going to have to get to $40 a ton of CO_2 before you offset that. I think there are a lot of companies—not every company—but there are many companies that would do this today, if there was some way to bridge that financial gap between having to add two and a half cents cost today with no ability to offset those costs, and some future point in time where that would be offset, because of the CO_2 benefits.

Senator DORGAN. But, the implication of your answer is that the technology is there, it's just a matter of cost. I don't think that's the case. I mean, it's true, we can capture in certain areas, but capture and storage—it seems to me—requires much, much, much more technology. And, the pursuit of that technology is going to require substantially new investment. And, it looks to me like the President's budget is, perhaps, less than half of what is necessary, with no increase from the previous year, which suggests that this is not a priority. I think it's a huge priority.

Others? Yes, sir, Mr. Rencheck?

Mr. RENCHECK. We need additional support in funding, I recommend approximately a billion dollar a year, consistent with the MIT folks. And, we also support FutureGen, and we think it's important for the further development of the IGCC technology. We are working now, off of a platform technology to go commercial that was developed in the early eighties, to mid-nineties, we'll take that to a commercial scale with today's present technology and prove it in operation, but then FutureGen takes it to the next step, where it will, truly, involve the invention of new technology, such as a hydrogen combustion turbine that will truly enable them to generate electricity, separate out CO_2, and capture.

We also need monies to study the geologies. As you know, different areas of the country have different formations, and at times, the formations aren't consistent within a region. So, we have to drill more holes, understand more about the geology, and start injection projects in those areas, so we can understand how CO_2 will behave in those rock formations.

Senator DORGAN. Are any of you bullish on where we're headed here? Are you bullish on technology?

Mr. WILSON. Yes.

Senator DORGAN. OK.

Mr. WILSON. Yes, I'm bullish on technology and I——

Senator DORGAN. Give me some encouragement, would you, Mr. Wilson?

Mr. WILSON. Yes, the point I just wanted to make is we've always been an advocate of higher funding, essentially, on the development programs, we're a participant in virtually every DOE pro-

gram that comes out. And we provide our expertise, essentially, into these programs. And we are very bullish that, if we want to accomplish a greater goal, we certainly think we can.

It's the political will that has to be behind it in order for funding, and also for the demonstration project that my compatriots all talk about. Is that their significant projects have to be demonstrated, in order for them to be commercially viable, and adopted wholesale.

So that, we believe, yes, indeed, I'm bullish, that the technology is there. The question is, it has to be brought to the scale that utility plants operate at.

Senator DORGAN. And I'm not suggesting, by the way—just to finish this thought—I'm not suggesting that the demonstration through FutureGen of IGCC is irrelevant, it is not. I'm not suggesting it's not valuable, it is. What I am saying is that, even as we do this, and claim a significantly larger part of our budget, and our appropriations for FutureGen, we're not seeing the ramp up of a country that says there's an urgent need to deal with coal research, and the research on carbon capture, so that we open up and unlock the opportunities to be able to continue to use our coal. That's my, that's my problem with this.

And so I, let me thank Senator Kerry, for leadership in this area. I think all of us—Senator Thune, myself, and others—all of us have to figure out that this is urgent. I mean, this isn't something, this isn't like every other problem.

If we're going to be able to continue to use these resources in the future, given the intersection we've now come to with respect to energy and climate change, if we're going to continue to use these resources, we had better figure out that these minds of ours—the fertile minds of, that exist here in this country that have unlocked a lot of mysteries through scientific inquiry and research, we can do the same with technology in coal development.

But it requires significant investment. And it is not coming in this budget. So, we have to be attentive—that's why I think this hearing is very important.

I appreciate—I interrupted you, Mr. Chaisson, I'm sorry for interrupting you——

Mr. CHAISSON. That's fine.

Senator DORGAN.—but let me thank the Chairman for the time, and I thank all of the witnesses for your presentations. I was chairing another hearing so I, but I had read your presentations, and I appreciate your contributions.

Senator KERRY. Senator Dorgan, thank you very much. Couldn't, couldn't agree with you more. Part of the purpose of this hearing and the others we're holding is to raise the level of urgency about this.

And, as I said, you can't be half-pregnant on this thing. Either you accept the science, and then you've got to, if you're accepting the science for valid reasons, to act on it. And, we're not. So, we have a huge challenge.

Let me establish something quickly before I turn to Senator Thune.

Senator Dorgan spoke about the capture of CO_2 that's taking place now, and the piping that takes on, and I had mentioned ear-

lier, we're able to pipe CO_2 naturally out of the Earth, and we're using it also for enhanced oil recovery, I guess it's called.

What's the restraint here, on the capture? You keep saying, "Well, we're going to have to develop the ability to be able to capture out of the IGCC," can you share with us, what do we get out of IGCC, what's left to get, and why can't we get that other piece yet?

Mr. Rencheck, go ahead.

