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THE AMERICAN ENERGY INITIATIVE, PART 29: A FOCUS ON H.R. 6172

HEARING

BEFORE THE

SUBCOMMITTEE ON ENERGY AND POWER

OF THE

COMMITTEE ON ENERGY AND COMMERCE

HOUSE OF REPRESENTATIVES

ONE HUNDRED TWELFTH CONGRESS

SECOND SESSION

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THE AMERICAN ENERGY INITIATIVE, PART 29: A FOCUS ON H.R. 6172

THURSDAY, SEPTEMBER 20, 2012

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

The subcommittee met, pursuant to call, at 10:05 a.m., in room 2322 of the Rayburn House Office Building, Hon. Ed Whitfield (chairman of the subcommittee) presiding.

Members present: Representatives Whitfield, Shimkus, Walden, Terry, Burgess, Bilbray, Scalise, Olson, McKinley, Gardner, Pompeo, Griffith, Barton, Upton (ex officio), Rush, Markey, Green, Capps, Doyle, and Waxman (ex officio).

Staff present: Anita Bradley, Senior Policy Advisor to Chairman Emeritus; Maryam Brown, Chief Counsel, Energy and Power; Allison Busbee, Legislative Clerk; Patrick Currier, Counsel, Energy and Power; Andy Duberstein, Deputy Press Secretary; Cory Hicks, Policy Coordinator, Energy and Power; Heidi King, Chief Economist; Ben Lieberman, Counsel, Energy and Power; Mary Neumayr, Senior Energy Counsel; Peter Spencer, Professional Staff Member, Oversight; Kristina Friedman, Democratic EPA Detailee; Caitlin Haberman, Democratic Policy Analyst; and Alexandra Teitz, Democratic Senior Counsel, Energy and Environment.

OPENING STATEMENT OF HON. ED WHITFIELD, A REPRESENTATIVE IN CONGRESS FROM THE COMMONWEALTH OF KENTUCKY

Mr. WHITFIELD. I would like to call this hearing to order, and once again, I want to thank the members of the panel for being here and we look forward to your testimony. All of you have had a lot of experience in the issues that we will be talking about, so after we finish opening statements, I will be introducing each one of you individually.

Today we are holding the 29th day of our American Energy Initiative hearing. We will be focusing on H.R. 6172, which would prohibit EPA's proposed New Source Performance Standard for greenhouse gases from being finalized until it is technologically and economically feasible. I want to thank Mr. McKinley of West Virginia for spearheading this legislation, and I also want to thank the Democratic members who cosponsored this legislation.

I don't think that anyone is not aware of the fact that this administration has a strong bias against coal. We all are familiar with the President's comments in San Francisco when he was run-

ning for President that people would be able to build coal plants if he is elected President but they would be bankrupt. Yesterday, many of you read about Alpha Resources closing down eight coalmines, 1,200 jobs. Patriot Coal recently announced they were going into bankruptcy. Murray Coal up in Ohio, West Virginia, Kentucky and Illinois has announced they are going to be closing down three mines. And I understand the argument on the other side because they say it has nothing to with us, it has nothing to do with our regulations, this is because natural-gas prices are low, which is true. But even if that were not the case, once this regulation becomes final, no one will be able to build a new coal power plant in America. And so I lay that at the foot of the President and his administration. It is their responsibility and they are responsible for where we are today as it relates to coal. It still produces a great portion of the electricity in our country.

Now, it is easy to talk about the benefits of lowering carbon dioxide emissions, and I would be the first to admit the Clean Air Act has been very successful. But I would also say that when EPA considers the benefits, and there are benefits from many regulations, that they have a responsibility to consider the cost and the impact on the health care of the thousands of people who lose their jobs as a direct result of the regulations. And of course, they never consider those costs.

And so this legislation is very simple. It basically says no, you are not going to be able to implement this until it is shown that, technologically and economically, it is feasible to use carbon capture and sequestration and it appoints three different agencies in the government to make that decision.

[The prepared statement of Mr. Whitfield and H.R. 6172 follow:]

Opening Statement of the Honorable Ed Whitfield
Subcommittee on Energy and Power
Hearing on "The American Energy Initiative: A Focus on H.R. 6172"
September 20, 2012
(As Prepared for Delivery)

Today we are holding the twenty-ninth day of our American Energy Initiative hearing. We will be focusing on H.R. 6172, which would prohibit EPA's proposed New Source Performance Standard (NSPS) for greenhouse gases from being finalized until it is technologically and economically feasible. I applaud my friend and colleague David McKinley for spearheading this important effort.

It is now clear to everyone that the Obama administration intends to limit or eliminate the use of coal for electricity generation. Any doubts about this have been erased by the mounting casualties, including mine closings, power plant shutdowns, and associated layoffs that are being announced on an almost weekly basis. Most recently, Alpha Natural Resources has said it will close eight coal mines and lay off of up to 1,200 employees. And the bad news for those who depend on coal just keeps on coming.

And given the fact that several of EPA's anti-coal regulations have yet to go into effect, this situation is only going to intensify, and the job losses and electricity price increases and threats to reliability are only going to become more severe in the years ahead. Nonetheless, the Obama administration still denies that it is opposed to the use of coal.

But those denials become even more far-fetched in light of EPA's proposed NSPS for greenhouse gases from fossil fuel-fired electric generating units. The reason is that this rule would effectively mandate carbon capture and storage (CCS) for new units – a technology that is currently a very long way from widespread use and for which a great many questions remain unanswered. In my view, the proposed rule amounts to nothing less than an outright ban on new coal-fired power plants, and one that could later be extended to existing plants as well.

That is why this bill, or something like it, is so critical. The bottom line is that the federal government would have to be on record that what it is requiring of coal-fired power plants is achievable in the real world. Of course, this is something regulators should be doing without having to be told. And in fact this bill does nothing more than bring back a common sense approach to regulation.

Coal, historically our largest fuel source for electricity generation, has been a major focus of EPA's regulatory agenda ever since it was created in 1970. For all those years, EPA has regulated coal in a manner that reduced emissions but allowed its ongoing use. And it did so under both Democratic and Republican administrations. Indeed, the track record shows that the nation can continue using coal while cleaning up the air we breathe.

Only under President Obama have we seen the unprecedented step of coal being targeted for extinction. And given that coal is America's most abundant energy source, the stakes could not be higher.

The sad thing about this bill is that it shouldn't be necessary, but under the Obama EPA it is. H.R. 6172 is important to the future viability of American coal, and for that reason is important to the future of the American economy.

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112TH CONGRESS
2D SESSION

H. R. 6172

To prohibit the Administrator of the Environmental Protection Agency from finalizing any rule imposing any standard of performance for carbon dioxide emissions from any existing or new source that is a fossil fuel-fired electric utility generating unit unless and until carbon capture and storage is found to be technologically and economically feasible.

IN THE HOUSE OF REPRESENTATIVES

JULY 24, 2012

Mr. MCKINLEY (for himself, Mr. RAHALL, Mr. GRIFFITH of Virginia, Mr. HOLDEN, Mrs. LUMMIS, Mrs. CAPITO, Mr. JOHNSON of Ohio, Mr. ALTMIRE, Mr. COSTELLO, and Mr. CARDOZA) introduced the following bill; which was referred to the Committee on Energy and Commerce

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A BILL

To prohibit the Administrator of the Environmental Protection Agency from finalizing any rule imposing any standard of performance for carbon dioxide emissions from any existing or new source that is a fossil fuel-fired electric utility generating unit unless and until carbon capture and storage is found to be technologically and economically feasible.

1 *Be it enacted by the Senate and House of Representa-*
2 *tives of the United States of America in Congress assembled,*

SECTION 1. NO FINALIZATION OF ANY STANDARD OF PERFORMANCE FOR CARBON DIOXIDE EMISSIONS FROM ANY EXISTING OR NEW FOSSIL FUEL-FIRED ELECTRIC UTILITY GENERATING UNIT UNTIL COMPLIANCE TECHNOLOGY IS FEASIBLE.

(a) IN GENERAL.—The Administrator of the Environmental Protection Agency shall not finalize any rule imposing any standard of performance under section 111 of the Clean Air Act (42 U.S.C. 7411) for emissions of carbon dioxide from any existing or new source that is a fossil fuel-fired electric utility generating unit unless and until at least 3 of the 4 officials listed in subsection (b) publish in the Federal Register, and submit to the Congress, a report finding that carbon capture and storage is technologically and economically feasible for fossil fuel-fired electric utility generating units.

(b) LISTED OFFICIALS.—The officials listed in this subsection are—

(1) the Administrator of the Energy Information Administration;

(2) the Comptroller General of the United States;

(3) the Director of the National Energy Technology Laboratory; and

1 (4) the Under Secretary of Commerce for
2 Standards and Technology.
3 (c) DEFINITIONS.—In this section, the terms "exist-
4 ing source" and "new source" have the meanings given
5 such term in section 111(a) of the Clean Air Act (42
6 U.S.C. 7411(a)).

○

Mr. WHITFIELD. So I was going to yield to Mr. Barton. I see he is not here. Mr. Shimkus, do you have any comments you would like to make?

OPENING STATEMENT OF HON. JOHN SHIMKUS, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF ILLINOIS

Mr. SHIMKUS. Thank you, Mr. Chairman. I appreciate the hearing.

There was a huge rally in deep southern Illinois over the weekend to protect and save coalmining jobs in the country, and for the administration to continue to make this assault on our cheapest form of electricity generation, and I think for a lot of us who have been in this fight for a long time, it is the multitude of rules and regulations that are coming down from boiler MACT, mercury MACT, cooling towers to CSAPR. You name it, there is another rule and reg. No wonder there is uncertainty in the sector and no wonder they have to make tough decisions. These tough decisions are the loss of jobs, coalmining jobs in rural America.

The untold story is also the loss of a taxpaying base to small, rural America that helps support our schools, our hospitals, our local communities, our public-safety net. That is why we are as impassioned as our friends on the other side saying we just have to stop this assault, so I appreciate the hearing. It comes at a critical time, and thank you for it.

Mr. WHITFIELD. At this time I recognize the gentleman from Illinois, Mr. Rush, for 5 minutes.

OPENING STATEMENT OF HON. BOBBY L. RUSH, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF ILLINOIS

Mr. RUSH. I want to thank you, Mr. Chairman, and Mr. Chairman, we are here yet another time, yet another day, yet another bill being introduced by my Republican colleagues that will attempt to roll back the progress that the American people have made and block and delay EPA rules that are designed to make our air, land, and water cleaner for the American people including those people who now currently have and will in the future work in coalmines.

Today's hearing marks the 29th in a series of hearings that the majority party has dubbed the American Energy Initiative, but from each of those hearings, which represents hundreds of hours of endless debate, endless discussion and endless delay, we have enacted exactly zero, nada energy policy to move the country forward. All this hearings and it hasn't produced one bill that moved this country forward.

Mr. Chairman, if today's hearing feels a bit like dÉjà vu all over again, as Yogi Berra would say, to those that are watching this subcommittee just because we have been here and we have done this countless times already.

Today's hearing will focus on H.R. 6172, a bill that prohibits the EPA from finalizing standards of performance under section 111 of the Clean Air Act for carbon dioxide emissions from existing or new fossil fuel-fired power plants unless or until carbon capture and storage is found to be technologically and economically feasible. Ironically, Mr. Chairman, this bill comes on the heels of the last markup the subcommittee held where the majority defeated an

amendment I offered that would have exempted future clean-coal projects from the arbitrary December 2011 deadline, and my Republican colleagues' misguided attempts to disrupt the Department of Energy loan program by prohibiting any funding for future proposals regardless of the merits or technological advances of those projects. So as the first attempt to abandon any new Department of Energy funding for future clean-coal projects, the majority party is now bringing forth a bill that would block and delay EPA rules from finalizing the proposed carbon pollution standards for new power plants or any future carbon pollution standards for existing power plants until carbon capture and sequestration is technologically and economically feasible. This bill to most people would seem simply another attempt to try and shield the dirtiest polluters from commonsense air quality standards that would make their facilities cleaner and more efficient while protecting Americans' health.

Mr. Chairman, this messaging bill sends a clear message to industry that if we don't succeed once, twice, 10, 20, or in this instance, 29 times, we will try and try and try again to show the industry that we are with them standing shoulder to shoulder not to be divided by the plight or the affairs of Americans' public health.

Mr. Chairman, this is a dead-on-arrival bill, as you well know, and if the stakes weren't so high and important to the protect the American people, then we could get a laugh out of 29 times and nothing to show for it, these message after message attempts on the part of the Republicans. Whatever happened to governing through bipartisan legislation?

Mr. Chairman, I think that this bill and our time here is a waste of our energy, a waste of our time, and it certainly is not an attack on coal, it is an attack on progress and what is best for the American people and common sense.

I yield back.

Mr. WHITFIELD. Thank you, Mr. Rush.

At this time I recognize the gentleman from Michigan, Mr. Upton, for 5 minutes.

OPENING STATEMENT OF HON. FRED UPTON, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF MICHIGAN

Mr. UPTON. Well, thank you, Mr. Chairman.

This hearing on H.R. 6172 continues the committee's oversight of EPA's costly regulatory agenda and follows previous subcommittee hearings on EPA's myriad greenhouse gas regulations, including its most recently proposed rule that would establish new emissions standards for fossil-fuel-fired power plants. We are extremely concerned about the impacts that this proposed rule would have on the future of affordable coal-fired power generation in America if indeed it is finalized.

As currently written, the rule requires any new coal-fired plants to install costly carbon capture and sequestration technology. However, even President Obama's Department of Energy has acknowledged that CCS technology is not yet commercially available and that large-scale commercialization remains years, if not decades, away.

Leaders in CCS technology and industry stakeholders agree that significant technical, legal and regulatory hurdles still need to be overcome in order to successfully bring CCS to commercial scale. And because CCS technology remains in its early stages of development, not a single CCS developer in the world can currently guarantee that its technology will work at commercial scale, and without such a guarantee, power plant operators will not, and cannot, make investment in CCS technology.

In other words, unless and until CCS technology is proven to be commercially viable and cost-effective, EPA's proposed rule will effectively prevent the construction of any new coal-fired power plants in America. But a ban on coal-fired generation is the end result that the administration probably is trying to achieve.

We shouldn't be surprised by that. This administration's position on coal has been crystal clear: President Obama himself said he wants to "bankrupt" coal companies and that "electricity prices will necessarily skyrocket." Meanwhile, the Secretary of Energy has declared that coal is his worst nightmare. Those are his words.

This proposed rule would do exactly what the administration set out to do from the very start: prohibit the future use of coal in this country. Clearly, there is a war on coal that is being waged by the administration. Just ask the 1,200 employees of Alpha Natural Resources that were told this week that they are going to be out very quickly because of the announced mine closures forced in part by Federal regs aimed at restricting the use of coal, or the hundreds, probably thousands of other miners across the coal belt who have recently received pink slips too.

If finalized, this rule will have a detrimental impact on electricity generation in the country and future electricity prices as well. This is why we are going to continue to scrutinize EPA's proposed rule and why I appreciate the gentleman from West Virginia's leadership on this bill, and I will yield now the balance of my time to Mr. McKinley.

[The prepared statement of Mr. Upton follows:]

Opening Statement of the Honorable Fred Upton
Subcommittee on Energy and Power
Hearing on "The American Energy Initiative: A Focus on H.R. 6172"
September 20, 2012
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Today's legislative hearing on H.R. 6172 continues the committee's oversight of EPA's costly regulatory agenda and follows previous subcommittee hearings on EPA's myriad greenhouse gas regulations, including its most recently proposed rule that would establish new emissions standards for fossil fuel-fired power plants.

We are extremely concerned about the impacts this proposed rule would have on the future of affordable coal-fired power generation in America if it is finalized. As currently written, the rule requires any new coal-fired plants to install costly carbon capture and sequestration (CCS) technology. However, even President Obama's own Department of Energy has acknowledged that CCS technology is not yet commercially available and that large-scale commercialization remains several years, if not decades, away.

Leaders in CCS technology and industry stakeholders agree that significant technical, legal, and regulatory hurdles need to be overcome in order to successfully bring CCS to commercial scale. And because CCS technology remains in its nascent stages of development, not a single CCS developer in the world can currently guarantee that its technology will work at commercial scale. Without such a guarantee, power plant operators will not, and cannot, make investment in CCS technology.

In other words, unless and until CCS technology is proven to be commercially viable and cost effective, EPA's proposed rule will effectively prevent the construction of any new coal-fired power plants in America. But a ban on coal-fired generation is the end result this administration is hoping to achieve.

We shouldn't be surprised by the intended result of this rule. The Obama administration's position on coal has been crystal clear: President Obama himself said he wants to "bankrupt" coal companies and that "electricity prices will necessarily skyrocket." Meanwhile, the Secretary of Energy has declared that "coal is his worst nightmare."

This proposed rule would do exactly what the administration set out to do from the very beginning: prohibit the future use of coal in this country. Clearly, there is a "War on Coal" being waged by this administration. Just ask the 1,200 employees of Alpha Natural Resources that will be out of work soon due to recently announced mine closures forced in part by federal regulations aimed at restricting the use of coal. Or the hundreds of other miners across the coal belt who have recently received pink slips.

If finalized, this rule will have a detrimental impact on electricity generation in America and future electricity prices. This is why we will continue to scrutinize EPA's proposed rule and why I appreciate Mr. McKinley's leadership on this bill.

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OPENING STATEMENT OF HON. DAVID B. MCKINLEY, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF WEST VIRGINIA

Mr. MCKINLEY. Thank you, Mr. Chairman.

The EPA is indeed proposing a regulation that future coal-fired facilities must implement a carbon capture system that reduces their emissions by 50 percent, but like you have heard from some of the other speakers, it cannot be performed. There are no commercial applications available. We have even heard testimony, as you before from the EPA, saying we know that it can't be done for 10 years or more. Therefore, the mission here is no coal-fired electric powerhouses will be constructed in America until this technology is available.

Now, that has to be coupled with the concept of maybe through research and development, maybe that will happen, but we all know here in Congress that this administration has cut the research money in National Energy Technology Lab last year 40 percent, this year 41 percent. How are we going to achieve this objective if we don't have the research into the development of this process?

You have heard the quotes. I will add one more. Joe Biden, the Vice President, has said that this administration does not support clean-coal technology. What better manifestation of it in this particular rule that they are promulgating? They are trying to bankrupt us to stop us from burning coal and what they are doing is hurting the working men and women all across America, putting them out of work, these 1,200 people.

We have learned that AEP has already canceled one of its own projects, the Mountaineer plant, because they found out that that cost was going to be, as I understand it, increasing the utility bills by 80 percent to consumers, to schools, to manufacturers, and they chose not to do it.

So for anyone that believes that there is no war on coal, they are in denial. This President, this administration and those who support him are hurting our consumers. They are hurting our Nation. They are close-minded about where we are going to go in developing our fossil fuels, the fuel that feuded our industry revolution.

So this war on coal must stop. These ideologically driven regulations must not be implemented until the technology and the economics justify their cost.

Thank you very much, and I yield back the balance of my time.

Mr. WHITFIELD. At this time I recognize the gentleman from California, Mr. Waxman, for 5 minutes.

OPENING STATEMENT OF HON. HENRY A. WAXMAN, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF CALIFORNIA

Mr. WAXMAN. Thank you very much, Mr. Chairman.

This committee has heard a lot of arguments from victims and people are being convinced that they are victims by the government when that is not the case. Let me cite an example. This committee had a hearing on EPA's proposed regulation of farm dust. Can anybody think of anything more ridiculous than regulating farm dust that is ubiquitous to farms? So this committee rushed legislation

to protect the farmers from EPA regulation of farm dust even though EPA said they had no plans to regulate farm dust, and we passed a bill. Do you know what the bill did? It provided for repeal of regulations from open-pit mining that put out particulate matter and toxic substances in the air. So the farmers were told they were victims and they were being used for a different purpose.

It is not the government's fault if a utility decides it is cheaper to use natural gas than coal. That is what we call economics. If it is cheaper to use another substance, they will use it. Do we want to stop them from doing that? Do we want to stop the free enterprise system?

We don't have the technology to remove the carbon from coal and store it. It is a technology we all should want to have. But the industry has no incentive to develop that technology because they are doing fine selling coal and using coal without that technology. That would just be an extra expense.

So you have two ways you could get that technology. One is to say you have got to use it in order to achieve a certain standard. Well, the best way to achieve that standard, that is the way the environmental laws have worked in the past as long as we allow source of electricity to compete as long as it does not cause unacceptable harm to health and the environment. This bill picks winners and losers. The other EPA would set a standard that companies that generate electricity from coal will not have a free pass on pollution.

But there was another way to do it. That was the way Mr. Upton proposed in legislation that would have put a fee on those who get electricity from coal and that fee would have been used exclusively for research and development of the technology. That was a bill he introduced in the last Congress with Mr. Boucher, and I suggested to him that we would take up that bill and vote for it. If we can't do anything else, at least do that. Never heard any other word on the subject after we proposed doing that.

The Republicans in this House passed H.R. 910, the Upton-Inhofe bill. That would have barred EPA from reducing dangerous carbon pollution and codified science denial by overturning EPA's scientific finding that carbon pollution endangers health and welfare. It is a premise that climate change is a hoax, and since that time early last year, this Republican House has proved to be the most anti-environmental in the history of the Congress.

Republicans have voted more than 300 times on the House Floor to weaken longstanding public-health and environmental laws, block environmental standards, defund protections of our air, water and public lands, oppose clean energy. They voted 47 times to block action on climate change. When they passed that Upton-Inhofe bill a year and a half ago, House Republicans argued the science was uncertain, EPA was exceeding its authority. By now, everybody should understand that they were wrong on both counts. The science has been clear and clearer, and just look at all the signs of climate change occurring around us: recent wildfires, droughts, heat waves, exactly the type of extreme weather events that scientists have been predicting for years and that this committee has been ignoring.

Since the passage of the Upton-Inhofe bill, we have sent 17 letters to the chairman of this committee requesting hearings on new developments in climate science. We haven't even gotten a reply. Instead, what we have is the leadership of this committee talking about a war on coal, and if coalminers are losing their jobs, it is because of the government. Well, it is because of economics and the unwillingness of the Republicans who control the House to figure a way out of this issue.

The EPA is not overreaching. The courts have affirmed their power to regulate in this area. It is about time we try to help the people in the coal area be viable in a new economy that is coming. Otherwise you can scare them with talk of war against them but it is a dishonest approach. It doesn't help them. It stirs up the feelings of victimology by the people in these areas, and I suppose it is supposed to help Republicans in the election. But sometimes let us stop playing politics and deal with national urgent matters, and this committee has refused to do it for a year and a half.

Mr. WHITFIELD. At this time I would like to introduce the members of the panel. Once again, thank you for being with us today. We look forward to your testimony.

First, we have Mr. Eugene Trisko, who is an attorney at law representing the United Mine Workers of America. We have Mr. Mark McCullough, who is Executive Vice President of Generation at American Electric Power. We have Mr. John Voyles, Jr., who is the Vice President of Transmission and Generation Services at Louisville Gas and Electric and KU Energy. We have Mr. Robert Hilton, who is Vice President of Power Technologies for Government Affairs at Alstom Power. And we have Mr. John Thompson, who is the Director of Fossil Transition Project at the Clean Air Task Force, and we have Dr. Dan Lashof, who is the Director of Climate and Clean Air for the Natural Resources Defense Council, and we have Dr. John R. Christy, who is Professor and Director of the Earth Science System Center at the University of Alabama in Huntsville.

So thank you for being with us. Each one of you will be given 5 minutes to give an opening statement, and you will notice there is a little clock up here, so once your time is expired, it is expired. Obviously I am not going to just immediately cut you off but I wouldn't want you to go on like 10 minutes, but we do look forward to your testimony.

Mr. Trisko, I will recognize you for 5 minutes for your opening statement.

STATEMENTS OF EUGENE M. TRISKO, ATTORNEY AT LAW, ON BEHALF OF UNITED MINE WORKERS OF AMERICA; MARK MCCULLOUGH, EXECUTIVE VICE PRESIDENT, GENERATION, AMERICAN ELECTRIC POWER; JOHN N. VOYLES, JR., VICE PRESIDENT, TRANSMISSION AND GENERATION SERVICES, LG&E AND KU ENERGY LLC; ROBERT HILTON, VICE PRESIDENT, POWER TECHNOLOGIES FOR GOVERNMENT AFFAIRS, ALSTOM; JOHN THOMPSON, DIRECTOR, FOSSIL TRANSITION PROJECT, CLEAN AIR TASK FORCE; DANIEL A. LASHOF, DIRECTOR, CLIMATE AND CLEAN AIR PROGRAM, NATIONAL RESOURCES DEFENSE COUNCIL; AND JOHN R. CHRISTY, PROFESSOR OF ATMOSPHERIC SCIENCE AND DIRECTOR, EARTH SYSTEM SCIENCE CENTER, UNIVERSITY OF ALABAMA IN HUNTSVILLE

STATEMENT OF EUGENE M. TRISKO

Mr. TRISKO. Thank you. Good morning, Chairman Whitfield, Ranking Member Rush, distinguished members. I am Eugene Trisko. I am an attorney in private practice, and I am pleased to be here today to testify on behalf of the United Mine Workers of America to support the enactment of H.R. 6172. I have had the honor of representing the UMWA in Clean Air Act and domestic international climate change issues for the past 25 years.

H.R. 6172 is sound policy and a commonsense solution to the threat to new advanced coal generation posed by EPA's proposed carbon pollution standard rule. That rule sets a uniform CO_2 emissions rate of 1,000 pounds of CO_2 per megawatt-hour applicable to both coal and natural-gas combined cycle units. New coal units would need to employ CCS technology to comply while new natural-gas combined cycle units could comply without CCS.

EPA and DOE's National Energy Technology Lab estimates that applying CCS to new coal-based units would increase the cost of electric power by 80 percent. CCS has not been commercially demonstrated in this country as indicated by the findings of the 2010 Interagency Task Force Report on Carbon Capture and Storage. EPA's proposed rule is simply a means of forcing winners and losers in the future market for electric generation.

The proposed rule also ignores 40 years of EPA regulation under the Clean Air Act by lumping together these two very different sources of electric generation into one category subject to a single emission standard that only one type of source can meet. The EPA rule says in effect that the best system of emission reduction for new coal and natural-gas units is natural-gas combined cycle technology. The mine workers comments to EPA, which are attached to my testimony, note that natural-gas combined cycle is a form of producing electricity, not a best system of emission reduction under the Clean Air Act.

The UMWA has supported previous legislation to accelerate the commercial demonstration of CCS technologies including the Upton-Boucher bill. This legislation has not been enacted and funding available through DOE has not been adequate to support successful large-scale demonstration of CCS technology. We are hopeful that new proposals will be developed to put CCS demonstration projects on a firmer financial footing.

Coal is an indispensable part of America's energy supply and must be a core element of any all-of-the-above energy policy. More than one-third of our Nation's electricity is generated by coal, mainly in baseload plants. The principal alternatives to coal for future baseload generation are nuclear and natural gas. While natural-gas prices have declined recently, substantial uncertainty surrounds future natural-gas prices, particularly in view of the 40- to 60-year lifetimes of electric generation assets.

The United States should take the lead in establishing the technical and commercial viability of CCS technology for use both here and abroad. India and China have vast coal reserves and will continue to rely upon them to support their own economic development. China alone consumes three times more coal than we do. Our recoverable coal reserves hold the energy equivalent of the world's proven oil reserves.

The United States should pursue policies that will accelerate, not stymie, the full range of advanced coal technologies including commercial-scale demonstration and deployment of CCS. Rethinking the EPA carbon pollution standard rule is an important step in that direction, and we support this bill. Thank you, Mr. Chairman.

[The prepared statement of Mr. Trisko follows:]

Summary Statement of Eugene M. Trisko on behalf of the United Mine Workers of America
September 20, 2012
In re H.R. 6172

I am pleased to be here today to testify on behalf of the United Mine Workers of America (UMWA) to support enactment of H.R. 6172.

H.R. 6172 eliminates the threat to advanced new coal generation posed by EPA's proposed "Carbon Pollution Standards Rule." That rule sets a uniform carbon dioxide emission rate of 1,000 pounds of CO2 per Megawatt-hour applicable to both coal and natural gas combined-cycle generation units. New coal units would need to employ CCS technology to comply, while new natural gas combined-cycle units could comply without CCS. EPA estimates that applying CCS to new coal-based units would increase the cost of electric power produced by 80 percent.

CCS has not been commercially demonstrated in this country, as indicated by the 2010 Interagency Task Force Report on Carbon Capture and Storage. EPA's proposed rule is simply a means of forcing winners and losers in the future market for electric generation. It also ignores 40 years' of EPA regulation under the Clean Air Act by lumping together these two very different sources of electric generation.

The UMWA has supported previous legislation to accelerate the commercial demonstration of CCS technologies. This legislation has not been enacted, and funding available through DOE appropriations and ARRA has not been adequate to support successful large-scale demonstration of CCS technologies.

Coal is an indispensable part of America's energy supply and must be a core element of any "all of the above" energy policy. More than one-third of our nation's electricity is generated by coal, principally in baseload plants. The principal alternatives to coal for future baseload generation are nuclear and natural gas. While natural gas prices have declined recently, substantial uncertainties surround future natural gas prices, particularly in view of the 40-60 year lifetimes of generation assets.

The U.S. should take the lead in establishing the technical and commercial viability of CCS technologies for use both here and abroad. India and China have vast coal reserves, and will continue to rely upon them to support their economic development. Our recoverable coal reserves hold the energy equivalent of the world's proven oil reserves. The U.S. should pursue policies that will accelerate – not stymie – the full range of advanced coal technologies, including commercial-scale demonstration and deployment of CCS. Rethinking the EPA Carbon Pollution Standards Rule is an important step in that direction.

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Statement on Behalf of the
United Mine Workers of America, AFL-CIO
Before the
Energy and Power Subcommittee
Committee on Energy and Commerce
U.S. House of Representatives
September 20, 2012

In re H.R. 6172

Chairman Whitfield, Ranking Member Rush and distinguished members of the Subcommittee:

I am pleased to be here today to testify on behalf of the United Mine Workers of America (UMWA), the labor union representing the nation's organized coal miners. I have represented the UMWA in clean air and global climate change issues for some 25 years, including participation as an NGO at all major United Nations climate change negotiating sessions since the 1992 Rio Summit. A copy of my bio is Attachment 1, and a summary of my statement is attached to the front cover.

Background

The UMWA supported the development in 2008 of the Boucher-Rahall bill, H.R. 6258, to facilitate the commercial-scale demonstration of CCS technologies through a non-budget "wires charge" imposed on sales of fossil-based electricity. The bill would have raised $10 billion over ten years to support the deployment of several commercial-scale demonstration projects, such as the AEP Mountaineer project and others. The union supported similar measures in the Senate. CCS has significant potential for creating jobs as well as mitigating carbon emissions.[1]

For a variety of reasons, these bills were not enacted, and the funding available through DOE and from the 2009 ARRA legislation has not been adequate to support successful large-scale CCS demonstrations.

In recognition of this, the 2010 Report of the Administration's Task Force on Carbon Capture and Storage concluded that:

> CO2 removal technologies are not ready for implementation on coal-based power plants for three primary reasons:
>
> 1) they have not been demonstrated at the larger scale necessary for power plant application,

[1] See, *e.g.*, Keybridge Research LLC and University of Maryland Inforum Modeling Project, Estimating the Economic Impacts of Carbon Capture and Storage (April 2010), available at http://www.coaltransition.org/filebin/pdf/CCS_Jobs_Study_CATF.pdf, and BBC Research & Consulting, Employment and Other Economic Benefits from Advanced Coal Electric Generation with Carbon Capture and Storage (2009, sponsored by ACCCE, AFL-CIO Industrial Union Council, IBEW, IBB, and UMWA), available at http://www.americaspower.org/sites/default/files/BBC-FINAL.pdf.

> 2) the energy penalty associated with CO2 capture would significantly decrease power generating capacity, and
>
> 3) if successfully scaled up, they would not be cost effective at their current level of process development.
>
> Other technical challenges associated with the application of these CO2 capture technologies to coal-based power plants include high capture and compression auxiliary power loads, capture process energy integration with existing power system, impacts of flue gas contaminants (NOx, SOx, PM) on CO2 capture system, increased water consumption and cost effective O2 supply for oxy-combustion systems.[2]

Support for H.R. 6172

The UMWA supports enactment of H.R. 6172, a bipartisan bill introduced by Reps. McKinley, Rahall and several other members. The bill prohibits U.S. EPA from finalizing any rule imposing a standard of performance for carbon dioxide emissions from new or existing fossil-fueled electric generating sources until and unless carbon capture and storage (CCS) technology is found to be technologically and economically feasible. The bill requires this determination to be made by at least 3 of 4 federal officials from the Energy Information Administration, the Comptroller General, the National Energy Technology Laboratory, and the Department of Commerce.

[2] Report of the Interagency Task Force on Carbon Capture and Storage (August 2010) at A-11, 12 (citations omitted.)

The UMWA recommends that H.R. 6172 be amended in one respect, to clarify that any determination of economic feasibility discounts federal or other financial assistance received to support the design, construction, or operation of CCS projects.

The UMWA views U.S. EPA's recent proposal for limiting carbon dioxide emissions from new coal- and natural gas-based generation sources[3] as a means of forcing winners and losers in the future market for electric generation. The so-called "Carbon Pollution Standards Rule" sets a uniform carbon dioxide emission rate standard of 1,000 pounds of CO2 per Megawatt-hour applicable to both coal and natural gas combined-cycle generation units. New coal units would need to employ CCS technology to comply, while new natural gas combined-cycle units could comply without CCS.

Based on DOE/NETL data, EPA estimates that applying CCS to new coal-based units would increase the cost of electric power produced by 80 percent.[4] EPA's analysis of the costs of producing electricity from new coal and natural gas units assumes a carbon penalty on new coal units equivalent to $15/ton of CO2, but

[3] Docket EPA-HQ-OAR-2011-0660, Proposed Standards of Performance for Greenhouse Gas Emissions for New Stationary Sources: Electric Utility Generating Units, 77 FR 22392 (April 13, 2012).
[4] *Id.*, at 22415.

no comparable charge is added to the costs of natural gas combined-cycle units.[5] Natural gas combined-cycle units emit CO2 at approximately one-half the rate of pulverized coal units.

For the reasons outlined in UMWA's comments on this proposed rule, included as Attachment 2, the proposed rule is unworkable and unsound. UMWA has recommended that any new source standards for carbon dioxide emissions be set on a separate basis for coal and natural gas combined- cycle units, consistent with some 40 years' of EPA regulation under Section 111 of the Clean Air Act.

The Role of Coal in "All of the Above" Energy Policy

Coal is an indispensable part of America's energy supply. The U.S. has a demonstrated coal reserve base of over 480 billion tons, with an estimated 259 billion tons of recoverable reserves.[6] Our recoverable coal reserves have the energy equivalent of about one trillion barrels of oil, an amount comparable to the world's known oil reserves.

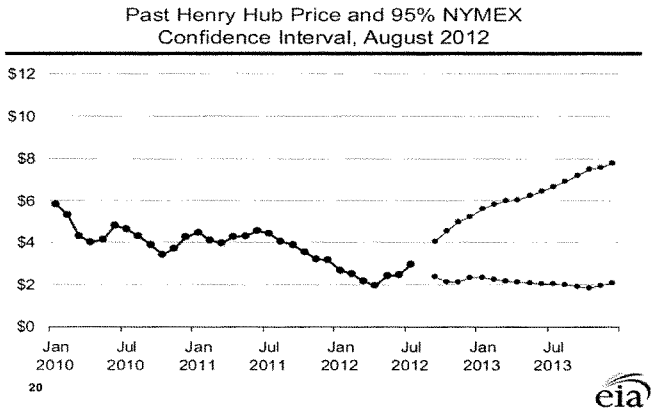
More than one-third of our nation's electricity is generated by coal, principally in baseload plants. Intermittent renewables such as wind cannot replace baseload coal, and usually are backed up with natural gas. To reduce coal in our energy supply mix means using another fuel to replace it for baseload

[5] See, EPA, Regulatory Impact Analysis of the Proposed Standards of Performance for Greenhouse Gas Emissions for New Stationary Sources: Electric Utility Generating Units (2012) at 5-15, 16. The carbon penalty is assessed as a 3% adder to the cost of capital for new coal units.
[6] http://www.eia.gov/coal/annual/pdf/table15.pdf

generation, most likely a combination of nuclear and natural gas. Such a fundamental shift in U.S. energy policy would bring into question the cost of natural gas supplies. Substantial increases in demand for natural gas from the utility and transportation sectors likely would lead to higher electric generation costs and electric rates for consumers.

An "all of the above" energy policy requires that new advanced coal generation employing state-of-the-art Best Available Control Technologies for reducing criteria and hazardous air pollutants be available as part of our future energy mix. Environmental policies that drive electric utilities away from coal conflict with the goal of maintaining a reliable, low-cost mix of generating sources.

The uncertainty associated with natural gas futures prices underscores the need for a balanced future mix of electric generation capacity, particularly given the 40-60 year lifetimes of generating assets. The chart below shows EIA's August 2012 assessment of the 95% confidence interval surrounding the NYMEX futures contract through December 2013. The indicated range of prices in December 2013 is from $2/MMBTU to $8 per MMBTU:



Source: U.S. DOE/EIA, Short Term Energy Outlook (August 7, 2012).

EPA's Proposed GHG NSPS Rule May Delay CCS Demonstrations

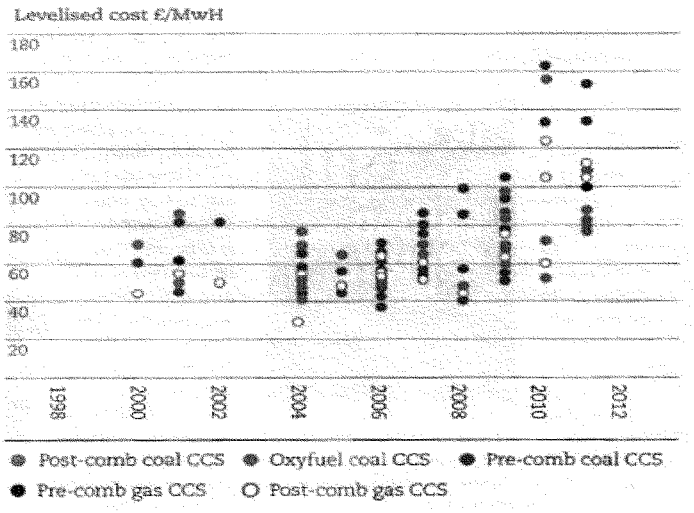
CCS technology can store carbon dioxide emissions from power plants underground in deep storage sites, such as saline aquifers and shale formations. The U.S. is estimated to have several hundreds of years of storage potential at many locations across the nation.

Unfortunately, EPA's proposed GHG NSPS rule likely would have the counterproductive effect of indefinitely delaying investments in CCS technologies, by focusing new generation investments on natural gas combined-cycle plants. As UMWA pointed out in its attached comments on the proposed rule, natural gas and coal generation are roughly comparable in life-cycle greenhouse gas emissions.

We also are concerned by recent international analyses indicating major

increases in the costs of CCS technologies. Historically, the costs of conventional pollution controls such as scrubbers have declined as a result of "learning-by-doing," economies of scale, and other factors. CCS, at this relatively early stage of development, appears to be increasing in cost. The chart below summarizes the findings of an independent, interdisciplinary study of the viability of CCS technologies conducted by researchers at four U.K. universities. It suggests a trend of increasing costs per Megawatt-hour of CCS capacity across five different CCS technologies for coal and natural gas units:

Costs of CCS Technologies, 2000-2012



Source: "CCS – Realizing the Potential?" *Carbon Capture Journal* (July-August 2012) at 11.

Relationship of CCS to Climate Change Mitigation

The U.S. should take the lead in establishing the technical and commercial viability of CCS technologies for use both here and abroad. The world's ability to stabilize global CO_2 concentrations – the long-term goal of the U.N. Framework Convention on Climate Change (FCCC) - depends largely upon the willingness of major developing economies like India and China to accept meaningful and legally-binding commitments to reduce their future rate of emissions. These countries have vast coal reserves, and will continue to rely upon them to support their economic development. China alone consumes three times more coal than the United States. To date, however, the U.N. climate process has not produced a workable framework for a binding global climate change agreement that could achieve the long-term goal of the FCCC.

The Intergovernmental Panel on Climate Change has recognized the critical role that CCS needs to play in any future scenario to reduce global GHG emissions:

> In most scenarios for stabilization of atmospheric greenhouse gas concentrations between 450 and 750 ppmv CO2 and in a least-cost portfolio of mitigation options, the economic potential of CCS would amount to 220–2,200 GtCO2 (60–600 GtC) cumulatively, which would mean that CCS contributes 15–55% to the cumulative mitigation effort worldwide until 2100, averaged over a range of baseline scenarios.[7]

[7] IPCC Special Report on Carbon Dioxide Capture and Storage (2005) at 12.

The U.S. should pursue policies that will accelerate – not stymie – the full range of advanced coal technologies, including the commercial-scale demonstration and deployment of CCS technologies. Rethinking EPA's Carbon Pollution Standards Rule is an important first step in this direction.

Conclusion

H.R. 6172 is an appropriate response to EPA's premature Carbon Pollution Rule. It would help to ensure that new advanced coal units employing Best Available Control Technologies can be constructed. The bill is not a substitute for legislation to advance the commercial demonstration of CCS, which should be considered separately.

The UMWA thanks the Chairman, the Ranking Member, and the Subcommittee for their consideration of its views.

Attachment 1

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Mr. Trisko has a B.A. in economics and politics from New York University (1972) and a J.D. degree from Georgetown University Law Center (1977). He is admitted in the District of Columbia, and has appeared before the U.S. Court of Appeals for the D.C. Circuit in matters concerning the Clean Air Act. He has lectured on the Clean Air Act and climate change at Penn State University and West Virginia University College of Law.

Mr. Trisko was active on behalf of the United Mine Workers of America in the reauthorization of the 1990 Clean Air Act Amendments. He has participated as an NGO on behalf of the UMWA in all United Nations climate change negotiating sessions since the 1992 Rio Earth Summit. In 2006 and 2007, he represented the UMWA in mercury proceedings in Pennsylvania, and in the Illinois Climate Change Advisory Group. In 2010, he represented the Illinois AFL-CIO, the UMWA and IBEW local unions in the Midwest Governors' Association climate change process.

Mr. Trisko was a member of U.S. EPA's Clean Air Act Advisory Committee from 2003 to 2010. He served on EPA's Mercury MACT Work Group from 2003 to 2005, and on the Advanced Coal Technology Working Group in 2007-08. In 2000 and again in 2007, he was appointed by the U.S. Department of State to represent U.S. labor and stationary source interests as a member of the U.S. Delegation in bilateral air quality negotiations with Canada.

Mr. Trisko is the author of more than 25 articles on energy, climate and clean air policy issues published in environmental and law journals. Before entering private practice, he served as an attorney with the Federal Trade Commission, and as an energy economist with Robert R. Nathan Associates. He has appeared as an expert witness on utility cost of capital before several state public service commissions.

Attachment 2

United Mine Workers of America

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June 25, 2012

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Attn: Docket EPA-HQ-OAR-2011-0660

Proposed Standards of Performance for Greenhouse Gas Emissions for New Stationary Sources: Electric Utility Generating Units

Ladies & gentlemen:

These comments are submitted on behalf of the United Mine Workers of America, AFL-CIO (UMWA). UMWA represents active and retired coal miners across the United States whose welfare will be critically impacted by U.S. EPA's decisions regarding the proposed New Source Performance Standards (NSPS) for greenhouse gas (GHG) emissions from fossil-fueled electric generating units.

For the reasons outlined below, we request that EPA re-propose this rule to provide a basis for the construction of well-controlled new coal generation facilities meeting Best Available Control Technology (BACT) Standards for GHGs and other air pollutants, consistent with the agency's current GHG BACT Guidance.[1] As proposed, the rule imposes an unworkable and infeasible carbon dioxide (CO2) emission limitation that would require the application of carbon capture and storage (CCS) technology during the commercial lifetime of any new coal generation unit.

The UMWA has actively supported legislation to provide funding for the commercial demonstration of CCS technology. To date, however, Congress has not acted

[1] U.S. EPA, "PSD and Title V Permitting Guidance for Greenhouse Gases" (November 10, 2010).

beyond the relatively modest funding provided for programs operated by DOE's Office of Fossil Energy. As a result, CCS technology has not been commercially demonstrated at utility scale applications in this country. The 2010 Report of the Interagency Task Force on CCS[2] recognizes this fact. The International Energy Agency's recent report, "Golden Rules for a Golden Age of Natural Gas,"[3] assumes that CCS will not be deployed until 2035.

The proposed rule envisions that new coal plants would be able to meet an average emission limit of 1,000 lbs CO2/MWH by installing CCS ten years after initial operation of a new coal plant. This is an unrealistic assumption. Plant owners would be unable to obtain financing for the future application of CCS technology due to the inherent uncertainties associated with securing all of the legal, regulatory, and permitting approvals associated with the application of an undemonstrated technology ten or more years after initial commercial operation of a new coal generation unit. We doubt that engineering and construction contractors would even be willing to bid on the future construction of CCS facilities so far in advance of construction and operations.

Our most fundamental objection to the proposed rule is its unprecedented combination of coal-based steam electric and natural gas combined cycle (NGCC) units into one category, requiring these very different generation technologies to meet the same standard of 1,000 lbs. CO2 per MWH. NGCC units can meet this limit with no additional controls. EPA acknowledges that the CCS requirement would raise the cost of electricity at coal plants by 80 percent. Faced with this magnitude of generation cost increase, no prospective plant developer could be assured of a future market for the output of the plant. State utility commissions are not likely to issue certificates of "convenience and necessity" for uneconomic generation facilities.

UMWA members are suffering significant job losses due to current low natural gas prices and the hundreds of coal plant retirements announced in response to EPA's Utility MATS rule. An NSPS rule that effectively bans the construction of new coal plants is fundamentally inconsistent with the Administration's commitment to an "all of the above" energy policy, and will deprive coalfield communities in dozens of states of any prospects for recovery from the job losses they are now experiencing.

We therefore respectfully urge EPA to re-propose the GHG NSPS rule on a basis that provides separate, achievable standards for steam-electric coal and NGCC technologies. As discussed below, we recommend that the standards for new coal-based units be based on the performance of supercritical or ultra-supercritical technologies equipped with scrubbers and other state-of-the-art emission controls.

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[2] **Report of the Interagency Task Force on Carbon Capture and Storage** (August 2010).

[3] International Energy Agency, "Golden Rules for a Golden Age of Gas," (World Energy Outlook Special Report on Unconventional Gas, 2012) pp. 91-92.

Coal and Natural Gas Require Separate GHG NSPS

The proposed NSPS combine natural gas combined cycle and steam electric coal-based generation into a single category for purposes of meeting a 1,000 lb. CO2/MMBTU emission standard over the lifetime of a new fossil-based electric generating facility. The "best system of emission reduction" EPA chose to set this standard is natural gas combined cycle generation, with no controls for CO2 emissions. Coal units are offered an alternative NSPS based on the application of CCS meeting either "day one" compliance or a 30-year average emission rate of 1,000 lbs/MMBTU.

We disagree with this proposed combination of source types for three reasons: 1) NGCC is not a "system of emission reduction" but is a form of electric generation technology that emits CO2 and other pollutants, and is itself potentially subject to the application of CCS technologies; 2) applying CCS only to coal units, but exempting natural gas, discriminates against the construction of new coal units and lacks any environmental justification; and 3) the selective application of CCS to new coal units is contrary to the Clean Air Act's requirement that NSPS be "adequately demonstrated."

EPA has not provided any justification for limiting the application of CCS to new coal-based units. However, CCS technology is potentially available to reduce CO2 emissions from NGCC units,[4] at estimated costs below those associated with the application of CCS to coal units.[5] While we are not now advocating for the application of CCS to natural gas units – for the same reasons that we do not support its application to coal units – the record of this rulemaking appears deficient in the absence of a justification for applying CCS solely to new coal units.

We note in this regard research by Dr. Tom Wigley of the National Center for Atmospheric Research[6] and the recent assessment by the International Energy Agency of policies encouraging the substitution of natural gas for coal in the electric generation sector.[7] This body of research illustrates that methane leakage associated with natural gas production, transportation, and generation produces lifetime greenhouse gas emissions and concentrations roughly equivalent to coal generation.

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[4] *See,* http://www.netl.doe.gov/energy-analyses/pubs/deskreference/B_NGCC_051507.pdf

[5] *See*, Ron Edelstein, Gas Technology Institute, "Natural Gas and Carbon Capture and Sequestration," (presented at NARUC 122d Annual Conference, Atlanta, GA, November 2010); http://naruc.org/meetingpresentations.cfm?7

[6] Tom M.L. Wigley (2011), Coal to gas: the influence of methane leakage, *Climatic Change* DOI 10.1007/s10584-011-0217-3.

[7] International Energy Agency, "Golden Rules for a Golden Age of Gas," (World Energy Outlook Special Report on Unconventional Gas, 2012) pp. 91-92.

CCS is Not Adequately Demonstrated

CAA section 111(a)(1) defines a "standard of performance" as a "standard for emissions of air pollutants which reflects the degree of emission reduction which (taking into account ... cost ... and any nonair quality health and environmental impact and energy requirements) ... has been adequately demonstrated."

In the proposed rule, EPA argues that "...CCS is technologically feasible for implementation at new coalfired power plants and its core components (CO2 capture, compression, transportation and storage) have already been implemented at commercial scale."[8] The agency cites DOE's National Energy Technology Lab findings that the application of CCS may cause the cost of electricity from pulverized coal power plants to increase by "around 80 percent."[9]

In contrast, EPA's November 2010 Guidance on GHG BACT in the NSR permitting process recognized CCS as an "available" technology option but declined to recommend its application, citing uncertainties about CCS commercial availability noted by the Administration's Interagency Task Force Report:

> For the purposes of a BACT analysis for GHGs, EPA classifies CCS as an add-on pollution control technology that is "available" for large CO2-emitting facilities including fossil fuel-fired power plants and industrial facilities with high-purity CO2 streams (*e.g.*, hydrogen production, ammonia production, natural gas processing, ethanol production, ethylene oxide production, cement production, and iron and steel manufacturing). For these types of facilities, CCS should be listed in Step 1 of a top-down BACT analysis for GHGs. This does not necessarily mean CCS should be selected as BACT for such sources. Many other case-specific factors, such as the technical feasibility and cost of CCS technology for the specific application, size of the facility, proposed location of the source, and availability and access to transportation and storage opportunities, should be assessed at later steps of a top-down BACT analysis. However, for these types of facilities and particularly for new facilities, CCS is an option that merits initial consideration and, if the permitting authority eliminates this option at some later point in the top-down BACT process, the grounds for doing so should be reflected in the record with an appropriate level of detail.[10]

The Interagency Task Force on CCS reached the following conclusions on the commercial readiness of CCS technologies:

> Current technologies could be used to capture CO2 from new and existing fossil energy power plants; however, they are not ready for widespread

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[8] 77 FR 22392 at 22417.
[9] *Id.*, at 22415.
[10] U.S. EPA, "PSD and Title V Permitting Guidance for Greenhouse Gases" (November 10, 2010) at 33-34 (footnotes omitted.)

> implementation primarily because they have not been demonstrated at the scale necessary to establish confidence for power plant application. Since the CO2 capture capacities used in current industrial processes are generally much smaller than the capacity required for the purposes of GHG emissions mitigation at a typical power plant, there is considerable uncertainty associated with capacities at volumes necessary for commercial deployment.[11]

The proposed rule's unprecedented combination of fossil generation sources ignores 40 years' of EPA regulation under Section 111 of the Clean Air Act. It would create severe market distortions favoring natural gas over coal even if the price of natural gas rises to the point that advanced coal-based generation becomes the clear economic choice for utility investments in 40-50 year generating capacity.

The history of establishing separate NSPS for coal-based steam electric generation began with the promulgation of the 1971 NSPS limiting sulfur dioxide (SO2) emissions from coal generation to 1.2 lbs. SO2 per MMBTU,[12] proceeded through the 1979 NSPS setting a sliding-scale SO2 percentage reduction requirement for new coal generation sources,[13] continued through the 2006 NSPS revisions for SO2, NOx, and particulate matter (PM) emissions for steam-electric generating units,[14] and concluded most recently with fuel-neutral revised NSPS for SO2, PM and NOx emissions from steam electric generating units, including coal-based sources.[15] The specific emission limitations that EPA set in the 2012 NSPS reflect the application of scrubbers, fabric filters, selective catalytic reduction and other technologies to coal-based generation sources.[16]

In all of these rulemakings, EPA set NSPS limitations reflecting the performance of commercially-available control technologies that the agency determined to represent

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[11] **Report of the Interagency Task Force on Carbon Capture and Storage** (August 2010) at 34-35.
[12] 36 FR 24876 (December 23, 1971).
[13] 44 FR 33580 (June 11, 1979).
[14] 71 FR 9866 (February 27, 2006).
[15] 77 FR 9304 (February 16, 2012). The SO2 emission limit for new and reconstructed EGUs is 130 ng/J (1.0 lb/MWh) gross energy output or 97 percent reduction regardless of the type of fuel burned. *Id.*, at 9423. In the initial proposal of the revised NSPS, EPA explained that coal-based units provided the bases for the Best Demonstrated Technology standards adopted as NSPS in the final MATS rule: "To develop a fuel- and technology neutral emission limit, we first analyzed data on emission control performance from coal-fired units to establish an emission level that represents BDT for units burning coal. We adopted this approach because the higher sulfur, nitrogen, and ash contents for coal compared to oil or gas makes application of BDT to coal-fired units more complex than application of BDT to either oil- or gas-fired units. Because of these complexities, emission levels selected for coal-fired steam generating units using BDT would also be achievable by oil- and gas-fired EGUs." 76 FR 24976 at 25062 (May 3, 2011).
[16] *See,* 76 FR 24976 at 25060-63.

Best Demonstrated Technology (BDT). The same policy rationale should apply to the limitation of GHG emissions from sources employing different fossil fuels and entirely different combustion technologies.

Coal-Based NSPS Should Reflect State-of-the-Art Generation Efficiency

CCS is not an adequately demonstrated technology, and is not economic in the absence of a carbon market or other financial program to defray its incremental costs. Consequently, EPA should establish NSPS for new coal generation plants reflecting state-of-the-art generation technology and emission control for criteria and hazardous pollutants. In the event that natural gas prices do not conform to current expectations, this would avoid locking in power providers to natural gas as their dominant generation choice.

We concur with EPA that supercritical and ultra-supercritical coal-based generation technologies offer superior energy efficiency at competitive costs:

> In determining the "best system of emission reduction" for this category of boilers and combined cycle units, we considered a range of natural gas-fired and coal-fired generation technologies, with available controls. We considered modern supercritical and ultra-supercritical coal-fired boilers. This technology is available — it is currently deployed in Europe and is now being widely deployed in Asia (especially China). ... These supercritical and ultra-supercritical boilers have CO2 emissions of approximately 1,800 lb/MWh and provide the lowest overall costs for conventional coal-based electricity.[17]

As an alternative to the proposed rule, UMWA supports a coal-based NSPS for CO2 emissions reflecting the performance of supercritical or ultrasupercritical units equipped with the emissions controls needed to comply with other applicable CAA requirements (e.g., scrubbers, SCRs, fabric filters, activated carbon injection.) Such an alternative would be consistent with the energy-efficiency emphasis of current GHG BACT Guidance, and could be revised in subsequent NSPS rulemakings to incorporate CCS technology if warranted.

International Considerations

The UMWA was the first U.S. labor union to engage the United Nations climate change negotiation process, immediately following the negotiation of the 1992 Rio Framework Convention on Climate Change. We have participated as a separately-accredited NGO at every major UN FCCC negotiation session over the past 20 years.

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[17] 77 FR 22392 at 22417.

We have consistently urged that domestic actions to reduce greenhouse gas emissions should occur in the context of a multilateral framework for reducing GHG emissions from major industrial and developing economics. Developing nations will account for 70% of global energy-related greenhouse gas emissions by 2050.[18] Without meaningful long-term commitments from these nations, unilateral domestic emissions reductions would do little to reduce global concentrations of greenhouse gases.[19]

Participation in a global climate change mitigation program, with access to international offsets, also could significantly reduce U.S. compliance costs and other economic impacts. EPA estimated that the marginal cost of GHG abatement under the proposed 2010 American Power Act would increase by 89% in the absence of international offsets.[20]

The "Durban Platform" agreed to in December 2011 at 17th Conference of the Parties (COP-17) to the FCCC sets in motion a three-year negotiation process intended to produce a global agreement "with legal force" applicable to all parties to the FCCC:

> *The Conference of the Parties,*
>
> *Recognizing* that climate change represents an urgent and potentially irreversible threat to human societies and the planet and thus requires to be urgently addressed by all Parties, and acknowledging that the global nature of climate change calls for the widest possible cooperation by all countries and their participation in an effective and appropriate international response, with a view to accelerating the reduction of global greenhouse gas emissions ...
>
> 1. *Decides* to extend the Ad Hoc Working Group on Long-term Cooperative Action under the Convention for one year in order for it to continue its work and reach the agreed outcome pursuant to decision 1/CP.13 (Bali Action Plan) ...
>
> 2. *Also decides* to launch a process to develop a protocol, another legal instrument or an agreed outcome with legal force under the United Nations Framework Convention on Climate Change applicable to all Parties, through a subsidiary body under the Convention hereby established and to be known as the Ad Hoc Working Group on the Durban Platform for Enhanced Action; ...

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[18] OECD, *OECD Environmental Outlook to 2050*, (November 2011, Ch. 3) at 5.

[19] *See, e.g.*, EPA, Analysis of the American Power Act (2010) at 21 (adding US action based on the APA to the reference case scenario lowers global CO2e concentrations in 2100 from 932 ppm to 868 ppm.)

[20] *Id.*, at 31 (scenario 7 versus scenario 2, H.R. 2454)

> 4. *Decides* that the Ad Hoc Working Group on the Durban Platform for Enhanced Action shall complete its work as early as possible but no later than 2015 in order to adopt this protocol, legal instrument or agreed outcome with legal force at the twenty-first session of the Conference of the Parties and for it to come into effect and be implemented from 2020. ...[21]

Successful negotiation of a global climate agreement would provide a pathway for the U.S. to join its major international trade partners in a program covering both industrial and developing nations. The participation of developing nations is critical not only from the perspective of climate change mitigation, but also for reducing the domestic costs of compliance with any agreed targets and timetables through access to low-cost international offsets and other flexibility mechanisms. With the costs of CCS applied to new coal-based power plants likely to exceed $70 per ton of CO2 captured and stored, access to international offsets would substantially reduce U.S. costs of reducing GHGs.

As noted in EPA's analysis of the proposed 2010 American Power Act:

> If international offsets were not allowed, the allowance price would increase 34 to 118 percent relative to the core policy scenario, and household consumption losses would increase 31 to 114 percent, the large range due to the differing international offset core scenario usage projections of EPA's two models.[22]

Rational design of a global climate change program should coordinate policies governing the future application of CCS across utility and industrial sources on a multilateral basis, consistent with agreed targets and timetables for GHG emission reductions, including flexibility mechanisms such as offsets, credits for reducing deforestation, and emissions trading.

These international considerations, coupled with the fact that CCS is not "adequately demonstrated" for purposes of establishing GHG NSPS, support deferring judgment on the need to apply CCS technology to either coal or natural gas generation at this time.

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[21] Decision FCCC/CP.17/2011/LX, Establishment of an Ad Hoc Working Group on the Durban Platform for Enhanced Action, December 10, 2011 at 1-2.

[22] EPA, Analysis of the American Power Act (2010) at 4.

For these reasons, UMWA urges EPA to re-propose this rule on a basis that provides separate, achievable NSPS for NGCC and coal-based electric generating units.

Thank you.

Sincerely,

Cecil E. Roberts

Mr. WHITFIELD. Thank you.

Mr. McCullough, you are recognized for 5 minutes.

STATEMENT OF MARK MCCULLOUGH

Mr. MCCULLOUGH. Chairman Whitfield, Ranking Minority Member Rush and distinguished members of the Committee on Energy and Commerce, thank you for inviting me here today. I appreciate this opportunity to offer the views of AEP on EPA's proposed Greenhouse Gas New Source Performance Standard and the current state of carbon capture and storage technology.

My name is Mark McCullough. I am the Executive Vice President of Generation at AEP. AEP is one of the Nation's largest generators, owning more than 37,000 megawatts of generating capacity and serving more than 5 million retail customers. EPA's generating fleet employs diverse fuel sources including coal, nuclear, hydroelectric, natural gas, oil and wind. Due to the location of our service area and historic importance of coal to the economies of our States, approximately two-thirds of our generating capacity utilizes coal.

AEP has a long history of proactive involvement in environmental stewardship, particularly with regard to reducing its net carbon emissions. Perhaps AEP's most significant contribution to technology solutions for addressing greenhouse gas emissions was a successful completion of a validation scale demonstration of the world's first fully integrated CCS project at an existing coal-fired electric generating unit. The Mountaineer CCS Project treated a 20-megawatt portion of flue gas from our 1,300-megawatt Mountaineer plant, removed the CO_2, compressed it and injected it into two deep underground formations from 2009 to 2011, permanently storing nearly 40,000 tons of CO_2.

AEP has long maintained that the Clean Air Act is not a practical or cost-effective vehicle to limit greenhouse gas emission and any system to regulate greenhouse gas emissions should be developed by Congress. Global climate change and greenhouse gas emissions present a new set of issues that the existing framework of the Clean Air Act was never intended to address. As such, regulation of greenhouse gases under the existing Act is likely to be ill designed and significantly more costly than a more flexible legislative approach.

The proposed New Source Performance Standard is a fuel-discriminatory rule that in effect requires CCS technologies that are not yet commercially available to be used on all new coal plants. As such, the NSPS is impractical and not legally justifiable. AEP's main concerns are the combination of two source categories, coal and natural gas, and setting a single standard based on EPA's estimate of the emission rate achievable at a new natural-gas combined cycle unit. This standard will preclude the construction of new coal-fired generation without the addition of CCS. However, based on AEP's experience and EPA's own admission, this technology is neither commercially demonstrated nor economically viable for coal-fired electric generation. Without a viable CCS solution, the NSPS forces reliance on a historically volatile commodity—natural gas—for new fossil generation, which could burden consumers with additional and unnecessary future risk in their energy costs.

AEP believes that technological solutions such as CCS are critical to reducing emissions. However, CCS technology has not yet been proved at a commercial scale and cannot be provided with robust guarantees on performance and reliability. Furthermore, the path to CCS commercialization is also filled with significant regulatory and legal barriers regarding the ownership of storage space and long-term liability, which will also need to be resolved prior to commercialization. Given the obvious need for commercially available and cost-effective CCS in order to meet EPA's proposed NSPS for coal plants, H.R. 6172, introduced by Representative McKinley, provides much needed Congressional direction in finalizing the NSPS for power plants and ensures that coal continues as a fuel for a balanced energy future.

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

[The prepared statement of Mr. McCullough follows:]

SUMMARY OF TESTIMONY OF MARK MCCULLOUGH ON BEHALF OF AMERICAN ELECTRIC POWER

AEP has a long history of proactive involvement in environmental stewardship, particularly with regard to reducing its net carbon emissions. Past experiences include reforestation programs, participation in a greenhouse gas credit trading program and advances in generation technology efficiency, which include many first-in-the-world accomplishments.

Perhaps AEP's most significant contribution to technology solutions for addressing greenhouse gas emissions was the successful completion of a validation-scale demonstration of the world's first fully integrated carbon capture and sequestration (CCS) project at an existing coal-fired electric generating unit. The Mountaineer CCS Project treated a 20-MW portion of flue gas from our 1300-MW Mountaineer Plant, removed the CO_2 and compressed and injected it into two deep underground formations from 2009 to 2011, permanently storing nearly 40,000 tons of CO_2.

AEP has long maintained that the Clean Air Act is not a practical or cost-effective vehicle to limit greenhouse gas emissions and any system to regulate greenhouse gas emissions should be developed by Congress. Global climate change and greenhouse gas emissions present a new set of issues that the existing framework of the Clean Air Act was never intended to address. As such, regulation of greenhouse gases under the existing Clean Air Act authorities is likely to be ill-designed, inflexible, and significantly more costly than a more flexible legislative approach.

The proposed New Source Performance Standard (NSPS) for limiting CO_2 from power plants is a fuel-discriminatory rule that in effect requires nascent, not yet commercially-available CCS technologies to be used on all new coal plants. As such, the NSPS is impractical and not legally justifiable. AEP provided detailed comments to EPA on its concerns with the proposed NSPS and requested that EPA withdraw the rule to address those concerns. AEP's main concerns are the combination of two source categories, coal and natural gas, and setting a single standard based on EPA's estimate of the emission rate achievable at a new natural gas combined cycle unit. This standard will preclude the construction of new coal-fired generation without the addition of CCS. However, based on AEP's experience and EPA's own admission, this technology is neither commercially demonstrated nor economically viable for coal-fired electric generation. Without a viable CCS solution, the NSPS forces reliance on a very volatile commodity, natural gas, for new fossil generation which could burden consumers with additional and unnecessary future energy costs over the long-term.

AEP believes that technological solutions such as CCS are critical to reducing CO_2 emissions. Even with a successful demonstration project, AEP is convinced that CCS is many years from being a commercially viable solution to reducing CO_2 emissions. CCS technology has not yet been proved at a commercial scale on a representative application and cannot be provided with robust guarantees on performance and reliability. Furthermore, the path to CCS commercialization is also filled with significant regulatory and legal barriers regarding ownership of storage space and long-term liability, which will also need to be resolved prior to commercialization.

Given the obvious need for commercially-available and cost-effective CCS in order to meet the EPA proposed NSPS for coal plants, H.R. 6172 introduced by Representative McKinley provides much needed congressional direction in finalizing the NSPS for power plants and ensures a balanced energy portfolio in which coal is in the mix as a fuel for the future. This bill provides for greater fuel and energy diversity, helps promote the commercial development of CCS technology, and lowers the costs of reducing CO_2 emissions.

WRITTEN TESTIMONY OF MARK MCCULLOUGH

EXECUTIVE VICE PRESIDENT

AMERICAN ELECTRIC POWER

BEFORE THE U.S. HOUSE OF REPRESENTATIVES

ENERGY AND COMMERCE COMMITTEE

SUBCOMMITTEE ON ENERGY AND POWER

September 14, 2011

Chairman Whitfield, Ranking Minority Member Rush and distinguished members of the Committee on Energy and Commerce, thank you for inviting me here today. I appreciate this opportunity to offer the views of American Electric Power (AEP) on EPA's Proposed Greenhouse Gas (GHG) New Source Performance Standard (NSPS) for Fossil-Fueled Electric Generating Units (EGUs) and the current state of Carbon Capture and Storage (CCS) Technology. My name is Mark McCullough, and I am the Executive Vice President of Generation at AEP. Headquartered in Columbus, Ohio, AEP is one of the nation's largest generators – with more than 37,000 megawatts (MW) of generating capacity – and serves 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 fuel sources – including coal, nuclear, hydroelectric, natural gas, oil, and wind power. Due to the location of our service area and the historic importance of coal to the economies of our states, approximately two-thirds of our generating capacity uses coal to generate electricity.

AEP History in Environmental Stewardship and New Technologies

AEP has a long history of proactive involvement in environmental stewardship, particularly with regard to reducing its net carbon emissions. Beginning as early as the 1940's, AEP has been involved in re-forestation

programs, including specific efforts at portions of its large land holdings to return acreage that had been devoted to agricultural and mining activities to potential carbon sinks. These efforts were expanded in 2003 when AEP became a founding member of the Chicago Climate Exchange (CCX), the first voluntary GHG credit trading system in the United States. AEP established and met goals to reduce or offset significantly its annual system-wide GHG emissions, including its goal of achieving a 6% reduction of its annual emissions in 2010 (compared to emission levels during 1998-2001). We have voluntarily established a further goal of reducing or offsetting our GHG emissions by 10% (compared to 2010 levels) by 2020.

AEP's leadership and innovation in our core generation, transmission and distribution services have led to improvements in the efficiency of the delivery of our product. We accomplished these improvements through continual advances in generation technology efficiency, lowering transmission line losses, energy audits, support of improvements in the efficiency of end-use appliances and fixtures, and improved delivery of real-time pricing and usage information of the electric grid.

For over a century, AEP has been a pioneer in the development of advanced coal-fueled generation technologies, which include many first-in-the-world accomplishments that have set the standard for combustion efficiencies, emissions control, and system performance. A few examples include the first reheat generating coal unit (1924); the first heat rate (a measure of efficiency) below 10,000 Btu/kWh at a coal plant (1950); the first natural-draft, hyperbolic cooling tower in the Western Hemisphere (1963); and the first combined-cycle operation of a pressurized, fluidized bed combustion plant in the United States (1990).

While the AEP generation portfolio has shifted over the last decade to include more natural gas-fired generation, we will also, this year, complete construction of the country's first ultra-supercritical coal-fired generating unit, the John W. Turk, Jr. Power Plant in Hempstead County, Arkansas. The Turk Plant has thermal efficiency comparable to the current generation of integrated gasification combined cycle (IGCC) units, and is better suited to low-sulfur western coals than IGCC technology.

Perhaps AEP's most significant contribution to technology solutions for addressing GHG emissions was the successful completion of a validation-scale demonstration of the world's first fully integrated carbon capture and storage project at an existing coal-fired electric generating unit. The Mountaineer CCS Project treated a 20-MW portion of flue gas from our 1300-MW Mountaineer Plant, removed the carbon dioxide (CO_2), and compressed and injected the CO_2 into two deep underground formations more than 7,000 feet below the surface of the plant property. The project successfully operated from 2009 to 2011, and permanently stored nearly 40,000 tons of CO_2 in deep saline reservoirs, with continuing post-closure monitoring. A second phase of that project, which would have advanced the technology to a 235-MW commercial scale, was deferred due to the rejection by our state regulators of our request for cost recovery of the demonstration project costs in customer rates.

EPA REGULATION OF GHG IS THE WRONG APPROACH

Notwithstanding our lengthy history of environmental conservation and support for federal GHG reduction efforts, AEP has long maintained that the Clean Air Act (CAA or Act) is not a practical or cost-effective vehicle to limit GHG emissions and any system to regulate GHG emissions should be developed by Congress. To this end, we have supported over the past decade ambitious federal legislation to reduce GHG emissions on an economy-wide basis through flexible market-based mechanisms. Although not enacted into law, these bills

would have established a declining economy-wide cap on GHG emissions and achieved substantial GHG emissions reductions in an efficient and cost-effective manner through an emissions trading system.

In the absence of federal legislation to reduce GHG emissions, and in response to the 2007 Supreme Court decision of *Massachusetts v. EPA*, the EPA has begun to regulate GHG emissions using its existing CAA authorities. The EPA has already established a rule requiring new and modified major stationary sources to obtain pre-construction permits for their GHG emissions under the New Source Review (NSR) provisions of the Act.[1] In April 2012, EPA proposed a New Source Performance Standard (NSPS) for CO_2 emissions from new EGUs under Section 111 of the CAA.

Both of these existing regulatory programs are based on a framework that was never intended to apply to GHG emissions from stationary sources. Both programs impose source-specific emissions control requirements that lack the kind of flexibility that would encourage widespread, cost-effective implementation of a broad suite of emission reduction techniques and technologies. When the CAA was developed over 40 years ago, its primary focus was on reducing emissions of certain air pollutants with recognized, localized health effects. A major part of the Act established ambient air quality standards for criteria pollutants such as NO_x, ozone, SO_2, PM, and lead. These standards were implemented through facility-by-facility emission limits that ensured that health-based standards were met on an airshed-by-airshed, state-by-state basis. In 1990, Congress added specific provisions to address new science that suggested that SO_2 and NO_x emissions also presented other broader regional or interstate concerns that could not be adequately or cost-effectively addressed

[1] The NSR permit requirements include a rigorous technology review requirement to ensure the installation of state-of-the-art air pollution control equipment and extensive public notice and comment procedures.

without giving regulators new tools under the existing CAA. Congress provided that tool with the SO_2 allowance program in Title IV of the 1990 Clean Air Act Amendments.

However, concerns regarding the relationship of global climate change and GHG emissions present a totally different set of issues (*e.g.*, both national and global emissions and ultimately global GHG concentrations are relevant) that the existing framework of the CAA was never intended to address. As such, regulation of GHGs under the existing CAA authorities is likely to be ill-designed, inflexible, and significantly more costly than a more flexible approach, while doing little to address the global issue of climate change. Therefore, if this nation wants to move forward with effective GHG regulatory programs, congressional action is necessary to provide the tools required to ensure flexible, cost-effective regulation of GHG emissions on an economy-wide basis.

AEP does not support EPA's proposed CO_2 NSPS for EGUs and has submitted extensive comments to the Agency about its concerns with the EPA proposal. EPA itself acknowledges that its proposal will not alter current plans for new generating facilities by noting that the proposal merely reinforces what the market currently dictates and what EPA assumes will continue to dictate in the future – that in an era of record-setting low natural gas prices and abundant reserves, the logical fuel of choice is natural gas. But the proposal treats **current** market conditions as if they are reliable constants **in the future**. History tells us a very different story. History tells us that fuel diversity is a critical component of stable energy costs, and that relying on a single fuel creates significant vulnerability to major fluctuations in market prices.

Furthermore, we believe that EPA's proposed rule is unlawful, is based on faulty information, and would hinder the very efforts to develop clean coal

technology that Congress, EPA, and AEP have worked so long and so hard to further. AEP is particularly concerned that the proposed rule will likely impede the development of CCS technology and hinder the progress that will be needed for coal to continue to play a vital role in America's energy policy. A summary of the current state of CCS technology is included later in this testimony, which supports EPA's own conclusion that CCS is neither commercially demonstrated nor economically viable for coal-fueled EGUs. Notably, this is the same conclusion that numerous other public and private efforts have reached, including President Obama's Interagency Task Force on CCS, the Secretary of Energy's National Coal Council, and the Department of Energy's research and development programs.

THE PROPOSED NSPS HAS CONSIDERABLE FLAWS

The specifics of EPA's recently proposed NSPS standards for new EGUs further supports our concerns that the CAA is not the proper vehicle to address GHG emissions. The proposed regulations do not represent a balanced or cost-effective solution. For example, EPA has taken the extraordinary step of combining two separate well-established NSPS source categories that set different standards for different fuels for all other types of emissions, and proposed a single NSPS limit for CO_2 emissions that applies to **all** new fossil-fueled EGUs from those two categories.[2] The proposal requires that both new coal-fueled and natural gas-fueled EGUs meet a CO_2 emissions limit of 1,000 pounds per megawatt-hour (lb/MWh). AEP believes that the proposed regulations are both arbitrary and unlawful because they fail to establish standards that can be achieved regardless of the fuel used (a so-called "fuel neutral" standard). Instead, for the first time, EPA has proposed to set one, **uniform**, performance standard for **all** sources within the combined EGU source category that is potentially achievable only by units burning fuels with the lowest

[2] The proposed rule combines the NSPS source categories of Subpart Da (for fossil-fuel fired electric steam generating units) and Subpart KKKK (for stationary combustion turbines) into a common source category for GHG emissions (Subpart TTTT).

inherent emissions (*i.e.*, natural gas).[3]

Under the proposed regulations, **all** new baseload and intermediate demand fossil-fueled EGUs would have to achieve an emission rate equivalent to EPA's estimate of the emission rate achievable at a new natural gas combined cycle unit. However, due to different fuel characteristics, plant designs, and operational considerations between coal and natural gas power plants, a coal-fueled power plant cannot meet a CO_2 emission rate equivalent to natural gas without some form of emissions control. This proposed regulation is instead fuel discriminatory in that it prevents the construction of **any** new coal-fueled units without CCS. However, at this time, CCS is not commercially available or economically viable for the reasons described later.

EPA justifies its proposal to adopt a fuel discriminatory standard by stating that the proposed NSPS would not impose any additional costs on the economy because under current economic conditions, no new coal-fueled units will be built. While AEP agrees that **current** market conditions generally do not support development of new coal-fueled units, this result is driven primarily by current low prices of a very volatile commodity, natural gas. Natural gas prices have fluctuated over the past decade between $2 and $13 per MMBtu on a monthly average basis. Average prices over most of the last decade have been above $6 per MMBtu. In light of the significant historical fluctuation of natural gas prices, it is reasonable to plan for some continued variation in natural gas prices over the long-term even though shale gas reserves appear to be plentiful at this time. If,

[3] In past NSPS rulemakings for power plants, EPA has used one of the following two methodologies. The first is to set different performance standards based on lowest emission rate achievable through application of "best demonstrated technology" for each specific type of fuel burned (*i.e.*, coal, oil, natural gas). The second is to set a single performance standard for all fuels based on the emissions control levels achievable through application of the "best demonstrated technology" at *all* power plants, regardless of the fuels used. Under the latter approach, EPA has set the single performance standard based on the lowest emissions rate achievable by EGUs using coal. However, as noted above, EPA has never adopted a single NSPS for all fossil-fueled power plants based on an emissions rate achievable only by the fuel with the lowest inherent emissions (*i.e.*, natural gas).

for example, natural gas prices were to increase modestly to levels seen only a few years ago, electric generating companies could opt to build new coal units based on economics, absent the proposed CO_2 NSPS requirements. However, with EPA's proposal to adopt a NSPS based on the performance of natural gas combined cycle units, electric generating companies are unable to build coal-fueled units without assuming unreasonable risks, and therefore generally have no choice but to build gas units instead.

AEP believes that it is not prudent for EPA, or any other agency, to adopt federal policies that foreclose the use of coal in the future development of baseload generation. Locking exclusively into new natural gas baseload generation over the long term could increase our reliance on natural gas for power generation to the detriment of the economy. Rather, maintaining fuel diversity through a balanced portfolio of energy resources that includes coal has been a successful strategy in providing abundant, reliable, low-cost electricity to power the nation's economic growth and high standard of living. The continued reliance on a diverse portfolio of fuels is clearly the wisest course of action to safeguard against the risk of market price fluctuations of natural gas or any our energy resource over the long-term.

By contrast, foreclosing the option to use of coal over the long-term could burden U.S. consumers with additional and unnecessary costs as U.S. energy providers replace retiring older generation sources and try to keep up with rising demand over the coming years. Further, as EGUs begin to rely more heavily on natural gas for electric generation, we run the risk that the energy prices will become increasingly volatile over the long term, with implications for the entire economy.

IMPORTANCE OF FUEL DIVERSITY

Fuel diversity is a concept that cannot be overstated when considering economic and energy security. Too great a reliance upon any one energy source creates a significant risk exposure to electricity price escalation and supply disruptions. As has been proven repeatedly across the globe, such exposure can lead to severe impacts on residential, commercial, and industrial customers.

For example, the recent catastrophe in Japan serves as a sobering reminder of what can happen if a single energy source is abruptly removed from use. In 2011, an earthquake and tsunami devastated shoreline communities and seriously damaged the Fukushima Daiichi nuclear power plant. Resultant radiation leaks and a greatly eroded public faith in safety of nuclear power have led to the shutting down of all of Japan's 54 nuclear reactors for mandatory maintenance and safety checks. Heavily populated areas of the country have faced the realities of rolling blackouts, while manufacturing facilities are reducing output, with some making moves to relocate abroad. Meanwhile, natural gas prices in Japan have nearly tripled as power producers have scrambled to fill the massive void left in their energy infrastructure.

Domestic energy disruptions and their consequences are clearly evident by such disasters as Hurricane Katrina in 2005, where nine oil refineries were shut down for an extended period of time and 30 oil platforms were either damaged or completely destroyed, dramatically hampering oil and gas production. United States natural gas prices spiked following the disaster and for months afterward remained more than double the price over the previous year.

There is another unique feature to coal that must be considered from an energy security perspective. Coal is a solid and physically stable energy

resource that can be safely stockpiled at the power plant site. A typical power plant takes advantage of this property by keeping an inventory of 30 to 60 days' supply of coal at the plant site. This is an incredibly valuable characteristic when considering the risks associated with supply interruptions. If storms, natural disasters, or other forces interrupt major gas pipeline infrastructure, gas-fired power plants immediately cease to produce electricity and cannot resume production until infrastructure repairs are made. Coal plants, on the other hand, can continue to operate if the major fuel supply is compromised. This is a factor of fundamental value to any energy security solution and has national security benefits as well.

CURRENT AND FUTURE STATE OF CCS

AEP believes that technological solutions are critical to reducing emissions or improving the reliability and availability of electricity production. More than a century of technology innovation qualifies AEP as an industry leader and expert in these topics. Nonetheless, as a consequence of our first-hand experience and intimate understanding of CCS technologies, AEP is convinced that CCS is many years from providing a commercially viable solution to reducing CO_2 emissions due to the numerous technical, financial, legal, and regulatory challenges that must first be addressed.

In 2007, AEP partnered with Alstom to design, build, and operate the world's first integrated CCS project on a coal-based electricity generating plant. The validation project began operation on September 1, 2009 and continued through May 31, 2011. Over that period, the installed chilled ammonia process captured more than 50,000 metric tons of CO_2 and injected nearly 40,000 metric tons of that CO_2 into deep saline reservoirs beneath the plant site. Because the system was built as a validation platform, with all the flexibilities necessary for systematic process adjustments, the operators were able to fine-tune and control all process streams and energy inputs to thoroughly evaluate the technology. Once

completed, the AEP/Alstom team possessed a comprehensive understanding of the integrated CCS processes and specifics about the operation of each system within the process. This in-depth knowledge includes a detailed understanding of key process parameters such as energy penalty, reagent loss, CO_2 capture rate, and all aspects of geologic CO_2 sequestration. The success of the validation project positioned the team to receive a grant from the US Department of Energy to move forward with an engineering study and preliminary design of a commercial-scale CCS project at the same facility. The lessons learned from these efforts uniquely position AEP to comment on the current status and future prospects of CCS technology deployment, including operational performance and cost specifics, as well as the significant remaining developmental challenges that must be addressed before CCS can be considered commercially available.

"Commercially available" technologies are those that can be purchased from a vendor, have been proven at commercial scale on a representative application, and are offered with robust guarantees on performance and reliability. Vendors cannot provide meaningful guarantees without extensive testing at representative scale. Based on this point of reference, no commercially available technologies for the capture of CO_2 from coal-based power plants exist today. The Department of Energy's Major CCS Demonstration program currently includes twelve projects that propose to demonstrate CO_2 capture along with some form of storage and/or utilization of the captured CO_2. If this were a list of twelve successfully completed projects, then it could certainly be argued that the technologies are ready for commercial deployment. However, not one of the projects has been completed, and in fact, none have even commenced operation. Most are no more developed than the work on paper required for conception of the project. Moreover, some that had previously been included on DOE's list have been cancelled or delayed indefinitely. From a global perspective, the United States leads all others in work completed and proposed for future CCS projects. But today, the technologies to

capture and sequester CO_2 are not commercially available, domestically or otherwise.

While several promising CO_2 capture technologies are under development, none are ready for commercial deployment. They must be advanced in a systematic and step-wise manner to ensure their technological and economic feasibility. AEP had begun the process of moving the technology to commercial scale with the Mountaineer CCS Project, but the lack of an adequate funding mechanism resulted in the company placing the project on hold. Even if AEP's project had remained on schedule, the CCS technology, like other first-of-a-kind projects, would have been installed without any commercial guarantees from vendors and would have run the risk of not continuously or reliably achieving high CO_2 capture levels. AEP's expectation was that a commercial-scale CCS demonstration project was essential *now*, so that in 2020 or later, a reliable commercial-scale CO_2 capture system *might* be commercially available and ready for deployment.

With the suspension of the AEP project and as similar DOE projects are delayed or discontinued, the date for commercial readiness of CCS technology continues to move further out on the horizon. A reasonable estimate for commercial availability, based on the current state of technology development, is at least ten years away, and this is assuming that current financial and regulatory barriers to demonstration projects are expeditiously removed. Without a clear path forward, we will remain, perhaps indefinitely, or at best ten years or more from commercialization of CO_2 capture technology. Numerous studies and projects by public and private organizations also have concluded that the availability of commercially available CCS is at least a decade away, even if a much more ambitious research, development, and demonstration program were implemented. The attached table in Appendix A summarizes the results of some of the studies.

Furthermore, the path to CCS commercialization is filled with significant regulatory and legal barriers. These include issues related to the ownership of, acquisition of, and/or access to geologic pore space, as well as issues surrounding long-term liability and stewardship of geologically stored CO_2. The removal of these barriers in many cases will be through the development of state legislation and regulatory programs. Efforts at the state and federal level are underway and in various stages of development, but significant challenges remain before these and other legal and regulatory issues will be sufficiently resolved to support the commercialization of CCS on coal-based generation.