Mr. RENCHECK. Yes, on an IGCC plant, the fundamentals of the way it works with the flue gas stream, when you shift the gas reaction into hydrogen and CO_2, you now have to combust the hydrogen. That CO_2 adds mass flow into the gas turbine, so it's like adding horsepower into a car engine—when you remove that, you generate much less electricity, and then you have to supply energy for the compression, to either put it into a pipeline, or to sequester.

We need to evolve that integration and those systems, so that the electricity amount produced is contained and maintained, and not degraded.

Senator KERRY. But that's the challenge, but not the actual capture of the carbon itself?

Mr. RENCHECK. On IGCC, it is ahead of pulverized coal units in that area. If you looked at the two technologies, PC combustion is further advanced than IGCC, there's a lot to learn. In the capture piece, I would put IGCC ahead than pulverized coal, but the technology race is on for the two to see which one will ultimately be the winner. And, we believe that both, both have a place, and both have a role.

Senator KERRY. But the key is not to degrade the power that you get out of it in the process?

Mr. RENCHECK. That's correct.

Senator KERRY. OK.

Mr. RENCHECK. You can see power prices as an example, using today's state-of-the-art technology——

Senator KERRY. Because if you degrade it, then you've got to replace it. And then the question is cost for what you're providing.

Mr. RENCHECK. Fifty dollars a megawatt would go to $113 a megawatt, is an example on a pulverized coal unit——

Senator KERRY. I understand.

Mr. RENCHECK.—in that range.

Senator KERRY. What about on the sequestration, if you could all, somebody else raised their hand, but you wanted to add something?

Dr. MCRAE. Just on the issue of technology, just to follow up on the comments that were made by Senator Dorgan—coming from MIT, I'm clearly very bullish on technology.

One of the key themes in the MIT *Coal Study* is a sense of urgency, to really move very, very quickly. And, I think our time scales are somewhat shorter, to get the information that you need to solve this problem.

I think that the discussion about capture, sequestration illustrates how people have thought about it in the past. We have to think about it as a system—all the way from the beginning of mining the coal, all the way through to the sequestration.

If you think about how we've dealt with conventional pollutants, like sulfur oxides, and nitrogen oxides, we took, basically, conventional combustion processes, and then added to them control technologies to remove those pollutants. If you, sort of, think about the CO_2 capture problem in a slightly different way, there are some very, very interesting technologies coming along that could potentially cut the cost of both the capture—but without compromising the thermal efficiency of the plant.

For example, if you burnt the coal at pressure, with oxygen, you—it's much easier to take the carbon dioxide out of the gas stream, and you've already got a compressed gas stream which is partially ready for injection into the reservoir. And so our view is that, while FutureGen is focused on IGCC, it should not be to the exclusion of very different ways of thinking about the problem.

I mean, I'm very optimistic about the opportunities—you know, a lot of the technologies that we've been talking about are 50 years old. There's not a lot of investment that has been built into how to capture CO_2 out of a gas stream. I mean, we're still using technology that's 50 years old. The problem is to turn it around—what molecule should you have to design to take the CO_2 out of the gas stream? You know, pose it that way.

So, our view is that if you step back a little bit from the problem, think of it as a systems perspective, it opens up a whole bunch of different ways of thinking about the problem.

So, I think—two points. One, is that I think we have technology to deal with the problem today, at cost. I think there are lots of opportunities for dramatically lowering those costs, costs over time.

The other issue is the issue of scale. In the United States, there's very little activity that addresses this problem at scale. To be able to monitor it, to make sure that it actually stays in the ground——

Senator KERRY. That's the 10 demo projects, so to speak, that we——

Dr. MCRAE. Most of the interesting work that's going on is out of—outside of the United States. All of the big sequestration experiments are being done in Algeria, they're being done in the North Sea, they're being done in Canada, and I just had a workshop over the last couple of days at MIT, where we brought together all of the people that are doing the sequestration experiments from around the world, and one of the key themes that kept coming up over, and over, and over again, was the need to do these at scale, and the need to develop a monitoring program so that you could assure the public that the stuff is going to stay in the ground, where you put it.

Senator KERRY. Great.

Dr. MCRAE. And our view is that you can do that in less than 10 years.

Senator KERRY. Well, I'm going to come back to this, because I want to pursue it, I just don't want to cut in on Senator Thune, so let me go to Senator Thune, and then we'll come back.

STATEMENT OF HON. JOHN THUNE,
U.S. SENATOR FROM SOUTH DAKOTA

Senator THUNE. Thank you, Mr. Chairman. I want to express my appreciation for you holding this hearing on what is a very impor-

tant topic, clean coal technologies, and the important role that coal can play in securing our energy independence. And, as I know everybody on this Committee is probably aware, that we have an abundant supply of coal, in fact, coal-fired plants supply 22 percent of our U.S. energy demand, and over 50 percent of the energy used by the electric power sector. And, it is projected the U.S. has a 250-year domestic supply of coal.

As the witnesses have testified, I think we are on the horizon of an exciting new generation of coal power, IGCC, and other advanced clean coal technologies are very much in their infancy stages, but considering the potential for carbon capture and sequestration, coal could provide a clean and reliable source of energy for generations to come.

So, I too, appreciate the testimony that we've heard this morning, and your thoughts about where this is headed, and I am interested in knowing, as well, what we can do to facilitate the things that will get us to where we need to be, sooner rather than later.

And I think the next step is to continue investing in these technologies, so that IGCC can be implemented on a wide-scale, and that's going to require significant investment, research and development. So, we welcome your input and suggestions about how to do that and what we ought to be doing here to support the efforts that are underway.

Let me, if I could, pose a couple of quick questions.

Mr. Denis, in your testimony, you state that Sierra Pacific's Ely Energy Center, which is a four-unit coal-powered complex, totaling 2,500 megawatts in eastern Nevada, will pave the way for additional renewable energy sources in eastern Nevada. I'd be interested to know what is the relationship between coal facilities and future development of renewable energy projects, such as wind power? And how much of the new transmission capacity could be available for other types of energy, and energy generation, such as wind?

Mr. DENIS. Certainly. Certainly, Senator.

The relationship between the Ely Energy Center and the additional development of renewables is, the Center is being built in a very sparsely populated portion of our State. Essentially, there are no transmission facilities, there are no wires, but yet, there's a lot of wind. So, you can put up all the windmills you want, but there's nowhere for the electricity to go.

This $600 million transmission line is just economically unfeasible to build just for several hundred megawatts of wind and resources that exist in the area. We've identified up to about 500 megawatts of proposals from wind farms that are in the area that could develop, and could use this transmission line, then, to get the power to the market, primarily to the Las Vegas region. This is 250 miles north of Las Vegas, is where this plant is.

So, without the ability of the Ely Energy Center being there, and economically justifying the construction of this facility, we basically have some locked-in geotherm—wind resources.

In addition, the northern part of the state of Nevada, as it's closer to California, is really blessed with geothermal resources. We're the leaders in geothermal production. Yet, there's going to be more geothermal energy than there are people to consume the electricity.

We need to get that electricity to the South, where the big load centers are.

So, we have now, a combination where we have a marriage where this coal unit is a catalyst to provide for additional, and fostering additional development of renewable energy. So, that's the nexus that exists between the two.

Senator THUNE. Well, we've got the same problem in South Dakota, a lot of wide-open space, a lot of wind—in fact, I saw a study the other day that South Dakota could provide 52 percent of the entire electrical demand in this country, just from the wind we generate in our State alone. But, we have the same problem—we're not close to population centers, and transmission is prohibitively expensive.

And, so, I was interested in what you're doing there, in leveraging with an investment in another facility, but being able to use that capacity for renewables. We also have a lot of wide-open space, and, wind turbines. Things that in some parts of the country, people don't want to have in their back yard, are things that my state would welcome.

South Dakota, obviously, is close to Western sub-bituminous coal from Wyoming and Montana—you mentioned how it's more economical to use Eastern bituminous coal—do you know of any research that's taking place in either the public or private sector, working to make Western sub-bituminous coal more economical for IGCC? And in your view, would such research warrant a Federal investment?

Mr. DENIS. Well the—the issue of sub-bituminous coal, the studies that have been performed, particularly by Electric Power Research Institute is that when you add the carbon—the estimated costs of the carbon capture systems, and you're talking about IGCC with Western Powder River Basin coal, sub-bituminous coal, that the economics are that it is less costly to add the carbon capture to a supercritical coal unit.

The answer here, I think, the takeaway from that—in other words, IGCC is more costly with Western coals, with carbon capture than it is on Eastern bituminous coal without—with carbon capture, relative to a supercritical coal.

I think the takeaway from this is that there is no silver bullet with regards to what is the answer to the CO_2. We really must be investing in multiple initiatives—not just in FutureGen, and not just in the experiment that we are conducting with EPRI at Wisconsin Energy, WE Energies, or the answer that AEP has for their Ohio plant—we really must be looking, rather than placing the bet on just a single technology, we must be looking across a series of technologies at present, so that we're not disappointed in the future that we picked the wrong technology going forward.

Senator THUNE. Well——

Mr. DENIS. I'm not sure if I answered your question, but——

Senator THUNE. I think you did, I was just, specifically homing in on Eastern sub-bituminous, versus Western.

Mr. Chaisson?

Mr. CHAISSON. Senator Thune, I guess I'd like to sort of add a slightly different perspective. The EPRI work has been based solely

on the Shell gasifier, which is the sort of, best gasifier for low-ranked coals, of sort of the traditional gasifiers.

There are two new gasifiers that are probably going to be excellent for low-ranked coals, the new Siemens gasifier, and Mitsubishi's gasifier, which simply are too new to have been incorporated in these studies. And, I know NRG—a large independent power developer that's very active in Texas—is been very bullish on using the Mitsubishi gasifier on Texas lignite coals.