Finally, EPA has proposed an alternative compliance option that will not help coal-fueled EGUs achieve the CO_2 performance standard.[4] EPA's averaging approach will not work without much greater certainty pertaining to CCS cost and technology. In fact, this alternative compliance option does nothing to ensure the demonstration and deployment of CCS technologies. As just discussed, CCS is not yet commercially demonstrated for large-scale commercial applications and the high cost of the CCS technology effectively precludes its commercial deployment, even if the technology was ready. As a result, there are many technical, economic, and legal risks with CCS technology that must be addressed **before** an EGU developer would consider investing in a new multi-billion dollar plant. These risks will not be taken if the new plant might have to cease operation after ten years given that no real-world data exists to assure CCS can achieve the CO_2 performance standard. Without much greater certainty on the timing and success of CCS commercialization efforts, such risk

[4] Under this approach, a new coal-fueled EGU could be built without CCS, provided that the developer of the new power plant commits to achieve the following two requirements. The first is that the new coal plant achieves a CO_2 emissions limit of a highly efficient ultra-supercritical coal-fueled EGU (set at 1,800 pounds per MWh) during the first ten years of operation. The second is that the developer commits to install and operate CCS on the new plant by the 11th year of operation and achieve a CO_2 emissions limit of 600 pounds per MWh during the next 20 years so that the weighted average CO_2 emissions rate during the 30-year period would comply with the 1,000 lb/MWh CO_2 performance standard.

simply will not be acceptable and will effectively preclude the development of any new generation technology that must rely on CCS to operate. Similarly, it is unlikely that the developer could ever obtain the necessary funding for building the plant until these matters are satisfactorily addressed. Lending institutions and state regulatory commissions will not risk several billion dollars[5] unless they obtain adequate assurances that a CCS technology is capable of achieving the CO_2 performance standard and can be installed at the new coal-fueled plant within the initial ten-year period of operation.

Simply put, a utility operator will never select an electric generating technology or unit design that requires a control equipment retrofit of *unknown* technology to be installed ten years after initial operation. Work done to date on the advancement of CCS technology has yielded incremental improvements in cost and process efficiency. Substantial "game changing" innovations for CCS cost and performance will require the integration of new CCS technologies with advanced next generation coal-based systems, such as advanced IGCC, oxycombustion, and chemical looping combustion or gasification. As a result, EPA's proposed rule is likely to delay for many years the development of CCS technology because new coal-fueled generation will not be built and, without the development of such new coal-based units in the future, the incentive to invest in and advance CCS technology will be greatly diminished.

SUMMARY

AEP believes that EPA's proposed NSPS is a fuel-discriminatory standard that in effect requires nascent, not yet commercially-available CCS technologies to be used on all new coal plants. As such, the proposed NSPS is impractical and not legally justifiable. AEP provided detailed comments to EPA on its concerns with the proposed NSPS and requested that EPA withdraw the rule to

[5] EIA estimates that the capital cost of a single 650 MW coal-fueled EGU without any CCS technology is approximately $1.9 billion. This means that a new multiple unit coal-fueled plant without CCS would cost well in excess of $4 billion including financing costs.

address those concerns.

Given the obvious need for commercially available and cost-effective CCS in order to meet the EPA proposed NSPS for coal plants, H.R. 6172 introduced by Rep. McKinley provides much needed congressional direction in finalizing the NSPS for power plants. The bill requires a report be submitted to Congress "finding that carbon capture and storage is technologically and economically feasible" prior to the finalization of any NSPS for GHGs. This provision helps ensure that any final NSPS will keep coal in the mix as a fuel for the future, provides for greater fuel and energy diversity and lower costs to customers, helps promote the commercial development of CCS technology, and lowers the costs of reducing CO_2 emissions.

Thank you for the opportunity to testify.

Assessments of the State of CCS Development for Coal-Based Electric Generation

Organization	Date	State of CCS	Barriers to Commercially Acceptable CCS	Prospects for CCS Development
President Obama's Interagency Task Force on Carbon Capture and Storage. Report of the Interagency Task Force[6]	Aug. 2010	"Current technologies could be used to capture CO_2 from new and existing fossil energy power plants; however, they are not ready for widespread implementation because they have not been demonstrated at the scale necessary to establish confidence for power plant application." (p.50) "CCS technologies...are not likely to be widely deployed at coal-fired power plants....without additional knowledge generated by research, development, and demonstration activities." (p.87)	"Though CCS technologies exist, "scaling up" these existing processes and integrating them with coal-based power generation poses technical, economic, and regulatory challenges." (p.9) "..barriers hamper near-term and long-term demonstration and deployment of CCS technology." (p.14) "A concerted effort to properly address financial, economic, technological, legal, institutional, and social barriers will enable CCS to be a viable climate change mitigation option..." (p.8)	"Administration analyses of proposed climate change legislation suggest that CCS technologies will not be widely deployed in the next two decades..." (p.8) "The focus of CCS RD&D is....to facilitate widespread cost-effective deployment after 2020." (p.9)
The National Coal Council (a Federal Advisory Committee to Secretary of Energy Chu). *Expedited CCS Development: Challenges & Opportunities*[7]	Mar. 2011	"..a range of issues must be addressed before CCS processes are commercially acceptable for coal-based electric generating units. ...key development concerns include the fact that commercial-scale CCS processes have *not yet* been demonstrated on a coal-fired generating unit" (p.1)	"...the current CCS demonstration program in the [U.S.]...is not on pace to significantly advance CCS development in the near-term due to technical and equally non-technical obstacles.... Challenges to CCS development...can be broadly categorized into technical, financial, and regulatory areas." (p.1)	"At the current [development] rate, CCS technologies will continue to be in an early development stage by 2020." (p.64) "Ongoing and planned CCS projects for coal-based generation are advancing the development of the technology, but not at the pace necessary to support an expedited and broad-based deployment of CCS by 2050." (p.14)
DOE / NETL Advanced Carbon Dioxide Capture R&D Program: Technology Update[8]	May 2011	"...in their current state of development [the CO_2 capture technologies being used in industrial applications] are not ready for implementation on coal-based power plants" (p.4)	"[CO_2 capture] technologies are not ready for implementation on coal-based power plants [because] (1) they have not been demonstrated at the larger scale necessary for power plant application; (2) the parasitic loads (steam and power) required to support CO_2 capture would decrease power generating capacity...; and (3) if successfully scaled-up, they would not be cost-effective at their current level of process development." (p.4)	"It is anticipated that successful progression from laboratory-to full-scale demonstration will result in several of these [CO_2 capture] technologies being available for commercial deployment by 2030." (p.10)
DOE / NETL CO_2 Capture and Storage RD&D Roadmap[9]	Dec. 2010	"...cost-effective and efficient CCS technologies will need to be developed and demonstrated at full-scale prior to their availability for widespread commercial deployment." p. 5 "...at their current state of development these [CO_2 capture] technologies are not ready for implementation on coal-based power plants." (p.21)	"...advanced technologies developed in the CCS RD&D effort need to be tested at full scale in an integrated facility before they are ready for commercial deployment." (p.11)	"....the overall timeline for RD&D....involves pursuing advanced CCS technology from the fundamental / applied stage through pilot-scale so that full-scale demonstrations can begin by 2020. The RD&D effort will produce the data and knowledge needed to establish the technology base, reduce implementation risks by industry, and enable broader commercial deployment of CCS to begin by 2030." (p.10)
DOE / NETL Carbon Sequestration Program: Technology Program Plan[10]	Feb. 2011	"The overall objective of the Carbon Sequestration Program is to develop and advance CCS technologies that will be ready for widespread commercial deployment by 2020." (p. 10)	"To accomplish widespread [commercial] deployment [of CCS by 2020], four program goals have been established: (1) [reduce CCS related costs]; (2) [improve the] ability to predict CO_2 [geologic] storage capacity; (3) develop technologies to demonstrate that...CO_2 remains in the injection zones; (4) complete Best Practices Manuals...for site selection, characterization, site operations, and closure practices." (p. 10)	"Only by accomplishing these goals [of the DOE Carbon Sequestration Program] will CCS technologies be ready for safe, effective commercial deployment both domestically and abroad beginning in 2020 and through the next several decades." (p.10)

[6] "Report of the Interagency Task Force on Carbon Capture and Storage." Aug 2010. www.fe.doe.gov/programs/sequestration/ccs_task_force.html
[7] "Expediting CCS Development: Challenges and Opportunities." Mar 2011. Library of Congress Catalog #2011926623. www.nationalcoalcouncil.org
[8] Department of Energy / National Energy Technology Lab. May 2011. www.netl.doe.gov/technologies/coalpower/cwr/pubs/CO2Handbook/
[9] Department of Energy / National Energy Technology Lab. Dec 2010. www.netl.doe.gov/technologies/carbon_seq/refshelf/CCSRoadmap.pdf
[10] Department of Energy / National Energy Technology Lab. Feb 2011. www.netl.doe.gov/technologies/carbon_seq/refshelf/2011_Sequestration_Program_Plan.pdf

Mr. WHITFIELD. Thank you very much.

And Mr. Voyles, you are recognized for 5 minutes.

STATEMENT OF JOHN N. VOYLES, JR.

Mr. VOYLES. Good morning, Chairman Whitfield, Ranking Minority Member Rush and distinguished subcommittee members, thank you for the opportunity to appear before you today to present comments regarding proposed House bill 6172. My name is John Voyles, Jr. I am the Vice President of Transmission and Generation Services for LG&E and KU Energy. LG&E and KU Energy is a wholly owned subsidy of PPL Corporation and operate Louisville Gas and Electric Company and Kentucky Utilities Company, regulated utilities that serve 1.3 million customers in 90 Kentucky counties and five counties in Virginia.

Today, the company's operated capacity is approximately 8,100 megawatts. Of that capacity, 74 percent is coal-fired, 25 percent is gas-fired peaking units, and the remaining 1 percent is hydroelectric. Approximately 96 percent of our coal-fired capacity is equipped with controls for sulfur dioxide and 67 percent of the capacity has SCR for nitrogen dioxide control. After assessing the impact of the most recent regulations promulgated by the EPA, the companies developed compliance plans, which were presented to and approved by the Kentucky Public Service Commission in December of 2011 and May of 2012. Those plans include installing additional environmental controls at four stations, retiring 800 megawatts of coal-fired capacity and constructing a new 640-megawatt gas-fired combined cycle unit. These investments are expected to cost up to an additional $3 billion and projected to raise electric rates by up to 14 percent and 18 percent for KU and LG&E customers, respectively, by 2016.

My company has not been standing idly by on the sidelines waiting for carbon dioxide policy or regulatory developments. Since 2006, we have invested millions of dollars in research and development aimed at finding technically and economically viable carbon management solutions for electric generating units. We were the founding member of the Carbon Management Research Group at the University of Kentucky's Center for Applied Energy Research and a member of the Western Kentucky Carbon Storage Foundation. The CMRG membership has grown to include three other electric generators that operate in Kentucky and the Electric Power Research Institute. We have made our E.W. Brown coal-fired plant site available to the CMRG as the test location for a carbon capture slipstream project which received a $14.5 million supporting grant from the Department of Energy in 2011. Additionally, we fund research on carbon capture technology supported by two other DOE grants, one with the University of Texas and one with the 3H Company. As a member of EPRI, we continue to fund collaborative research for carbon management and stay abreast of technological developments. Through these efforts we track several pilot projects in North America and across the globe. We are aware of no full-scale application of carbon capture and storage in continuous operation on a fossil-fueled electric generating unit. There are several technical and policy hurdles for CCS that remain unresolved which I will highlight briefly today.

First, the energy penalty to add CCS technology to a coal-fired electric generating unit is prohibitively high. Many of the current pilot projects estimate that the parasitic load and cycle efficiency penalties to be at least 25 or 30 percent of a generating station output. For a company like mine, those penalties would mean if CCS technology were retrofitted to an existing 2,000-megawatt coal-fired station producing power for our customers today, the output from the plant would be reduced by 500 megawatts at a minimum. That loss of production capability would have to be replaced by some source of energy supply, creating additional costs for the consumers and perhaps other emissions to the environment.

However, an even bigger challenge is the application of CO_2 storage technology. While some carbon dioxide is successfully being utilized in enhanced oil or methane recovery operations and other pilots have successfully injected small quantities of CO_2 into deep saline aquifers, the volume of storage necessary to facilitate such operations on a continuous basis for the life of an electric generating station has yet to be established. Very serious questions remain regarding the implications such injection processes have on mineral and property rights, the monitoring of the CO_2 plume across property lines or State boundaries, and the verification systems necessary to ensure long-term monitoring is taken into account. We believe these questions loom much larger than the simple view that CO_2 can be captured and injected underground and might be done more cost-effectively with less energy penalties at some undetermined point in the future.

Until such time as CCS technology is commercially available to be deployed at full scale in a technical and economical manner, we are concerned that any standard of performance proposed for CO_2 emissions from existing or new electric generating units will effectively eliminate coal-fired generation from the Nation's energy portfolio. On July 16, 2012, we provided testimony to this subcommittee on the U.S. EPA's proposed Greenhouse Gas New Source Performance Standards. In those comments, we explained the importance of having separate standards for new and existing plants by fuel type and our concern that EPA's proposal for new plants could not even be met by new gas-fired plants. Those comments assumed that EPA is required by law to develop greenhouse gas standards. A clearly better course would be for Congress to pass legislation relieving EPA of the obligation to develop greenhouse gas standards until carbon capture and storage becomes an economically and technologically viable option.

Thank you for the opportunity to comment on House bill 6172.

[The prepared statement of Mr. Voyles follows:]

BEFORE THE

UNITED STATES HOUSE OF REPRESENTATIVES

COMMITTEE ON ENERGY AND COMMERCE

SUBCOMMITTEE ON ENERGY AND POWER

TESTIMONY OF JOHN N. VOYLES, JR.

VICE PRESIDENT, TRANSMISSION AND GENERATION SERVICES

LG&E AND KU ENERGY LLC

ON

"The American Energy Initiative"

H. R. 6172

September 20, 2012

LG&E and KU Energy LLC
220 W. Main Street
P.O. Box 32020
Louisville, KY 40232

Summary for Testimony of John N. Voyles, Jr.
On behalf of
LG&E and KU Energy LLC

Representing LG&E and KU Energy LLC, a wholly owned subsidiary of PPL Corporation (PPL), the following is a summary of comments the Company has regarding H.R. 6172 as provided at the hearing on September 20, 2012 and the company's major concerns with the United States Environmental Protection Agency's proposed Greenhouse Gas New Source Performance Standards released for public comment on Friday, April 13, 2012:

- The Company supports the principles embodied in H.R. 6172;
- The Company is investing in research and development of carbon capture and storage (CCS) technology and does not believe it is ready for deployment at a scale necessary for electric utility units;
- Significant energy and efficiency penalties exist with the current CCS technologies, the impact of which must be taken under consideration for application to new or existing electric utility units;
- Carbon storage implications, both technical and legal, are yet to be fully understood and debated to ensure it will be deployable on a commercial scale;

Good morning Chairman Whitfield and Subcommittee Members

Thank you for the opportunity to appear before you today to present comments regarding the proposed House of Representatives Bill 6172 that would prohibit imposition of standards for carbon dioxide (CO_2) emissions from existing or new fossil fueled electric generating units until carbon capture and storage (CCS) is found to be technologically and economically feasible.

My name is John N. Voyles, Jr. I am Vice President, Transmission & Generation Services for LG&E and KU Energy LLC. LG&E and KU Energy is a wholly owned subsidiary of PPL Corporation (PPL) and operate Louisville Gas and Electric Company and Kentucky Utilities Company; both vertically integrated, regulated utilities that serve of 1.3 million customers in 90 Kentucky counties and 5 counties in Virginia.

Today, the companies operate electric generating stations with a capacity of approximately 8,100 MW. Of this capacity, 74% is coal-fired, 25% is gas-fired peaking units and the remaining 1% is hydroelectric units. Approximately 96% of our coal-fired capacity is equipped with controls for sulfur dioxide and 67% of the capacity has SCR for nitrogen dioxide control. After assessing the impact of the most recent regulations promulgated by the EPA, specifically the revised National Ambient Air Quality Standards (for SO_2 and NO_2) and the Mercury and Air Toxics Standards (MATS) rule, the companies developed compliance plans, which were presented to and approved by the Kentucky Public Service Commission in December 2011 and May 2012. Those plans include installing additional environmental controls at 4 stations,

retiring 800 MW of coal-fired capacity and constructing a new 640 MW gas-fired combined cycle unit. These investments are expected to cost up to an estimated $3 billion and projected to raise electric rates by up to 14% and 18% for KU and LG&E customers respectively by 2016.

My company has not been standing idly by on the sidelines waiting for carbon dioxide (CO_2) policy or regulatory developments. Since 2006, we have invested millions of dollars in research and development aimed at finding technically and economically viable carbon management solutions for electric generating units. We were the founding member of the Carbon Management Research Group (CMRG) at the University of Kentucky's Center for Applied Energy Research (CAER) and a member of the Western Kentucky Carbon Storage Foundation. The CMRG membership has grown to include three (3) other electric generators that operate in Kentucky and the Electric Power Research Institute (EPRI). We have made our E. W. Brown coal-fired plant site available to the CMRG as the test location for a carbon capture slip stream project which received a $14.5 million supporting grant from the DOE in 2011. Additionally, we fund research on carbon capture technology supported by two other DOE grants; one with the University of Texas and one with the 3H Company.

As a member of EPRI, we continue to fund collaborative research for carbon management and stay abreast of technological developments. Through these efforts we track several pilot projects in North America and across the globe. We are aware of no full scale application of carbon capture and storage (CCS) in continuous operation on a fossil-fueled electric generating unit. There are several technical and policy hurdles for CCS that remain unresolved which I will highlight briefly today:

First, the energy penalty to add CCS technology to a coal-fired electric generating unit is prohibitively high. Many of the current pilot projects estimate the parasitic load and cycle efficiency penalties to be at least 25 or 30% of a generating station output. For a company like mine, those penalties would mean if CCS technology were retrofitted to an existing 2,000 MW coal-fired station producing power for our customers today, the output from the plant would be reduced by 500 MW at a minimum. That loss of production capability would have to be replaced by some source of energy supply, creating additional costs for the consumers and perhaps other emissions to the environment.

However, an even bigger challenge is the application of CO_2 storage technology. While some carbon dioxide is successfully being utilized in enhanced oil or methane recovery operations and other pilots have successfully injected small quantities of CO_2 into deep saline aquifers, the volume of storage necessary to facilitate such operations on a continuous basis for the life of an electric generating station has yet to be established. Very serious questions remain regarding the implications such injection processes have on mineral and property rights, the monitoring of the CO_2 plume across property lines or state boundaries and the verification systems necessary to ensure long term monitoring is taken into account. We believe these questions loom much larger than the simple view that CO_2 can be captured and injected underground and might be done more cost effectively, with less energy penalties at some undetermined point in the future.

Until such time as CCS technology is commercially available to be deployed at full scale in a technical and economical manner, we are concerned that any standard of performance

proposed for CO_2 emissions from existing or new electric generating units will effectively eliminate coal-fired generation from the nation's energy portfolio.

On July 16, 2012, we provided testimony to this Subcommittee on the U. S. EPA's proposed Greenhouse Gas New Source Performance Standards. In those comments, we explained the importance of having separate standards for new and existing plants by fuel type and the concern that EPA's proposal for new plants could not even be met by new gas-fired plants. Those comments assumed that EPA is required by law to develop greenhouse gas standards. A clearly better course would be for Congress to pass legislation relieving EPA of the obligation to develop greenhouse gas standards until carbon capture and storage becomes an economically and technologically viable option.

Thank you for the opportunity to comment on H.R. 6172.

Mr. WHITFIELD. Thank you very much, Mr. Voyles.

Mr. Hilton, you are recognized for 5 minutes.

STATEMENT OF ROBERT HILTON

Mr. HILTON. Thank you. Good morning. My name is Robert Hilton. I hold the position of Vice President of Power Technologies for Government Affairs for Alstom. I would like to thank Chairman Whitfield and Ranking Member Rush as well as the entire subcommittee for the opportunity to address these key issues on CCS.

Alstom is a global leader in power generation, transmission and transportation infrastructure. More than 50 percent of the power plants in the United States have Alstom equipment, and 25 percent of the world's electricity is generated on Alstom equipment. We are the largest air pollution control company in the world. In the United States, Alstom employs about 6,000 full-time permanent employees in 45 States, and 91,000 globally. Alstom provides virtually all power generation technology options. Significant pillars of our program are deployment of non-CO_2 sources of generation, like renewables and nuclear, reduced CO_2 emissions through efficiency, and the CO_2 capture from fossil fuels. Alstom invests approximately $1 billion annually in R&D. Alstom has completed work on four pilot and validation-scale plants and has 10 pilots, validation, and commercial-scale plants in operation, design, or construction worldwide. These CCS projects include both coal and gas generation.

We are here today to specifically address the status of CCS as a commercial technology. CCS is, within the realm of innovation, no different than any other technology under development. It is required to move through various stages of development at consistently larger scale. Alstom has taken each of its CCS-related technologies from the bench level to validation scale with the aim of finally reaching commercial. However, to date, no CCS technologies have been deployed at commercial scale. Validation scale is the proof of technology in real field conditions. This is important. It is at this point we can say confidently that the basic technology works. CCS technology is technologically feasible now.

The final stage to reach commercial status is to perform a demonstration at full scale. It is critical to define the risk of technology to make offers. This cannot be defined until the technology can be shown to work at full scale. This is the first opportunity we have to work with the exact equipment in the exact operating conditions that will become the subject of contractual conditions including performance and other contractual guarantees. This also becomes the first opportunity to optimize the process and equipment to effect best performance and seek cost reduction. Based on these criteria, Alstom does not currently deem its technologies for CCS commercial and, to my knowledge, there are no other technology suppliers globally that can do so. I emphasize, however, that the technologies being developed by Alstom and others work successfully.

For a number of reasons primarily related to technology funding and lack of regulatory clarity, the timeline for commercialization for CCS is not clear. The current DOE program for first generation-technologies on CCS appears not likely to become operational until

2017 with the exception of the Kemper plant. Globally, the picture is similar.

When we look at the history of the EPA and the air-pollution-control industry, we generally see a harmony of regulation and technology development. In many cases, we have had the ability to meet or anticipate the need for certain technologies and in other cases we have developed the base technologies either in other industries. In its recent rulemaking, EPA has required CCS for all new coal plants and, conceivably gas plants. While Alstom, in conjunction with AEP, has run the largest plant, we are not ready to do this on 500- or 1,000-megawatt plants. It has been suggested that the proposed rule would stimulate CCS development. However, advancing CCS requires a regulatory approach that recognizes the steps of the technology development process and the need for financing. Commercial power plants cannot secure financing for a plant that includes technology still under development and that carries with it undefined guarantees.

Coal is an important part of America's future energy mix as it has been in the past. It is an abundant resource we have, and we have the technologies to make it clean in all other respects. CCS is coming but preventing new highly efficient coal plants from being built to replace older less efficient plants by requiring a technology not yet in practice is not in keeping with the needs of the industry or the public. We believe a more realistic approach would be to provide a reasonable ramp down of CO_2 over time that can take advantage of efficiency and other technologies to reduce CO_2 in a gradual manner. This would provide the industry, along with State and local regulators, with the needed incentive to support CCS.

Alstom believes that the technology will be commercial when the industry determines that both buyer and seller can enter into ordinary contractual relations that meet the needs of both parties. We know that carbon capture technology works. We believe CCS will play a pivotal role in meeting the needs of carbon. We need time and support to reach the point of commercial offerings.

I thank you.

[The prepared statement of Mr. Hilton follows:]

Testimony Of Robert Hilton
Before the U.S. House of Representatives
Subcommittee on Energy and Power
"The American Energy Initiative" Hearing
September 20, 2012

Good morning. My name is Robert Hilton. I hold the position of Vice President, Power Technologies for Government Affairs for Alstom. I would like to thank Chairman Whitfield and Ranking Member Rush as well as the entire Subcommittee for this opportunity to address these key issues on Carbon Capture and Sequestration (CCS).

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

Alstom employs more than 91,000 people in 100 countries, and had sales of $25 billion in 2011-2012. In the U.S., Alstom employs approximately 6,000 full time permanent employees in 45 states. That number virtually doubles when you include workers hired for specific projects.

Alstom has a broad portfolio of power generation technology options: including coal, oil, natural gas, wind, hydro, geothermal, solar and nuclear. Significant pillars of our program are rapid and successful deployment of non-CO_2 sources of generation, namely nuclear and renewables; reduced CO_2 emissions through more efficient generation; and the capture of CO_2 from fossil fuel powered generation

(CCS). Alstom invests approximately $1 billion in annually in research and development.

Alstom is a leader in the field of CCS having completed work on four pilot or validation scale plants and with 10 pilots, validation, and commercial scale demonstration plants in operation, design, or construction worldwide. These CCS projects include both coal and gas generation facilities. Alstom is commercializing three first generation capture related technologies: chilled ammonia, advanced amine, and oxy-firing. We also have second generation technologies like chemical looping in development with DOE.

We are here today to specifically address the status of CCS as a commercial technology.

CCS is, within the realm of innovation, no different than any other technology under development. It is required to move through various stages of development at consistently larger scale or size. This process has been shown over decades to be the best approach to ensure commercial success by meeting the high standards of our industry and providing the confidence and reliability required by the power industry and the electricity consumers.

Alstom has taken each of its CCS related technologies from the bench level to small and then larger pilots, followed by validation scale demonstrations with the aim to finally reach commercial scale demonstration. To date, no CCS technologies have been deployed at commercial scale demonstration size. Alstom has successfully taken several of its technologies through the validation scale demonstration. This stage is the proof of technology in real field conditions (or in this case actual

power plant flue gas). It is at this point we can say confidently that the basic technology works. It is technologically feasible.

However, the final stage to reach commercial status is to perform a demonstration at full commercial scale. There are several reasons for this requirement. It is critical to be at commercial scale to define the risk of offering the technology. This cannot be defined until the technology can be shown to work at full scale. This is the first opportunity that we have to work with the exact equipment in the exact operating conditions that will become the subject of contractual conditions when the technology is declared commercial and is offered under standard commercial terms including performance and other contractual guarantees. This also becomes the first opportunity to optimize the process and equipment to effect best performance and, very importantly, seek cost reduction. These too are required to define commercial contractual conditions.

Based on these criteria, Alstom does not currently deem its technologies for CCS commercial and, to my knowledge, there are no other technology suppliers globally that can meet this criteria or are willing to make a normal commercial contract for CCS at commercial scale. I emphasize however that the technologies being developed by Alstom and others work successfully.

For a number of reasons primarily related to technology funding and lack of regulatory clarity, the time to commercialization for CCS technology is not clear. The current DOE program for first generation technologies on CCS has encountered serious difficulties in bringing projects of commercial scale to operation. It appears that most of the projects, if they continue, are not likely to become operational until 2017 with the exception of Radcliffe/Kemper. Globally the picture is similar.

The EU, and notably the UK, are targeting 2016 for commercial scale demos to start up. The Chinese have a roadmap aimed at two commercial scale demos to begin operation in 2016. But note: these are startups. A period of operation must follow before the technology is deemed ready for commercial offer.

When we look at the history of the Environmental Protection Agency and the air pollution control industry, we generally see a harmony of regulation and technology development. In many cases, we have had the ability to meet or anticipate the need for certain technologies and in other cases we have developed the base technologies either in industries other than power or in other global venues. CCS has been in development for approximately the last 12-14 years- a relatively short time for such a complex and critical technology. In the power industry, development periods of 20-25 years are common.

In its recent rule making, EPA has required CCS for all new coal plants and, conceivably some gas plants. While Alstom, in conjunction with American Electric Power, have built and operated the largest continuous CCS operation on a coal plant through to sequestration, this plant was approximately 50 MWth. This plant while proving the technology works very well was not of such scale as to use the real equipment required for a 500 or 1000 MW Coal plant. Many of the components including the chillers and heat exchangers will change for use on a larger plant. While this plant was capable of capturing and storing over 100,000 tons per year, it was not ready to be offered commercially on a 3-6 million ton per year power plant.

When the EPA came forward with a requirement for a technology in commercial practice that is not yet available commercially as the only way to meet a

regulation, it seemed a departure from its history. Alstom has communicated this message in many seminars, papers, and communications with the Agency and with Congress. The DOE program supporting CCS reflects the same results.

It has been suggested that the proposed rule would stimulate CCS development. However advancing CCS requires a regulatory approach that recognizes the steps of the technology development process and the need for financing. Commercial power plants cannot secure financing for a plant that includes technology still under development and that carries with it undefined guarantees. Doing so would impact the plant's ability to compete in the market or even generate electricity, as the technology becomes part of the power plant's operating permit.

Coal is an important part of America's future energy mix as it has been in the past. It is a great resource we have and we have the technologies to make it clean in all other respects. CCS is coming but preventing new highly efficient coal plants from being built to replace older less efficient plants by requiring a technology not yet in practice is not in keeping with the Agency's history or the needs of the industry or the public. We believe a more realistic approach would be to provide a reasonable ramp down of CO2 over time that can take advantage of efficiency and other technologies to reduce CO2 in a gradual manner. This would provide the industry, along with the state and local regulators, with the incentive to consider demonstrations and allow them to be funded to place the industry in a position to meet the long term reduction goals that are sought in the most efficient and cost effective manner without removing critical resources like coal from the generator's strategy.

Alstom believes that the technology will be commercial when the industry determines that both buyer and seller can enter in ordinary contractual relations that meet the needs of both parties - not when a regulation is announced. As part of this industry, we have always prided ourselves on being ready to meet regulations and our customer's needs in a prompt, efficient and cost effective manner. It is for the government and the regulators to offer standards to be met and for the industry to provide technology and solutions to meet those standards.

We know that carbon capture technology works. We need time and support to reach the point of commercial offerings.

Major Highlights From the Testimony of Robert Hilton Before the House of Representatives Subcommittee on Energy and Power at the Hearing on The American Energy Initiative
September 20, 2012

1) CCS technology is proven and is technologically feasible

2) CCS is not commercially available as it has not been demonstrated at commercial power plant scale

3) The CCS technology requires both policy direction and financial support to be demonstrated at commercial scale

4) Demonstration at commercial scale is critical to define risks, optimize process and achieve cost reduction to support commercial contracting.

5) Regulation should depend on technology that is commercially available when the regulation goes into effect.

6) Coal is a critical domestic resource and should remain a vital part of the United States' energy mix to help strengthen energy security.

7) CCS needs to be part of the American technology portfolio and not developed else where.

ALSTOM

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1409 Centerpoint Boulevard
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25 June 2012

EPA Docket Center (Air Docket)
U.S. Environmental Protection Agency
Mail Code: 2822T
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Attention: Docket ID Number: EPA–HQ–OAR–2011–0660

Re: Standards of Performance for Greenhouse Gas Emissions for New Stationary Sources: Electric Utility Generating Units; 77 FR 22392-22441 (April 13, 2012)

Alstom is a global leader in the power generation, rail transportation infrastructure and power transmission and distribution industries. Our company sets the benchmark for innovative and environmentally friendly technologies. Today, Alstom equipment can be found in approximately 50% of U.S. power plants, while globally it generates about 25% of the world's electricity. Alstom also is the world's largest air pollution control company. Alstom employs more than 93,000 people in 70 countries and had sales of approximately $30 billion in 2010-2011.

Alstom is among the world's leading suppliers of fossil fuel combustion equipment for electric power generation including gas turbines and steam boilers and turbines. Alstom is also the leading air pollution control company globally.

Additionally, Alstom is a leader in developing carbon capture technologies to lower CO_2 emissions. Alstom is commercializing three CCS technologies: oxy-firing combustion, Chilled Ammonia and Advanced Amine for post-combustion control. Currently, Alstom has 12 CCS projects in the operation, construction, or engineering stages around the world. These range from small pilot plants up to 250 MW commercial size plants.

Overarching Comments

Alstom supports the need to protect the environment, deploy the most efficient technologies, and provide sustainable power generation. However, Alstom, in reviewing the proposed standards for Greenhouse Gas emissions for New Stationary Sources, finds the proposal fails to adequately consider the state of the technology evolution in power generation and is in fact a proposal that does not reduce greenhouse gases in a meaningful way to provide environmental benefit. As EPA itself points out this proposal merely slows the rate of acceleration of GHGs in atmosphere rather than providing meaningful environmental benefit.

Alstom offers specific comments below. We have concentrated our comments on a few specific areas, most particularly relating to technology. Alstom sees the combining of gas and coal as a single category as inappropriate not simply for historical reasons but because the fuels are unique unto themselves in power generation technology and should be considered in that manner. Suggesting gas turbines are an acceptable means of emission reduction for coal fired units is a failure to embrace technology and understand the complexity of the electric generation industry where fuel price is not the only consideration in selecting generation.

Further, CCS is a truly evolving technology and will be critical to achieving significant GHG reductions when the technology is deployable at scale and when the standards are geared to meaningful reductions in GHG emissions. But EPA's suggestion that either Carbon Capture or Sequestration is currently available for deployment at commercial scale is simply a misunderstanding of the state of the technology development.

Alstom also offers comments on appropriate level of emissions given the scope of operation EPA has defined and based on operation of electric generating units as the market demands. As the market for generation continues to change with renewables and other factors, it is critical to understand the roles of gas and coal in servicing the generation industry within the whole of the interconnected electric system.

Finally, Alstom offers an alternative method to calculate the rolling average that is more reflective of the way electricity is generated and avoids the potential inappropriate weighting of marginal or seasonal emission periods.

Specific Comments

I. New Source Performance Standard, Source Category, and Best System of Emission Reduction

Alstom Power, Inc. offers the following detailed comments with respect to the New Source Performance Standards (NSPS) for Greenhouse Gases for New electric generating Units.

It would appear that EPA has chosen for convenience and misinterpretation of the information from the Energy Information Agency that Natural Gas Combined Cycle Units (NGCC) and coal combustion technology are now the same source category. In the forty-year plus history of the EPA and the NSPS promulgation, these technologies have always been separate source categories. Through all other criteria pollutants and Hazardous Air Pollutants these technology areas have been separate, which would require separate standards for Greenhouse Gases. However, EPA relies on the EIA finding that "no new coal plants will be built in the near term" to make a justification for a single new category. Alstom would point out that this reliance is based on the so-called Reference Study and EIA has done no real sensitivity to determine the accuracy of the low natural gas prices to warrant such reliance. Alstom points out the history of gas pricing reflecting that in the last 12 years gas prices have ranged from $2/mmBtu to over $14/mmBtu. EIA is currently reviewing potential sensitivity for publication later in 2012. Moreover, the EIA study does not compensate for such factors as localization, value of fuel diversity, and other strategies pursued by utilities in the commercial world. Further, NSPS are to reflect the degree of emission reduction achievable through application of the best system of emission reduction which (taking into account the cost of achieving such reduction and any non-air quality health and environmental impact and energy requirements) the Administrator determines has been adequately demonstrated. The format of NSPS can vary from category to category (and even from facility to facility type within an NSPS) although such standards are based on the effectiveness of one or more **specific air pollution control systems** (emphasis added), section 111 (b) (5) provides that the EPA may not prescribe a particular technology that must be used to comply with an NSPS, except in the instances where the Administrator determines it is not feasible to prescribe or enforce a standard of performance. Alstom wishes to point out in this rule making that an NGCC is not "an air pollution control system" but an alternative way to convert certain fossil fuels into energy and electricity. Thus it does meet the definition of a "best system of emission reduction". Similarly, by allowing coal plants only with CCS (a technology that is not available- to be discussed later) EPA is mandating the selection of NGCC technology in its BACT process which is contradictory to EPA policy that EPA cannot mandate technology or interfere in commercial markets.

Alstom also cites the EPA memo on Philosophy of BACT (January 4, 1979 by David Hawkins) which says "In setting the NSPS, for example, emission limits are selected which can reasonably be met by all new or modified sources in an industrial category, even though some individual sources are capable of lower emissions. Additionally, because of resource limitations in EPA, revision of new source standards must lag somewhat behind the evolution of new or improved technology. Accordingly, new or modified facilities in some source categories may be capable of achieving lower emission levels than NSPS without substantial economic impacts. The case-by-case BACT approach provides a mechanism for determining and applying the best technology in each individual situation. Hence, NSPS and NESHAPS are Federal guidelines for BACT determinations and establish minimum acceptable control requirements for a BACT determination."

II. Availability of Carbon Capture and Sequestration

Alstom wishes to deal with this subject as two distinct issues: Carbon Capture and then Sequestration.

Alstom is a leading global developer of carbon captures technology. The true state of the technology is that today there has been one 58 MW capture unit at AEP's Mountaineer Plant (since shut down), one 25 MW capture plant at Southern Company's Plant Barry (still in start up) and one 40 MW capture plant in Mongstad, Norway that started up in May 2012. This is the extent of the largest current capture technology on power plants. The Department of Energy (DOE) is participating in a number of projects sited by EPA in its text which are about or nearly demonstration size that are all estimated to start between 2015 and 2017. Alstom would point out the recent report by the Congressional Research Service (Carbon Capture and Sequestration (CCS):A Primer , Peter Folger ,Specialist in Energy and Natural Resources Policy; May 14, 2012), which calls into question whether all or any of these will become fully operational. Alstom would contend that while the technology has been proven that the capture processes work, the industry has yet to reach demonstration stages to reduce the cost and reduce the risk of scaling these technologies from pilot or validation scale to full scale. Thus Alstom would challenge EPA on the argument that Carbon Capture is available and demonstrated. Without demonstration, the technology cannot be considered for application as NSPS or best system of emission reduction.

Alstom would also point out to EPA, that it is unaware that any supplier of this technology is ready or able to offer commercial guarantees for such full-scale systems of carbon capture. This would in turn mean that no new coal burning plant could be permitted or financed. Hence it is unlikely that such systems will be available prior to the EPA obligatory eight-year review of this proposed NSPS.

Alstom would also point out to EPA that DOE has developed a comprehensive roadmap and timeline for the commercialization of CCS technologies which ultimately points to general deployment around 2020 after the technology has been demonstrated at scale and second generation technologies can reduce costs. This timeline, if embraced by EPA, would set CCS aside until the EPA suggested eight-year review of NSPS, thus avoiding conflict between agency visions. Similarly, by simply requiring all technologies be the highest possible efficiency (such as Ultra Super Critical technology), this proposal would promote the policy of having the best available technologies to replace the older less efficient existing fleet.

Alstom would also take exception to EPA's position that this rule would incent the development of CCS. We are very much in an economic period where public utility commissions and regulators are fighting to maintain the lowest cost of electricity to the ratepayers. Since Alstom would agree that EPA's NSPS would keep any new plants from being built (albeit for different reasons outlined above), it is very unlikely that any commission will allow the recovery of development costs on existing plants based on a new plant rule. Reaching demonstration scale is critical to the successful adoption and application of the CCS technology by generators and acceptance by the financial community. We also point out that since the only avenue might be the 30 year averaging scheme, this will mean CCS will not be required until late in the mid 2025 period meaning R&D will be have to continue for an additional 5-8 years beyond current market forecasts. Thus EPA expects the industry to continue to develop a very long-range technology without any apparent Federal or governmental support. Thus Alstom would contend that this proposed rulemaking would likely delay the development of the technology. Alstom would also suggest that it is highly unlikely that anyone would engage in the 30 year averaging scheme due to the level of uncertainty associated with potential NSPS review EPA mentions combined with uncertainty associated with unknown costs and availability of CCS to allow financing.

Finally, Alstom would comment on sequestration. EPA was diligent in quoting sections of the President's Inter-Agency Taskforce on carbon capture potential. However, EPA failed to note the Taskforce listed a number of barriers to the deployment of sequestration such as undefined pore space ownership, sequestration liability, permitting, status of CO2 under RCRA and many other subjects. Virtually all of these remain unresolved and are barriers to any serious deployment of the technology beyond a few demonstrations. The few examples of sequestration EPA sites are either outside the United States, not associated with power plants, or are granted under special R&D status permits.

III. Appropriateness of Recommended Standards

Alstom would suggest that EPA reconsider the proposed standards for both NGCC and Coal based generation. The study performed by University of California Berkley (Matthew J. Kotchen and Erin T. Mansur, "How Stringent is the EPA's Proposed Carbon Pollution Standard for New Power Plants?" University of California Center for Energy and Environmental Economics, April 2012), was based on actual emission data as opposed to EPA's predicted and adjusted data. The UC study point out that approximately 16-29% of the NGCCs (depending on calculation methods) will fail the 1000 pounds per MWHr standard as opposed to the 5% failure rate EPA has suggested. This clearly reflects the need to establish a standard for NGCCs in the 1100 – 1200 pound range to allow for low load operation in support of reliability in the grid, support of renewables, and other unplanned events.

Alstom has reviewed the 1800 pound per MWHr for coal based units and it appears that given the same operating conditions the industry is now experiencing that it is uncertain if any unit can make this standard. It would seem the very best units on bituminous coal may make the standard by a different calculation method, but based on heat rates projected for IGCC, and USC on lower rank coals, the standard of 1800 is unachievable. With the unavailability of CCS, it means no new units could even be considered. A detailed analysis of the proposed standard and operational impacts is presented below.

The EPA proposed an alternative compliance option whereby power plants would be limited to 1800 lb CO_2/MWh_{gross} for the first 10 years of operation and then be required to install CCS equipment. The EPA reviewed data from its Clean Air Markets Database and concluded that this annual standard is appropriate for all new coal-fired power plants, regardless of fuel type. While it is true that a modern power plant can theoretically achieve these emission levels for selected fuels, it is extremely difficult or impossible in practice to achieve these limits when real world conditions are factored in, such as fuel characteristics, load following, site/ambient conditions, and equipment degradation.

Table 1 shows the expected CO_2 emissions for selected US fuels, ranging from bituminous coal to lignite and for a modern PC power plant operating at full load conditions. Natural gas is included for comparison. This table shows that the 1800 lb/MWh limit may be achievable at full load conditions for bituminous coals, barely achievable for subbituminous coals, and unattainable for lignites.

Table 1: Specific CO_2 Emissions vs. Fuel Type

Fuel	lbm CO2/Mwh-gross
Texas Lignite	1827
North Dakota Lignite	1857
Wyoming Sub-Bit	1781
Illinios High Vol Bit	1698
Natural Gas	922

However, there are a number of other factors that impact plant heat rate and thus CO_2 emissions that also must be taken into account. All of these factors make the proposed EPA target that much more difficult to achieve or beyond attainment. These will be discussed individually below:

Partial Load Operation
The net plant heat rate increases as the plant operating load is reduced, which corresponding increases the specific CO_2 emissions. Based on a recent commercial power plant, the heat rate increases 1% at 75% load and 6% at 50% load. The heat rate increases dramatically at even lower loads, rising by almost 20% at 35% load. This has a significant impact on the specific CO_2 emissions as a result of normal plant load variations. Power plants typically follow either a baseload or cycling operation load profile, depending upon factors such as the plant's dispatch cost and grid requirements. These situations had quite different patterns of load variations and corresponding emissions levels.

Baseload Operation
All power plants have some load variation that will have impacts on a plant's heat rate and CO_2 emissions. A typical PC baseload plant may operate 60% of the time at 100% load and another 35% between 50-75% load. The average capacity factor would be about 85% and it would have an average heat rate typically about 1% higher than at 100% load. This alone would be sufficient to increase the specific CO_2 emission from a PC plant firing Wyoming subbituminous coal from 1781 to 1799 lb CO_2/MWh – essentially at the 1800 limit.