So, I think the availability of gasification for low-ranked coals is probably a more complicated picture than has been presented by some of these earlier studies.

Senator THUNE. OK.

Mr. RENCHECK. I would concur. The issue with the Western coal being less efficient is with the moisture in the coal. In the gasifier, you're required to dry the coal before you can partially combust it within the gasifier. That drying takes energy, which makes it less efficient than a pulverized coal plant.

Those processes, for example, we've signed a Memorandum of Cooperation with Siemens to help develop that technology, but those processes need funding for development, and with the proper funding, would advance over time.

Senator THUNE. I, yes, Mr. Denis?

Mr. DENIS. Just to add to my prior statement that there's no silver bullet, and we really must look at a menu of technologies to prove out which one works best—in the sense that there's no one-size-fits-all, there should not be a one-size-fits-all attitude.

Also, the—in my opening statements, one of the issues that we have in the West is also the altitude. Our Ely site is at 6,200 feet of altitude, and yet, there is to be proven whether some of the technologies, in particular, IGCC, how they perform at those higher levels where the air is less dense.

That's not to say it's not a good technology, in fact our company was one of the few companies that participated in the DOE Clean Coal Program of the 1990s, we built an IGCC. It never worked. It sits idle, and it was abandoned, ultimately.

Senator KERRY. Who built it?

Mr. DENIS. It was a combination, I believe, it was a Kellog gasifier——

Senator KERRY. When was it built?

Mr. DENIS. I'm sorry?

Senator KERRY. When was it built?

Mr. DENIS. It was built, it was started in—the negotiations with DOE started in 1991, it started construction in 1995, was completed in 2001.

Senator KERRY. And why did it not work?

Mr. DENIS. It was first of a kind technology. We were experimenting—this was when DOE and their Clean Coal Program of the 1990s was experimenting with different IGCCs to determine which technologies worked. We eventually abandoned the facility, it sits outside of Reno, idle. The consumers of the State and the Federal taxpayers lost $335 million on that.

But, it taught us some important lessons in the need to move forward——

Senator KERRY. Is it not retrofit? Is it not retrofittable to the technology that General Electric or Siemens, or others have developed?

Mr. DENIS. No, it's not. It'd be more—it'd be less costly to, probably, start from scratch than to try and modify what is there.

Senator THUNE. Well, I thank you—those aren't exactly the answers I wanted to hear, Mr. Chairman, but I appreciate them, nonetheless. So, thank you for your input.

Senator KERRY. Well, don't go away for a minute, because I want to explore something that may be of interest to you.

The difficulty that Senator Thune mentioned with respect to the wind power that could be produced is the transmission. And, I know that, there's an issue always about the length, the distance from the wind turbine to the grid, but I assume transformers can have a profound impact on that, correct? If you can come into—sorry, go ahead, Mr. Rencheck?

Mr. RENCHECK. It's, it really is the voltage level of the transmission lines. AEP is proposing across our system, and in other places, to construct a 765 kV line, 765 kilovolt that would be able to transport power more efficiently.

Part of the discussion around CO_2 is also the efficiency of energy transmission. Those high-voltage lines are very difficult to get permitted, as we all know. In West Virginia, we permitted an extension that took us upwards of what, 12 years?

Mr. KAVANAGH. Sixteen.

Mr. RENCHECK. Sixteen years to get permitted. So, that can have a very, very large effect on being able to move power across the Country.

Senator KERRY. We obviously don't have 16 years to fool around with, here. But, that's why I think we ought to consider thinking out of the box a little bit, and thinking, as you've said, sort of systemically, and differently.

But, with respect to that, you know, the 1930s, when electricity first came around, Roosevelt decided that it was important to get this out to the whole Country. And so, the Government invested in making certain that within a certain period of time, every home was going to be wired. Now, I don't think this is unlike that.

If South Dakota has the ability to be able to provide 52 percent of the electricity, and we're looking at this emissions challenge we have over these next years, what is the value of our investing in that line, and providing an ability for them to do it, and you joint venture this with the urgency that we have to provide that.

Mr. DENIS. Ultimately, it boils down to the cost of electricity. If you look at the cost of that investment, plus the cost of the electricity produced by the wind——

Senator KERRY. But, I'm not talking about this being private sector-driven, I'm talking about the Federal Government investing as we did in the TVA, and otherwise, in order to provide the connection, and help make this happen at a cost that then doesn't kill the consumer, and makes a return on investment viable. Until you get going, until you get up and running and you've pushed these other technologies. Is that viable?

Mr. WILSON. Siemens provides transmission and distribution products and services; essentially, this is one of our major busi-

nesses, both in the U.S. and globally. And, your point is well-taken; the U.S. is not a highly well-interconnected system compared to Europe or other highly interconnected systems.

There's a great deal of value that could be gained by increasing the transmission and distribution capacities of the U.S., to basically balance the loads. This would enable us to make use of the best most efficient plants and decrease the emissions. It also would provide improved access for and wider distribution of, of our renewable sources. This is another of the key challenges that we're going to face.

Senator KERRY. Mr. Rencheck?

Mr. RENCHECK. Yes, the 765 kV line is just that—it will open up a highway for electric transmission. And you will find private industry willing to invest in that, as well, with Government funding, it could be expanded. The point will be in the permitting process. If we wanted to expand those lines, we couldn't wait 16 years to address that.

Senator KERRY. I agree. We have to have an expedited process, we've got to put on in place. We've got to behave like this is urgent. It is urgent, so we've got to behave that way. And I think we've got to take a look at these kinds of options.

I'd be happy to work with you, Senator Thune, to see if there's some way to go at that.

Dr. MCRAE. Senator?

Senator KERRY. Yes.

Dr. MCRAE. The issue about the infrastructure, which is, you're touching on with power lines, is very, very important, it's an often critically missing part of the debate. I mean, we're dealing with, not just with transmission lines, for moving electricity, we're also beginning to be looking at——

Senator KERRY. We're going to have to move carbon dioxide.

Dr. MCRAE.—carbon dioxide, and getting the regulatory structures in place——

Senator KERRY. Right.

Dr. MCRAE.—to be able to do that, I think, is very crucial.

Senator KERRY. I completely agree with you, I understand that.

If that's the avenue we go down. Now, you know, if we push the R&D, in 2004, I talked about putting $2 billion up front on the table immediately for clean coal technology R&D. Because, I think the minute you start to push this, who knows whether you guys are going to come up with some other technology, or someone at MIT, or Cal Tech, or Carnegie Mellon or somewhere, is going to sit there and say, "Hey, there may be a better way to do this." Once the marketplace is beckoning, I'll bet you there are 10 new Googles out there, waiting to be created——

Yes, go ahead.

Dr. MCRAE. Perhaps a small anecdote might illustrate this point. I teach the Senior Design Course in Chemical Engineering at MIT, and this semester we had 72 students who were interested in how to burn coal in a clean way. We broke the class up into 18 teams of four students, and each team was assigned a different piece of the problem. And this is the first time in my whole academic career, that after the class finished, teams of students have come back to me and said, "We want to continue to working on this

project, because we've got this neat new idea for how to capture CO_2," or a neat new idea to think about how to build a fertilizer market.

I think—two things here. One is, that there's a group of very talented young people who want to work on this problem, but more importantly, by thinking out of the box, they can come up with many different ideas about how to tackle the problem.

I mean, just one example, just following up on your discussion about Wyoming, if you think about it as a systems problem, you can—in addition to taking CO_2 and putting it in the ground, you can also use it as a basis for a C1 chemical industry. And, if you have electricity, but you can't move it, you can make hydrogen, if you had the CO_2, then you can make methanol, you've got a transportation fuel. That's—you'd have to work through this in a lot more detail.

But the idea here is that we need, in my view, to start to think about this problem much more broadly than just pure generation of power, because I think that opens up a very different way of thinking about the technology. And it's what I see when I look at all of these technologies, is a crucial thing about beginning to think about them in a life cycle sense.

You hear a lot about, for example, solid photovoltaic cells as clean power sources. But what's often missing is the debate that you probably have to run them for at least 3 years before you get more power out than was used to actually produce it in the first place, and there are all kinds of other environmental impacts associated with the production of silicone.

So, I think, in addition to sort of thinking about infrastructure issues, I think we need to couple that with sort of a life cycle view of what these technologies might be, because, on the surface, some of them look very good. But, when you look at the co-effects of them, you often get a very different picture.

Senator KERRY. Yes, Mr. Denis?

Mr. DENIS. Mr. Chairman, I think you've touched on something that is very important, and this is that the—if we, as we agree in the science, there has to be a comprehensive solution, the solution is not only the carbon capture and sequestration. We really must focus on the development of renewables, we must focus on the conservation of energy. I know you have a proposal in a bill to make the Capitol carbon-neutral, I observe that we don't have compact fluorescent lights in this room. Things that we could be doing to reduce our energy use in this Country, that really have the effect of reducing the carbon dioxide.

So, it's not a simple answer, it—I think it's a portfolio of initiatives that we need—really need to pursue to solve this quandary, this problem that we have in front of us.

Senator KERRY. Oh, I couldn't agree more. That's why I introduced the bill. We can't talk about this with legitimacy, if we don't take steps here in the Capitol and elsewhere to become carbon neutral and energy efficient.

The book that my wife and I have just written has a chapter about energy efficiency and the three biggies, clean coal being one of them.