Cycling Operation
A typical PC cycling plant may operate 30% of the time at 100% load, another 55% between 50-75% load, with the balance of operation at even lower loads. The average capacity factor would be about 70% and it would have an average heat rate typically about 4-5% higher than at 100% load. A 5% heat rate increase from cycling operation would increase the specific CO_2 emission of the Illinois bituminous coal from 1698 to 1783 lb CO_2/MWh – already getting very close to the 1800 limit. Note that this is particularly significant as more plants are expected to cycle in the future as renewables increase their share of power generation.

Degradation Due To Plant Age
Power plants are designed to operate for 30 years and many existing plants have operated much longer than that. Normal wear and tear is to be expected which has an impact on the plant heat rate. Looking at just the steam turbine, the plant heat rate could deteriorate by about 1% after 10 years of operation.

Site Factors

Other factors can impact a modern plant design that can also have a negative impact on plant heat rate and thus the CO_2 emissions. For example, areas with limited water resources could require an air-cooled condenser vs. water cooling. Local water temperature can also have an impact on condenser operating pressure and heat rate.

Table 2 summarizes the impact of an increase in plant heat rate due to the above factors on the specific CO_2 emissions for a state-of-the-art USC PC power plant. A plant that is required to cycle would likely have a heat rate 5% higher than its design 100% load heat rate. In this scenario, a bituminous coal would just barely meet the standard and the lower rank fuels would exceed the 1800 lb CO_2/MWh target. It is likely that the bituminous plant would also exceed this target when site specific factors, impacts of startup, shutdown, and age deterioration are also factored in. The cycling impact could be even more significant in the future as renewables assume a larger portion of the total power generation.

Table 2: Impact of Heat Rate Degradation on Specific CO_2 Emissions

	Specific CO_2 Emissions lbm CO_2/MWh-gross					
Fuel Type						
Texas Lignite	1827	1845	1863	1881	1900	1918
North Dakota Lignite	1857	1875	1894	1912	1931	1949
Wyoming Sub-Bit	1781	1799	1817	1835	1852	1870
Illinios High Vol Bit	1698	1715	1732	1749	1766	1783
Natural Gas	922	931	940	949	958	968

EPA Clean Air Markets Database

The EPA cited data from their Clean Air Markets Database to support their selection of the 1800 lb CO_2/MWh target. A review of the database showed that while there were a limited number of plants that met this target, the bulk of the reporting plants exceeded it by a wide margin. The average specific CO_2 emissions from 230 reporting plants (after removing some obvious outliers) was 1916 lb CO_2/MWh.

Table 3 shows a comparison of the 4 SCPC plants that the EPA cited in justifying the proposed 1800 lb CO_2/MWh target. They looked at data reported to the EPA's Clean Air Markets database and picked out four of the best performing SCPC plants as representative of a new coal-fired power plant. An independent check was made of this data by reviewing the hourly emissions reported in the Energy Velocity database. The results show similar CO_2 emission rates. What stood out though was the high capacity factor for these four plants. All of them were clearly operating as baseload plants, with capacity factors in the mid 80% for three of them. Note that none of them would have met the proposed target if they operated as typical cycling units, as becomes more likely as renewables assume a larger share of power generation.

Table 3: Comparison of EPA Clean Air Markets and Energy Velocity Databases

Data from EPA Clean Air Markets Database				Data from Energy Velocity Database		
Facility	**Time Period**	**Primary Fuel**	**Max 12 month CO2 Emissions Rate - lb CO2/MWhr-gr**	**Time Period**	**Max 12 month CO2 Emissions Rate (lb CO2/MWhr-gr)**	**Average Capacity Factor (%)**
Bull Run 1	2009-2010	Bituminous	1740	2009-2011	1753	86
Weston 4	2008-2010	Subbituminous	1740	2007-2011	1740	84
WH Zimmer 1	2005-2009	Bituminous	1760	2005-2009	1721	86
Walter Scott Jr 4	2007-2010	Subbituminous	1800	2005-2011	1815	77

The EPA also states that marginal units can still achieve this standard by applying costly improvements, such as double reheat, coal drying (for lignites), even cofiring with natural gas. These modifications all add additional equipment at the expense of increased capital/operating cost and potentially decreased availability. The EPA should not be requiring the installation of this type of equipment in order to achieve their target. This requires added expense and makes coal-fired technology less competitive.

Alstom furthers suggests that working closely with industry EPA can refine these numbers. The objective should be to drive the most efficient technologies given fuel availability and technology limitations and availability. As EPA points out, this NSPS standard will be in review in eight years, which Alstom believes will be timely for the deployment of technologies such as CCS. This also is in line with the US Department of Energy's roadmap and timeline. The key point to be made is that permits are customarily permanent. Setting an output standard based on "as new" performance values for equipment that are known to lose efficiency with time will insure that eventually no plant will meet its permit limits.

IV. Rolling Average Calculation

EPA proposes a 12 month rolling average whereby the CO_2 emissions in a month are divided by the grow MWHrs in the month. Then the 12 contiguous monthly averages are summed and divided by 12 to develop the compliance average. This technique does not reflect the way the power industry actually performs. It gives equal weight to each month without regard for the actual production in a month impact of operations. The power industry normally has heavy production in the winter and summer and less production in the shoulder months of fall and spring. The EPA method would give equal weight to month where a unit was on low load and less hours (providing an average above the standard) to a month where a unit runs virtually all the time at high load (coming under the standard). In essence, the EPA calculation method will alter the generator's decisions on important issues like low load standby reserve, backup for renewables, and other conditions.

Alstom would suggest a method where in each twelve-month period the total emissions for the 12 contiguous months are divided by the total gross MWHrs in the months. This then reflects the actual production against the standard.

V. Specific Comments on Gas Turbines

In addition to comments above about appropriate standards, Alstom would comment on questions raised by EPA about gas turbine technology as follows.

Alstom offers no objection to exemption for simple cycle units proposed by EPA. Alstom does comment that the logic of being unable to set reasonable standards for simple cycles operating within the limited time window defined by EPA seems inconsistent. Since EPA is setting standards of performance for other fossil generating units, EPA should set relevant standards for simple cycle units to insure that the industry continues to pursue the most efficient technologies available.

To the EPA's question of whether or not exclusion of simple cycle gas turbines from the rulemaking would favor them over combined cycle gas turbines in the marketplace, Alstom believes that the economics of the application always govern the choice between simple and combined cycle with capital costs and efficiencies being significantly different between the two. Thus anticipated run times (peaking, daily start-stop, or base load), the price of fuel, and capital cost of the power plant are the controlling drivers in decision making.

Finally, to the question of this regulation perhaps having the unintended effect of delaying the upgrading of simple cycle installations to combined cycle; Alstom believes that market conditions will continue to dictate upgrading when the need for the added generation capacity is seen. Since most combined cycle units will have no trouble meeting the proposed regulation, at least at high loads, we believe that this regulation will have little effect on the timing of upgrade decisions.

Alstom appreciates the opportunity to offer these comments to EPA and trusts they will be carefully considered. Alstom is available to EPA for consultation or discussion on these issues or any other issues related to these matters. It is always critical in setting such standards to consider the whole of the interconnected electric system and the impact these proposals will have on the system. Technologies must deliver reliable, available, and cost effect electricity to the American people and the only way to accomplish these objectives is to consider the whole system and the way technology for generation works within the larger system.

Very truly yours,

Robert G. Hilton

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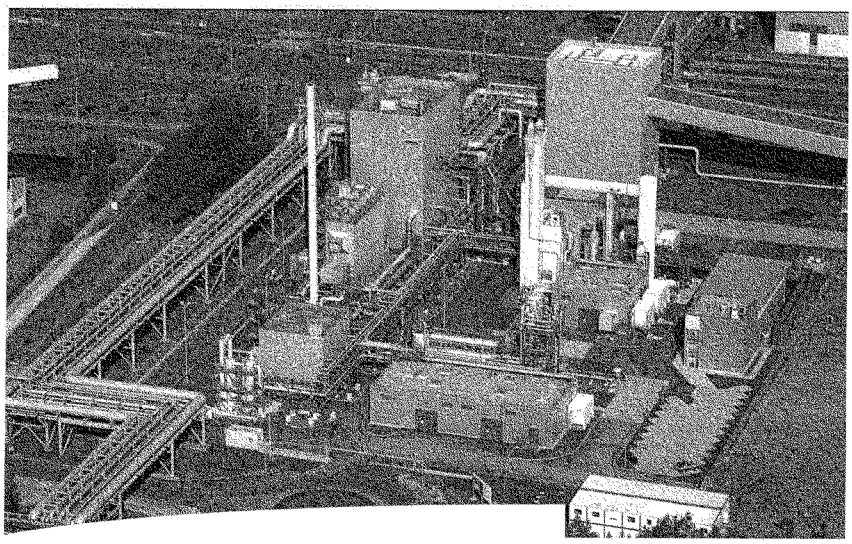
Cost assessment of fossil power plants equipped with CCS under typical scenarios

Jean-François Léandri,
Adrian Skea, Christian Bohtz,
Gerhard Heinz
Alstom Power – June 2012



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Cost assessment of fossil power plants equipped with CCS under typical scenarios

Jean-François Léandri,
Adrian Skea, Christian Bohtz, Gerhard Heinz

Alstom Power

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Foreword

Among the many challenges faced in implementing technology to reduce CO2 emissions from the power generation sector, minimising both the energy penalty and the cost of electricity for fossil fuelled power plants equipped with CCS are two of the most significant.

Many parameters have to be taken into account to calculate these costs, including those related to technical performance. Evaluations and comparisons often result in endless debates due to the infinite number of possible combinations of these input parameters.

This paper attempts to rationalize and evaluate the impact of the key parameters under typical scenarios and presents a sensitivity analysis. The work is based on the experience developed by Alstom on conventional turnkey plants and on the last five years of experience gained on CCS demonstration plants and reference designs.

Different capture technologies are considered in the evaluation and comparison of the impact of CCS on future commercial fossil-fuelled power plants (coal and gas). The influence of the technology learning curves on both performance and the CCS incremental CAPEX and OPEX costs are estimated during the next two decades. Although retrofit applications are more difficult to analyse, as each case is specific, a tentative estimation has been made to evaluate the main differences compared with new installations.

Finally, the cost assessment is put in perspective relative to some other low-carbon methods of producing electricity and against the other challenges in developing CCS technology, such as, the implementation of regulations and impact of public opinion.

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1- Introduction

The "IPCC Summary for Policymakers" published in May 2007, gives a target for the maximum concentration of Greenhouse Gas (GHG) in the atmosphere of 450 ppm CO_2 equivalent. This is required in order to give a reasonable chance of limiting the earth's long-term surface temperature increase to a maximum of 2°C above pre-industrial levels by 2100. This figure was agreed by all countries at Copenhagen & Cancun. To achieve this goal, CO_2 emissions will need to be reduced massively.

The main contributors to CO_2 emissions today are Power Generation (c.a. 40%), Transport (c.a.20%) and Industry (c.a.20%). Power generation currently emits 12 $GtCO_2$/yr. Power is projected to grow significantly, and the 2°C goal will require full de-carbonisation of Power generation. Low carbon technologies are needed both for new power generation plants, and for the existing installed base.

The possibilities to reduce CO_2 emissions in the Power sector include: i) demand reduction, ii) efficiency increase, iii) nuclear, iv) renewables (wind, hydro, solar, biomass...), and v) Carbon Capture and Storage (CCS). This last alternative will by necessity play a major role:

- The IEA[1] calculates that 54 to 67% of worldwide electricity generation will still be provided by fossil power plants in 2035. CCS is the only option to deal with the resulting emissions during a transition period until around 2050+ after which time it may be possible to move toward a power generation system not reliant on fossil fuels. The IEA estimates a CO2 reduction from CCS in the Power sector of 1100 and 2700 Mt/yr will be necessary respectively in 2030 and 2035 (corresponding to 232 and 598 GWe with CCS).

- CCS is necessary not only on coal but also on gas. In the EU region, under the Current Policies Scenario, the IEA predicts that 1190 Mt/yr CO_2 will be produced by the power sector in 2035 of which, 671 Mt (56%) by coal plants and 495 Mt (42%) by Gas plants. Under the 450 ppm scenario, it will be necessary to abate the emissions from coal down to 104 Mt (-85%) and from gas down to 130 Mt (-74%) in 2035, CCS contributing for c.a. 20% of this reduction.

CCS is a technology under development, still several years from commercial deployment, and a key question for policy makers and utilities is whether or not CCS is a competitive option compared to the other low carbon alternatives. **The answer given in this paper is unequivocally yes.**

[1] World Energy outlook 2010, International Energy Agency (IEA), Paris, France – New and Current Policies Scenarios

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2- Methodology and key assumptions

The Alstom Cost of Electricity (COE) analysis is based on:

- early and substantial investment in the development of several capture technologies since 1998 and the knowledge/experience feedback from 16 pilots and demonstrators,
- power plant engineering procurement and construction (EPC) expertise (coal & gas turnkey plant experience over many decades), enabling optimised integration of the capture system with the conventional plant,
- experience in designing and manufacturing key components (boilers, AQCS, gas and steam turbines, control systems etc.) to optimise the CCS interface adaptation.

The assumptions and case studies presented in this paper have been selected to best reflect the market and are not related to any specific supplier. The main assumptions are:

1) Three regions: Europe (EUR), North America (NAM), South East Asia (excluding China & India)
2) Two technologies: oxy-combustion (Oxy), post combustion capture (PCC)
3) Three types of fuel: Hardcoal, Lignite (raw and dried for EUR only) and Gas,
4) Two phases: Commercial first of a kind in ~2017-18, mature market in ~2030-35

For each region and fuel type, "reference plants" are defined (table1). For coal power plants, the reference plants are based on a Supercritical steam cycle of 275bar/600/620°C in 2017, then performance improvements are considered (e.g. double re-heat steam turbine from 2020).

		EUR			NAM	SEA
Fuel type		Bituminous	Raw Lignite	Dried Lignite	PRB coal	Bituminous
Fuel heating value	KJ/Kg LHV	24 930	10 278	21 283	20 425	20 896
Carbon content	UB mass%	65%	31%	57%	56%	53%
Fuel price 2011	Euro/t	78,2	24,3	24,3	25,7	53,4
	Euro/GJ	3,14	2,37	2,13	1,26	2,56
Cycle argt 2020/30	bar/°C/°C	300b/600/620°C	272b/600/605°C	300b/600/620°C	300b/600/620°C	300b/600/620°C
Cooling type	°C	13°C - Direct C	18°C - Direct C	18°C - Direct C	19°C - CT	28°C - Direct C
Net Output	MWe net	837	1 000	1 000	837	837
Net eff. 15/20/30	% LHV	46.2/48/48.4 %	44/-/- %	47,6/48,8/49 %	44/46.2/46.7 %	41/42.7/43 %
EPC 2015/20/30	€/KW net	1794/1916/1916	1955/-/-	2070/2200/2200	1612/1722/1722	814/869/869

Table 1 : main market assumptions for coal reference plants (without CCS, EPC before owner costs)

Reference plant operating time is set at 7446 hours per annum, construction time: 4 years for Hardcoal and Lignite. Base year for cost is 2011. EPC indicated costs are market price.

Years 2015-35 (horizontal axis) in the presented graphs are defined as year of order, Notice to Proceed (NTP). Scope variations throughout the 2015-2035 period are valued and included in the CAPEX (e.g. cost for double reheat steam plant).

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For power plants based on gas fuel, the reference plants consists of a base load combined cycle power plant (CCPP) with some regional variation in arrangement (1-1 SS in EUR and SEA and 2-1 MS in NAM). The construction time considered is 30 months.

Performance and cost improvements were considered on the reference plants. It was assumed that a combined cycle power plant with CCS would operate 7000 hours annually.

		EUR	NAM	SEA
Fuel type		Natural gas	Natural gas	Natural gas
Fuel heating value	KJ/Kg LHV	50 000	50 000	50 000
Carbon content	mass%	75%	75%	75%
Fuel price 2011	Euro/GJ	7,2	2,8	3,8 (subs.)
Cycle argt 2020/30		1-1 SS	2-1 MS	1-1 SS
Cooling type	°C	13°C - Direct C	19°C - CT	28°C - Direct C
Net Output 15/20/30	MWe net	600/650/700	850/900/950	538/583/628
Net eff. 15/20/30	% LHV	61/62/63 %	60/61/62 %	60/61/62 %
EPC cost 15/20/30	€/KW net	558/544/529	452/441/429	473/461/449

Table 2 : main market assumptions for Combined-Cycle Power Plants

The CCS technologies covered in this paper are:

- PCC advanced amine and Oxy on coal plants (for Hard coal the CCS plant was increased in gross size to compensate the energy penalty and to align on the same MWe net output of the reference plant), 90% capture of the CO_2 emitted by the CCS plant,
- PCC Amine with Flue Gas Re-circulation on CCPP with two cases, one at 90% capture of the CO_2 emitted by the CCS plant , plus one case at 70% capture (design point) for EUR.

Alstom has also performed comparable studies for its Chilled Ammonia Process CAP, though the data is not presented here. Generally though, it can be stated that CAP is competitive with the Amines process. A choice between the two technologies for a particular application would depend upon the site specific conditions that might favour one technology over the other. The conclusions of this report are therefore equally applicable to the CAP technology.

Feedback from pilots in operation, detailed engineering studies made on large-scale demonstrators and reference designs provide the basis of the input data for Oxy and PCC.

Disaggregated learning corrections are applied throughout the 2017-33 period, including:

- a performance improvement for the reference and the CCS incremental capture plants evaluated separately for each sub-systems (e.g. in EUR, the ASU consumption was selected at 180 kWh/tO_2 in 2017 down to 150 kWh/tO_2, solvent re-generation duty improvement was 0.4 GJ/tCO_2), and then on an integrated turnkey basis (e.g. heat recovery)
- a correction on the resulting Capex and Opex costs of the CCS incremental sub-systems for volume, and for size when applicable. The base case market ramp-up profile used is upon IEA CCS installed base forecast. Lower ramp-up would delay by a few years the cost reduction achievement, but it would not change the cost level on the long term.

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To check consistency, we consolidated all the improvement factors and back-calculated an aggregated rate to compare with traditional learning curves[2]. The aggregated rate was a little lower and more conservative than a traditional one. Finally, we ran a sensitivity analysis on key sub-systems, to check the impact of the improvement factor range on COE.

The owner costs and contingencies in addition to the EPC cost of the integrated plant equipped with CO_2 Capture system are 20% for coal PP and gas CCPP

Figure 1 presents the assumptions considered for the on-shore and off-shore transport and storage (T&S) EUR Hard coal reference cases. However, the spread of transport and storage costs is large, and there is a feeling in the CCS community that the literature is currently underestimating these costs, so a variation range is proposed in the sensitivity analysis.

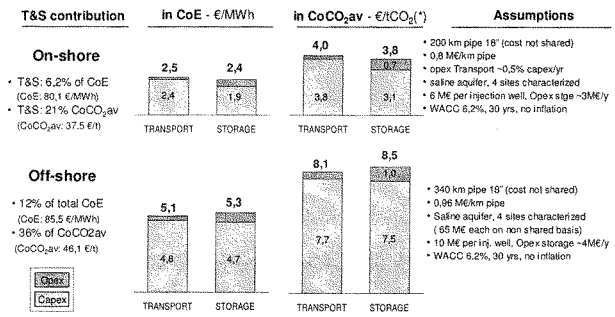

Figure 1: Base case assumptions for transport and storage

The levelized cost of electricity (COE or LCOE) is the theoretical constant electricity price that would be required for the life of the plant to cover all operating expenses, payment of debt and accrued interest on initial expenses, and the payment of a return to investors. It considers Transport and Storage and regional and technology variations. No inflation, no escalation and no CO_2 price changes were accounted for in the presented base cases below (2011 base year, real rates). CO_2 price is considered in the sensitivity analysis.

Exchange rate: 1 Euro = 1.33 USD	EUR / NAM / ASIA
• Debt cost (real rate w/o inflation):	3,3% / 3,0% / 8,2%
• Cost of Equity (real rate w/o inflation):	9,76% / 9,76% / 11%
• Debt fraction:	50% / 50% / 50%
• Tax rate:	35% / 35% / 35%
• Interest rate during construction: WACC rate also used	
• Annuity period: 25 years for New Coal PP and 20 years for Gas CC for all regions	

[2] E. Rubin et Al., 2004. learning curves for environmental technology and their importance for climate policy analysis. Elsevier, Energy 29.

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3- Main results - CCS Hard coal plant

The resulting Costs of Electricity (COE), including CO_2 transport and storage, for Hardcoal CCS cases with PCC advanced amine and Oxy are presented by region in the figure 2.

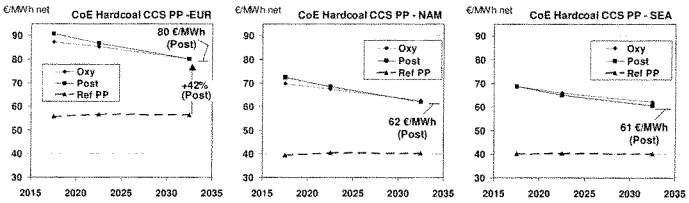

Figure 2: Cost of electricity for Hardcoal power plant equipped with CCS

The Increase in COE resulting from implementation of CCS in 2032-33 could be cut from 60- 65% in 2017 down to about 42% in 2032-33 in EUR (COE 80 €/MWh). In NAM and SEA regions, the COE of the plant equipped with CCS are ~17% lower than in Europe in 2032-33, reaching 62 €/MWh in NAM because of a cheaper coal fuel and 61 €/MWh in SEA because of lower Capex and Opex costs. The resulting Cost of CO_2 avoided could then target ~30 €/t in NAM and SEA and 35 €/t in EUR in 2032-33 (no CO_2 price being accounted for).

A specific energy penalty of 15-16 % can be realistically targeted in 2032 for CCS in Europe (figure 3). It is defined as the additional auxiliary consumption of the plant needed for the Capture system in % of reference plant net MWe (EP= [Net MWe Ref PP – Net MWe CCS PP]/Net MWe Ref PP). Figures in other regions depend on cooling temperature and coal data.

The energy penalty is ~2% MWe net higher in NAM compared with EUR, and ~2 to 4% higher in SEA, where Oxy is a slightly more penalized by the much higher cooling temperature..

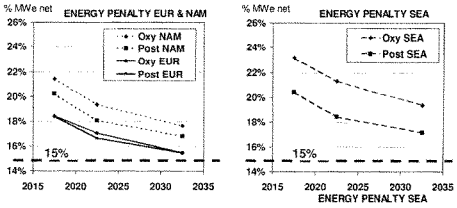

Figure 3: Energy penalty due to CO_2 capture systems, by region

In the selected case, the impact on performance is due to higher cooling water temperature in SEA versus NAM as well as a much higher fuel cost. This offsets the lower CAPEX figures resulting in a comparable COE despite the differences between the two regions.

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The incremental CCS CAPEX as a percentage of the reference plant CAPEX drops in Europe: from 67% to 45% for Oxy over the period 2017-32 and from 66% to 39% for PCC. This is due to the combined effect of the performance improvement and the cost reduction for volume effect. These figures are calculated for reference plant and CCS plant at same net MWe net output.

In NAM and SEA, the CCS/Ref CAPEX ratio also decreases following the same trend, although the % could be at a slightly different level because of regional specific assumptions (ex: higher cooling temperatures than in Europe). For CCS incremental fixed and variable O&M costs, the learning curve is also applicable, driving down the Opex cost.

Figure 4 shows the impact of the full CCS chain on the total COE under our scenario ('REF' is relative to the reference plant without CCS). The regional specific data such as, pressure, air temperature, cooling temperature, coal characteristics, cost level (equipment, construction and fuel) drives the variation in COE breakdown between Capex, Opex, Fuel cost and T&S.

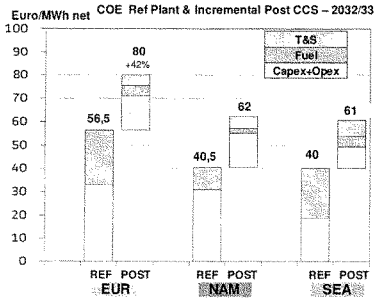

Figure 4: Post: Fuel, Capex & Opex contribution in the COE

In Europe and SEA, the hard coal fuel cost could strongly impact the reference plant COE, but to a lesser extent the CCS incremental COE. For PCC amine, the impact of T&S on COE ranges from 5,2/4,8 €/MWh in EUR to 7,2/6,6 €/MWh in SEA in 2017/32 respectively depending on the year, the regional coal characteristics and the environmental conditions, corresponding to a range of 8 to 10 €/tCO_2 avoided.

4- Main results - CCS Lignite plant

Lignite was only studied in the European region. Costs were analysed for two different cooling temperature conditions: at 13°C, which compares with the hard coal base case, and at 18°C, which is more realistic since the main driver for site selection will be the proximity to the lignite mine where direct cooling is generally not available.

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The Cost of electricity and the cost of CO_2 avoided are presented in figure 5 for Oxy and PCC advanced amine technologies.

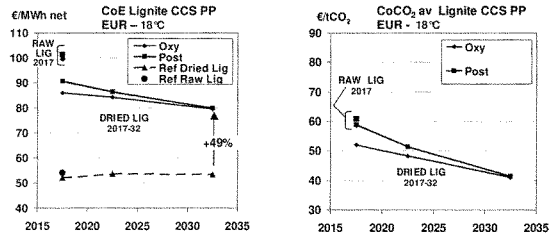
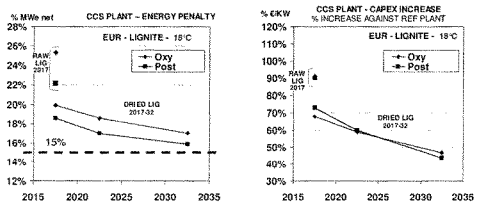


Figure 5: CoE and CoCO2 avoided for Lignite power plant equipped with CCS

Raw lignite is presented in 2017 only for comparison with dried lignite. After 2017 this option would bear a +15% extra cost against dried lignite and hard coal.

The Increase in Cost of Electricity linked to CCS on a dried lignite plant in 2032 could be cut from 65-75% in 2017 down to about 49% in 2032 in Europe (COE 80 €/MWh). The Cost of CO_2 avoided could target approximately 41 €/t in 2032 (no CO_2 price being accounted for). An energy penalty of 15-16 % can be targeted in 2032 for the CCS technologies in Europe.



The Capex increase against reference plant drops from around 73% in 2017 down to around 45% in 2032.

Figure 6: CCS Lignite plant - Energy penalty and Capex increase

In the calculation, the net output of the CCS lignite Oxy or PCC plant is reduced compared with the reference plant (Same MWe gross for Reference plant and CCS plant) . The assumption of same MWe net output made for hard coal has not been extended to the lignite case as it would have led to an unrealistic boiler size.

Figure 7 shows that despite the high incremental Capex and Opex, the COE of CCS plant with dried lignite coal would be viable because of the better performances. As an illustration, in 2032-33 in Europe, a CCS dried lignite plant with a cooling temperature of 18°C could compete with a CCS hardcoal plant equipped with a direct cooling at 13°C.

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If direct cooling is possible the COE could be reduced further (for example by 1,7% for Oxy with a 13°C cooling temperature in 2032).

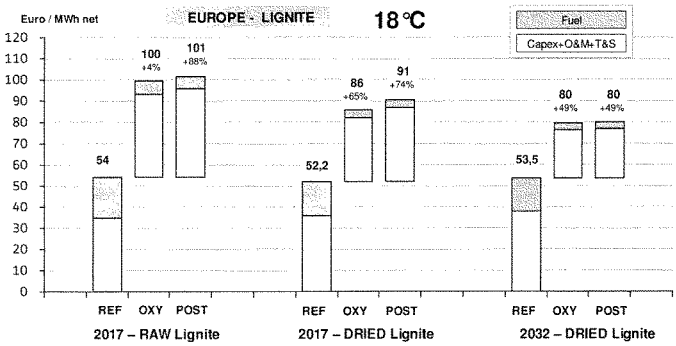

Figure 7: Fuel cost, Capex and Opex contribution in the CoE

5- Main results - Combined-Cycle Power Plant with CCS

The resulting COE by region for Gas CCPP with CCS PCC advanced amine and with flue gas recirculation (FGR) are presented in the figure below for Europe, NAM and SEA.

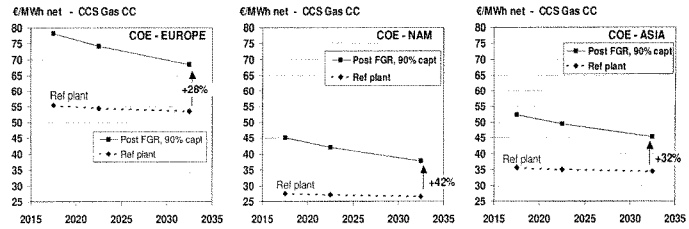

Figure 8: CoE of gas combined cycle plant equipped with CCS and flue gas recirculation

For the reference case at 90% capture, the Increase in Cost of Electricity due to CCS in 2032 could be cut from 41% to about 28% in Europe and from 63% to 42% in NAM, because of the difference in fuel costs. The reference plant and the CCS plants were calculated at same thermal gross assuming no change in the gas turbine design (resulting in lower net power output with CCS).

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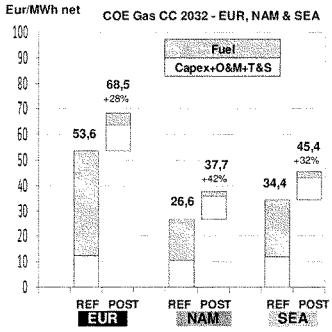
A 70% capture rate case in Europe (design point and not operating point) would reduce the total COE by approximately 6%. Without flue gas recirculation, the COE are slightly higher in absolute values, +5% should be added on the 28%, 42% and 32% shown in fig. 8.



The Cost of CO_2 avoided can target ~40 €/t in NAM/SEA in 2032 with FGR, but above 50 in Europe. Without FGR, these costs of CO_2 avoided increases by ~15% in all regions.

A 10 % energy penalty target can be reached in 2032 for the Post combustion CCS technology.

The Capex increase for CCS in % of the reference plant reduces from 118% to 70% in Europe, and from 125% to 75% in NAM throughout the 2017-32 period.

Figure 9: Gas Fuel contribution in the CoE of Gas CCPP

Figure 9 shows the major contribution of the gas fuel cost on the reference plant COE. Comparatively, the incremental Capex, Opex and T&S cost for CCS is limited. The COE of the CCS gas plant will be primarily driven by the fuel cost, more than by the energy penalty and the incremental CCS cost. The Europe region on figure 9 gives an illustration of this: the COE is higher than in NAM because of the higher gas price considered (7,2 €/GJ) which offsets the other differences in CCS Capex and Opex.

The impact of T&S on COE ranges from 1,9 (NAM-2032) to 2,5 (SEA-2017) €/MWh net depending on year and environmental conditions. The corresponding cost ranges on €/tCO_2 are respectively to 6,7 to 8,5 €/tCO_2 avoided.

6- Main results – Sensitivity analysis

The few reference cases (or base cases) presented in the above sections are based on a given set of assumptions to be able to compare the different CCS technologies. In addition, a sensitivity analysis is useful to understand the possible range of variation of the cost of electricity.

For each of the main parameters, a realistic range with high and low values is considered, and the corresponding impact on COE is estimated. The ranges cover in particular the CO_2 price impact, different transport and storage configuration, and variations in learning outcomes.

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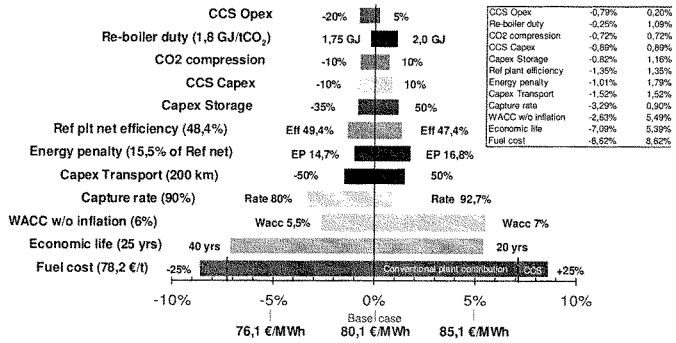
6.1 Sensitivity analysis Hard coal CCS plant:

Figure 10 summarises the impact of the main parameters on COE of the hardcoal PCC amine case in EUR in 2032 (with onshore T&S). A range is indicated for each parameter around the base case value (ie: 1,75-2,0 Gj/t for re-boiler duty around the 1,8 GJ/tCO_2 base case value).



CCS Opex	-0,79%	0,20%
Re-boiler duty	-0,25%	1,09%
CO2 compression	-0,72%	0,72%
CCS Capex	-0,69%	0,69%
Capex Storage	-0,82%	1,16%
Ref plant efficiency	-1,35%	1,35%
Energy penalty	-1,01%	1,79%
Capex Transport	-1,52%	1,52%
Capture rate	-3,29%	0,90%
WACC w/o inflation	-2,63%	5,49%
Economic life	-7,09%	5,39%
Fuel cost	-8,62%	8,62%

Figure 10: Sensitivity on CoE base case 2032 (Europe, Post adv. amine , on-shore T&S, no CO2 price)

Within the considered ranges, each of the following economic parameters: fuel cost, Economic life, WACC, impacts the COE by +/-6%, much more than CCS Perf/Capex/Opex parameters, but this impact is not fully attributable to the CCS additionality, an important share occurs in the conventional scope.

Figure 11 summarizes the impact of applying a CO_2 price or moving from on-shore to off-shore or changing the plant load again on the COE of the same base case..

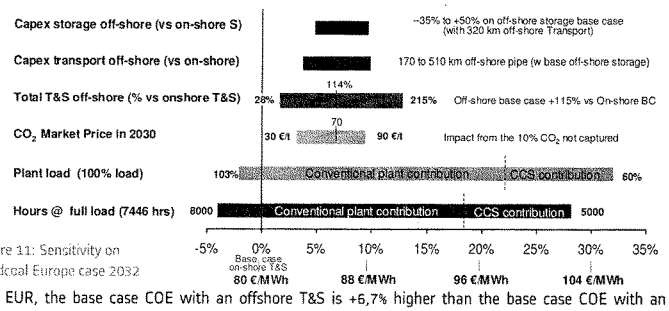


Figure 11: Sensitivity on Hardcoal Europe case 2032

For EUR, the base case COE with an offshore T&S is +6,7% higher than the base case COE with an onshore T&S (T&S offshare cost +114% in variation on T&S onshore costs).

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The impact on COE of a 70 €/t CO2 price in 2032 versus no CO2 price is +7%. The impact of an partial plant load at 60% instead of 100% is +32% on the COE, because of the reduced efficiency of the reference plant and the CCS plant not operating at full MWe. Only a small share of ~30% is attributable to CCS.

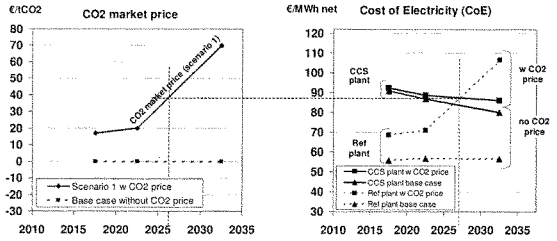

Figure 12: CO_2 price impact on reference and CCS plants for Hardcoal with Post AAP -

Under the CO_2 market price scenario presented in figure 12, in 2027, for a CO_2 price of 39 €/tCO_2, we have the same COE for reference and CCS plants at 88 €/MWh. In 2032, with a CO_2 price assumed at 70 €/t, the COE would be 106 €/MWh for the reference plant and 86 €/MWh for the CCS plant, increases of +88% and 7% respectively compared to cases without CO_2 price.

When conservatively consolidating all min/max, we obtain a resulting range of variation for hard coal reference case in Europe in 2032 of around +/- 25 to 30% for PCC amine and Oxy.

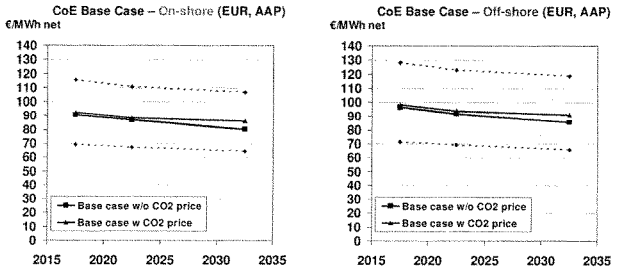

Figure 13: Final range for Hard coal CCS plant with Post AAP - Europe

(note: consolidated upper range includes conservatively all parameters and CO_2 price but excludes Plant load variation left constant at 100%. Consolidated lower range excludes some parameters to also remain conservative)

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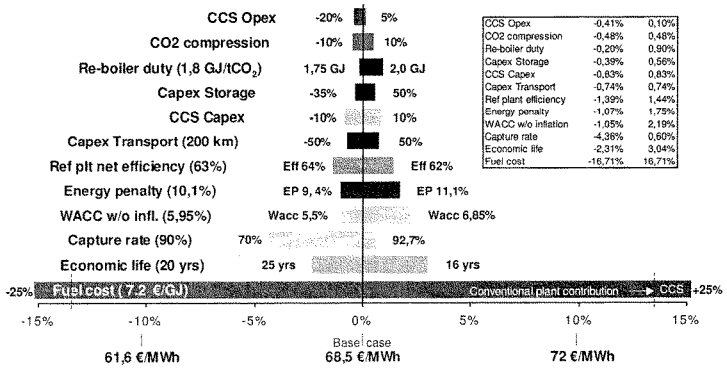
Figure 13 shows data that are relative to the PCC Amine case. Oxy results are not detailed but ranges are close to the PCC amine. Some specific parameters are presented in the table 3.

Parameter	Base case value 2030	Sensitivity value	Rationale for change	Impact on CoE % of CoE (80,2 €/MWh)
Energy penalty % net ref PP	15,5%	16,3% (+5%)	• Different site conditions (Pa & T°)	1,4%
ASU consumption KWh/tO2	150	140 (-7%)	• Ademe target second generation techno	-1,1%
GPU consumption KWh/tCO2	114	107 (-6%)	• Target second generation techno	-0,7%
Cooling T° °Celcius	13°C	18°C	• Direct cooling not possible on the site	1,8%
CCS Net output MWe net	837 (same net ref PP)	708 (same gross ref PP)	• Gross MWe cannot be increased on CCS PP	2,2%
CCS incr Capex %	100%	90%	• Cost convergence scenario SEA-EU	-1,2%

Table 3 : Hardcoal Oxy: Sensitivity on specific factors, Europe 2032, onshore T&S, no CO_2 price

6.2-Sensitivity analysis Gas Combined-Cycle Power Plant with CCS:

Figure 14 summarises the impact of the main parameters on the COE of a gas combined cycle power plant with CCS PCC advanced amine and FGR in Europe in 2032 (onshore T&S).



CCS Opex	-0,41%	0,10%
CO2 compression	-0,48%	0,48%
Re-boiler duty	-0,20%	0,90%
Capex Storage	-0,39%	0,56%
CCS Capex	-0,83%	0,83%
Capex Transport	-0,74%	0,74%
Ref plant efficiency	-1,39%	1,44%
Energy penalty	-1,07%	1,75%
WACC w/o inflation	-1,05%	2,19%
Capture rate	-4,36%	0,60%
Economic life	-2,31%	3,04%
Fuel cost	-16,71%	16,71%

Figure 14: Sensitivity CoE Gas CC CCS, base case 2032 (EUR, PCC amine, on-shore T&S, no CO_2 price)

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Gas fuel cost is highly impacting the COE (Figure 15):

- it is the most important driver of total COE, far ahead of CCS Perf/Capex/Opex parameters, although the impact on COE increased slightly with the addition of CCS.
- it demonstrates the importance of having a diversified mix

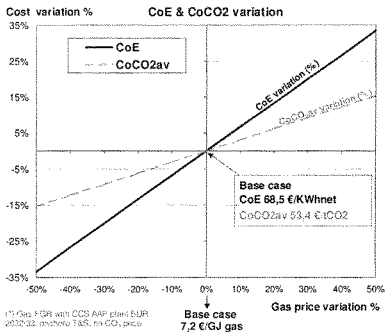

Figure 15: CoE CCS gas CCPP Europe with FGR - Sensitivity on gas price

The economic life assumed for the levelized costs and the WACC could impact COE more than CCS Perf/Capex/Opex parameters, although they are far behind the impact of the Gas fuel cost. However, the impact of these specific parameters is not fully attributable to CCS incremental and the reference plant must take most of the share..

Figure 16 summarizes the impact of applying a CO_2 price or moving from on-shore to off-shore on the COE of the same base case.

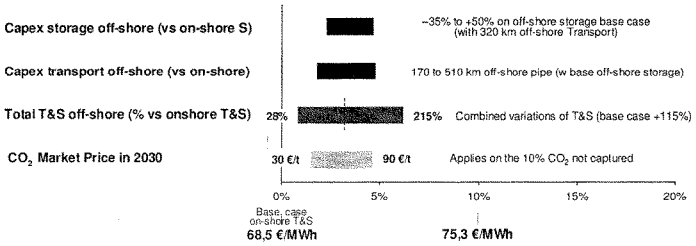

Figure 16: Sensitivity on CoE Gas CC CCS plant, base case Europe 2032

The impact of T&S offshore base case versus onshore base case is +4,2 % on COE (average value)

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Figure 17 shows that in ~2029, for a CO_2 price of around 57 €/tCO_2, we have the same COE for reference and CCS plants at ~71 €/MWh. In 2032, with a CO_2 price assumed at 70 €/tCO_2, the impact is +41% on the reference plant COE and +3,5% on the CCS plant COE.

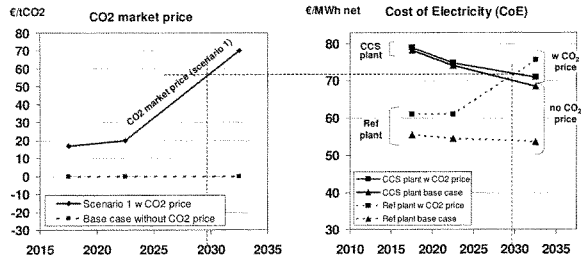

Figure 17: CO_2 price impact on reference and CCS plants for gas CCPP with Post amine - Europe

When consolidating all min/max using the same conservative approach as for hardcoal, we obtain a typical resulting range of variation for Gas fuel Base case in Europe in 2032 of around +/-30 to 40% for PCC advanced amine (note: CO_2 price is accounted in the consolidated range). The width of this range is larger than Coal because of the larger fuel range, this impact being attributable mainly to the conventional plant and not only to the additional CCS systems.

7- CCS Retrofit

CCS Retrofit could play a larger role after 2025, especially on coal plants in China. Nevertheless, CCS Retrofit is likely to remain a variable of adjustment to meet the CO_2 reduction target once all the others means have been implemented, and when the techo-economic data are favourable.