I mean, there are only three ways we're going to grab this thing fast enough. And one is clean coal technology, two is alternative and renewables, and three is energy efficiency. You can do your other things at the margins, but those are the big three. And the energy efficiency piece happens to be the cheapest, fastest, most efficient and effective way of grabbing it fast. And a lot of companies have understood that.

You know Texas Instruments built a new plant down in Texas that saved 88,000 jobs. It's going to provide $14 billion to the economy over its lifetime, and they're burning 25 percent more effective on their energy use, 35 percent less water, I mean, these are the things we can do all over the country, we've got to, and there's a lot of money to be made, incidentally, in the companies that wind up doing these things, it'll be more effective.

Let me come back, if I can, for the clean coal piece of this for a second, I just want to make sure my own understanding, as well as the record, is complete on it.

The IGCC, Integrated Gasification Combined Cycle, in layman's terms, can you just tell people what that does, how it does it?

Mr. Rencheck?

Mr. RENCHECK. It partially combusts coal to produce a syngas, synthetic gas, and that synthetic gas has sulfur, methane in it. You clean out the sulfur, and what you essentially do, then, is combust the gas, it's a clean gas at that point.

Senator KERRY. And it requires no flue component at that point?

Mr. RENCHECK. You get an exhaust emission out of the HRSG of basically the combined cycle plant, the heat regenerative, heat exchanger. You get the combustion flue from the gas turbines.

Senator KERRY. And how complicated is it to attach the carbon capture to that?

Mr. RENCHECK. It would require, basically, a new type of combustion turbine that would burn hydrogen. And that is one of the emphases of FutureGen to develop. The DOE is also working on that, both with Siemens and General Electric, but you would, essentially, at that point, move the gas stream from a methane-based type gas stream to a higher, if not purer, hydrogen-based gas stream. And its combustion profiles are a lot different than with the syngas. And, to understand that, and be able to get the delivered horsepower from that engine so that you could maintain electrical output is what the quest is all about.

Senator KERRY. But, prototype-wise, the basics work, the key now is to take it to scale.

Mr. RENCHECK. For the conventional combined cycle, that's correct. For the hydrogen turbine—it's still in the laboratory.

Senator KERRY. What—sorry.

Mr. WILSON. Siemens is actually heavily involved, in the DOE programs for development of hydrogen fuel combustion. And your point is well-taken in terms of, it's a different combustion phenomena, it's a much hotter flame, and thus a, higher performance standard is required of the gas turbine. So, we're working in order to make the turbine parts more robust, to be able to maintain the turbine and maintain the cooling technology, so they don't degrade quickly.

So, the hydrogen turbine, the next step in advancement, in terms of gas turbine technologies. Gas turbines originally operated very very inefficiently and at very low temperature. They're now very efficient, very high temperature with methane-type gasses. The next step in turbine technology is the hydrogen capable gas turbine and Siemens is heavily involved in the development of this technology.

Senator KERRY. And, is that the key to the carbon capture itself?

Mr. WILSON. Yes.

Senator KERRY. Now, what kind of a threat is thermal solar? Solar thermal?

Mr. WILSON. Threat, it's actually a very promising technology.

Senator KERRY. But if you can do solar thermal, and drive a steam turbine as a consequence of that and produce electricity, what does that say to the coal industry in the long-term?

Mr. WILSON. Well,—we actually are suppliers of steam turbines for virtually almost all of the solar-thermal plants in the world. Siemens has a steam turbine that actually is well-suited for solar industry application.

The challenge is, it's a fraction of a percent of the contribution of thermal electricity to the overall electrical demand. The scale of these projects is relatively small. These are all multi-megawatt plants, compared to the utility-scale project, which is 500, 1,000, 2,500 megawatts.

Senator KERRY. Yes, but isn't that, because they're new and they are sort of coming online, can't they be taken to scale?

Mr. DENIS. Mr. Chairman, if I may——

Senator KERRY. Yes.

Mr. DENIS.—next month, we will put in El Dorado Valley, just south of Las Vegas, into service, the largest solar thermal facility built in the United States in the last 15 years. It's a 64 megawatt facility, using the sun, the strong sun that we have in southern Nevada, to generate the 64 megawatts of electricity. The—as you come into Las Vegas, if you land, you will look to one side——

Senator KERRY. Well, you hope you land.

Mr. DENIS.—you will see half a square mile covered with mirrors.

Senator KERRY. Yes, I've seen that.

Mr. DENIS. That will generate the 64 megawatts. We're very excited about this. There are similar facilities that exist in California that were built in the 1980s, late 1980s, but this one is the first one built in the last 15 years. And we're very excited about that, and it will provide——

Senator KERRY. Who built it?

Mr. DENIS. The company that started—it has changed hands several times, it was initially Duke Solar, then they sold it to a company called Solargenics, which is now the majority of, the Solargenics is owned by a Spanish company called Axiona.

Senator KERRY. Very interesting.

Mr. DENIS. But it is a promising technology for the deserts of the Southwest.