The future CCS retrofit market can be sub-segmented in the non CCS ready plants on the one hand and CCS ready plants on the other. Both PCC combustion and oxy-combustion capture technologies are suitable for coal plants.

The retrofit solutions to address existing non-CCS ready coal plants are specific to, and dependant on the characteristics of, the existing plant. Many technical and economical parameters are involved. Among these, storage availability, space availability, plant lay-out are the first items to be checked to determine eligibility for retrofit..

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In terms of cost, implementing a CCS retrofit concurrent with a major refurbishment of a steam plant, which occurs generally at mid life (~20 to 25 years), would present significant advantages such as:

- potential upgrading of the conventional plant will reduce the CCS energy penalty,
- modification of the steam turbine for the steam extraction with a PCC technology could be more easily implemented, as well as the boiler adaptation required with Oxy technology,
- integration between the capture system and the rest of the plant can be implemented
- savings through synergies between retrofit and maintenance tasks
- NPV of the CCS retrofit project could be substantially increased if the plant is already amortised and if a plant life extension (ex ~15 years) could be implemented at a limited cost.

Typically, units in operation for 20 to 25 years with net efficiency of ~39% or more could be addressed from 2018, which corresponds, on average, to coal plants built from 1995-2000 onwards.

Because of this, for EU and NAM the eligible 'non-CCS ready' base for CCS Retrofit is likely to shrink after 2020 compared with the CCS ready base, and will be limited from 2030. For China, the installed base profile is different with many 'non-CCS ready' plants with high efficiency, built recently, which would be retrofitable in the longer term (e.g. from 2030).

Nevertheless capture ready plants would be much easier to retrofit. Paving the way by building all coal plants as "CCS-READY" from now on is in our view a no regrets option. We note that this is the requirement already in Europe under the CCS Directive and we recommend that the relevant authorities ensure the requirement is fully applied.

8- CCS competitiveness against low carbon alternatives

A comparison of the COE for different carbon-free technologies in Europe is presented in figure 18 for power plants to be ordered during the 2012 - 2017 period. Even when considering the very conservative range of variation assumed in our study, **CCS is competitive, starting in 2017, with any other low carbon or "carbon-free" technology**.

The cost of the integration of intermittent renewables was not taken in account, but it will have an impact in terms of back-up capacity needs, lower utilization of the existing fleet, and grid extension requirements. On the other hand, the learning curve will also apply to renewables contributing to reduce the cost during the next decade.

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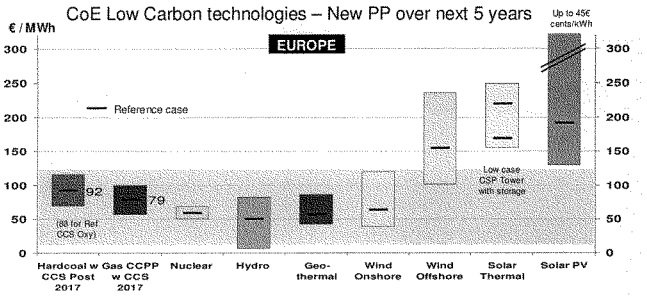
The indicated values for CCS plants in the bar chart are for Post amine and include a CO_2 price of 14 €/ton. The large upper range, consolidated conservatively (see sensitivity analysis) was plotted on the graph, and still CCS solutions for coal and gas remain competitive within this upper range



Source : Alstom analysis 2012. CCS w Post amine 2017 costs, including on shore T&S & CO_2 price (Flue Gas Recirculation for CCS Gas CC)
CoE do not include "externalities" of intermittent power (Back-up cost, balancing cost, grid enhancement if required)

Figure 18: CoE of low carbon technologies – Europe 2012-17

The relative increase in COE because of CCS is lower on gas than on coal. This is due to the fact that the emissions of a gas plant are half of the emissions of coal plant per MWh produced, hence less CO_2 needs to be captured and the CCS equipment is smaller, with lower Capex and a lower energy penalty than for coal

We therefore expect that projections of fuel cost will remain the key determinant between those fuels for power generation. In 2032, for Europe, the cost of CO_2 avoided, including transport and storage is expected to reach levels below 35 €/t on coal and 53 €/t on gas with flue gas recirculation (below 39 €/t on gas for NAM with a much lower fuel cost).

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9- Conclusion

Cost is often presented as a main concern for the viability of Carbon Capture and Storage technology. Based on the results of our CCS pilot efforts combined with the engineering experience gained in the design of the first large-scale CCS demonstration units, Alstom completed an extensive study of the costs of PCC and oxy-combustion technologies now and projected into the future.

The main results are the following:

- with electricity costs varying between 68 and 90 €/MWh for steam plants, depending on fuels and regions (China excluded), the first large scale CCS units, to be ordered starting 2017-18, will already be fully competitive with any other low-carbon power generation solution,
- CCS is at the start of its learning curve, and a CCS COE below 80 €/MWh along with a CO_2 avoided cost below 40 €/t is realistically expected in 2030-35 in Europe for CCS Steam plants. Compared with other mature technologies, the greater potential learning curve improvement of CCS will reinforce its competitiveness over time,
- contrary to popular belief, the relative COE competitiveness of gas is slightly improved versus coal for the first plants to be ordered from 2017-18, when applying CCS on both fuels, with COE for gas CCPP with CCS varying between 45 and 80 €/MWh depending on the region,
- relative fuel price and security of supply should remain the key determinants for choosing decarbonised fossil fuelled power generation.

With the right policy framework, technology and costs are not in themselves obstacles to CCS deployment, but other significant issues should be addressed:

- strong and long-term signals are now needed to secure the long development cycle of CCS technology,
- an immediate policy framework capable of rewarding developers of CCS projects on an equal footing with any other decarbonised power production technology. What is needed is a level playing field in terms of market regulation that does not discriminate for or against one or other low carbon technology (ex: feed-in tariff, or FIT, for wind and not for CCS),
- the progressive tightening of the EU ETS. Given the trajectory we set out for the evolution of CCS costs, this could make CCS commercially viable without FIT – type subsidies sometime from the 2025's and, consistent with the EU's longer term emission reduction goals, certainly by 2030-35,
- clear long-term carbon regulation signals designed to ensure a fair and non-distorted technology choice for new decarbonised power generation assets, In the past, the reduction of other types of emissions has been successfully achieved with specific environmental regulations. The review of the CCS Directive in 2015 offers crucial opportunities here,

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- clear regulations on storage and long-term liabilities should be set as soon as possible. The EU Directive on CO_2 storage should be in force since June 2011, but many Members States are late in translating this directive into legislation. This patchy progress is impacting decision making on important large-scale demonstration projects,
- storage validation should be accelerated through large-scale demonstration projects and in particular the development of CCS clusters. The "cluster" approach for early CCS deployment will alleviate key uncertainties when grouping projects around publicly accepted and geologically validated storage sites. Offshore storage has obvious advantages in this respect,
- Financial support for these projects must be provided to an adequate level and in a timely manner if momentum is to be restored to the demonstration programme. Large scale demonstration projects are crucial to achieving the cost reductions which are assessed in this report.

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Abbreviations

AAP	Advanced Amine Process
AQCS	Air Quality Control Systems
ASU	Air Separation Unit
CAP	Chilled Ammonia Process
CAPEX	Capital Expenditure
CC	Combined Cycle
CCPP	Combined Cycle Power Plant
CCS	Carbon Capture and Storage
CCS PP	Turnkey Power Plant equipped with Capture Transport and Storage
$CoCO_2av$	Cost of CO_2 avoided
COE	Levelized Cost of Electricity
EPC	Engineering Procurement and Construction
ETS	Emissions Trading Scheme
EU	European or Europe
EUR	Europe
FGR	Flue Gas Recirculation
FIT	Feed-In Tariff
GHG	Greenhouse Gas
GJ	Giga Joule
GPU	Gas Processing Unit (compression, purification CO_2)
GWe	Gigawatt Electrical
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
LCOE	Levelized Cost of Electricity
LIG	Lignite
MS	Multiple Shafts (relative to combined cycle)
NAM	North America
NPV	Net Present Value
NTP	Notice To Proceed
O&M	Operating and Maintenance
OPEX	Operating Expense
OXY	Oxy-Combustion Capture
PC	Pulverized Coal
PCC	Post-Combustion Capture
PERF	Performance
PP	Power Plant
PV	Photovoltaic
REF	Reference Power Plant (without CCS)
SEA	South East Asia (excluding China India)
SS	Single Shaft (relative to combined cycle)
T&S	Transport and Storage (of CO_2)
WACC	Weighted Average Cost of Capital

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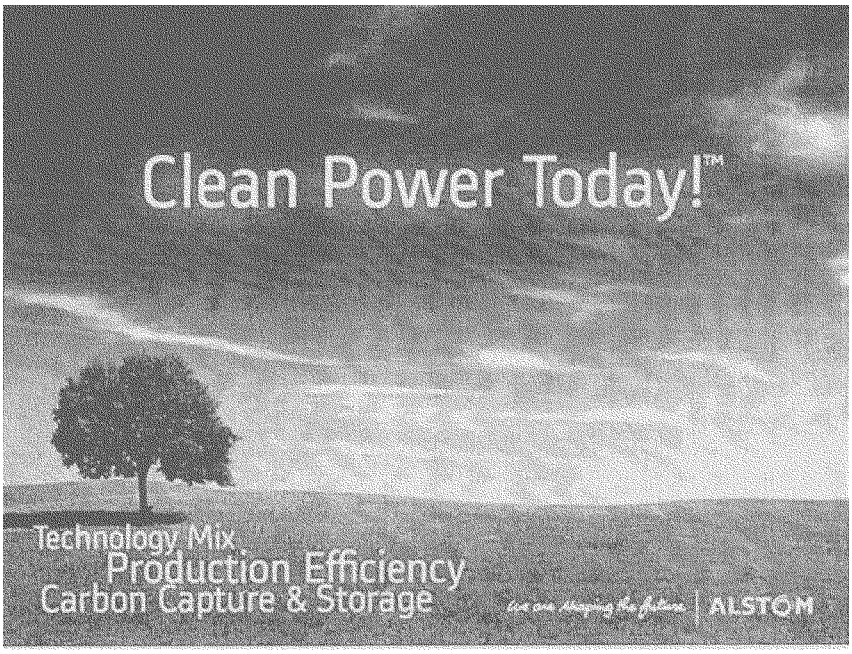

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Mr. WHITFIELD. Thanks, Mr. Hilton.

Mr. Thompson, you are recognized for 5 minutes.

STATEMENT OF JOHN THOMPSON

Mr. THOMPSON. Thank you, Mr. Chairman, Ranking Member Rush, members of the committee. My name is John Thompson. I direct the Fossil Transition Project of the Clean Air Task Force. The Clean Air Task Force is a nonprofit environmental group headquartered in Boston and with offices in Beijing, Illinois, Ohio, Washington, DC, Texas, New Hampshire and Maine. I am from our Carbondale, Illinois, office.

Our mission is to reduce the air pollutants associated with climate change and premature death and disease. We work throughout the United States and China on these issues, and the project I direct works to shift fossil fuels to use technologies that have less impact on the environment.

I want to be clear: worldwide coal use will increase dramatically in the coming decades as the standard of living in developing nations improves. Increasing energy efficiency, greater use of renewables and nuclear power will displace some of the CO_2 emissions associated with this growth in fossil use but any meaningful climate action must include widespread use of carbon and storage. It is the only technology that can remove up to 90 percent of the carbon dioxide from large stationary sources. Without CCS, it will be difficult, if not impossible, to avoid the worst aspects of climate change.

The Clean Air Task Force is committed to finding ways to advance CCS development. Our organization has filed comments in support of air permits for coal plants with CCS. We have advocated for coal projects that use advanced technology before State public service commissions. We have worked to promote incentives for CCS and EOR, and we have supported regulations that establish CO_2 emission limits that enable CCS. We have promoted partnerships between U.S. and Chinese companies that would lower CCS costs and encourage projects in both countries. I also serve on the National Coal Council, which advises DOE on coal-related projects.

I would like to make a few points this morning. First, the value of CCS goes beyond reducing emissions for the purpose of climate change. Capture of CO_2 from industrial and power sources could be used to expand domestic oil production through EOR. Currently, EOR accounts for 6 percent of domestic oil production but with additional supplies of carbon dioxide, more oil could be produced from domestic oil wells. Estimates for the amount of EOR that can be produced domestically have grown in recent years. DOE has estimated that approximately 67 billion barrels of oil are economically recoverable, but to produce that 67 billion barrels of oil, we need approximately 20 billion tons of CO_2. That is an amount that is equivalent to about 30 years of CO_2 emissions from about a third of the Nation's coal plants.

Now, contrary to assertions earlier today, several coal plants are proposed or are under construction that show the feasibility of CCS at scale and would meet EPA's CO_2 emissions standards for fossil plants, and they would use the CO_2 for EOR to increase domestic oil production. These include Mississippi Power's Plant Ratcliffe in

Kemper County and Summit Power's Texas Clean Energy Plant in Odessa, Texas. Plant Ratcliffe is a 582-megawatts IGCC plant which began construction in 2010 and is expected to go into operation in 2014. It will gasify lignite, capture 65 percent of the CO_2 emissions and sell them for EOR. The Texas clean energy plant is a 400-megawatt gross plant that would capture 90 percent of its CO_2 and produce about 200 megawatts of power and fertilizer and produce about 2.5 million tons of CO_2 to produce 7 million barrels of oil annually.

What I would like to make as points are a couple things here. First of all, CO_2 performance standards are needed to gain public service commission approval for coal CCS projects. After AEP's West Virginia Mountaineer project was denied, Mike Morris, the CEO of AEP made a statement that included this sentence: "It is impossible to gain regulatory approval to recover our share of costs for validating and deploying the technology without Federal requirements to reduce greenhouse gas emissions already in place."

U.S. EPA considered technical feasibility and cost in its draft CCS rule. They concluded CCS was technically feasible, and addressed the cost issues through a number of means: establishing reasonable standards of 50 percent reduction overall through partial capture rather than full capture of 90 percent. They provided regulatory flexibility. They gave longer periods of time to comply with the standards, and I think this approach is reasonable.

I would like to just conclude by saying that the problem with H.R. 6172 is that you can't consider technical and economic feasibility in a vacuum. You must consider it in the context of regulations, and EPA's regulatory approach is reasonable, and what is more, contrary to the intent of the sponsors of this bill, I believe this will add confusion to regulations, which will only help the building of natural-gas plants. We need certainty. What H.R. 6172, by creating this regulatory confusion, would do would contribute to the following problems. It would delay new CCS projects because regulators would not know whether they had to meet these standards in order to build them. It would delay the economic production of oil through EOR, and it would replace longstanding precedent of promoting technology that has achieved significant public-health and environmental benefits with a static, backward-looking approach.

So I would conclude by saying that what Congress really needs to focus on is two things: we need performance standards but we also need incentives to move EOR. EPA's regulations coupled with further incentives I believe is the correct approach. H.R. 6172 would delay that progress. Thank you.

[The prepared statement of Mr. Thompson follows:]

Written Testimony of John Thompson
Director of Fossil Transition Project, Clean Air Task Force
before the
U.S. House Subcommittee on Energy and Power
on "American Energy Initiative" H.R. 6172

Thursday September 20, 2012

Summary

My testimony makes several points:

About CCS

- Captured CO_2 has new importance in developing domestic oil supplies through enhanced oil recovery (EOR)
- Several coal plants (either under construction or in advanced development) would meet USEPA's proposed CO_2 emission limits using CCS. They would also use captured CO_2 for EOR.

About Performance Standards

- CO_2 performance standards are needed to gain state public service commission approval for coal CCS projects that would be added to a utility's rate base.
- USEPA considered technical feasibility and cost of CCS in its draft rule. They concluded that CCS was technically feasible for new coal plants, and addressed cost in the proposed rule by establishing reasonable emission limits, providing flexibility in how standards could be met by new plants, and by allowing extended compliance deadlines.
- Recently finalized Canadian emission limits for coal plants (new and existing) are set on the same bases as the US EPA standards and are similar to USEPA's proposed rules in emission limits and flexibility.

About H.R. 6172

H.R. 6172 would create regulatory confusion that would contribute to the following problems:

- Delay new coal plants (with and without CCS) because H.R. 6172 creates additional uncertainty about future regulations. Contrary to the intentions of the bill's sponsors, this regulatory confusion will favor natural gas plants not coal.
- Delay U.S. domestic oil production through EOR. There is a need for CO_2 from industrial sources to expand domestic oil production. Performance standards, coupled with incentives to lower capture costs, can drive greater domestic oil production.
- Replaces long-standing precedent promoting technology advancement that has achieved significant public health and environmental benefits, with a static, backward looking approach that only considers what is already achieved.
- Significantly delay the nation's ability to get CO_2 emissions from the largest stationary CO_2 sources in the United States.

Congress should focus on solutions that can achieve meaningful reductions in CO_2 emissions from the power sector – which is the largest source of domestic CO2 emissions -- and at the same time can expand domestic oil production in existing basins, using EOR. EPA's proposed performance standards, coupled with an expanded program of incentives to drive EOR using CO_2 captured from fossil EGUs could achieve cost-effective reductions in the CO_2 emissions causing climate change from the industry most responsible for those emissions. At the same time, the standards can have the added economic benefit of supporting domestic oil production through enhanced oil recovery (EOR). H.R. 6172 would not achieve either goal, and would only create new problems.

Introduction

Thank you for this opportunity to testify on H.R. 6172, the "American Energy Initiative." My name is John Thompson. I direct the Fossil Transition Project of the Clean Air Task Force (CATF). The Clean Air Task Force is a non-profit environmental group headquartered in Boston Massachusetts and with offices in Beijing, Illinois, Ohio, Washington DC, Texas, and New Hampshire and Maine. Our mission is to reduce the air pollutants associated with climate change and premature death and disease. We work throughout the United States and China on these issues. The Fossil Transition Project that I direct works to shift fossil fuels use to technologies that have less impact on the environment.

Worldwide fossil use, especially coal, will increase dramatically in the coming decades as the standard of living in developing nations improves. Increasing energy efficiency, greater use of renewables, and nuclear will displace some of the CO_2 emissions associated with this projected growth in fossil use, but any meaningful climate action must include widespread use of carbon capture and storage (CCS). CCS is the only technology that can remove up to 90% of the carbon dioxide from large stationary sources. Without CCS, it will be difficult if not impossible to avoid the worst aspects of climate change.

The Clean Air Task Force is committed to finding ways to advance CCS deployment. Our organization has filed comments in support of air permits for coal plants with CCS, advocated for coal projects that use advanced technology before state public service commissions, worked to promote incentives for CCS and EOR, supported regulations that

establish CO_2 emission limits that enable CCS, and promoted partnerships between US and Chinese companies that would lower CCS costs and encourage CCS projects in both countries.

I also serve on the National Coal Council. The National Coal Council advises DOE on coal-related topics. Our organization has published numerous reports on coal, including "Coal Without Carbon: An Investment Plan for Federal Action."

My testimony today will share information on several topics, including EOR, CCS projects, USEPA's rule, and use this information to offer opinions on H.R. 6172.

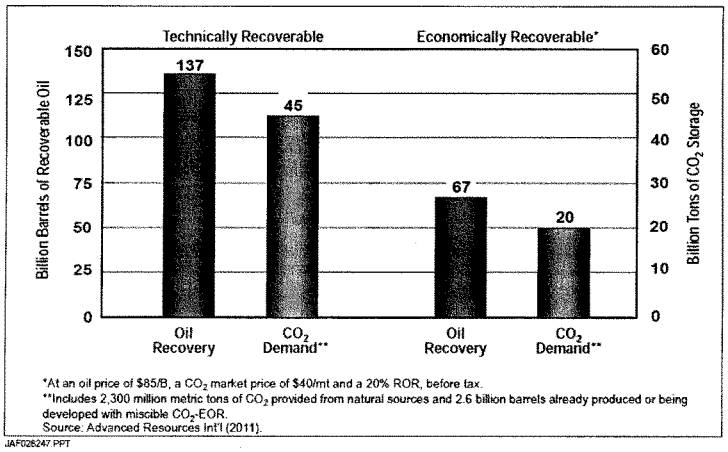
Carbon Capture and Storage (CCS) and Enhanced Oil Recovery (EOR)

CCS consists of three separate technologies: Capture, clean-up and compression of CO_2 that result from the use of coal in a power plant, transport through pipeline, and storage into either depleted oil fields for use in EOR or injection into saline aquifers deep below the ground. All of these components have been used at scale for long-time periods, often in other industries besides power generation.

The value of CCS, however, goes beyond reducing CO_2 emissions for the purposes of preventing climate change. Capture CO_2 from industrial and power plant sources could be used to expand domestic oil production through EOR. Currently, EOR accounts for 6% of domestic oil production. But with additional supplies of carbon dioxide, more oil could be produced from domestic oil wells.

U.S. Department of Energy estimates that approximately 137 billion barrels of domestic oil are technically recoverable through EOR, and of this amount, 67 billion barrels of oil are economically recoverable at an oil price of $85 per barrel, a CO_2 market price of $40 ton, and a ROR of 20%.[1] To produce 67 billion barrels of oil would use approximately 20 billion tons of CO_2, an amount equivalent to thirty years of CO2 emissions from 93 GWs of coal plants or about 1/3 of the U.S. coal fleet.

Figure II-4. Domestic Oil Supplies and CO_2 Demand (Storage) Volumes from "Next Generation" CO_2-EOR Technology"*



EOR represents a substantial opportunity to both reduce carbon dioxide emissions from the power sector that contributes to climate change and use that CO_2 to replace foreign oil with domestic oil supplies. Only about 2 billion of tons of CO_2 are presently available from existing natural and traditional anthropogenic sources, which leaves an

[1] NETL, *Improving domestic energy security and lowering CO2 emissions with "next generation" CO2 enhanced oil recovery* (2011) (Available at http://www.netl.doe.gov/energy-analyses/pubs/storing%20co2%20w%20eor_final.pdf). Attached as Exh.III-77.

additional demand and storage capacity for approximately 18 billion metric tons for next-generation EOR in the main pay zones of oil formations. The most recent report by the National Coal Council cites new studies relating to residual oil zones that indicate CO_2 could help produce an additional 33 billion barrels of oil, requiring an additional 13 billion tons of CO_2[2]. Taken together, these projections indicate that an estimated 31 billion additional metric tons of CO_2 is needed in order to produce 100 billion barrels of oil in the US . In total, this is roughly equivalent to the capture of the emissions from 165 GW of coal-fired power plant over a 30-year period.

The challenge then, is to find ways to capture CO_2 from power plants that accomplishes both goals. Performance standards such as the ones USEPA has proposed, together with potentially self-financing tax incentives for CO_2, EOR incentives, can help meet this need.

Several coal plants are proposed or under construction that show the feasibility of CCS at scale, meet USEPA's proposed 1,000 lb CO_2/MWh emission standard for fossil plants, and use captured CO_2 for EOR. The plants include:

Mississippi Power's Plant Ratcliffe in Kemper County, MS

This 582 MW Integrated Gasification Combined Cycle (IGCC) plant began construction in December 2010 and is expected to go into operation in 2014. It will gasify lignite. The plant will capture 65% of the CO_2 emissions and sell them for use

[2] "Harnessing Coal's Carbon Content, to Advance, the Economy, Environment, and Energy Security", National Coal Council, June 22, 2012.

in EOR. The Clean Air Task Force estimates that the CO_2 emissions from the Kemper County EGU facility will be approximately 786 pounds CO_2 per MWh (net), equivalent to 541 pounds CO_2 per MWh (gross), and well below the proposed performance standard.[3]

When Southern Company's Mississippi Power Company subsidiary won approval from the Mississippi Public Service Commission to build the 522 MW Kemper County IGCC power plant with 65% CCS, its senior executives testified that decades of industrial gas capture experience with Selexol™ was an important factor for the Mississippi Public Service Commission to use in assessing risk. Thomas O. Anderson, Vice President, Generation Development for Mississippi Power, testified that:

> The carbon capture process being utilized for the Kemper County IGCC is a commercial technology referred to as SelexolTM. The SelexolTM process is a commercial technology that uses proprietary solvents, but is based on a technology and principles that have been in commercial use in the chemical industry for over 40 years. Thus, the risk associated with the design and operation of the carbon capture equipment incorporated into the Plant's design is manageable.[4]

Also, Kimberly D. Flowers, Vice President and Senior Production Office of Mississippi Power Company, testified that "[t]he carbon capture process design proposed for this Project has been in commercial use in the chemical industry for

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[3] According to Mississippi Power Company filings before the Mississippi Public Service Commission the net output of the Kemper IGCC facility (when not using natural gas-fired duct burners) will be 522 MW and there will be 237 MW of auxiliary loads, implying a gross output of 759 MW derived from coal. CO2 emissions are expected to be 1.6 million short tons per year, at 89% capacity factor. This implies an average emission rate of 786 lb per MWh (net), equivalent to 541 lb per MWh (gross). *See* MPSC Docket No, 2009-UA-0014, MPCo response to Boston Pacific data request of December 15, 2009, items 3-35 and 3-50 and 3-53.

[4] Mississippi Power Company, MS Public Service Commission Docket 2009-UA-14, Phase Two Direct Testimony of Thomas O. Anderson, Page 22, filed December 7, 2009.

decades. Thus, the risk associated with the design and operation of the carbon capture equipment incorporated in the Plant's design is "manageable."[5]

In a 2011 analysts briefing, Mississippi Power Company President and CEO Ed Day and Executive Vice President, Engineering and Construction Penny Manuel concluded that the Kemper IGCC posed no construction risks that were materially different than other major construction projects including scrubber additions to existing power plants or new builds to the company's natural gas combined cycle fleet. These conclusions are shown in the final slide of their presentation, reproduced below:[6]

[5] Mississippi Power Company, MS Public Service Commission Docket 2009-UA-14, Direct Testimony of Kimberly D. Flowers, page 42, filed January 16, 2009.
[6] Day, E. and Manual, P, *Plant Ratcliffe Update*, available at http://files.shareholder.com/downloads/SO/0x0x448822/cc532fc1-beb9-4af2-b48f-f9619ffb918d/Plant Ratcliffe Update.pdf,

Scale of Construction Comparison

	Scherer Units 1-4 FGD, SCR, and Baghouse	McDonough Unit 4,5,6 CC	Ratcliffe IGCC Unit 1
MWs	3,400	2,520	580
Craft Work (hrs)	13,500,000	4,500,000	8,000,000
Concrete (yds³)	90,000	52,000	70,000
Steel (tons)	71,000	7,000	32,000
Piping (LF)	420,000	370,000	600,000
Site Grading (yds³)	2,600,000	750,000	3,500,000

Construction risk for IGCC is not materially different from any other major construction project

SOUTHERN COMPANY

Summit Power's Texas Clean Energy Plant, Odessa TX

The Texas Clean Energy Plant is a 400 MW (gross) polygen plant that will gasify Powder River Basin coal to produce three products: 1) Approximately 200 MW of power, 2) 700,000 tons per year of urea fertilizer, and 3) 2.5 million tons of CO_2 for use in producing 7 million barrels/year of oil. The plant will capture 90% of the CO_2 that is produced. The project has sold all of its output, obtained all permits, ordered major equipment, and is expected to formally break ground in early 2013. The plant will go into operation in 2017. The company's president, Eric Redman, stated in May of this year that "CO2 emissions would amount to about 200 pounds per MWh,

making the Texas plant far more climate-friendly than even the best combined-cycle natural-gas plants, which emit about 850 to 1,000 pounds per MWh."[7]

According to a February 2012 announcement by Summit Power Group, the Texas Clean Energy Project will have "firm-price, turnkey EPC [engineering-procurement-construction] contracts that guarantee price, schedule and performance for the integrated coal gasification combined cycle (IGCC) project' and "a separate, 15-year O&M [operation and maintenance] contract...for the complete, turnkey operation and maintenance of the entire 600-acre facility, including day-to-day operation, and short term and long term maintenance."[8]

Both Plant Ratcliffe and the Texas Clean Energy Project have received incentives that helped with facility financing. Plant Ratcliffe was awarded a $270 million grant from the Department of Energy (DOE) and $133 million in investment tax credits plus a federal loan guarantee. The Texas Clean Energy Project received a $450 million grant from the DOE and also a number of state and federal tax benefits.

CO_2 Performance Standard for Fossil Power Plants

After the West Virginia Public Service Commission rejected the expansion of the Mountaineer CCS project, Mike Morris, CEO of AEP, stated:

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[7] Summit Power, Latest News, *at* http://www.summitpower.com/in-the-news/can-environmentalists-learn-to-love-a-texas-coal-plant/, *citing Can Environmentalists Learn To Love a Texas Coal Plant?*, Yale Environment 360 (May 31, 2012).
[8] *See* http://www.texascleanenergyproject.com/2012/summits-texas-clean-energy-project-reaches-major-milestone-with-signed-epc-and-om-contracts (emphasis added).

> We are clearly in a classic 'which comes first?' situation," Morris said. "The commercialization of this technology is vital if owners of coal-fueled generation are to comply with potential future climate regulations without prematurely retiring efficient, cost-effective generating capacity. ***But as a regulated utility, it is impossible to gain regulatory approval to recover our share of the costs for validating and deploying the technology without federal requirements to reduce greenhouse gas emissions already in place.*** The uncertainty also makes it difficult to attract partners to help fund the industry's share (emphasis added). [9]

Properly developed, performance standards play a key roll in helping CCS projects get placed in the rate base of utilities. The Mountaineer experience suggests that absent rules that require CCS, it is very hard to win approval for pollution control equipment from state public service commissions.

Furthermore, our experience with sulfur dioxide scrubbers indicate that setting performance standards plays a major role in reducing technology costs – a step which is important for CCS deployment both in the US and in rapidly developing countries like China and India. Research by Carnegie-Mellon University concluded that NSPS and best available control technology (BACT) permitting requirements for sulfur dioxide scrubbers, in combination with public R&D investments, dropped the capital cost of the technology two-fold from 1975 through 1995[10]. This reduction in cost was driven by a traversing the technology learning curve through deployment (165MWe deployed), a burst of investment in innovation during this period (as measured by patent filings), and an 8-fold increase in R&D collaborations.

USEPA, in my opinion, has done a good job in developing a proposed set of CO_2 performance standards for fossil fuel power plants through its NSPS authority. The proposed rules help advance CCS projects, signal that CCS is a certainty in a way that will boost EOR, help reduce costs, and begins the much needed process of bringing CO_2 emissions from the power sector down to combat climate change.

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[9] See "AEP Places Carbon Capture Commercialization On Hold, Citing Uncertain Status Of Climate Policy, Weak Economy" at http://www.aep.com/newsroom/newsreleases/?id=1704

[10] "Regulation as the Mother of Innovation: The Case of SO_2 Control", Taylor, Rubin, and Hounshell. Law & Policy, Vol. 27, No. 2, April 2005

In considering CCS as part of it proposed rules, EPA concluded that CCS is "technologically feasible for implementation at new coal-fired power plants, and its core components (CO_2 capture, compressions, transportation and storage) have already been implemented at commercial scale." 77 Fed. Reg. at 22,414/3. On its own record USEPA reached four conclusions:

1. CCS is technologically achievable for implementation at new coal-fired power plants and its core components (CO_2 capture, compression, transportation and storage) are commercially available.[11]

2. There is reason to expect that the costs of CCS will decrease over time, and in any event, economic subsidies for CCS, as for other energy systems and new control technologies are not an unusual condition.[12]

3. USEPA expects construction of no more than a few new coal-fired power plants by 2020 and that CCS is "feasible and sufficiently available for the expected number of coal plants, based on a 30-year averaging compliance path."[13]

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[11] 77 Fed. Reg. at 22,415-16, 22,418, & n.56. (*citing* DOE/NETL Carbon Dioxide Capture and Storage RD&D Roadmap, U.S. Department of Energy National Energy Technology Laboratory (December 2010)) (attached as Exh. III-4); *see also Summary of Interagency Working Group Comments on Draft Language*, Docket Id. No. EPA-HQ-OAR-2011-0660-0030 at 1.

[12] 77 Fed. Reg. at 22,418/3, nn. 57-58 (*citing* John M. Dutton and Annie Thomas, "Treating progress Functions as a Managerial Opportunity," 2, 235-247; Dennis Epple, Linda Argote, and Rukmini Devadas, "Organizational Learning Curves: A Method for Investing Intra-plant Transfer of Knowledge Acquired Through Learning by Doing," Organizational Science, Vol. 2, No. 1, February 1991; International Energy Agency, Experience Curves for Energy Technology Policy, 2000; and Paul L. Joskow and Nancy L. Rose, "The Effects of Technological Change, Experience, and Environmental Regulation on the Construction Cost of Coal-Burning Generating Units," RAND Journal of Economics, Vol. 16, Issue 1, 1-27, 1985. See discussion in "The Benefits and Costs of the Clean Air Act from 1990 to 2020," U.S. EPA, Office of Air and Radiation, April 2011; Ruben, E.S.; Yeh, S.; Antes, M.; Berkenpas, M.; Davison J.; "Use of experience curves to estimate the further cost of power plants with CO2 capture," 1 Intl. J. of Greenhouse Gas Control,188 (2007)).

[13] 77 Fed. Reg. at 22, 414/1 (Noting that EPA used the Integrated Planning Model (IPM), Docket ID No. EPA-HQ-OAR-0660-0060, for projected new coal plant construction, keyed to the Annual Energy Outlook (AEO) and showing a pattern of little future construction of new coal-fired plants); *see also id.* n.46 (citing http://www.epa.gov/airmarkets/progsregs/epa-ipm/BaseCasev410.html#documentation); *id.* at 22,418 -22,419 (noting that EPA identifies

4. Several states already have set emission standards that make implementation of CCS necessary for the development of new coal-fired power plants.[14]

USEPA also recognized that natural gas is much less expensive than coal for new power generation, even if CO_2 emission limits are not established. The USEPA noted:

> "Because of the economics of the energy sector, the EPA and others project that NGCC will be the predominant choice for new fossil fuel-fired generation even absent this rule. In its base case analysis, the EPA does not project any new coal-fired EGUs without CCS to be built in the absence of this proposal through 2030. New coal-fired or pet coke-fired units could meet the standard either by employing carbon capture and storage (CCS) of approximately 50% of the CO_2 in the exhaust gas at startup, or through later application of more effective CCS to meet the standard on average over a 30- year period. The 30-year averaging option could also provide flexibility for owners and operators of coal or pet coke units implementing CCS at the outset of the unit's operation that were designed and operated to emit at less than 1,000 lb CO_2/MWh to address startup concerns or short term interruptions in their ability to sequester captured carbon dioxide."[15]

USEPA's regulatory approach does several important things. First, it addresses the large CO_2 emissions of the power sector. The US needs to transform the energy sector so that it emits much less CO_2. It sends a strong regulatory signal while also promoting technology innovation. H.R. 6172, however, looks backward. It replaces long-standing precedent promoting technology advancement that has achieved significant public health and environmental benefits and lowered costs, with a static, backward looking approach that only considers what technology has achieved in the past.

CCS as a compliance option based in part on the expectation that it will cost less in the future).

[14] 77 Fed. Reg. at 22,414/2 (*citing* California Senate Bill 1368 (2006), Washington Senate Bill 6001 (2007), and Oregon Senate Bill 101 (2009)) (Attached as Exh. III-5).

[15] 77 Fed. Reg. Page 22392

The "economic feasibility" of a technology cannot be considered in a vacuum as I believe H.R. 6172 does. In particular, asking for a determination about whether CCS is economically feasible before considering the details, design and probable effect of specific regulatory drivers for innovation puts the cart before the horse. That's because CCS economic feasibility is not simply a function of capital and energy costs, but is very dependent on capture levels, flexibility in regulatory approach, and compliance time. USEPA addressed CCS cost issues in the proposed rule through several means, including: 1) establishing reasonable emission limits that reflect partial capture (50-65%) rather than full capture (90%); 2) Flexibility in how standards could be met by new plants, and 3) Longer time periods to meet compliance with the standard. The approach and rules EPA has proposed to address CO_2 emissions from new fossil power plants are reasonable.

The approach taken by Canada for establishing performance standards for coal plants is similar to that developed by USEPA. On September 12, 2012, Canada's Minister for the Environment published final CO_2 performance standards applicable to both new coal-fired EGUs and to coal-fired units that have reached the end of their useful lives.[16] The standard, promulgated under the Canadian Environmental Protection Act of 1999, is set at an emissions rate of 420 metric tons per gigawatt hour ("GW-hr"), a rate equivalent to 925.10 lbs/MWh (partial net),[17] comparable to USEPA's proposal. The Canadian rule, like

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[16] See *Reduction of Carbon Dioxide Emissions from Coal-fired Generation of Electricity Regulations,* SOR/2012-167 §§ 3(1), 2(definitions of "old unit" and "useful life"), 146 C. Gaz. II, 19 (Sept. 12, 2012); available at: http://www.gazette.gc.ca/rp-pr/p2/2012/2012-09-12/html/sor-dors167-eng.html

[17] At a rate of 2.205 lbs/kg, and given that 420 metric tons = 420,000 kg, 420 metric tons/GW-hr is equivalent to 926,100 lbs/GW-hr, or 926.10 lbs/kW-hr. This rate is "partial

USEPA's proposal, provides flexibility. It contemplates that plants may use CCS (and that carbon dioxide might be used for EOR) and provides that a plant owner may apply for an extension, up to 2025 or 2030 depending upon the age of the plant, to comply with the standard.

Public materials issued with the Canadian rule note further the economic benefits expected to be realized from it: "It is estimated that Canadians will be better off by $7.3 billion [Canadian] as a result of these regulations due to avoided costs associated with climate change and electricity generation, and avoided health problems from smog and air pollutants. There are also large benefits from the use of carbon capture and storage technology in which captured CO2 is used for enhanced oil recovery."[18]

About H. R. 6172

H.R. 6172 would prohibit the US Environmental Protection Agency (USEPA) from finalizing any rule that establishes CO_2 emissions limits on any coal, gas or oil-fired power plant unless and until three out of four non-EPA officials publish in the Federal Register and submit a report to Congress that finds carbon capture and storage (CCS) is "technically and economically feasible."

H.R. 6172 suffers from a central problem. It places so-called "technical feasibility" and "economic feasibility" at the threshold of the standard setting decision process, and

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net" because it is based on total gross electricity produces less electricity used to capture (but not pressurize) the carbon dioxide. Canadian Rule, §19(1).
14. Questions and Answers: Reduction of Carbon Dioxide Emissions from Coal-Fired Generation of Electricity Regulations, available at: http://www.ec.gc.ca/default.asp?lang=En&n=714D9AAE-1&news=4D34AE9B-1768-415D-A546-8CCF09010A23 (last viewed September 14, 2012).

in so doing it stymies innovation and maintains only the status quo. As I described earlier in my testimony, the question of technical and economic feasibility for CCS (or any other pollution control) has mostly to do with how deep are the required reductions, how fast they are required to occur, and how flexible are the options for meeting them. These considerations are purely regulatory, and any determination of feasibility must be made in the context of a proposed regulation. Furthermore, the listed officials in the bill -- the Administrator of the Energy Information Administration, the Comptroller General of the United States, the Director of the National Energy Technology Laboratory; and the Under Secretary of Commerce for Standards and Technology—with all due respect to their offices and expertise, are fundamentally not the correct authorities to be making what is at is core an environmental regulatory decision. As a result, H. R. 6172, if enacted into law, would create new problems. It would delay for no good reason, USEPA's ability to finalize reasonable CO_2 standards that they have developed for fossil power plants. As a consequence of this delay, H.R. 6172 would:

- Delay new coal plants (with and without CCS) because H.R. 6172 creates additional uncertainty about future regulations. In today's environment, regulatory uncertainty favors natural gas. Industry needs to know what it must do to lower its air pollution emissions, including CO_2 in order to gain permits, rate base projects, and obtain financing. The uncertainty would have an especially damaging effect on proposed coal CCS projects because they need performance standards to gain Public

Service Commission approvals if they are to recoup any of their costs through electricity rates.

- Delay U.S. domestic oil production through EOR. There is a need for CO_2 from industrial sources to expand domestic oil production. Performance standards, coupled with incentives to lower capture costs, can drive greater domestic oil production.

- Delay technology cost reduction, by foregoing the benefit performance standards provide in terms of driving learning, investment, and collaboration.

- Replaces long-standing precedent promoting technology advancement that has achieved significant public health and environmental benefits, with a static, backward looking approach that only considers what is already achieved.

- Significantly delay our ability to get CO_2 emissions from the largest stationary CO_2 sources in the United States.

Conclusions

EPA's proposed performance standards, coupled with an expanded program of incentives to drive EOR using CO_2 captured from fossil EGUs has the potential to achieve cost-effective reductions in the CO_2 emissions causing climate change from the industry most responsible for those emissions. At the same time, the standards can have the added

economic benefit of supporting domestic oil production through enhanced oil recovery (EOR) by signaling that CCS is part of the regulatory future. H.R. 6172 would not achieve either goal but instead would only create new problems, including further uncertainty that would harm the development of more CCS projects and hinder the ability to achieve lasting CO_2 reductions.

Mr. WHITFIELD. Dr. Lashof, you are recognized for 5 minutes.

STATEMENT OF DANIEL A. LASHOF

Mr. LASHOF. Thank you, Mr. Chairman, Mr. Rush and members of the committee. My name is Daniel Lashof. I am the Director of the Climate and Clean Air Program at NRDC, and I appreciate the opportunity to testify before the committee.

NRDC strongly opposes H.R. 6172 for a simple reason: It would interfere with EPA doing its job, which the taxpayers pay it to do and want it to do of protecting public health from dangerous carbon pollution. And let us not make any mistake: Carbon pollution is dangerous. It is imposing staggering health and environmental costs in the United States and around the world now, contributing to more severe heat waves, worsening smog pollution, fueling more extreme weather that takes the lives of thousands of Americans and causes billions of dollars in damage. So EPA is moving forward under the law and following the science in proposing the standards that it has proposed to set performance standards for carbon dioxide emissions from power plants.

Let me just give you one—Mr. Rush commented that this seems like deja vu. Let me give you one piece of new information. This was released yesterday, and it updates my testimony even though it was only submitted a couple days before NASA released new data showing the minimal arctic ice that we have ever seen since satellites have been monitoring this in 1979. The minimum was reached on September 16th. It is a full 50 percent below the minimum from 1979 when the records started, about 50 percent below the average from the 1980s and 1990s. And we are confident that this is driven by carbon pollution, which is trapping heat in the atmosphere, because not only are we setting this record minimum ice extent but the thickness of the remaining ice is much lower, making it more vulnerable, and the warming that we see is not just in the ice. Heat is accumulating in the oceans, which is a major driver of this.

Now, this is the arctic. It is far away. Most Americans don't visit the arctic. None of us own land up there except a few folks in Alaska, so why do we care about this? The fact is that what happens in the arctic doesn't stay in the arctic. The changes here are so dramatic and they affect the energy balance of the entire earth. They change the position of the jet stream. They accelerate the melting of the Greenland ice, which does contribute to more rapid sea-level rise, and they contribute to enhancing global warming in several other ways that I detail in my testimony. So this startling image I think should give us all pause, and recognize that we need to allow EPA to move forward and do its job.

Now, I want to comment specifically on the proposed regulation that EPA has issued because we have heard language about a war on coal, about how the EPA is picking winners and losers. The fact is that EPA's proposed standards for carbon emissions are fuel and technology neutral. They set a rate for all plants that provide the same service of providing baseload and intermediate-load electricity to consumers. This is the kind of commonsense performance-based standard that I would expect Congress to welcome. It is not a com-

mand-and-control regulation. It doesn't say what technology to use. It is completely technology and fuel neutral.

H.R. 6172 turns that on its head by limiting EPA's ability to move forward with that regulation until one particular technology is deemed technically and economically feasible. Now, as both Mr. Thompson and Mr. Hilton have testified, CCS is technically feasible. It is not economically feasible for the simple reason that no commercial entity is building new coal-fired power plants with or without CCS now. The economics in the absence of performance standards for carbon dioxide dictate that we are meeting our electricity needs through energy efficiency, through expansion of renewable energy such as wind, and through natural gas, which is much less expensive. So Congress can no more repeal those rules of economics than they can repeal the physics and chemistry that is driving climate change.

The reality is that we hold no other EPA standards up to this single-technology approach. EPA has moved forward for decades with performance-based standards, and they should be allowed to do their job as the American people would like them to do to set sensible performance standards for carbon emissions from power plants. Thank you.

[The prepared statement of Mr. Lashof follows:]

NRDC
THE EARTH'S BEST DEFENSE

NATURAL RESOURCES DEFENSE COUNCIL

Testimony of Daniel A. Lashof, Ph.D.
Director, Climate and Clean Air Program
Natural Resources Defense Council

Hearing on H.R. 6172

Subcommittee on Energy and Power
Committee on Energy and Commerce
House of Representatives
September 20, 2012

Summary

- NRDC strongly opposes H.R. 6172 because it would interfere with EPA's ability to do its job of setting standards to protect public health from the effects of dangerous carbon pollution emitted by power plants.

- Carbon pollution is imposing staggering health and environmental costs, including by contributing to more severe heat waves and worsened smog pollution and by fueling increasingly extreme weather that takes lives and causes billions of dollars in property damage each year. January through August, 2012 was the warmest such period ever in the U.S.

- Arctic sea ice extent is currently at the lowest level ever recorded—45 percent below the 1979-2000 average for this time of year. Unfortunately, what happens in the Arctic doesn't stay in the Arctic. The dramatic loss of arctic ice contributes to more extreme weather in the United States.

- By proposing carbon pollution standards for new power plants under Section 111(b) of the Clean Air Act, EPA is following the law and the science. Power plants are the largest U.S. source of heat-trapping pollution: 2.2 billion metric tons of CO_2 last year, which was 39 percent of the U.S. total.

- Two Supreme Court decisions, *Massachusetts v. EPA* and *American Electric Power v. Connecticut*, confirm that it is EPA's job under the Clean Air Act as Congress enacted it to protect the American people from carbon pollution from both cars and power plants.

- Section 1(a) of H.R. 6172 would rewrite the Clean Air Act to block EPA from setting any standards for power plant carbon pollution until one specific technology – carbon capture and storage (CCS) – is deemed "technologically and economically feasible" for fossil fuel-fired power plants by a panel of four federal officials outside of EPA.

- This new legal hurdle has just one purpose: To block EPA from doing its job to protect us from dangerous power plant pollution. We would never have held clean car and fuel efficiency standards hostage to one technology, like electric cars. It makes no more sense for power plants and CCS.

- No other polluter and no other pollutant are shielded by such a special hurdle under the Clean Air Act. For more than 40 years EPA has set pollution standards for scores of industrial categories based on emissions performance, not on a particular technology. Instead of command-and-control requirements to use a specific technology, each company is free to choose the cheapest way to meet that standard. H.R. 6172 would turn that approach on its head, weakening the Clean Air Act to protect the country's biggest carbon polluters. H.R. 6172 puts authority over power plant standards in the hands of four non-EPA officials with no mandate to protect public health and the environment. This is an unprecedented and dangerous change to the Clean Air Act.

- The panel may never be able to make the finding that CCS is economically competitive because the marketplace is already providing cleaner and more competitive alternatives. New coal-fired plants aren't competitive today even without CCS, because our needs for new power are being met more cheaply by low-cost natural gas, improved wind turbines, and inexpensive energy efficiency. So even though there are proven ways to cut power plant carbon emissions, EPA could be permanently blocked from setting any standards at all.

- Analysts from government, the power industry, and the financial world all forecast that we will meet electricity needs over the next two decades without constructing new coal-fired plants.

- Other jurisdictions have already established power plant carbon dioxide emission standards. Canada recently set a standard equivalent to 926 lbs/MWh, which is significantly more stringent than the standard proposed by EPA. New York, Washington, Oregon, and California also have power plant carbon emission performance standards.

- Thus, despite all the rhetoric and scape-goating, EPA's proposed standard, which this bill would interfere with, will impose no additional costs on the industry or on electricity rate-payers and will have no adverse impact on jobs.

- It is technically feasible today to build CCS-equipped coal-fired plants that meet EPA's proposed standard. NRDC supports provisions proposed by EPA to facilitate construction of CCS-equipped plants by allowing such plants to average their emissions over their first 30 years of operation. NRDC has also long supported well-designed legislative measures to accelerate the deployment of CCS. But under current market conditions there is little or no interest in building new coal-fired power plants with or without CCS.

- H.R. 6172 would do nothing to accelerate deployment of CCS. Instead it would just block other solutions.

- More than 3 million Americans have raised their voices in comments to support EPA's proposed carbon pollution standard for power plants—far more comments than EPA has received on any previous proposal. More than 60 percent of Americans support EPA's setting carbon pollution standards according to a recent bipartisan poll conducted for the American Lung Association.

- EPA needs to move forward to start the joint Federal-state process of cutting the more than 2 billion tons of dangerous carbon pollution from the existing fleet of power plants under Section 111(d) of the Clean Air Act. It is just plain false to claim that existing coal plants will be required to meet the new plant standard. The criteria and procedures for new and existing plants are different. EPA and the states must set existing source standards that are achievable and affordable. NRDC believes significant, cost-effective reductions can and should be made within that legal framework.

Introduction

Thank you Chairman Whitfield and Ranking Member Rush for the opportunity to testify on behalf of the Natural Resources Defense Council about H.R. 6172. Founded in 1970, NRDC is a national nonprofit environmental organization of scientist, lawyers, and environmental specialists with more than 1.3 million members and online activists, served from offices in New York, Washington, Chicago, San Francisco, Los Angeles, and Beijing. I am director of NRDC's Climate and Clean Air Program. Before joining NRDC in 1989 I served as an environmental scientist at EPA. I have taught environmental policy at Yale and the University of Maryland. I hold a Ph.D. in Energy and Resources from the University of California.

Dangers of Carbon Pollution

NRDC strongly opposes H.R. 6172 because it would prevent EPA from establishing life-saving standards to reduce carbon dioxide emissions from power plants, the largest source of this dangerous pollutant in the United States.[1] Carbon pollution is imposing, and will continue to impose, staggering health and environmental costs. The health consequences include contributing to more severe heat waves and worsened smog pollution, which trigger more asthma attacks and other life-threatening illnesses. Carbon pollution is driving climate change that is fueling increasingly extreme weather, including more extreme heat, more extreme storms, more severe droughts, rising sea levels and more severe coastal flooding, and many other threats to life, limb, and property.[2]

Americans have had extraordinary personal experiences with extreme weather this year. January through August, 2012 was the warmest such period ever in the U.S., with more than 29,000

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[1] Power plants were responsible for 39 percent of energy-related carbon dioxide emissions in 2011 according to data from the Energy Information Administration, Monthly Energy Review, August 2012.

[2] IPCC, 2012: Summary for Policymakers. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 3-21.

daily high temperature records set so far this year.[3] If America's climate were not changing we would expect approximately the same number of record high temperatures and record low temperatures each year, but so far this year there have been almost seven times as many daily high temperature records as low temperature records. In mid-July more than 80 percent of the United States was abnormally dry or in drought conditions. Despite recent storms, which caused their own problems, more than 70 percent of the country remains abnormally dry or worse.[4] The drought is devastating U.S. crops, with more than half of the corn crop rated as being in poor or very poor conditions as of September 9th.[5]

Looking back over the past decade, case studies of six extreme weather events – heat waves, wildfires, floods, smog episodes, hurricanes, and disease outbreaks – yielded health-related costs of more than $14 billion.[6] A recent study by the Rocky Mountain Climate Organization and NRDC shows that the number of extreme rainstorms – storms dumping more than three inches of rain in a day – has doubled over the last 50 years in eight Midwestern states, causing huge flooding losses.[7] Looking forward, excessive heat due to global warming could kill more than 150,000 Americans by the end of this century in our 40 largest cities.[8]

The effects of global warming are perhaps most obvious and dramatic in the Arctic, where the sea ice extent is currently at the lowest level ever recorded—at least 45 percent below the 1979-2000 average for this time of year. Unfortunately, what happens in the Arctic doesn't stay in the Arctic. The

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[3] http://www.ncdc.noaa.gov/extremes/records/, accessed September 17, 2012.
[4] http://droughtmonitor.unl.edu/DM_tables.htm?conus, accessed September 17, 2012.
[5] http://usda01.library.cornell.edu/usda/current/CropProg/CropProg-09-10-2012.pdf
[6] Knowlton, *et al.*, "Six Climate Change–Related Events In The United States Accounted For About $14 Billion In Lost Lives And Health Costs," *Health Affairs*, **30**:11, pp. 2167-76 (Nov. 2011). *See also* NRDC, "Health and Climate Change: Accounting for Costs," Nov. 2011, http://www.nrdc.org/health/accountingforcosts/files/accountingcosts.pdf (attached for the record).
[7] Rocky Mountain Climate Organization & NRDC, "Double Trouble: More Midwestern Extreme Storms," May, 2012, http://www.rockymountainclimate.org/images/DoubledTroubleHigh.pdf.
[8] http://www.nrdc.org/globalwarming/killer-heat/

dramatic loss of arctic ice contributes to more extreme weather in the United States in at least three ways[9]:

- by altering the position and shape of the jet stream, favoring a pattern with more pronounced waves that allows tropical air to penetrate further north and arctic air to penetrate further south;
- by amplifying warming across the Arctic, accelerating melting of the Greenland ice sheet, which raises sea levels, increasing the risk of coastal flooding in the United States; and
- by accelerating the release of carbon dioxide and methane from what used to be permafrost.

The driving force behind the disappearance of arctic sea ice, the rise of global temperatures, and the increasing incidence of heat waves, severe storms and intense droughts is not difficult to find. In fact, it's all around us. The concentration of carbon dioxide in our atmosphere has increased by 24 percent during my lifetime, from 316 parts per million when continuous measurements began in 1959 to 392 parts per million in 2011.[10] We know that burning fossil fuels produces carbon dioxide and we know that carbon dioxide traps heat in our atmosphere—that's basic physics and chemistry. What would be surprising is if carbon pollution were not affecting our climate.

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[9] http://www.climatecentral.org/news/astonishing-arctic-sea-ice-melt-may-lead-to-extreme-winter-weather-14989

[10] As measured at the Mauna Loa Observatory, Hawaii. Carbon dioxide remains in the atmosphere for many decades after being emitted, allowing it to mix almost evenly throughout the atmosphere. Hence the observations at Mauna Loa are representative of the atmosphere as a whole. Data from http://co2now.org/Current-CO2/CO2-Now/noaa-mauna-loa-co2-data.html, accessed September 17, 2012.

EPA Following the Law and the Science

The Supreme Court's landmark 2007 ruling in *Massachusetts v. EPA*[11] confirmed that greenhouse gases, just like any other chemicals released into the air, are "air pollutants" under the Clean Air Act. The Court held that EPA must make a science-based determination whether these pollutants may reasonably be anticipated to endanger public health or welfare, and if so, that EPA must set standards to their emissions under the Clean Air Act. EPA made that endangerment finding in 2009, based on a mountain of scientific evidence that demonstrates that carbon dioxide and other heat-trapping pollutants are already harming, and will continue to harm, the health and well-being of our families, our children, and our communities.

The Supreme Court spoke a second time specifically addressing power plants, in June 2011 in *American Electric Power v. Connecticut*,[12] confirming that it is EPA's job to protect the American people from power plants' dangerous carbon emissions by setting standards under Section 111 of the Clean Air Act. The "new source performance standard" that EPA has proposed for new power plants under Section 111(b) is a critical step toward providing that protection.

Power plants have long topped the list of categories of industrial stationary sources that contribute significantly to air pollution that endangers public health and welfare. Fossil fuel-fired power plants are responsible for more than 2 billion metric tons per year of CO_2 emissions, approximately 40 percent of total U.S. CO_2, and more than a third of all U.S. greenhouse gas emissions. American power plants account for nearly 10 percent of *global* CO_2 emissions. By any standard, power plants contribute significantly to dangerous greenhouse gas air pollution. By proposing standards for new power plants under Section 111(b) of the Clean Air Act, EPA is simply following the law and the science. Its proposal to set the first national limits on carbon pollution from new power plant, which applies only to new plants, not existing or modified ones, is long overdue.

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[11] 549 U.S. 497 (2007).
[12] 131 S.Ct. 2527 (2011).

NRDC supports EPA's determination to establish a single category that includes both natural gas-fired generating units and coal-fired generating units. As EPA has found, these units perform the same function of base-load and intermediate-load power generation, and prospective owners and operators have the flexibility to choose among these technologies when building new plants to serve this function. Consequently, NRDC also supports setting a single, fuel- and technology-neutral, emissions-rate standard applicable to all new plants in the category. EPA has proposed 1000 lbs/MWh standard and a range of levels around this mark. NRDC supports setting the new source standard somewhat below 1000 lbs/MWh because modern new natural gas combined cycle plants can meet such levels at no additional cost. New coal-fired plants equipped with carbon capture and storage technology (CCS) can also meet that level, especially with the 30-year averaging provisions that EPA has proposed. In fact, Canada has recently established as standard for both new and existing coal plants set at the equivalent of 926 lbs/MWh. New York, Washington, Oregon, and California also have power plant carbon emission performance standards.

There is no truth to claims that grouping all new plants that perform the same function – whether natural gas- or coal-fired – in the same category under the proposed new source standard is a "de facto ban" on constructing new coal-fired plants, nor to claims that the standard will cause lost jobs and higher utility bills. These are phony arguments. The proposed new source standard actually will impose <u>no additional costs</u> on the industry or on electricity rate-payers and will have <u>no adverse impact on jobs</u>.

The reason is that market realities have already driven decisions on new power plants away from building new conventional coal plants. As Brookings senior economist Peter Wilcoxen explained in April: "To put it simply: the life-cycle costs of coal-fired power are considerably higher than gas-fired power. This is not a theoretical matter: over the last decade, the electric power sector has responded by adding more than about 200 gigawatts of gas-fired capacity and about 2 gigawatts of coal. The US

now has considerably more gas-fired capacity than coal-fired capacity and low gas prices will accelerate that trend even without the EPA decision." He continued: "Finally, because it only rules out an expensive option that wouldn't have been used anyway, the EPA rule will have no significant effect on electricity prices."[13]

Analysts from government departments, the power industry, and the financial world all agree in forecasting that the nation will meet its electricity needs over the next two decades without constructing new coal-fired plants.[14] Power companies simply aren't planning to build new coal plants due to the availability of low-cost natural gas, strong growth in wind and solar power, big opportunities to improve energy efficiency, and even the potential for nuclear power. For example, the country's largest current CO2 emitter, American Electric Power, stated that the proposed rule "doesn't cause immediate concern" for the company. "We don't have any plans to build new coal plants," said AEP spokesperson Melissa McHenry in March. She continued, "Any additional generational plants we'd build for the next generation will be natural gas."[15] And Jim Rogers, CEO of Duke Energy, operating in the Carolinas, Indiana, Kentucky, and Ohio, told the National Journal in February: "We're not going to build any coal plants in any event. You're going to choose to build gas plants every time, regardless of what the rule is."[16]

These market forecasts are robust. EPA's sensitivity analyses in the Regulatory Impact Analysis show that power companies will not choose to construct any new conventional coal-fired plants before

[13] http://mediamatters.org/research/201204020012.
[14] See sources cited by Lashof, "Financial Analysts, Private Economists, and Government Forecasters All Agree: Market Realities, Not EPA, Driving New Power Plants Away from Coal," April 2012, http://switchboard.nrdc.org/blogs/dlashof/financial_analysts_private_eco.html.
[15] National Journal, Government Executive (Mar. 27, 2012), http://www.govexec.com/oversight/2012/03/first-major-climate-regs-obama-epa-sure-stir-political-debate/41580/
[16] National Journal, Need to Know: Energy (Feb. 2, 2012).

2030 even if natural gas becomes *4-5 times more costly than it is today and power demand increases faster than expected.*[17]

The proposed new source standard reinforces what most power company executives and investors already understand – that carbon pollution and climate change are serious concerns, and that if and when underlying market economics support a comeback for new coal-fired power plants, they will need to be designed with CCS.

The nation's utilities also have huge money-saving opportunities to shift investments to energy efficiency, which is cheaper than power from either coal or gas-fired plants. By doing so they will create hundreds of thousands of jobs, since it takes a lot more people to upgrade homes, offices, and factories with better insulation and lighting, high performance heating and cooling systems, and more efficient appliances and equipment. Between 2007 and 2011, energy efficiency budgets of American electric utilities and non-utility program administrators more than doubled, from $2.7 billion to $6.8 billion, but they have only scratched the surface of the cost-effective efficiency resource that is available to us.[18] According to McKinsey & Co., we could save $1.2 trillion on our national energy bill while creating almost 1 million jobs if we captured all of this resource.[19]

NRDC supports provisions EPA has proposed to facilitate construction of coal-fired plants equipped with CCS. NRDC agrees that CCS-equipped plants are technically feasible today and can be built – and are being built today[20] – even under current market conditions with subsidies provided under

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[17] EPA Regulatory Impact Analysis for the Proposed Standards of Performance for Greenhouse Gas Emissions for New Stationary Sources: Electric Utility Generating Units, Chapter 5 (March 2012), http://epa.gov/carbonpollutionstandard/pdfs/20120327proposalRIA.pdf.

[18] Consortium for Energy Efficiency, "Energy Efficiency Picture Emerges," http://www.cee1.org/ee-pe/2011AIR.php3.

[19] McKinsey & Co. , "Electric Power and Natural Gas, Unlocking Energy Efficiency in the U.S. Economy," 6 and 118, McKinseyGlobal Energy and Materials, July 2009, http://www.mckinsey.com/client_service/electric_power_and_natural_gas/latest_thinking/unlocking_energy_efficiency_in_the_us_economy.

[20] For example, Mississippi Power Company's Kemper County Plant Ratcliffe is now under construction and will capture and sequester 65 percent of its carbon dioxide emissions.

federal law. Further, NRDC agrees with EPA's assessment that further experience with CCS can bring costs down. I will also note that NRDC has long supported well-designed legislative measures to accelerate the deployment of CCS, including tens of billions of dollars of support that would have been provided to power companies for adopting CCS under the climate and energy legislation considered in the last Congress.

Going forward, EPA also needs to issue standards and guidelines under Section 111(d) of the Clean Air Act to start the joint Federal-state process of cutting the 2.3 billion tons of dangerous carbon pollution from the existing fleet of power plants. Another false claim you will hear is doing so will wipe out existing coal plants by requiring them to meet the same standard that EPA has proposed for new plants. But this is not what the Act requires. The criteria and procedures under Sections 111(b) and 111(d) are different, and under the statute EPA and the states share the job of setting performance standards for existing sources. EPA and the states have a legal obligation to set standards that are achievable and affordable. Within that legal framework, NRDC believes significant, cost-effective reductions in the heat-trapping CO_2 from existing power plants can and must be made, and EPA must begin that process forthwith.

H.R. 6172 Blocks Life-Saving Standards

While EPA is proceeding deliberately to set carbon pollution standards that follow the law and the science, H.R. 6172 would rewrite the Clean Air Act and indefinitely block action to clean up America's largest source of carbon pollution.

Section 1(a) of H.R. 6172 would rewrite the Clean Air Act to block EPA from setting any standards for power plant carbon pollution until one specific technology – carbon capture and storage (CCS) – is deemed "technologically and economically feasible" for fossil fuel-fired power plants by a panel of four federal officials outside of EPA. H.R. 6172 puts authority over power plant standards in the

hands of four non-EPA officials with no mandate to protect public health and the environment. This is an unprecedented and dangerous change to the Clean Air Act.

Make no mistake; H.R. 6172 would do nothing to advance CCS. Instead, it blocks other solutions. This new legal hurdle would have just one effect: To prevent EPA from doing its job of protecting the public from dangerous power plant pollution. No other polluter and no other pollutant are shielded by such a special roadblock under the Clean Air Act. For more than 40 years EPA has set pollution standards for scores of industrial categories based on emissions performance, not on a particular technology. Instead of command-and-control requirements to use a specific technology, each company is free to choose the cheapest way to meet that standard.

H.R. 6172 would turn that approach on its head. We would never have held clean car and fuel efficiency standards hostage to one technology, like electric cars. It makes no more sense for power plants and CCS.

In fact, the panel established by H.R. 6172 may never be able to make the finding that CCS is "economically feasible" because the marketplace is already providing cleaner and more competitive alternatives. New coal-fired plants aren't competitive today even without CCS, because our needs for new power are being met more cheaply by low-cost natural gas, improved wind turbines, and inexpensive energy efficiency. So even though there are proven ways to cut power plant carbon emissions, EPA will be permanently blocked from setting any standards at all.

Americans want electricity that is both cleaner and affordable. Fortunately, they are starting to get both now from a revolution in the electricity industry driven by competition in the marketplace and technology-neutral clean air performance standards. Americans are getting power that is both cleaner and cheaper from a range of resources that are out-competing more expensive and dirtier alternatives.

Americans want EPA to continue to set and enforce life-saving standards. More than three million citizens across this country – more than triple the previous record number in the EPA's history –

have raised their voices in comments to support action under the Clean Air Act to curb the dangerous carbon pollution from our fleet of power plants.

This record outpouring should come as no surprise, since public polling consistently shows the American people supports the Environmental Protection Agency's doing its job, under the laws that Congress enacted, to protect their health and their future. For example, after hearing the most common arguments for and against, 60 percent of the American people support EPA's setting standards for carbon dioxide pollution, according to the most recent bipartisan poll conducted for the American Lung Association.[21]

Conclusion

Congress should stick with Clean Air Act performance-based standards and let the market work. Performance standards and markets drive innovation and save money for consumers. It worked for acid rain, it's working for clean cars, and it will work for carbon pollution.

Scientists and the public agree overwhelmingly that it is time to start protecting our families and the planet from the clear harm carbon pollution is causing. We owe it to our children to act now. Denial won't change the facts about carbon. It won't keep rising seas from eroding coastal property, just like it won't stop the wind from carrying pollution from one state to the next, mercury from being a brain poison, or soot from lodging in our lungs. Cleaning up pollution shouldn't be about politics. It's about fulfilling the promise to our families and our children that we will protect their health and their future from dangerous air pollution.

[21] http://www.prnewswire.com/news-releases/american-lung-association-bipartisan-poll-shows-strong-public-support-for-lifesaving-clean-air-act-116319864.html.

Mr. WHITFIELD. Thank you.

Dr. Christy, you are recognized for 5 minutes.

STATEMENT OF JOHN R. CHRISTY

Mr. CHRISTY. Thank you, Chairman Whitfield and Ranking Member Rush and members of the committee. I am John Christy, Alabama State Climatologist, Professor of Atmospheric Science, and Director of the Earth Systems Science Center at the University of Alabama at Huntsville. I am a climate scientist who builds data sets from scratch to answer questions about climate variability and to test assertions people make about climate change. That is really what the scientific method is all about.

During the heat wave of late June and early July, high temperature extremes became newsworthy. Claims were made that thousands of records were being broken and that this is what global warming looks like. However, these headlines were not based on climate science. As shown in figure 1.3 of my testimony, it is scientifically more accurate to say this is what Mother Nature looks like since heat waves even worse than these happened before greenhouse gases were increasing like they are today.

Now, it gives some people great comfort to offer a quick and easy answer when the weather strays from the average rather than struggle with the real truth, which is, we don't know enough about the climate to even predict these kinds of heat waves as Nature magazine itself reported yesterday.

More evidence is available now to suggest that the climate is not as sensitive to extra greenhouse gases as previously thought. A simple comparison between climate model output and observation makes this point. In figure 2.1 of my written text, I plotted 38 of the very latest climate model simulations. The models tend to overreact to carbon dioxide by warming the earth much more than what has actually happened. This has bearing on the recent 33-year record low of arctic sea ice coverage that you saw previously. Model projections warmed by CO_2 show somewhat more warming than in that region in the observations but not too much in figure 2.2.

It is tempting to believe that the models are correct and the CO_2 warming is the main cause of melting the ice. However, when compared with the area of sea ice around Antarctica, where as shown in figure 2.3 the temperature is not increasing and the sea ice is not decreasing. The models fail the test. The CO_2 warming in climate models doesn't explain what we see. I cite research in my testimony which again points to natural variability as the main cause.

I encourage you to propose legislation based upon what observations show rather than speculative climate models. Basing legislation on observations means addressing the large year-to-year variations like droughts and floods, which will always occur and which will continue to cause economic distress. When it comes to legislation and regulatory actions, there really is nothing that will definitively alter whatever the climate is going to do. However, I suspect there will be some discernible negative economic consequences if energy costs are made to rise.

As more CO_2 is released back into the atmosphere, there are benefits that are often overlooked. Most notable of these is the

invigoration of plant life on which we and the rest of the animal world depend for food. Atmospheric CO_2 fundamentally is plant food and therefore our food. In my opinion, higher food production is a benefit to society and should be factored in any cost-benefit analysis.

Now, with all due respect to former President Bush, in my opinion, he was not accurate to say in 2006 that we are addicted to oil. Oil and other carbon-based energies are simply the affordable means by which we satisfy our true addictions, and those are long life, good health, plentiful food, Internet services, freedom of mobility, comfortable homes with heating, cooling, lighting and even colossal entertainment systems. Carbon energy has made all those possible.

Today, carbon energy provides about 87 percent of the world's energy demand so rising CO_2 emissions can be an indicator that a nation is providing energy for its people, energy which allows them to live longer, healthier and more prosperous lives.

But, and I will close with this unpleasant thought, demanding a reduction in worldwide carbon emissions and without affordable and reliable energy alternatives means reducing the opportunities for many of our fellow world citizens to escape their impoverished conditions.

I thank you for your time and I will be happy to answer questions.

[The prepared statement of Mr. Christy follows:]

John R. Christy, PhD
Alabama State Climatologist
The University of Alabama in Huntsville
House Energy and Power Subcommittee
20 September 2012
One Page Summary

1. Extreme events, like the recent U.S. drought, will continue to occur, with or without human causation. These recent U.S. "extremes" were exceeded in previous decades.

2. The average warming rate of 38 CMIP5 IPCC models is greater than observations, suggesting models over-react to CO2. Policy based on observations will likely be far more effective than if based on speculative models, no matter what the future climate does. Regarding Arctic sea ice loss, the average model response to CO2 engenders little confidence because the models' output fails when applied to Antarctic sea ice conditions.

3. New discoveries explain part of the warming found in popular surface temperature datasets which is unrelated to the accumulation of heat due to the extra greenhouse gases, but related to human development around the stations. This means popular surface datasets are limited as proxies for greenhouse warming.

4. Widely publicized consensus reports by "thousands" of scientists rarely represent the range of scientific opinion that attends our murky field of climate research. Funding resources are recommended for "Red Teams" of credentialed investigators, who study low climate sensitivity and the role of natural variability. Policymakers need to be aware of the full range of scientific views, especially when it appears that one-sided-science is the basis for policies which, for example, lead to increased energy costs for citizens.

5. Atmospheric CO2 is food for plants which means it is food for people and animals. More CO2 generally means more food for all. Today, affordable carbon-based energy is a key component for lifting people out of crippling poverty. So, rising CO2 emissions are one indication of poverty-reduction which gives hope for those now living in a marginal existence without basic needs brought by electrification, transportation and industry. Additionally, modern, carbon-based energy reduces the need for deforestation and alleviates other environmental problems such as water and deadly indoor-air pollution. Until affordable and reliable energy is developed from non-carbon sources, the world will continue to use carbon as the main energy source.

Written Statement of John R. Christy
The University of Alabama in Huntsville
Subcommittee Energy and Power, U.S. House of Representatives
20 Sep 2012

I am John R. Christy, Professor of Atmospheric Science, Alabama's State Climatologist and Director of the Earth System Science Center at The University of Alabama in Huntsville. I have served as a Lead Author and Contributing Author of IPCC assessments, have been awarded NASA's Medal for Exceptional Scientific Achievement, and in 2002 elected a Fellow of the American Meteorological Society.

It is a privilege for me to offer my views of climate change based on my experience as a climate scientist. My research area might be best described as building datasets from scratch to advance our understanding of what the climate is doing and why. I have used traditional surface observations as well as measurements from balloons and satellites to document the climate story. Many of my datasets are used to test hypotheses of climate variability and change. In the following I will address five issues that are part of the discussion of climate change today, some of which will be assisted by the datasets I have built and published.

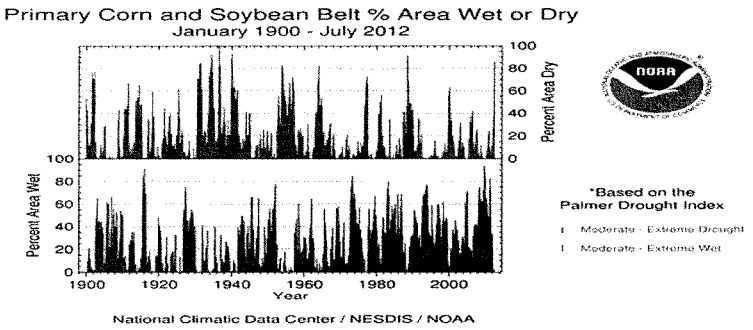
1. EXTREME EVENTS

Recently it has become popular to try and attribute certain extreme events to human causation. The Earth however, is very large, the weather is very dynamic, especially at local scales, so that extreme events of one type or another will occur somewhere on the planet in every year. Since there are innumerable ways to define an extreme event (i.e. record high/low temperatures, number of days of a certain quantity, precipitation total over 1, 2, 10 … days, snowfall amounts, etc.) this essentially assures us

that there will be numerous "extreme events" in every year because every year has unique weather patterns. The following assesses some of the recent "extreme events" and demonstrates why they are poor proxies for making claims about human causation.

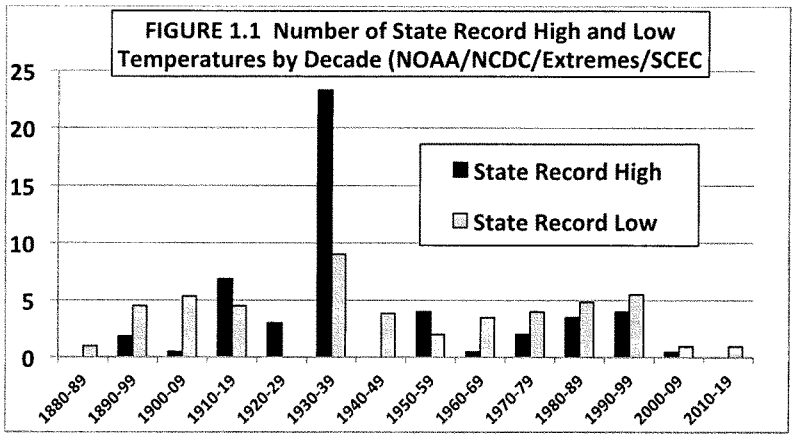
Midwestern Drought

To put it simply, Andreadis and Lettenmaier (2006) found that for the Midwest, "Droughts have, for the most part, become shorter, less frequent, less severe, and cover a smaller portion of the country over the last century." In other words, droughts have always happened in the Midwest and they are not getting worse (more on Midwest heat waves below and on Midwest drought in Section 2). The figure below indicates no long-term changes in drought in the primary corn and soybean belt.

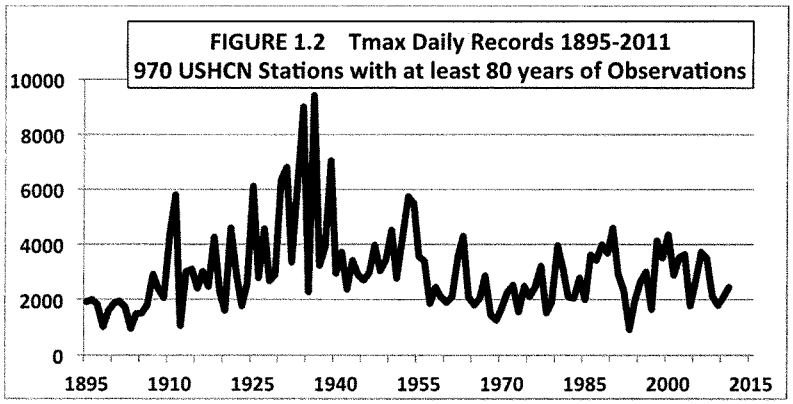


Extreme High and Low Temperatures

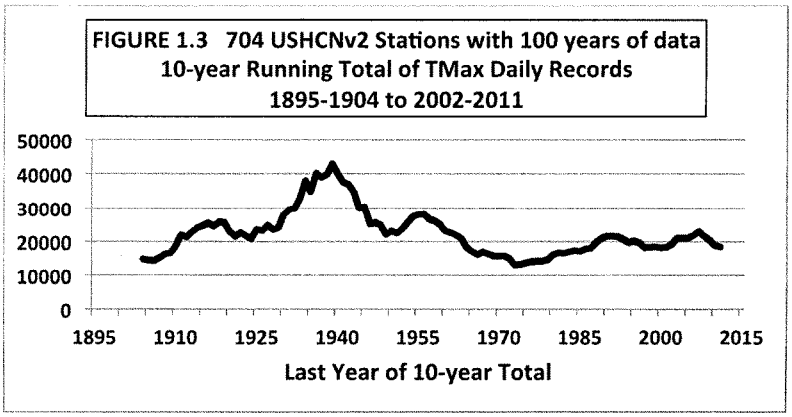
Another extreme metric is the all-time record high temperature for each state. The occurrence of the records by decade (Figure 1.1 below) makes it obvious that the 1930s were the most extreme decade and that since 1960, there have been more all-time cold records set than hot records in each decade.



However, there are only 50 states, and this is a number that isn't large enough to give the best statistical results. Below in Fig. 1.2 are the year-by-year numbers of *daily* all-time record high temperatures that stood as of 2011 from a set of 970 weather stations with at least 80 years of record (NOAA/NCDC/USHCNv2). There are 365 opportunities in each year (366 in leap years) for each of the 970 stations to set a record high (TMax). The clear evidence is that extreme high temperatures are not increasing in frequency. The recent claims about thousands of new record high temperatures were based on stations whose length-of-record could begin as recently as 1981, thus missing the many heat waves of the 20th century. So, any moderately hot day now will be publicized as setting records for these young stations because they were not operating in the 1930s. The figure below gives what a climatologist would want to know because it uses only stations with long records.

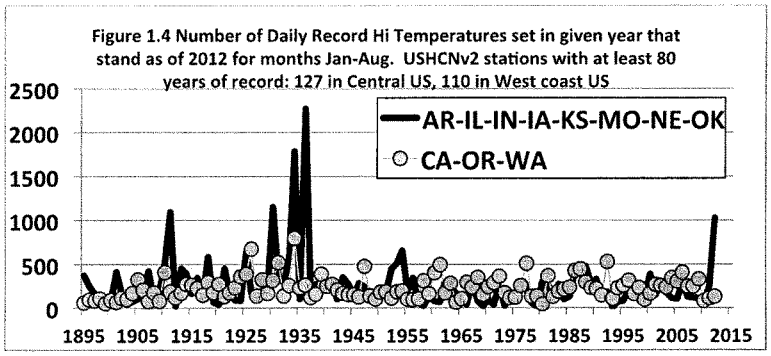


A more meaningful result comes if we take the total record highs by ten-year totals, i.e. 1895-1904, 1896-1905, … 2002-2011. In Figure 1.3 below are the record daily highs for 704 stations with at least 100 years of data. Note that the value for the most recent decade is less than half of what was observed in the 1930s.

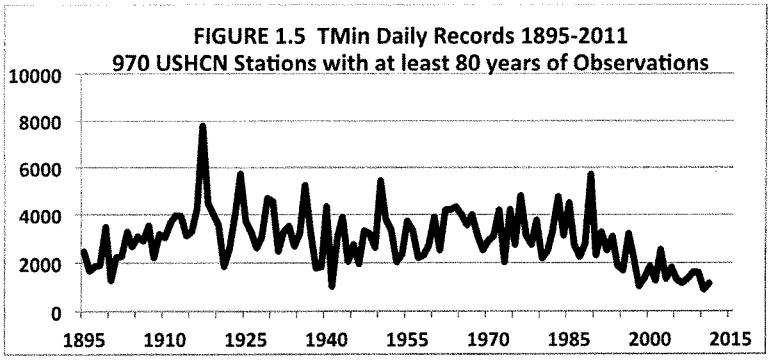


Regarding the heat wave of 2012, I calculated the number of record high temperatures that stand as of 2012 (Fig. 1.4) for stations in the 8 hardest-hit central states

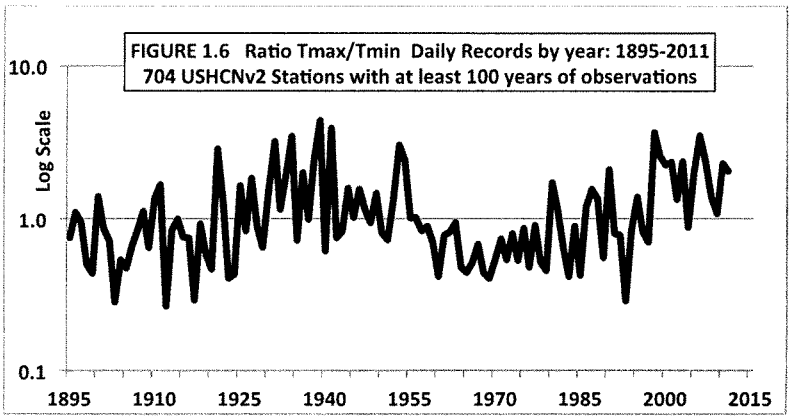
(AR-IL-IN-IA-KS-MO-NE-OK) and stations on the West Coast (CA-OR-WA). Notice that the Central-US and West Coast both felt the heat waves of the 1930s when the highest number of events occurred for both regions. However, the current 2012 event shows high numbers in the Central-US, but a dearth of record highs along the West Coast, indicating the heat wave is smaller and less severe than previous events.



Record cold temperatures are shown in Fig. 1.5 (TMin). Through the 1980s there was an even distribution with a fairly noticeable drop-off in record lows over the past 25 years. The cause for this drop-off is discussed in Section 3 of this testimony.



An interesting result is produced by taking the ratio year-by-year of the number of TMax daily records divided by the number of TMin daily records (Figure 1.6 below). The two large periods of more record highs than lows are in the 1930s and the last 15 years. The first high-ratio period in the 1930s was due to numerous TMax records while the more recent period was due to fewer TMin records. This decline in the record low temperatures (TMin) in the past 25 years is likely related to the general disturbance by human development around the thermometer stations (again, discussed in Section 3). Meehl et al., 2009 did a similar analysis, but started later, in 1950. This led to the claim of a rapidly rising ratio of record highs to record lows. Had the authors gone back only two more decades to look at a more complete climate record, and had taken into account the contamination of TMin values, the claim of rapidly increasing ratios would not hold.



Texas Drought of 2011

A recent claim that the 2011 drought in Texas was 20 times more likely due to extra greenhouse gases was based on statistics from a modeling exercise

(http://www.noaanews.noaa.gov/stories2012/20120710_stateoftheclimatereport.html.) However, the model overstated the warming rate of Texas, so that it's statistics wouldn't apply correctly to the real world. In fact, the authors actually made that point in their study saying the result gave very limited information about real world impacts, and that the impact of greenhouse gases was unknown. See http://blog.chron.com/climateabyss/2012/07/twenty-times-more-likely-not-the-science/ for more explanation.

Colorado Fires

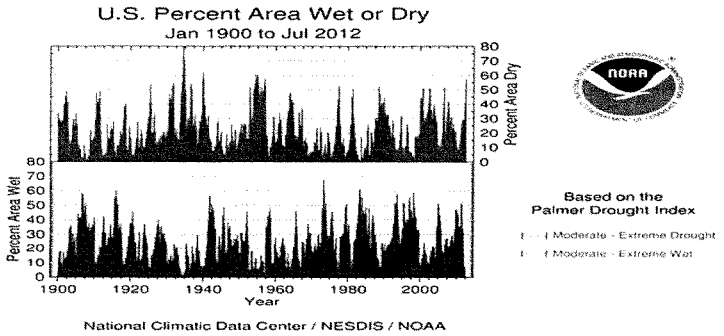
Colorado was in the news earlier this year due to a number of serious wildfires. These fires are usually caused by humans and problematic to study from a climate standpoint because of this and the fire suppression activities that have been around since 1900 or so. Whereas there were many low-intensity fires before settlement, now there tend to be fewer but more intense fires due to the buildup of fuel. In any case, droughts are related to weather patterns that become stationary, so it is useful to ask the question: have weather patterns shown a tendency to become more stationary, thus creating the opportunity for long dry/hot or wet/cool spells

A project which seeks to generate consistent and systematic weather maps back to 1871 (20th Century Reanalyisis Project, http://www.esrl.noaa.gov/psd/data/20thC_Rean/) has taken a look at the three major weather patterns which are often related to extreme events. As Dr. Gill Campo of the University of Colorado, leader of the study, noted to the *Wall Street Journal* (10 Feb 2011) "... we were surprised that none of the three major indices of climate variability that we used show a trend of increased circulation going

back to 1871" (Compo et al. 2011.) In other words, there appears to be no supporting evidence that human factors have influenced the circulation patterns which drive the larger-scale extreme events. Again we point to natural, unforced variability (i.e. Mother Nature) as the dominant feature of events that have transpired in the past 130 years.

U.S. Drought

Though the conterminous U.S. covers only 1.8% of the globe (6% of land area), we have good records for many weather variables. Below is the month-by-month percentage of the area that is classified as moderate to extreme for dryness and wetness from NOAA. As can be seen below there is a tremendous amount of variability (near zero to near 80 percent), but no long-term trend.