Senator KERRY. What other, besides the IGCC and this current concept, the hydrogen separation, are there other possibilities for clean coal?

Mr. WILSON. Clearly, there are.

Dr. MCRAE. There's actually quite a broad spectrum of possibilities. One, for example, is to—instead of using air, you use oxygen to burn the fuel, and if you use oxygen to burn the fuel, then the primary combustion products are just water and CO_2, and that separation problem is much, much easier than it is with the conventional technologies. The downside is, that you actually then have to supply the oxygen.

But, what's interesting is that there has been a very slow and measurable downward trend in the price of oxygen. So, oxy-firing is a system that I think is a very interesting alternative to IGCC. It also is an interesting possibility for retrofitting. So, that's one technology.

Senator KERRY. How many viable, how many different technologies, are being seriously explored at this point?

Dr. MCRAE. In our *Coal Study* we did an initial sieving, and we had about, I think 10 or 20 of them, and then we brought them down to four, which are the ones——

Senator KERRY. Right.

Dr. MCRAE.—which we think could be brought to bear very, very quickly.

Senator KERRY. We're going to be doing an incentive bill, in the Finance Committee, sometime in June. As we think about those incentives, should we be narrowing it down to the four? Or should we frame it in a way that allows people to make their own choice within the 20, let's say, or more.

Dr. MCRAE. My sense is that you need to engage the community with lots of different ideas about how to deal with this problem. I think the history of sort of mandating technology has not been very good. If you open it up to the marketplace and provide the appropriate incentives to deliver, then I think, in fact, you'll get very different and very innovative ways of dealing with the technology. And there's enough out there to suggest to me that there are real possibilities, and real alternatives to IGCC.

We can use IGCC now, there are some problems with the hydrogen turbines, and there are also some capture issues, but I think they're relatively small time-scale problems to solve, compared to bringing some of these other technologies. But they are there.

And I think just to build on a point that Mr. Denis made is that, what we need is a portfolio of approaches, so that we're bringing on technologies that are evolving over time. And, more importantly, that we put in place mechanisms to learn from these technologies.

One of the, the big problems that we had in carrying out the *Coal Study,* is that it's very difficult to extract the lessons learned from some of these demonstration projects. And, one of the things that I would argue, that if we do open this process up, that, in fact, we pay attention to how we can more efficiently learn about these technologies.

Mr. Chaisson mentioned about some of these gasifiers—it's very difficult to get your hands on what the chemistry that is going on inside those, what really is new and different. And my sense is that this, this kind of information——

Senator KERRY. Why is it so difficult to get your hands on—?

Dr. MCRAE. I think, in part, because it's, the way it's viewed commercially, you know, they view it as a——

Senator KERRY. You mean, because it's proprietary.

Dr. MCRAE.—proprietary, yes.

Senator KERRY. So, people hold it close to the vest.

Dr. MCRAE. But, I think there are things after the technologies being tried, if you're going to provide large amounts of government support to invest in these technologies, that you should, in fact, have the ability to——

Senator KERRY. Guarantee that there is some sort of review capacity for methodology and so forth?

Mr. DENIS. Mr. Chairman, I——

Senator KERRY. Well, that makes sense, yes, Mr. Rencheck? I'm sorry, who—?

Mr. DENIS. Mr. Chairman, I hope that in that June package of incentives that you were talking about crafting, that you don't forget the incentives for renewables. We believe that the investment tax credit and the production tax credit, the extension of those for at least 8 years is important to make sure that we have continuity in the program.

Senator KERRY. Those will be, absolutely.

Mr. DENIS. Also the, there's a disallowance, utilities cannot avail themselves of those investment tax credits presently, and the electric utility industry can be a key catalyst in making sure that we bring this country, and that we, in fact, bring a lot more renewables, which may do away with a lot of coal plants, may do away with a lot of gas plants.

Senator KERRY. Good advice.

Mr. DENIS. Thank you.

Senator KERRY. And we will do that.

Mr. Rencheck, then Mr. Chaisson.

Mr. RENCHECK. We are working with Babcock & Wilcox to pilot an oxy-coal plant in Barberton, Ohio. It will be a 10 megawatt electric demonstration plant, or scale plant, and from that, we'll use that to study and learn, so that we can scale it up to a commercial-size plant.

As we talk about funding, it is, it was imperative that we were able to fund demonstration plants. It takes a lot to get it from the drawing board to a commercial scale that we're talking about that can be economically applied to the grid, and hold down electric rates.

Senator KERRY. Understood, absolutely. I can see that.

Mr. Chaisson?

Mr. CHAISSON. Just two points, Senator. One is, we would certainly support having a very broad approach to incentives, so that any potentially viable technology gets a shot at the incentive funding. But, I would point out that our organization's perspective is much broader than CO_2, and while we agree that there are a lot of promising options for, for capturing CO_2 from coal to electricity, the processes, the other environmental aspects of those processes may vary significantly.