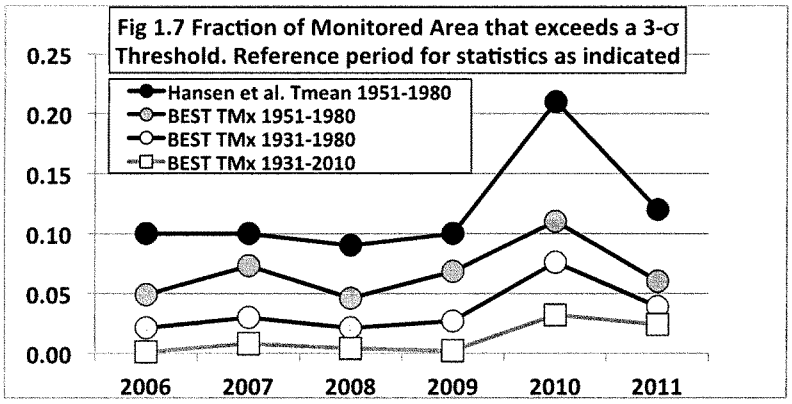


Claims of increasing extremes

NASA's James Hansen recently claimed that the Earth is experiencing extreme hot temperature conditions whose geographical extent is far in excess of what would be expected from natural variations (Hansen et al. 2012 and a *Washington Post* OpEd:

http://www.washingtonpost.com/opinions/climate-change-is-here--and-worse-than-we-thought/2012/08/03/6ae604c2-dd90-11e1-8e43-4a3c4375504a_story.html.) In a given year, the area covered by such extremes (known as 3-sigma or 3-σ) would be less than 1 percent, and under a gradual warming trend, such as we have seen since the cold 19th century, the area should not exceed the lower single-digit percentages. However, Hansen found that the average area experiencing these high extremes in the Northern Hemisphere summer was very large since 2006. This area, which averaged 12%, for 2006-11 is shown in the solid circles (top line) of Fig. 1.7 below as calculated by Hansen et al.

To arrive at such a large area, Hansen relied on daily mean temperatures which, as shown above and below, are contaminated by nighttime warming, giving a false climate-warming signal. I have recalculated this areal coverage using only daytime high temperatures from the Berkeley Earth Surface Temperature project (BEST, Muller et al. 2012.) When this climate-relevant metric is used, the area of extreme hot events drops by almost half, averaging only 6.7% (gray circles in Fig. 1.7.) Then, Hansen et al. selected a very quite period, 1951-80, as the reference from which to calculate today's extremes. This was a period with few hot events, so any hot events now would look unduly extreme by comparison. By simply adding 20 years of earlier data, i.e. picking up the extreme heat events of the 1930s, today's extremes don't appear nearly as dramatic with an average area of only 3.6% (open circles in Fig. 1.7.) Finally, if one takes the 80-year period as the reference (1931-2010, open squares in Fig. 1.7), the areal extent averages only 1.2%, the amount expected for a slow warming trend. A complete write-up may be found at http://www.drroyspencer.com/2012/08/fun-with-summer-statistics-part-2-the-northern-hemisphere-land/.



Hansen then suggests that besides extreme high temperatures, loading of the "climate dice" from "human-made global warming" means "extreme drought conditions can develop." Hansen makes this claim while not explaining evidence such as the NOAA charts in this testimony that droughts have not increased at all in the U.S. Hansen et al.'s claim about increasing droughts were shown to be false when applied to the U.S. by Dr. Patrick Michaels in which actual observations were used to assess the relationship between global temperatures and the magnitude and extent of U.S. droughts. In an ironic twist, Michaels shows that if anything, global warming has led to fewer U.S. droughts. http://www.nationalreview.com/planet-gore/316541/obama-s-drought-facts-patrick-michaels. So, in summary, the expression of "worse than we thought" climate change as documented in Hansen's OpEd does not stand up to scrutiny.

Recent snowfall in the United States

Snowfall reached record levels in 2009-10 and 2010-11 in some eastern US locations and also in a few western locations in 2010-11. NOAA's Climate Scene

Investigators committee issued the following statement regarding this, indicating, again, that natural, unforced variability (again, Mother Nature) explains the events.

> *Specifically, they wanted to know if human-induced global warming could have caused the snowstorms due to the fact that a warmer atmosphere holds more water vapor. The CSI Team's analysis indicates that's not likely. They found no evidence — no human "fingerprints" — to implicate our involvement in the snowstorms. If global warming was the culprit, the team would have expected to find a gradual increase in heavy snowstorms in the mid-Atlantic region as temperatures rose during the past century. But historical analysis revealed no such increase in snowfall.*

I have looked closely at the snowfall records of the Sierra Nevada mountains of California from the earliest records gathered by the Southern Pacific Railroad beginning in 1878. Long-term trends in snowfall (and thus water resources) in this part of California are essentially zero, indicating no change in this valuable resource to the state (Christy and Hnilo, 2010, Christy 2012.)

From the broad perspective, where we consider all the extremes above, we should see a warning – that the climate system has always had within itself the capability of causing devastating events and these will certainly continue with or without human influence on the climate. Thus, societies should plan for infrastructure projects to withstand the worst that we already know has occurred, and to recognize, in such a dynamical system, that even worse events *should* be expected. In other words, the set of

the *measured* extreme events of the small climate history we have, since about 1880, does *not* represent the full range of extreme events that the climate system (i.e. Mother Nature) can actually generate. The most recent 130 years is simply our current era's small sample of the long history of climate. Records are made to be broken. For example, one would assume that about 10 percent of the record extremes that occur over a thousand-year period ending in 2100 should occur in the 21st century. Are we prepared to deal with events even worse than we've seen so far? Spending which is directed to creating resiliency to these sure-to-come extremes, particularly drought/flood extremes, seems rather prudent to me – since there are no human means to make them go away.

Looking at the longer record of climate patterns

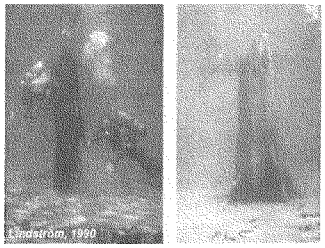
Climatologists realize that the period of time over which we have had instruments to measure the climate (~130 years) is very brief compared to the history of the current 10,000-year interglacial period. Taking a look at the larger picture shows the capability of Mother Nature to produce extreme situations.

Megadroughts of the past 1000+ years

There are several types of records from the flora and fauna of the past 1000 years that provide evidence that droughts of extreme duration (decades) occurred in our nation, primarily in the Great Plains westward to the Pacific Coast.

California

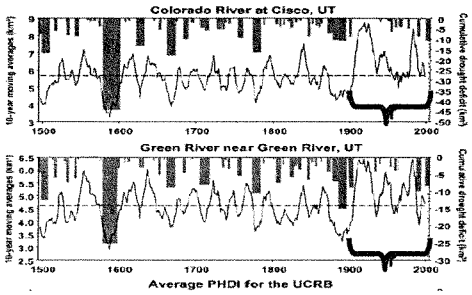
At right are photos from Lindstrom (1990) in which trees grew on dry ground around 900 years ago in what is now a Sierra Nevada alpine lake. This indicates



that a drastic but natural change to a much drier climate must have lasted for at least a century for trees to have grown to these sizes on dry ground.

Rocky Mountains

A 500-year history of moisture in the upper Colorado River basin (below) indicates the past century was quite moist while major multi-decadal droughts occurred in all four prior centuries (Piechota et al. 2004.) Indeed, the conclusion of Piechota et al. states that after examining the paleo-record, the present-day droughts "could be worse." These and other evidences point to the real probability that water supply in the West will see declines simply as a matter of the natural variability of climate.



Great Plains

In the Great Plains, the period from 3000 to 1500 years ago saw a drier and warmer climate during which a significant parabolic sand dune ecosystem developed, especially in western Nebraska and NE Colorado (Muhs 1985). In other words, the Great Plains resembled a desert. Many of these areas experienced dune "reactivation" during Medieval times (900-1300 AD). Then, the climate moistened and cooled beginning around 1300 AD to support the short-grass prairie seen today, though "reactivation" is possible at any time (Schmeisser, 2009). Indeed, Muhs and Holliday (1995) found that dune reactivation can occur within decadal time scales from extended drought by examining the Great Plains environment of only the past 150 years.

With the massive use of ground water for irrigation, the High Plains Aquifer has declined an average of 12.8 ft, with some areas in the Texas panhandle down over 150 ft. The key point here is that the Plains is subject to natural (and sobering) long-term droughts that would very likely tax the current water management system (ground-water withdrawals) while not replenishing the aquifer, producing a situation of reduced agricultural productivity, especially in its southern reaches.

Why extreme events are poor metrics for studying global changes

In the examples above, we don't see increases in extreme events (which is also true for tornadoes, hurricanes, floods, etc. - see my House testimony of 31 March 2011) but we must certainly be ready for more to come as part of nature's variability. I want to illustrate how one might use extreme events to conclude (improperly I believe) that the weather in the USA is becoming less extreme and/or colder.

Going back to Fig. 1.1 (the number of all-time state records) we see the following. About 75 percent of the states recorded their hottest temperature prior to 1955, and, over 50 percent of the states experienced their record cold temperatures after 1940. Overall, only a third of the records (hot or cold) have been set in the second half of the whole period. One could conclude, if they were so inclined, that the climate of the US is becoming less extreme because the occurrence of state extremes of hot and cold has diminished dramatically since 1955. Since 100 of anything appears to be a fairly large sample (2 values for each of 50 states), this on the surface seems a reasonable conclusion.

Then, one might look at the more recent record of extremes and learn that no state has achieved a record high temperature in the last 15 years (though one state has tied

theirs.) However, five states have observed their all-time record low temperature in these past 15 years plus one tie. This includes last year's record low of 31°F below zero in Oklahoma, breaking their previous record by a rather remarkable 4°F. If one were so inclined, one could conclude that the weather that people worry about (extreme cold) is getting worse in the US. (Note: this lowering of absolute cold temperature records is nowhere forecast in climate model projections, nor is a significant drop in the occurrence of extreme high temperature records.)

I am not using these statistics to prove the weather in the US is becoming less extreme and/or colder. My point is that extreme events are poor metrics to use for detecting climate change. Indeed, because of their rarity (by definition) using extreme events to bolster a claim about any type of climate change (warming or cooling) runs the risk of setting up the classic "non-falsifiable hypothesis." For example, we were told by the IPCC that "milder winter temperatures will decrease heavy snowstorms" (TAR WG2, 15.2.4.1.2.4). After the winters of 2009-10 and 2010-11, we are told the opposite by advocates of the IPCC position, "Climate Change Makes Major Snowstorms More Likely" (http://www.ucsusa.org/news/press_release/climate-change-makes-snowstorms-more-likely-0506.html).

The non-falsifiable hypotheses can be stated this way, "whatever happens is consistent with my hypothesis." In other words, there is no event that would "falsify" the hypothesis. As such, these assertions cannot be considered science or in anyway informative since the hypothesis' fundamental prediction is "anything may happen." In the example above if winters become milder or they become snowier, the non-falsifiable hypothesis stands. This is not science.

As noted above, there are innumerable types of events that can be defined as extreme events – so for the enterprising individual (unencumbered by the scientific method), weather statistics can supply an unlimited, target-rich environment in which to discover a "useful" extreme event. Thus, when the enterprising individual observes an unusual weather event, it may be tempting to define it as a once-for-all extreme metric to "prove" a point about climate change – even if the event was measured at a station with only 30 years of record. This works both ways with extremes. If one were prescient enough to have predicted in 1996 that over the next 15 years, five states would break all-time record cold temperatures while none would break record high temperatures as evidence for cooling, would that prove CO2 emissions have no impact on climate? No. Extreme events happen, and their causes are intricately tied to the semi-unstable dynamical situations that can occur out of an environment of natural, unforced variability.

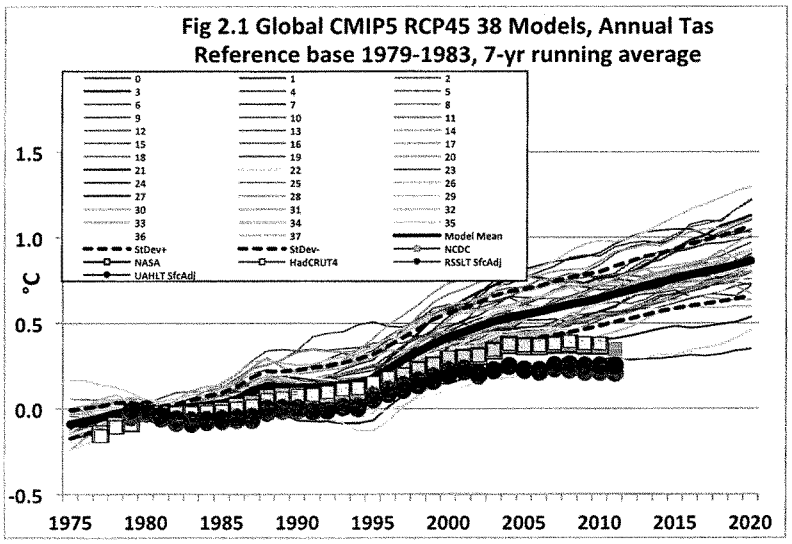
Science checks hypotheses (assertions) by testing specific, falsifiable predictions implied by those hypotheses. The predictions are to be made in a manner that, as much as possible, is blind to the data against which they are evaluated. It is the testable predictions from hypotheses, derived from climate model output, that run into trouble as shown in Section 2. Before going on to that test, the main point here is that extreme events do not lend themselves as being rigorous metrics for *convicting* human CO2 emissions of being guilty of causing them.

2. RECENT CLIMATE MODEL SIMULATIONS

One of the key questions policymakers ask is what will happen with the Earth's weather in the decades to come. More importantly, they want to know how things might

change specifically for their constituents. One pathway to seek answers is to examine the output of climate models that attempt to predict likely outcomes. If one has confidence in the model projections that terrible weather is on the horizon, then it is tempting to devise policy that the same models say would indicate would somehow mitigate that problem.

In Figure 2.1 below, I display the results from 38 of the latest climate model simulations of global temperature that will be used in the upcoming IPCC AR5 assessment on climate change (KNMI Climate Explorer). All of the data are given a reference of 1979-1983, i.e. the same starting line. Along with these individual model runs I show their average (thick black line) and the results from observations (symbols). The two satellite-based results (circles, UAH and RSS) have been proportionally adjusted so they represent surface variations for an apples-to-apples comparison. The evidence indicates the models on average are over-warming the planet by quite a bit, implying there should be little confidence that the models can answer the question asked by policymakers. Basing policy on the circles (i.e. real data) seems more prudent than basing policy on the thick line of model output. Policies based on the circles would include adaptation to extreme events that will happen because they've happened before (noted above and below) and since the underlying trend is relatively small.



Arctic Sea Ice Loss

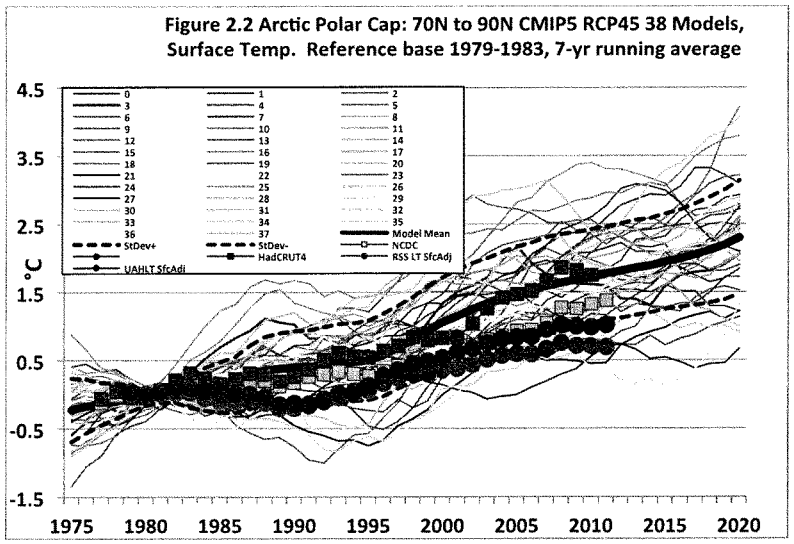
At present, the sea ice extent in the Arctic is at the lowest areal coverage since satellites began monitoring the extent over 30 years ago. In an area with extremely large natural variations, the question is: How much of the loss might be due to extra greenhouse gas warming relative to other causes? We know that there has been warming in the Arctic since the 1960s from all data sets. To explain this observation, Wallace et al. 2012 examined the different patterns of atmospheric circulation that can contribute to a warmer Arctic versus what might be expected from the extra warming due to the additional greenhouse gases being added to the atmosphere. They report:

These results support the notion that the enhanced wintertime warming over high northern latitudes from 1965 to 2000 was mainly a reflection

of unforced variability of the coupled climate system. Some of the simulations exhibit an enhancement of the warming along the Arctic coast, suggestive of exaggerated feedbacks.

In other words, natural variations of the circulation patterns that create warmer Arctic temperatures explain most of the warming that is detected according to this study (see also Liu and Curry 2004 and Curry's analysis using the notion of "climate shifts" in which combinations of natural modes of variability can lead to large changes in ice coverage: http://judithcurry.com/2011/03/19/pondering-the-arctic-ocean-part-i-climate-dynamics/). However, there is another non-greenhouse factor that may contribute to Arctic sea ice loss too. When particles from incomplete combustion of carbon fuels, i.e. black carbon aerosols, are transported to the Arctic they can settle on the ice, making the ice darker and more absorbent (less reflective) of the sun's energy (Jacobson 2006, Hansen et al. 2007.) This extra energy absorbed by the ice speeds up the melting process. It has been suggested that reducing black carbon aerosols may be the quickest way to slow the Arctic sea ice loss.

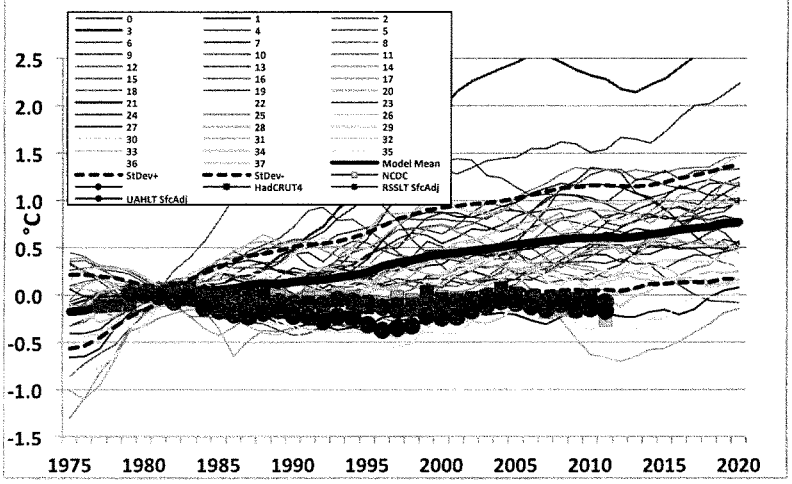
The question remains as to the contribution of the extra greenhouse gases to warming of the Arctic and the associated sea ice reduction. In Fig. 2.2 below is the Arctic surface temperature simulated by the same 38 models now being studied for the next IPCC report compared with four observational datasets.



The main cause for the upward trend in Figs. 2.1 and 2.2 is the way models react to added greenhouse gases. In Fig. 2.1 (global) the evidence indicates models are over-reacting, leading to more warming than is being observed. In the Arctic, the model average matches one of the data sets (HadCRUT4) while still being much warmer than the satellite datasets. Is this evidence that the Arctic warming is due to greenhouse gases? As a check, we can do the same analysis but for the southern hemisphere sea ice area shown in Fig. 2.3. Now we see what was generally demonstrated in Fig. 2.1, that the model average depicts a rising temperature trend in this sea ice band which is much greater than seen in observations. Indeed, all observational datasets portray a slight downward trend in temperature which is consistent with an increase in the extent of the sea ice there (near record coverage as we speak). Recently, Zwally et al. 2012, also find that the balance of ice on the continent of Antarctica has been positive, i.e. gains are

larger than losses. This is in contrast to many recent reports that the balance is negative, i.e. that Antarctica is losing ice. What is probably most important here is that the changes in Antarctica are so small relative to its size that determining whether there is gain or loss is not quite within our ability to measure precisely.

Figure 2.3 Antarctic Sea Ice Band: 75S-60S CMIP5 RCP45 38 Models, Surface Temperature. Reference base 1979-1983, 7-yr averages



The conclusion drawn from Figs. 2.1-2.3 is that the closer agreement of Arctic model temperatures and observations is likely so for the wrong reasons. In other words, the extra greenhouse gases induce strongly rising temperatures in the models for all these regions while observations show only one actually comes somewhat close to that result (Arctic.) This relates to the general failings of CMIP5 models to depict the way actual climate patterns vary over time (see also Driscoll et al. 2012 for a study on how none of the CMIP5 models they examined reproduced the large-scale features of the climate response to volcanoes.) Thus, the main reasons for the loss of Arctic sea ice seem to be

its large natural variability and perhaps the darkening of the ice due to black carbon. The greenhouse explanation doesn't hold up when examined for other regions.

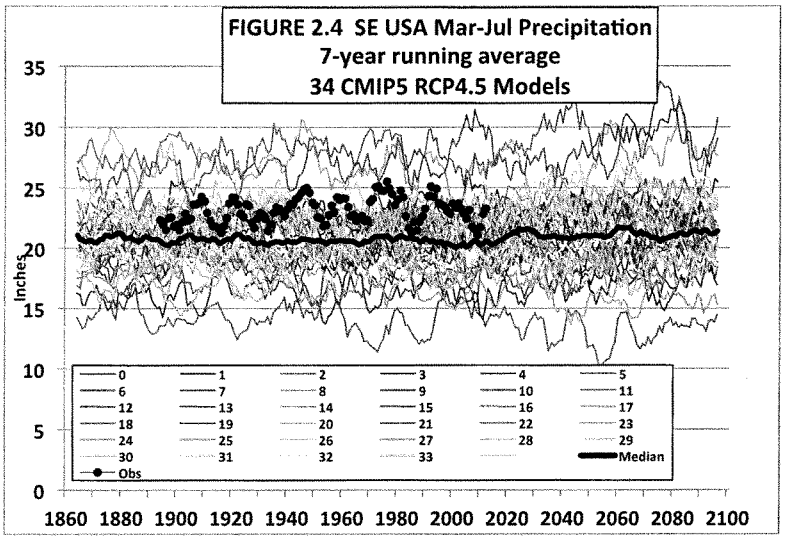
I often describe climate science as a murky science, and no where is this more true than in the field of paleoclimate where efforts are made to reconstruct the long-term climate history from evidence such as tree rings, sediments, ice cores, etc. Results are often contradictory, as in, for example, the magnitude of the medieval warm period.

As to sea ice extent, Kinnard et al. 2011 reconstructed the last 1450 years using several types of proxy data, including ice cores and tree-rings, showing the largest extent around the year 1430 and the second largest extent around 1920. At the very end of the time series, Kinnard et al. 2011 show a dramatic drop (as in an inverted hockey stick) with the most recent values below any of the early warm periods of the last 1450 years. However, there seems to be confusion with the tree-ring data and an examination of the long oxygen proxy component of this time series suggests only a long-term increase in sea ice (http://climateaudit.org/2011/12/03/kinnard-and-the-darrigo-wilson-chronologies/ and http://climateaudit.org/2011/12/05/kinnard-arctic-o18-series/). Indeed Esper et al. 2012 separately found that many previous tree-ring-based proxy studies underestimated the impact of solar forcing in the high latitudes. They produced a 2000+ year record showing a decline in high-latitude temperature since the Roman times. Esper et al. suggest that previous studies "may underestimate the pre-instrumental temperatures including the warmth during Medieval and Roman times." Antoniades et al. 2011 also report warmer Arctic temperatures 1400 to 800 years ago and before 3000 years ago based on paleo conditions of the largest Arctic ice shelf on Ellesmere Island. This implies

that consistently warmer temperatures than we experience today occurred in the Arctic within the relatively short history of Western civilization.

Southeastern Growing Season Rainfall

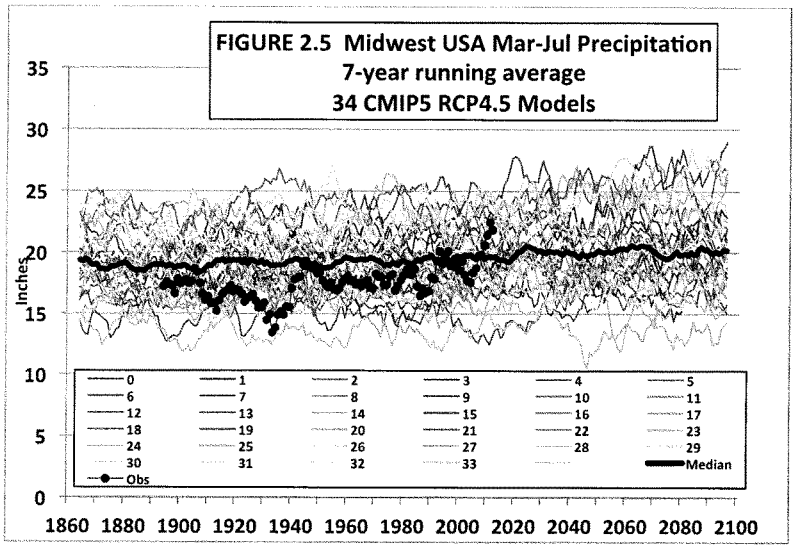
A more relevant question for those of us in the Southeast or Midwest is what might happen to our growing season rainfall – a key variable for our economies. Figure 2.4 below shows what 34 models depict for March to July rainfall (7-year running averages) with the circles being the observations. It's apparent first of all that the models are generally too dry. Secondly, there really is no information for policy here. The trend in the average of the models is so close to zero as to be uninformative (+0.8 inches/century for 1980 - 2100) with results varying from 3.7 inches/century wetter to 1.6 inches/century drier. Neither one of these rates is important because the year-to-year variations in rainfall from observations show a range from 14.9 to 30.7 inches. It is apparent that for a critical quantity such as precipitation, one cannot have confidence in model projections, nor in their attempts to demonstrate what might happen with control strategies for carbon dioxide. Again, an examination of the historical record of rainfall (circles) gives considerable information on what might be expected in terms of the variability, and thus a pathway to plan to accommodate the droughts and floods that are sure to come since they've happened in the past.



Central U.S. Growing Season Precipitation

A similar exercise was done for the Midwest region in Figure 2.5 below (100W-85W, 37.5N-45N), since crop losses in 2012 are in the news. The character of the actual precipitation shows a clear rise in total amount through the years. However, the same comments regarding the model results for the Southeast apply for the Midwest too as the models indicate an average trend (1980-2100) of a tiny +0.9 inches/century but which really comes down to a shift around 2020 with steady values thereon. The natural range for this region from history varies wildly from 8.7 to 26.7 inches from one growing season to the next. Once again, policies which deal with the large year-to-year variations which cause the most problems for the economy would address a real threat that will continue to occur regardless of the human effects on climate change. The model output

provides no information for substantive policy (see also Stephens et al. 2010 whose title is self explanatory, "The dreary state of precipitation in global models.")



3. NEW STUDIES ON SURFACE TEMPERATURE PROCESSES

In general, the issue of global warming is dominated by considering the near-surface air temperature (Tsfc) as if it were a standard by which one might measure the climate impact of the extra warming due to increases in greenhouse gases. Fundamentally, the proper variable to measure is heat content, or the amount of heat energy (measured in joules) in the climate system. Thus the basic measurement for detecting greenhouse warming is how many more joules of energy are accumulating in the climate system over that which would have occurred naturally. This is a truly "wicked" problem (see House Testimony, Dr. Judith Curry, 17 Nov 2010) because we do not know how much accumulation can occur naturally.

Unfortunately, discussions about global warming focus on Tsfc even though it is affected by many more processes than greenhouse gas increases. This means that using Tsfc, as a proxy for heat content (the real greenhouse variable) can lead to an overstatement of greenhouse warming if the two are assumed to be too closely related.

A new paper by my UAHuntsville colleague Dr. Richard McNider (McNider et al. 2012) looked at reasons for the fact daytime high temperatures (TMax) are really not warming much while nighttime low temperatures (TMin) show significant warming. This has been known for some time and found in several locations around the world (e.g. California - Christy et al. 2006, East Africa – Christy et al. 2009). Without going into much detail, the bottom line is that as humans disturb the surface (cities, farming, deforestation, etc.) this disrupts the normal formation of the shallow, surface layer of cooler air during the night when TMin is measured. In a complicated process, due to these local changes, there is greater mixing of the naturally warmer air above down to the shallow nighttime cool layer. This makes TMin warmer, giving the appearance of warmer nights over time. The subtle consequence of this phenomenon is that TMin temperatures will show warming, but this warming is caused by a turbulent process which redistributes heat near the surface not to the accumulation of heat related to greenhouse warming of the deep atmosphere. The importance of this is that many of the positive feedbacks that amplify the CO2 effect in climate models depend on warming of the deep atmosphere not the shallow nighttime layer.

During the day, the sun heats up the surface, and so air is mixed through a deep layer. Thus, the daily high temperature (TMax) is a better proxy of the heat content of the deep atmosphere since that air is being mixed more thoroughly down to where the

thermometer station is. The relative lack of warming in TMax indicates that the rate of warming due to the greenhouse effect is smaller than models project (Section 2).

The problem with the popular surface temperature datasets is they use the average of the daytime high and nighttime low (i.e. (TMax+TMin)/2). But if TMin is not representative of the greenhouse effect, then the use of TMin with TMax will be a misleading indicator of the greenhouse effect. TMax should be viewed as a more reliable proxy for the heat content of the atmosphere and thus a better indicator of the enhanced greenhouse effect. This exposes a double problem with models. First of all, they overwarm their surface compared with the popular surface datasets (the squares in Fig. 2.1). Secondly, the popular surface datasets are likely warming too much to begin with. This is why I include the global satellite datasets of temperature which are not affected by these surface problems and more directly represent the heat content of the atmosphere (see Christy et al. 2010, Klotzbach et al. 2010).

4. CONSENSUS SCIENCE

The term "consensus science" will often be appealed to regarding arguments about climate change to bolster an assertion. This is a form of "argument from authority." Consensus, however, is a political notion, not a scientific notion. As I testified to the Inter-Academy Council in June 2010, wrote in *Nature* that same year (Christy 2010), and documented in my written House Testimony last year (House Space, Science and Technology, 31 Mar 2011) the IPCC and other similar Assessments do not represent for me a consensus of much more than the consensus of those selected to agree with a particular consensus. The content of these climate reports is actually under the

control of a relatively small number of individuals - I often refer to them as the "climate establishment" – who through the years, in my opinion, came to act as *gatekeepers* of scientific opinion and information, rather than *brokers*. The voices of those of us who object to various statements and emphases in these assessments are by-in-large dismissed rather than accommodated. This establishment includes the same individuals who become the "experts" called on to promote IPCC claims in government reports such as the endangerment finding by the Environmental Protection Agency. As outlined in my House Testimony, these "experts" become the authors and evaluators of their own research relative to research which challenges their work. But with the luxury of having the "last word" as "expert" authors of the reports, alternative views vanish.

I've often stated that climate science is a "murky" science. We do not have laboratory methods of testing our hypotheses as many other sciences do. As a result what passes for science includes, opinion, arguments-from-authority, dramatic press releases, and fuzzy notions of consensus generated by preselected groups. This is not science.

I noticed the House passed an amendment last year to de-fund the U.N.'s Intergovernmental Panel on Climate Change (IPCC.) We know from Climategate emails and many other sources that the IPCC has had problems with those who take different positions on climate change than what the IPCC promotes. There is another way to deal with this however. Since the IPCC activity *is* funded by US taxpayers, then I propose that five to ten percent of the funds be allocated to a group of well-credentialed scientists to produce an assessment that expresses legitimate, alternative hypotheses that have been (in their view) marginalized, misrepresented or ignored in previous IPCC reports (and thus EPA and National Climate Assessments). Such activities are often called "Red

Team" reports and are widely used in government and industry. Decisions regarding funding for "Red Teams" should not be placed in the hands of the current "establishment" but in panels populated by credentialed scientists who have experience in examining these issues. Some efforts along this line have arisen from the private sector (i.e. *The Non-governmental International Panel on Climate Change* at http://nipccreport.org/ and Michaels (2012) *ADDENDUM:Global Climate Change Impacts in the United States*). I believe policymakers, with the public's purse, should actively support the assembling all of the information that is vital to addressing this murky and wicked science, since the public will ultimately pay the cost of any legislation alleged to deal with climate.

Topics to be addressed in this "Red Team" assessment, for example, would include (a) evidence for a low climate sensitivity to increasing greenhouse gases, (b) the role and importance of natural, unforced variability, (c) a rigorous and independent evaluation of climate model output, (d) a thorough discussion of uncertainty, (e) a focus on metrics that most directly relate to the rate of accumulation of heat in the climate system, (f) analysis of the many consequences, including benefits, that result from CO2 increases, and (g) the importance that affordable and accessible energy has to human health and welfare. What this proposal seeks is to provide to the Congress and other policymakers a parallel, scientifically-based assessment regarding the state of climate science which addresses issues which here-to-for have been un- or under-represented by previous tax-payer funded, government-directed climate reports. In other words, our policymakers need to see the entire range of findings regarding climate change.

5. IMPACT OF EMISSION CONTROL MEASURES

The evidence above suggests that climate models over-react to greenhouse gas increases. Also there is a lack of evidence to blame humans for an increase in extreme events. One cannot convict CO2 of causing any of these events, because they've happened in the past before CO2 levels rose. Even so, using these climate model simulations we can calculate that the theoretical impact of legislation on the global temperature is essentially imperceptible (Christy JR, House Ways and Means Testimony, 25 Feb 2009). In such calculations we simply run the model with and without the proposed changes in greenhouse gases to see the difference in the models' climates. The result is that actions will not produce a measurable climate effect that can be attributable or predictable with any level of confidence, especially at the regional level.

When I testified before the Energy and Commerce Oversight and Investigations subcommittee in 2006 I provided information on an imaginary world in which 1,000 1.4 gW nuclear power plants would be built and operated by 2020. This, of course, will not happen. Even so, this Herculean effort would result in at most a 10 percent reduction in global CO2 emissions, and thus exert a tiny impact on whatever the climate is going to do. The results today are still the same. Indeed, with the most recent estimates of low climate sensitivity, the impact of these emission-control measures will be even tinier since the climate system doesn't seem to be very sensitive to CO2 emissions. The recent switch to natural gas represents a partial move to decarbonize our energy production since methane has four hydrogen atoms for every one carbon atom. Thus, there are now even less U.S. CO2 emissions to legislate away.

The Energy Information Administration lists 190 countries by CO2 emissions and Gross Domestic Product. This can be used to answer the question, how much in terms of goods and services does a country generate per ton of CO2 emissions? In terms of efficiency, the U.S. is ranked 81st near Australia (91st) and Canada (78th) two other geographically-large and well-advanced countries with considerable natural resources. China is 186th but France is 9th due to the fact over 80 percent of its electricity comes from nuclear power rather than carbon. A different way to look at this is to realize the U.S. produces 29 percent of the world's goods and emits only 18 percent of the world's CO2 emissions (EIA 2009 values.) In other words, the U.S. ranks rather well considering the energy intensive industries of farming, manufacturing, mining, metals processing, etc. that are performed here, the goods of which are sold to the world. So, we produce quite a bit relative to our emissions – the kind of products and services that the world wants to buy. With the recent shift to more natural gas, the U.S. efficiency continues to rise. I suppose if one wanted to reduce U.S. emissions, one could legislate what the world should and should not buy. This, of course, is not a serious idea.

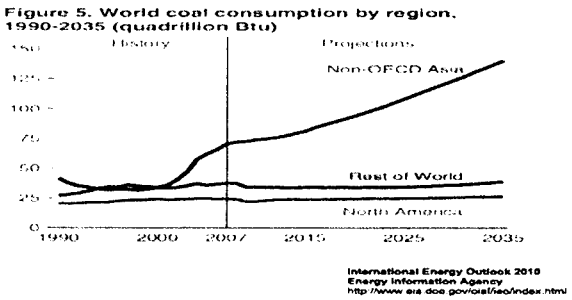
When thinking about policy regarding CO2, one cannot ignore the immense benefits produced directly by CO2 or indirectly from in its relationship to low-cost energy. It is a simple fact that CO2 is plant food and the world around us evolved when levels of CO2 were five to ten times what they are today. Our green world is a consequence of atmospheric CO2. And, food for plants means food for people. The extra CO2 we are putting into the atmosphere not only invigorates the biosphere, but also enhances the yields of our food crops. In my view, this is a tremendous benefit to nature and to us.

Now, with all due respect to former president Bush, in my opinion, he was not accurate to say in 2006 that we are "addicted to oil." Oil and other carbon-based energies are simply the affordable means by which we satisfy our true addictions – long life, good health, plentiful food, internet services, freedom of mobility, comfortable homes with heating, cooling, lighting and even colossal entertainment systems, and so on. Carbon energy has made these possible.

A rising CO2 concentration is thus an indicator of human progress in health, welfare and security provided by affordable carbon-based energy. As someone who has lived in a developing country, I can assure the committee that without energy, life is brutal and short. At present, hundreds of millions of people are dependent on low-grade biomass (tree branches, dung, etc.) for energy. These sources place a huge burden, literally, on people to find, cut and carry the material where needed. Landscapes are deforested and waterways contaminated by these activities. And tragically, the U.N. estimates about 2 million children die each year due to diseases fostered by the toxic fumes produced when burning wood and dung in the homes. Higher density sources of fuel such as coal and natural gas utilized in centrally-produced power stations actually improve the environmental footprint of the poorest nations while at the same time lifting people from the scourge of poverty.

Coal use, which generates a major portion of CO2 emissions, will continue to rise as indicated by the Energy Information Administration's chart below. Developing countries in Asia already burn more than twice the coal that North America does, and that discrepancy will continue to expand. The fact our legislative actions will be inconsequential in the grand scheme of things can be seen by noting that these actions

attempt to bend the blue curve for North American down a little, and that's all. So, downward adjustments to North American coal use will have virtually no effect on global CO2 emissions (or the climate), no matter how sensitive one thinks the climate system might be to the extra CO2 we are putting back into the atmosphere.



Thus, if the country deems it necessary to de-carbonize civilization's main energy sources, then *compelling* reasons beyond human-induced climate change need to be offered that must address, for example, ways to help poor countries develop affordable energy. Climate change alone is a weak leg on which to stand to justify a centrally-planned, massive change in energy production, infrastructure and cost.

Thank you for this opportunity to offer my views and research on climate change.

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Mr. WHITFIELD. Thank you, Dr. Christy, and thank all of you for your opening statements. At this time I will recognize each member for 5 minutes of questions, and I will begin by recognizing myself.

Mr. Trisko, Dr. Lashof in his opening statement made the comment that the standard under the proposed greenhouse gas regulation is a commonsense, performance-based, fuel-neutral standard. Now, it is my understanding that that proposed regulation reverses 40 years of precedent at EPA in that they are requiring coal to meet the same standards as any other fuel, and in the past they had standards for individual fuels—gas, coal, whatever. Is that your understanding?

Mr. TRISKO. In general, yes, Mr. Chairman, and let me explain the basis for this. We are talking really about setting particular standards for different types of generation technologies. EPA has regulated coal for the past 40 years under subpart (d)(A) regulations covering steam electric-generating units. These are basically large boilers utilizing coal or oil. There are not many oil boilers now being built. The first coal-based NSPS standard was set by EPA in 1971 pursuant to Section 111 of the 1970 Clean Air Act Amendments. That coal-based standard was subsequently revised by EPA in 1978 pursuant to the 1977 Clean Air Act Amendments that added the so-called percent reduction clause.

Mr. WHITFIELD. Excuse me. I asked a question and I am sorry to interrupt, but we all get caught up in this time clock, but the bottom line was that in this greenhouse gas regulation, the same emission standard was set for every fuel, and that had never been done before.

Mr. TRISKO. What had never been done before, Mr. Chairman, was to combine subpart (d)(A) for steam electric-generating units—coal or oil—with subpart (kkkk) which covers natural gas combined cycle units. Those had always been subject to separate, discrete standards.

Mr. WHITFIELD. But not under this regulation?

Mr. TRISKO. But not under this regulation.

Mr. WHITFIELD. And that is a significant change, and because of that, we cannot build a new coal-powered plant in the United States because the technology is simply not there at an affordable price. Is that correct?

Mr. TRISKO. Yes, Mr. Chairman, because in effect this regulation raises the cost of electric generation from coal plants by 80 percent but does not impose any increase in cost on natural gas combined cycle. Therefore, only natural gas combined cycle plants would be constructed in the future.

Mr. WHITFIELD. So in my opinion, this is not a fuel-neutral proposed regulation.

Now, we recognize that it only applies to new coal-powered plants but what creates additional problems is that the Utility MACT applies to existing coal-fired plants, and in order to meet those standards, they are going to have to modify some of the existing plants, and there is some genuine concern that if you modify, then you might be classified as new. Is that your understanding, Mr. Voyles?

Mr. VOYLES. Yes, sir, Mr. Chairman, that is my interpretation of how we read the rules, that you make modifications, it does subject you to different parts of the standard.

Mr. WHITFIELD. Yes, so, you know, when they were up here testifying, Lisa Jackson and others, they were talking about oh, this applies only to new plants but they had already pushed through the Utility MACT, as I said, that applies, makes you modify existing plants, and once you modify, then you have got to meet the new standard. So I think the President's comment when he was running for President clearly shows that there is a bias against coal and they are following through with that.

Now, Mr. Trisko, you are here on behalf of United Mine Workers. Is that correct?

Mr. TRISKO. Yes, sir.

Mr. WHITFIELD. And you read yesterday that Alpha Resources is closing down eight mines, and I am assuming your membership is quite concerned about the way things are happening to the coal industry.

Mr. TRISKO. These are not happy times in coalfields generally, Mr. Chairman.

Mr. WHITFIELD. And, you know, in my opening statement, I made the comment that even Lisa Jackson when she was here and she said well, if other countries don't do the same thing on greenhouse gas, then our doing it is not going to make any difference. But the thing that really upsets me is that all these analyses talk about the benefits on health improving because of regulations but they never explore, look at, consider in any way the negative impact on the health care of the thousands of people in this industry that are losing their jobs, and they have indicated, no, we don't consider that, which I do not think is a fair and balanced playing field.

My time is expired. I recognize for 5 minutes Mr. Rush.

Mr. RUSH. Dr. Lashof, Mr. Trisko indicated—he spoke disparagingly of the standards that the EPA is setting, and he also indicated that this plant that had modifications and that that plant would be classified as a new plant and it would suffer some negative responses, would have to newer, higher standard because of the new reclassification. How do you respond to some of the things he said?