And, at the moment, one reason why we are primarily only supportive of coal gasification, is because of all of the other environmental aspects. I think our view is that, in the long run, for coal to be sustainable, it must deal with CO_2, but it ultimately has to

deal with all of the other environmental aspects. And those should not be forgotten.

Senator KERRY. I couldn't agree more. Obviously, as we go down the road here, the marketplace is going to decide some of this, but probably some public policy needs to look at, the downstream water use, land use, and overall cost impacts. Because, if you look at liquefied coal, for instance, I don't know if anybody here is advocating it but, there's more and more evidence that that is just a huge mistake. I know there's some momentum here, by some, to sort of move in that direction, but it's more energy exploitative in the end, more costly, and threatens an even greater degree of CO_2.

I think we have to think in the, again, the larger piece here, of the consequences.

Is there anything with respect to the clean coal piece that we should know, that you haven't had a chance to share with us as we think about this? Yes.

Mr. CHAISSON. I'd just make one final comment. I think we see underground coal gasification as an extremely promising technology, Lawrence Livermore lab is doing a lot of work in that area, it's really not on the radar, except, perhaps the Governor of Wyoming, who you might want to have come in and talk about that—but that technology, if it proves out anything like its promise appears, it may be a very cost-effective way to use coal, with full capture of carbon, and at the same time, to really minimize most of the adverse impacts of using coal. And it's, it's just not in the studies, it's not kind of, on the radar, but there's actually a surprising amount of commercial activity moving forward in North America.

Senator KERRY. Well, that's terrific, thank you for calling that to our attention, and we will dig into it, get a handle on it, take a look at it, and understand it better.

Yes, Mr. Wilson?

Mr. WILSON. I just wanted to make one last point in terms of, we're looking at a lot of promising technologies for the next generation. We want to make sure that we address the fact that we have a very large fleet out there now. Whatever options you put in place need to also address the existing fleet, and essentially incentivize industry to address that existing fleet at the same time you invest in new projects. You've got to level the playing field, and not necessarily grandfather everything out there.

Senator KERRY. I couldn't agree more. I'm very opposed, personally, to a lot of grandfathering, which is why I got involved in TXU, and I think we have a serious issue there, and obviously we've got a fight here on the new source performance standards issued over the last few years which I think was just a terrible mistake, and will be one of those big contributions to the problem we have.

Yes, Dr. McRae?

Dr. MCRAE. Just one comment I would make, this morning was spoken mostly about what's going on in the United States, but we shouldn't lose sight of the fact that there's an enormous amount of activity going on in Europe, and in China and I think there's a crucial need to figure out how to——

Senator KERRY. Are we sharing any of that?

Mr. WILSON. I work in a global organization, and everything we do is basically on a global basis.

Dr. MCRAE. But, my general sense is, that there is sharing, individually, amongst companies, but there is an opportunity to learn a lot from some of the technology demonstrations that other—that are being done in other parts of the world. This meeting that we had on Monday about sequestration, I think, just getting all of these countries together to talk about how to do it——

Senator KERRY. Who brought them together?

Dr. MCRAE. This was MIT and Chamboucher, excuse me.

Senator KERRY. That's a very good thought. We need to think about how to augment the global effort. Previously, if I may say, when Senator Worth was serving as the Policy Director at the State Department, that position was essentially created to empower us to be engaged in these kind of talks. Obviously, for the last few years, given the Administration's attitude about Kyoto, there has been zero exchange in that regard. I think there's a very, you know, there's a huge pent-up demand for us to get involved in that kind of a dialogue, and I think we will, very shortly. Yes?

Mr. RENCHECK. We sponsored an Asian-Pacific partnership meeting, where we had members from India and China attend in very large numbers. It went over quite well, in discussions of energy efficiency, and also new generations of combustion and IGCC plants. So that, that sharing of technology is starting to occur.

There was recently a sponsored meeting in Japan that also went along those lines.

Senator KERRY. I can't thank you enough. I think it's been a very helpful, very interesting exchange, and we're all learning up here, trying to get up to speed.

I don't think there's any disagreement about the urgency, and it's interesting to hear you all accept that, readily accept the challenge, and understand that if you had greater resources, you believe you could move this thing an awful lot faster. I have complete confidence in that, incidentally.

Again, referencing back to the Clean Air Act experience, and the Clean Water Act experience of the 1970s, there is no doubt in my mind that once we get a standard in place, create a market, get this moving, American ingenuity—global ingenuity—but American ingenuity will contribute significantly, and we can get this done. But, we've got to treat it as the emergency and urgent effort that it is.

Thank you for contributing to that dialogue and we will certainly follow up with you.

I'm going to leave the record open for 2 weeks in the event that any colleagues want to submit any questions in writing, and the full text of all of your testimonies will be placed in the record.

Thank you very much, we stand adjourned.

[Whereupon, at 11:54 a.m., the hearing was adjourned.]

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