Mr. LASHOF. Thank you, Mr. Rush. Well, you know, it is funny because the EPA is actually very explicit in its proposal in saying that it does not apply to modified plants. They have not proposed any standards that apply to the existing fleet, and the argument that the existing plants couldn't meet the current standard is irrelevant because the proposal only applies to new plants. So, you know, the problem here with this legislation is, it doesn't actually do anything to promote CCS. It just blocks other solutions and cost-effective ways of reducing pollution.

Mr. RUSH. I guess that is really my point. I am from Illinois. Illinois is a coal-producing State. You know, the President is from Illinois, and I don't think that the President is waging an attack on coal. I think the President is taking some postures under his administration to make sure that coal is usable in the future and that it is not only energy, we can use coal for our energy needs but also

that coal does not have to be harmful to the climate and to our health.

Mr. Thompson, let me ask you this. Can you talk about some of the advances in clean-coal technology that has occurred under the President's administration?

Mr. THOMPSON. Well, I think perhaps the largest advance has just been the plants that have broken ground. I have mentioned two, the Kemper plant, which broke ground in 2010, and the Texas Clean Energy Project, which will break ground in 2013 and go into operation in 2017. There has been a lot of funding for Future Gen and projects like that, loan guarantees that help advance coal, but obviously there is more work that needs to be done, and I think Congress should pick up areas that I alluded to like incentives to promote enhanced oil recovery. There is a lot of work that can be done on both sides of the aisle.

Mr. RUSH. Mr. Hilton, what are the most important things we should do to stimulate CCS development and deployment?

Mr. HILTON. I think there is really I would say four things. You know, we do need proper regulatory structure that provides guidance to States for permitting and for funding of R&D, and we need financial support. You know, grants don't go far enough. Kemper goes ahead because it has got a 20 percent rate increase associated with it. All the rest of the projects are struggling. But then we have the issues, that sequestration is not going to happen until we resolve the issue of financial liability and pore ownership, you know, because you can't—so I think those are the four things.

Mr. RUSH. Those are the things that you think that this committee could be focused on that would really be of help to the industry at large. Is that correct?

Mr. HILTON. Yes.

Mr. RUSH. Mr. Lashof, how important is CCS technology to ensuring a long-term future for coal?

Mr. LASHOF. Well, NRDC has supported development of CCS technology. We supported the Upton-Boucher bill as part of comprehensive legislation that was passed in the last Congress, and as Mr. Thompson said, there are applications around the world so I think that there is a real need for the United States to be a leader in this technology and a big market for CCS.

The reality, though, is that the bill that this hearing is about would set up a catch-22 test because it would block the very standards that would actually create an incentive for the industry to invest in making that technology commercial.

Mr. RUSH. Thank you.

Mr. Chairman, I yield back.

Mr. BARTON [presiding]. Thank you. The gentleman's time is expired. The Chair now recognizes himself for 5 minutes.

Dr. Christy, you have got a very illustrious résumé both academically and professionally. Are you now or have you ever been a part of the IPCC process?

Mr. CHRISTY. The IPCC, yes, and about every year including being lead author in one of the assessments.

Mr. BARTON. So you would be acknowledged by the U.N. officials that operate that as a climate scientist?

Mr. CHRISTY. I have my certificate that says I am a Nobel Peace Prize winner.

Mr. BARTON. But you obviously do not appear to share some of the more generic, popularized conclusions that they have promoted. Is that a fair statement?

Mr. CHRISTY. That is a fair statement, yes.

Mr. BARTON. OK. How do you get along with Dr. Mann?

Mr. CHRISTY. I don't communicate with him since that time back in—we were lead authors together back in 2001.

Mr. BARTON. Is it fair to state—I mean, the popular presentation is that there are thousands of climate scientists and they all agree that the world is going to hell because of CO_2 and that the sooner we start restricting CO_2, the better. Obviously you don't share that opinion. How many climate scientists are there like you, and are you ever heard or welcomed in those discussions?

Mr. CHRISTY. Rarely am I welcomed or heard in those kinds of discussions but I would say that, you know, it depends on how you define a climate scientist, but it is——

Mr. BARTON. Well, however you define it, you obviously are one.

Mr. CHRISTY. I am one. Yes, I actually build climate data sets from scratch. I qualify as a working-stiff climate scientist. There aren't very many of us, by the way. Other people that like to use the term, you know, have some oblique relationship to how climate might impact something but in terms of the hard core, there aren't many of us, and I would say that they are a lot less confident about what climate models can do and can tell us, and the Nature article that just appeared yesterday was very clear about the lack of ability of climate models to tell us what is going on with the world and what will go on with the world.

Mr. BARTON. Is it fair to state, in your opinion and the scientists that share your opinion, that the science on CO_2 made by man being a primary contributor is unsettled and that it is not yet conclusive that manmade CO_2 is a primary contributor to global warming?

Mr. CHRISTY. That science is unsettled, and I think the clearest example of that is in the three figures I put in the written testimony that show what the real world is doing, what climate models say it is doing or should be doing, and the two don't agree.

Mr. BARTON. Dr. Lashof, we obviously are very pleased that you are here. We do want to have a balanced hearing. Unfortunately, there is only one of you and you are outnumbered, but we do appreciate you being here. When you talked about the performance-based standard, Chairman Whitfield pointed this out, but I think it bears repeating. We could do a performance-based standard based on wind power or nuclear power that would be zero, and those are the only two that could comply with it. On the other hand, we could do a performance-based standard set on the 1971 standards that were first put out under the 1970 Clean Air Act and all the conventional power sources could comply with that. So it is a little misleading to say we are just asking for performance-based standard when you know and everybody else at this table knows that the only ones that comply with the proposed EPA standard are natural gas, nuclear and wind power. No coal plant can comply.

Mr. LASHOF. Well, Mr. Barton, the EPA's authority is to regulate emissions from fossil fuels.

Mr. BARTON. But you admit what I said is true?

Mr. LASHOF. No, I don't, because we actually believe EPA could set a tighter standard than it has.

Mr. BARTON. So you are saying that you think there is an existing coal technology that is economic that can comply with this standard?

Mr. LASHOF. Well, as Mr. Thompson testified, there are two plants that are under construction that would meet the standard, and——

Mr. BARTON. Well, what is the subsidy to the clean-coal plant down in Texas? How many—I would almost say billions of dollars, and I support that plant. But on its own merit, it can't compete without the tax subsidies and the direct subsidies to it. Isn't that a fact?

Mr. LASHOF. That may be true but——

Mr. BARTON. That is not may be true; it is true.

Mr. LASHOF. Well——

Mr. BARTON. It is true.

Mr. LASHOF [continuing]. I think there are plants potentially that have enhanced oil recovery opportunity that may be competitive.

Mr. BARTON. My time is expired. I want to ask Mr. Voyles a question. What is the most economic clean-coal technology that is currently available today for commercialization, and how much does it add to the cost of the best coal technology that we already have in place—power plant generation technology?

Mr. VOYLES. In our case, the best technology is the recent unit that we just put in service in 2011. It is a supercritical coal-fired unit that has got all the available technology. It actually received an investment tax credit for clean-coal technology and it has been operating now for 2 years and it actually produces 20 to 30 percent less CO_2 than other technologies.

Mr. BARTON. And how much additional does it cost than the technology that it is replacing?

Mr. VOYLES. Because of its efficiency, it runs all in, in the $30-to-$40-a-megawatt range. It is a little bit more expensive because of the amount of controls that are on it but significantly less than what you would experience if you put in carbon capture and sequestration.

Mr. BARTON. Well, the number that I have been given is at a minimum——

Mr. RUSH. Mr. Chairman, we have to have regular order.

Mr. BARTON. You are exactly right, Mr. Rush.

Mr. RUSH. I thought you were going to stop at some point.

Mr. BARTON. You couldn't be more right, so as soon as I agree with you that you are right, I am going to recognize Mr. Doyle. Mr. Doyle is recognized for—is it Mr. Green instead of Mr. Doyle? I recognize the gentleman from Texas, Mr. Green, for 5 minutes.

Mr. GREEN. I am finally getting the rules down. If I come when the gavel goes down, when I come back they will let me speak. Thank you, Mr. Chairman.

I have a district in Texas. We have refineries and chemical plants, and I know the EPA, when they exempted coal, they grandfathered in the existing coal facilities, and yet the tenor of this hearing and what we hear so much is that all these layoffs, whether it be Alpha or a lot of them, are based on the Obama administration and EPA. There is not a coal plant that in existence that will have to deal with carbon under the EPA, and yet Canada is requiring their coal plants to retrofit. I hope that when the EPA gets around to my five refineries and chemical plants in our district that they would let us have the same grandfather clause. But that is the concern I have.

And I have an area that produces pet coke, not anything near what coal does, but we have not been able to use that pet coke in our own country because of the pollution problems and burning it, and we export it, and I support exporting coal. In fact, I know there is controversy over a port up in Washington. So, you know, is the export market, could that keep our coalmines open whether it be in West Virginia or Pennsylvania or western United States? Anyone from the coal industry.

Mr. TRISKO. Congressman Green, the United States consumes approximately 1 billion tons of coal annually, and the predominant customer for that coal is the electric utility industry, thus the cause of concern that we have expressed here today. There is a very robust international market in both steam coal and metallurgical coal with low-cost producers from countries such as Australia being able to in effect outcompete the United States. Now, our exports have increased a good deal over the course of the last 5 years but at most we are talking about an export market that is on the order of 60 to 70, 80 million tons a year against that 1-billion-ton utility demand.

Mr. GREEN. I guess I am trying to understand that if it is a billion tons that is used in existing coal facilities now and not one of them is being threatened to shut down because of carbon capture, it seems like we would continue. Now, I know there is a lot of things that enter into including the cheap price of natural gas. I am a big supporter of nuclear power. The problem is, if we didn't have loan guarantees and even questionable then, we wouldn't have a nuclear power plant because of the low price of natural gas. So I think it is a lot of market conditions, and coming from where I am, I can't not support natural gas expansion.

Mr. Thompson, you mentioned that several States already set emission standards for carbon capture for new coal-fired plants. Can you elaborate? How do companies plan to comply with these standards?

Mr. THOMPSON. There are several States that already have emission limits that are similar to what U.S. EPA has proposed. Some of them are like California and Washington State. There is a proposed coal project in California called HECP that seeks to meet that standard and do so with using carbon capture and storage. In places such as my State, Illinois, there is actually a clean-coal portfolio standard that seeks to promote coal projects with 50 percent capture. And some of those have not, I think are unlikely to move forward in Illinois simply because the price of gas is so low, and that is a real challenge.

But what I think is really important to understand is that what projects need is certainty, and the regulations that EPA has proposed are quite reasonable: 30 years to comply if you want to choose that route in some cases for new plants. The challenge with H.R. 6172 is that it introduces confusion about whether or not EPA would be allowed to issue those very reasonable standards, and in an era of low natural-gas prices, that uncertainty actually, I would submit, favors the expansion of gas because someone who wants to finance a project or is being asked to finance a project is going to say well, you know, I am not really sure if there is some——

Mr. GREEN. I am almost out of time, and I understand if somebody is cost-benefiting it out today and you are building a new power plant, you know, natural gas will get there. Wind, solar, nothing will get there without substantial tax incentives except for natural gas.

I am a big supporter of enhanced oil recovery, and we are trying to grow that in Texas because we have a lot of fields we can do, and do you have any suggestions on how we can further incentivize enhanced oil recovery, use some of that carbon from other States? And I know there is a potential pipeline from Mississippi into southeast Texas where our refineries are to be able to deal with that.

Mr. THOMPSON. A group of environmentalists, coal companies, chemical companies have gotten together under the umbrella of the National EOR initiative and recommended several recommendations. I will highlight one, and that is to actually to use a portion of the tax revenue that would have—that comes from new oil development and put that back into subsidizing some of the cost of CCS capture. That would allow a lot of projects to move ahead. So I would direct this committee to look at the National EOR Initiative's recommendations. I think that is a great starting point.

Mr. GREEN. Thank you, Mr. Chairman.

Mr. BARTON. I just want the record to show that I gave you extra time, but it was only because you are from Texas. If you had been from Illinois or Pennsylvania, I would have been on you.

Mr. GREEN. Well, maybe Mike can have a Texas drawl.

Mr. BARTON. We want to recognize the gentleman from the Cornhusker State, Mr. Terry.

Mr. TERRY. Since I am from the Cornhusker State, do I get 1 minute?

Mr. BARTON. It depends on how you are behaving.

Mr. TERRY. Thank you.

Mr. Hilton and Mr. Thompson, I want to ask you, as I am trying to sort through this, I haven't been able to resolve one specific question, and that is whether or not technology exists to meet the proposed standards, and Mr. Hilton suggests that it is a work in progress. Mr. Thompson, you are saying they are already building them. So Mr. Hilton, you start first. How do I resolve this as a Cornhusker?

Mr. HILTON. Well, the first part is, you know, is that it is technologically feasible. As far as getting to the point where it is commercially available, we need the proof that the technology, that what we guarantee and what we are going to do, and there are no plants currently operating out there right now at commercial scale. Kemp-

er will reach commercial scale because it has been able to get the financing, and this is what I have said that CCS needs. It has a 20 percent rate increase. Summit, if it goes ahead, because it doesn't have financing yet—it has an MOU with Sinopec to sell part of the project and get Chinese financing—it may go ahead and this is the point that I was making. There are no projects out there that are going ahead on their own with the financing package that is, you know, there. And that is what we need as suppliers to be able to sell and guarantee the performance. Southern also has a unique thing. It is their technology and they are a self, if you will, guarantor.

Mr. TERRY. Mr. Thompson?

Mr. THOMPSON. Thanks. I also agree with Bob about the technology is technically feasible. Here is the difference, I think, that maybe you are alluding to. Kemper and the Texas Clean Energy Project are using pre-combustion capture technology. That has been around for 30 years commercially available. If you look at my written statements, you will see what Mississippi Power said in support of that. What Bob is talking about is the post-combustion capture, and his technology from his company, I respect his opinion that it is not ready yet but there are projects in Texas like the Trailblazer Project. It is a proposed project, would be post-combustion capture but it is not moving ahead, fully permitted, that would use this post-combustion capture technology and they have been able to get warranties from either MHI or Fluor, I can't remember which, to do post-combustion.

Mr. TERRY. Let me interrupt, because you said something in a previous answer that stood out to me from Nebraska versus Texas is, we don't have oil fields, and you said having that available is a key component to its fiscal viability. So what about our northern coal-fired plants?

Mr. THOMPSON. Pipelines. We have been supporters——

Mr. TERRY. Oh, we have tried that. They are against it.

Mr. THOMPSON. Well, not everyone is. Seven hundred miles of pipelines have been proposed by Denbury to go from the Gulf Coast area through to Kentucky, Indiana, Illinois, and legislation has been passed in those three States to provide eminent domain authority to make that happen. So it is not easy, but that is my short answer.

Mr. TERRY. All right. Well, I appreciate that.

Then back to you, Mr. Hilton. You had mentioned the issue of there is liability issues. Can you in a minute and 15 seconds tell me what the liability issues are specifically and what other barriers in addition to liability?

Mr. HILTON. OK. The liability issue is obviously if you sequester, there is going to be need typically in accounting to have some liability associated with having put that CO_2 in a reservoir, so we expect that that is going to have to be dealt with just like any other waste that has happened. It may even end up that way in EOR before it is over, before things are done. So, I mean, there is a liability issue. There is an issue of pore ownership, you know, who owns the pore structure you are putting the CO_2 in, and in the history of the United States, it is the classic, you own to the center of the earth under your house and so, you know, if you add

in paying royalties to put CO_2 under people's houses if they will let you, you know, you have to get permission. This is a major issue. So I think those are the really two biggest issues that we are facing.

Mr. TERRY. All right.

Mr. THOMPSON. I would just say that with EOR, which could account for a third of the Nation's coal fleet, there are no liability issues. We have injected over a billion tons of CO_2 in Texas since the 1980s. So there are ways of addressing this issue even within the EOR context.

Mr. BARTON. The gentleman's time is expired. We now recognized the gentleman from the Keystone State, the winner of the Congressional baseball game manager, Mr. Doyle.

Mr. DOYLE. Thank you, Mr. Chairman.

Thank you for your all your testimony. I have read it. Mr. Trisko, you mentioned in your testimony a 2008 wires-charge bill, which I was a cosponsor of, by the way, which would have provided path forward for CCS funding. Can you tell us a little bit about where that bill ended up?

Mr. TRISKO. Congressman Doyle, the bill eventually ended up as Section 113 of the Waxman-Markey bill, the larger climate-change bill, and while that bill passed the House, the companion legislation in the Senate did not fare as well.

Mr. DOYLE. Thank you.

Mr. Hilton, in your testimony, you refer to several commercial-scale CCS demonstrations planned in other countries—the U.K., European Union, even China. Can you tell us how these projects are being funded?

Mr. HILTON. Well, the U.K. projects are being funded by a billion-pound fund the U.K. government is putting up. Most of the European projects are a combination of E.U. funding from what is called the NER–300, which is a grant for allowances which can be sold and then funded, which is somewhere on the order of $2–1/2 billion to $4 billion euros worth of funding. The Chinese projects are a little bit, I am going to say, different. The Chinese projects get funded because the Chinese government particularly says that project will go ahead and where the funding is actually comes from is harder.

Mr. DOYLE. From the Chinese government?

Mr. HILTON. Right.

Mr. DOYLE. What about the CCS projects here in the United States like the Summit plant? How is that being financed?

Mr. HILTON. Well, the Summit plant has a significant grant from the government. It is going to do EOR but its financing, it looks like it will come from selling part of the project as an MOU with Sinopec and Chinese banks.

Mr. DOYLE. Right. So would you say there is an argument here then for a commitment to Federal funding for CCS demonstration projects like we provided in the stimulus bill? In other words, we need to step up to the plate, don't we?

Mr. HILTON. Absolutely.

Mr. DOYLE. Thank you.

This question is for several of the panelists. There has been a lot of testimony this morning about the state of CCS technology devel-

opment and the need for better drivers of CCS technology. Many of you have addressed this in your testimony already, but I want to ask you what you think would be the best driver for commercialization of affordable CCS technology. Would it be EPA regulation? Would it be a carbon tax, cap and trade or something else? Just very quickly because I have some more to say. Go ahead.

Mr. TRISKO. Congressman Doyle, we would again advocate consideration of the wires-charge approach. That is a non-budget way to raise $10 billion to support CCS demonstrations. Until we have commercial-scale demonstrations, there will not be a regulatory structure that will allow that technology to proceed, and given the state of the Federal budget, which we are all acutely aware, we need to find a non-budget source of these revenues.

Mr. DOYLE. Thank you.

Mr. MCCULLOUGH. Yes, I first of all refer you to the CURC–EPRI roadmap that recognizes the technology roadmap to get to cost-effective, reliable CCS capture. We would also support the funding that Mr. Trisko just——

Mr. DOYLE. Great. I don't mean to rush you but I have some more to say.

Go ahead, Mr. Voyles.

Mr. VOYLES. And I would only add to what Mr. McCullough says by saying—and we have talked about the Kemper County plant. That plant has been progressing without the imposition of any standards so the industry is investing in carbon research, trying to develop technology, and that should continue.

Mr. DOYLE. Mr. Hilton?

Mr. HILTON. Clearly, I think a wires charge or similar thing.

Mr. THOMPSON. A combination, both performance standards and incentives that promote enhanced oil recovery.

Mr. LASHOF. Yes, I would say we need the standards to make it clear that if you are going to build fossil plants, you are going to need CCS in the future to motivate people to invest, and then we need support.

Mr. DOYLE. Dr. Christy?

Mr. CHRISTY. Yes, I would just say please don't raise the rates of Alabamians for utilities.

Mr. DOYLE. OK. Thank you.

This week, Mr. Chairman, in the House, our friends on the other side are going to bring a bill to stop the war on coal to the House Floor, and among other things, the bill prohibits any acknowledgement that global warming is caused by carbon emissions and it bars the Federal Government from setting any kind of carbon-emission limit. The bill we are debating here in the subcommittee also would bar the Federal Government from setting any kind of limit on carbon pollution. In 2009, Democrats passed a stimulus bill that provided $3.4 billion to CCS funding. That was 49 percent of all the energy funding in the stimulus bill went to CCS. Half of all that funding, CCS. That bill was denigrated, maligned and smeared by many in this House chamber. Also in 2009, we took up a cap-and-trade bill that had $60 billion for CCS funding as well as the $10 billion in wire charges that Mr. Trisko referred to in his testimony. That bill as well was smeared, denigrated and maligned by many on this House Floor.

So here we are today dealing with regulations that are a result of court-imposed deadlines and we are being told that the industry doesn't have commercially available tools to meet these limits. Well, whose fault is that? I would just say to my friends, when you want to bring a bill forward to invest—you know, you have to do both. You can't just——

Mr. GARDNER [presiding]. The gentleman's time is expired.

Mr. DOYLE. No, I would like 10 more seconds.

Mr. GARDNER. I am not from Texas.

Mr. DOYLE. Let me just say this to my friends. I have sympathy for what is going on in the coal industry. Bring a bill to the floor that says we need commercially available technology before we can do certain regulations, but where is the money to go with it? There is no commitment to fund the technology. We do this in nuclear and we do this in other areas. You know, show me the money. We had $60 billion on the table and that got voted down. So don't just come here and say you can't do something because the technology is not available.

Mr. GARDNER. The gentleman's time has expired. The gentleman from Texas is recognized for 5 minutes.

Mr. BURGESS. Thank you, Mr. Chairman, and I do feel obligated to point out that during the first 2 years of the Obama administration when cap and trade, Waxman-Markey passed and the stimulus bill did pass, of course the President's party controlled all the levers of government. Whatever this side of the dais wanted was absolutely irrelevant because the Democrats had a 50-vote majority in the House and a 60-vote filibuster-proof majority in the Senate. It was the Senate that was unable to do Waxman-Markey because after they saw the public angst over Waxman-Markey being shoved through the floor of the House the last day of June 2009, no Senator had the courage to step forward and say let us talk about this. They wanted to withdraw from that fight. Whether it was right or wrong, I mean, that is what happened. Blame us if you want if you can't find any other reason but the reality was, 60 Democratic votes in the Senate and the President could not get that bill even considered in the other body. So don't blame House Republicans. I didn't want that. I thought it was a bad idea. I thought it was a bad idea on several levels. I will still vote against it if you are able to bring it up again. But don't blame House Republicans for your inability to get that done because you know very well that thing was forced through this committee, subcommittee, full committee and the floor of the House and it was in fact to the detriment of your side because, honestly, you never recovered the public confidence after you did that. It was done in the worst possible way, and I would hope whatever happens with energy legislation going forward it is constructed in a bipartisan fashion. I think that is the lesson a lot of us can take away from the last 3 ½ years.

Mr. Hilton, I have a question for you, because when Michael Williams was Chairman of the Texas Railroad Commission, I think he came to this committee and testified either in committee or in a briefing, and he talked about how the State of Texas had taken title. You were answering some questions from Mr. Terry about the liability issues. The State of Texas, as I understand it, took title

to the carbon that was pumped back down for carbon sequestration. Is that not correct?

Mr. HILTON. Yes, that is correct.

Mr. BURGESS. Does that help with the liability issue?

Mr. HILTON. It helps in Texas.

Mr. BURGESS. Right. Has any other State stepped forward and done that?

Mr. HILTON. I don't believe so.

Mr. BURGESS. Now, Texas, of course, is a little bit different because we are our own country. We don't have Federal lands; we have State lands. So there actually is the availability of State land to do that. In other areas of the country where there are large amounts of Federal lands, has there been any discussion about the Federal Government taking title to the carbon that might be injected under Federal lands?

Mr. HILTON. I can say it has been suggested. I don't know if the Federal Government itself has discussed it, but, I mean, people have talked about it, of course.

Mr. BURGESS. But even there with the liability cloud removed as it was in Texas, I mean, it has been a slow go. It is not something that has really been—there hasn't been a lot of enthusiasm for it.

Dr. Christy, welcome back to our committee. You have spent a lot of time here over the years. I really appreciate the graphic representation that you brought to us today. It is fascinating because, I mean, I lived through at least half of it so I actually remember those years very well. There does seem to be a certain amount of randomness to the temperature variations that you described. There also seems to be some clustering. Are you able to make any predictions about, is this occurring on a cyclic basis? I mean, clearly some of the most startling temperatures were in the early part of the last century as opposed to these latter years when the carbon numbers were supposedly going up. Are you able to make any predictive statements based upon the data that you have collected?

Mr. CHRISTY. You know, my most confident predictive statement is that if it happened before, it will happen again and probably worse.

Mr. BURGESS. Well, history always repeats itself right up until the time that it doesn't.

Mr. CHRISTY. Yes. In fact, even on the arctic sea ice thing, I think it would be interesting to note that over western civilization the arctic has probably been warmer than it is today.

Mr. BURGESS. Well, let me ask you a question because it did come up that because of the reliance on natural gas when the price collapsed of natural gas in 2008, apparently carbon dioxide levels are lower now than what they were predicted to be. Is that correct?

Mr. CHRISTY. In this country, they have fallen, yes.

Mr. BURGESS. Is that happening worldwide or is it just this country?

Mr. CHRISTY. I believe that is not the case worldwide. It is still going up thanks to China and India, who are really burning a lot of coal.

Mr. BURGESS. So if we were really able to achieve the goals that were set forward in Waxman-Markey, the rest of the world could

actually negate any benefit effect if indeed that was the cause of global warming?

Mr. CHRISTY. Whatever the United States does, it will be pretty much imperceptible for the global climate.

Mr. BURGESS. Very good. Thank you, Mr. Chairman. I will yield back.

Mr. GARDNER. Thank you, Mr. Chairman—or thank you, Mr. Burgess.

Mr. BURGESS. I will yield you additional time.

Mr. GARDNER. Yes, that is right. Well, I was maybe getting even for Mr. Doyle right there.

Mr. Olson, you are recognized for 5 minutes.

Mr. OLSON. I thank the Chair, and on behalf of the people of Texas 22, welcome to our witnesses. Thank you for your time and expertise today.

Clean air and economic growth are not mutually exclusive. The great people of Texas 22 aren't buying the notion that EPA can create jobs by strangling business with overly burdensome and unnecessary regulations, especially when the electricity bills are going up. We all know, the people of my district, Texas 22, our rates by the comments our President made when he was running for the office in 2008 in San Francisco. You guys know these comments but just let me read them for you. If someone wants to build a new coal-fired power plant, they can, but it will bankrupt them because they will be charged a huge sum. I served 10 years in the United States Navy. It sounds like an attack on coal, doesn't it?

My first question is for you, Mr. McCullough and Mr. Hilton and Mr. Voyles. Do you believe EPA's goal with all these new rules is to shut down coal plants like the President said in San Francisco and keep new ones from being built?

Mr. MCCULLOUGH. Well, the motive is up to someone else to decide but the effect is that no new coal plants will be built.

Mr. OLSON. Mr. Voyles?

Mr. VOYLES. I would concur with that.

Mr. OLSON. Mr. Hilton?

Mr. HILTON. I would concur with that.

Mr. OLSON. Thank you.

Texas is predicted to have a severe supply shortage, meaning that we will need more electricity than it can generate. We are the second largest State, the fastest-growing State in our Nation. We are expected to have a 2,500-megawatt shortfall in generating capacity, equivalent to five large power plants, as early as 2014. We have proposed a pet coke plant in Texas, the Corpus Christi area, Las Brisas Energy Center, that EPA has been slow walking for more than 3 years. Some of my colleagues have wrote EPA about 2 months ago and they haven't gotten back to us yet. So we are optimistic that we will get something from EPA. But is this the sort of treatment you guys are getting used to from EPA, no answers, no responses? I will put it another way: has EPA been a corporate partner or are they an adversary working against you?

Mr. MCCULLOUGH. Well, we have certainly had our discussions with U.S. EPA around many rules, the MACT rule for mercury being included in that discussion, and saw very little in the way of response positively for our industry.

Mr. OLSON. Mr. Voyles?

Mr. VOYLES. We too have had numbers of discussions with EPA on numbers of rules, and the plant that I spoke of earlier, we had some discussions with them about the time that was taken to get our permits but we did finally achieve those.

Mr. OLSON. Mr. Hilton?

Mr. HILTON. As a technology supplier, we really don't get into those kind of discussions per se. We talk about technology with the agency.

Mr. OLSON. OK. One round of questions for all of you starting with Dr. Christy. Our former EPA regional administrator, Mr. Al Armendariz, was in charge of overseeing our power plants. He had resigned his radical agenda. He came forward to actually crucify—he used that term—to crucify the oil and gas companies but it went public. He now works for the Sierra Club, their beyond-coal campaign. What do you think about that? Are there more people like Dr. Armendariz working at EPA now?

Mr. CHRISTY. My impression in the Federal Government, there are several folks like that, have a pretty clear view of what the climate situation is.

Mr. OLSON. Mr. Trisko?

Mr. TRISKO. Our experience, Congressman, is that EPA is staffed by highly experienced experts in environmental regulation, and if one follows the letter of the Clean Air Act that has not been amended by Congress for some 22 years except by virtue of a 2007 5–4 Supreme Court ruling, it is not difficult to understand how we have ended up in the predicament we are today.

Mr. OLSON. Mr. McCullough?

Mr. MCCULLOUGH. Yes, I would agree. In the discussions, the Clean Air Act, I would classify as used as a reason or a crutch to not be flexible, and it is pretty consistent in that way.

Mr. OLSON. Mr. Voyles, your comment, sir?

Mr. VOYLES. I don't know that I would add anything that hasn't already been said. I am not sure where they get all the employees but they have some expertise that we talk to from time to time, and I think that they do try to use the Clean Air Act to the advantage of one side or the other, depending upon the issue.

Mr. MCCULLOUGH. Mr. Hilton?

Mr. HILTON. I have great respect for the professionals at EPA and they do have some terrific experts there, and I think the comments that Mr. Trisko made are probably very substantial.

Mr. OLSON. Thank you.

Mr. Thompson?

Mr. THOMPSON. My experience is, the EPA officials are very professional and some leave the agency to work for industry and some for environmental groups.

Mr. OLSON. And finally last but certainly not least, Dr. Lashof?

Mr. LASHOF. Yes, my experience is similar. EPA Is trying to protect public health by setting standards. They have proposed a fuel-neutral and technology-neutral standard, and the public supports it overwhelmingly.

Mr. OLSON. Thank you. I am way over time. I thank the Chair.

Mr. GARDNER. The gentleman from West Virginia, Mr. McKinley, is recognized for 5 minutes.

Mr. MCKINLEY. Thank you, Mr. Chairman.

Mr. Thompson, I want to focus back in on the enhanced oil recovery. Are you aware that earlier this year there was an amendment on the floor that was adopted by Congressman Connolly that cut the research funding in the enhanced oil recovery?

Mr. THOMPSON. I am not familiar with that.

Mr. MCKINLEY. So when we hear the folks on the other side talking about this, if we know this is going to be part of the solution, this is where we need to be focusing on but yet all these members, and Mr. Doyle was one of them that voted to cut the funding. I find that very interesting.

But let me build on that just a little bit. In fact, all the Democrats did. If the oil industry—because I am somewhat aware of this process. If the oil industry finds this is a possibility of increased recovery, instead of—well, how many of them are contributing from the oil industry, how many of them are contributing to the carbon-capture research so that would enable that to occur to provide them with a supply of material? Are any oil companies contributing to CCS research?

Mr. THOMPSON. Sure, Shell, among others, is.

Mr. MCKINLEY. Do you have numbers for that, how much? Are they contributing a million or they are contributing hundreds of millions of dollars?

Mr. THOMPSON. No, I don't, but what I would be happy to do is after the hearing——

Mr. MCKINLEY. I would like to understand more——

Mr. THOMPSON [continuing]. I would be happy to respond in writing.

Mr. MCKINLEY [continuing]. Because if they are going to be the ones that are going to benefit from this, I think they are the ones that should be contributing the money for it.

Let us go back now to Dr. Lashof. I am just curious. It was touched on just a minute ago about the CO_2 emissions. Are you aware that the CO_2 emissions across North America are down to a low that hasn't been seen in 20 years?

Mr. LASHOF. Yes, I am. I have published a report on that a month or so ago.

Mr. MCKINLEY. And so with that, you think we ought to go even—we need to continue this message, this fight?

Mr. LASHOF. Well, the amount of CO_2 in the atmosphere is 25 percent higher than it was in the year I was born, 1959, and what we need to do is stabilize that level. The United States needs to reduce further. Certainly, China and India also need to reduce. The United States has to provide leadership.

Mr. MCKINLEY. Because what you are saying is, it is the main culprit? I think I heard you say that is the main culprit of global warming.

Mr. LASHOF. Carbon dioxide traps heat in the atmosphere. It would be remarkable if it weren't causing global warming, and in fact, we are seeing global warming.

Mr. MCKINLEY. So you disagree with Dr. Lewis, Hal Lewis, when he resigned from his position, the American Physicists Society when he said this is the greatest pseudoscience fraud perpetrated on America?

Mr. LASHOF. Yes, I totally disagree with that.

Mr. MCKINLEY. I would assume you do. But I think several others have joined him in resigning because there are other scientists that disagree with you on that, that this is being used for other purposes. I look at what Hal Lewis has said, and if you look back to Milankovic, back to the Serbian physicist back in the last century, by virtue of his own studies had predicted that this was going to happen at this time in our history. Are you aware of that?

Mr. LASHOF. I am. Look, scientists will always disagree with each other. That is what they do. That is how they make a living is writing papers to disagree with other scientists. If we predicated policy on unanimity among scientists on any issue, we would never do anything.

Mr. MCKINLEY. Do you recognize too that National Geographic just came out with a study that says we are just coming out of an ice age, a mini-ice age, and therefore we should be expecting higher temperatures today?

Mr. LASHOF. I haven't seen that particular National Geographic article, but the fact is that the amount of heat trapping that the excess CO_2 that we put into the atmosphere from burning fossil fuels is now a much bigger factor in influencing the earth's climate than the Milankovic cycles and what we have had to start with. We have entered a new era that many scientists call the——

Mr. MCKINLEY. So my point here is, given that there is not unanimity—and I remember earlier last year when Lisa Jackson came before us, she said it is all been decided, that global warming is anthropogenic, global warming is manmade cause and it is CO_2 driven, that there is no argument anymore, but you also just acknowledged that it is not, that the science is still up in the air over that issue. So I accept that there is not a lack of unanimity on it because what we are about to do here is allow the EPA to impose a regulation. That is the purpose of my bill. Just hold back. If we had the scientific ways of doing it, then to go ahead and implement it, but when we don't have the technology available, let us hold back because there is enough evidence that possibly CO_2 is not contributing to as much of the problem as you are suggesting that it is. So let us just hold back. I am over my time——

Mr. LASHOF. Mr. McKinley, if I can just answer quickly, I don't agree that the science is up in the air. I said that there is not unanimity among scientists and there won't be, but the National Academy of Science said that the idea that carbon dioxide is contributing to climate change is as well proven as gravity, and I think that is a strong basis for making policy.

Mr. GARDNER. The gentleman's time is expired. The gentleman from Massachusetts is recognized for 5 minutes.

Mr. MARKEY. Could you recognize someone from the minority and then come back to me? Is that possible, Mr. Chairman?

Mr. GARDNER. The gentleman yields back.

Mr. RUSH. Mr. Chairman.

Mr. DOYLE. Will the gentleman yield for 30 seconds?

Mr. MARKEY. No, I am ready to go, if the majority does not need to have the time. Thank you, Mr. Chairman.

So here is what I would say, that coal has dropped from 51 percent of electrical generation down to 35 percent over the last 5

years, but there is a concomitant trend as well which is operating simultaneously which is that natural gas has risen from 21 percent to 30 percent. So there is a war between fossil fuels going on in our country right now.

By the way, the same thing is happening on home heating oil in New England. The market for home heating oil is collapsing as the price of natural gas is rising. Now, why is that? Because natural gas is so much less expensive than home heating oil. The price of natural gas has collapsed in terms of a source for generation for electricity. And by the way, the same thing is true for wind. Wind was only 1 percent of all electricity just 4 years ago. It is now 4 percent of all electricity.

So coal is losing a marketplace battle. There is no question about it. It is losing a marketplace battle. Natural gas is up to 30 percent. It will probably go up a percent a year every year. That is just a fossil-fuel battle. The same thing is true for home heating oil. Natural gas is eating into home heating oil in a very significant way. That is a fossil-fuel interfuel battle. And I know a lot of people don't like it, you know, any more than—let us be honest, any more than the horse industry likes the horseless-carriage industry. It just moving on, you know, but when the price drops, that is what you get.

So a lot of people are just trying to blame the concern, which the Obama administration or members of this committee that might care about clean air or pollution or science but that is not what has really been happening. This is all happening before there was any rule promulgated on CO_2. This is already happening and it is going to continue to happen because of the low price of natural gas. Now, again, the Democrats are the party of natural gas and the Republicans are the party of coal, if that is how you want to frame it, but that would of course be a wrong frame. That is the wrong frame. I am just bringing to you the marketplace reality, the economics of it. When a flat-screen TV costs $5,000, you don't buy it. When the cost collapses down to $299, you are buying one. That is what is happening with natural gas. People are buying natural gas, utilities and homeowners, and they are moving to it, plain and simple.

So Dr. Christy, I want to read to you two statements. One, scientific evidence strongly indicates that natural influences cannot explain the rapid increase in global near-surface temperatures observed during the second half of the 20th century, and two, it is virtually certain that increasing atmospheric concentrations of carbon dioxide and other greenhouse gases will cause global surface climate to be warmer. Dr. Christy, do you agree with those statements?

Mr. CHRISTY. Those statements have no magnitude to them, no metrics to them, so if the increase is 1,000th of a degree due to the greenhouse effect, you would say yes. You would agree with those statements.

Mr. MARKEY. OK. Well, Dr. Christy, those statements are direct quotes from the 2003 American Geophysical Union statement on human impacts on climate that you helped to draft. So Dr. Christy, in 2003, you agreed with those statements, but the Dr. Christy of 2012 does not agree with those statements.

Dr. Lashof, do you agree with those statements? Is the science, Dr. Lashof, more certain now than it was in 2003?

Mr. LASHOF. Yes, there has been a huge accumulation of observations and studies which tie the warming that we have seen to the accumulation of heat-trapping pollution in the atmosphere. Of course, as Dr. Christy says, there is natural variability. There will always be natural variability. But on top of the natural variability there is an undeniable trend that is very significant and very dangerous.

Mr. MARKEY. So Dr. Lashof, tell us the status of the arctic right now, could you?

Mr. LASHOF. Right. So NASA released data yesterday showing that the arctic ice has fallen to about 3.4 million square kilometers at minimum. It is less than 50 percent of what it was in 1979. It is about a 49 percent reduction form the average over the whole period from 1979 to——

Mr. MARKEY. Thank you, Doctor.

I yield to the gentleman from Pennsylvania, Mr. Doyle.

Mr. DOYLE. Thank you, Mr. Markey.

You know, I would just say in conclusion to my friends, and many weren't here when we passed the cap-and-trade bill in the House, but I think one thing is clear. Mr. Hilton says, you know, he has an MOU with the Chinese. We are going to use coal for the foreseeable future, and even if we don't use it, China is going to use it, India is going to use it, other countries are going to use it. It only makes sense that if it is going to be used, we try to do it in the most efficient and environmentally safe way. To do that, we have to make an investment in it. These things are not going to happen by themselves. So either the Chinese are going to develop the technology, they are going to come over here and fund the project and part of that deal is, they get the technology and then they get to market it to the world or the United States does it. I would suggest that, you know, if we want to deal with coal, I would say to my friends on the other side of the aisle, let us put our money where our mouth is, and if you are going to pass a bill saying there is no commercially available technology, then where is the money to make that happen? And until we do that, other countries will do that and they will have the technology and we won't.

Mr. GARDNER. The gentleman's time is expired. The gentleman from Virginia, Mr. Griffith, is recognized for 5 minutes.

Mr. GRIFFITH. Thank you, Mr. Chairman.

Dr. Christy, did you want to respond to anything that the previous gentleman said? I know that he made some assertions about your positions and you didn't get a chance to respond. Would you like to do that at this time?

Mr. CHRISTY. I agree with those statements in 2003. I was one of the authors. There were no magnitudes on those statements. CO_2 is a greenhouse gas. It will cause surface warming. How much is the uncertainty.

Mr. GRIFFITH. And I would point out that one of the things that I see as a difference with what is happening now, and lots of time people like to talk about the market conditions, and clearly the market conditions are important, but one of the things that is interesting is, is that there was a reference to the horseless carriage

versus the horse-drawn vehicles, but we didn't outlaw horses at the same time as the horseless carriage was being developed and that is the big difference, and while I am getting older every day and thankful for that, I can remember in my youth a gentleman who in my hometown still had his team of horses to plow fields, and people felt he did a great job and he made a living doing that for a number of years well into the 1970s, and horses were not made illegal by the advent of the automobile.

Mr. Hilton, did I hear you say that—and I may have misunderstood so please get me straight—that in regard to the Kemper coal-fired power plant with what they are doing that there would be a 20 percent rate increase?

Mr. HILTON. That is what I have read, yes.

Mr. GRIFFITH. You know, this is part of what causes me great concern, and Dr. Christy, you touched on this earlier as well, is that we have all of these requirements and it is not just the one that we are debating today but we have numerous requirements coming in and every time we turn around there is a rate increase. We are already experiencing that in my district, which is a coal-producing district in southwest Virginia, but the folks, you know, many counties away from where the coal is actually dug are watching their electric rates go up and it is making it hard on the working poor and on the poor folks because they can't afford a 10 percent increase, or in this case, a 20 percent increase. And you mentioned that they were having similar problems in your community in Alabama. Is that true, or that you have noticed this?

Mr. CHRISTY. I would just say this, that we have many, many poor people in my State and any increase in cost of living for them is really a hardship.

Mr. GRIFFITH. And that is true in my district as well, and I think that is probably true in a lot of the districts across the United States, that what you have is, you have—when the price goes up, then it makes it hard.

And you know, what is interesting is, is that everybody likes to talk about the statement by the President when he said that they would bankrupt the facilities if they were using coal or whatever but they also mentioned at that time in 2008 he mentioned as well because on capping greenhouse gases, coal power plants, you know, natural gas, you name it, whatever the plants were, whatever the industry was, they would have to retrofit their operations. That will cost money. They will pass that money on to consumers. So I just find it rather interesting that the consumer side of this equation is often left out.

And Dr. Christy, you indicated that if the United States took all these actions and we reduced and continued to reduce our carbon footprint that it would be relatively—and I don't want to put your words in your mouth, I don't remember, something along the lines of negligible, is that correct?

Mr. CHRISTY. Yes.

Mr. GRIFFITH. In the world's output. But wouldn't you agree with me that it is not negligible to the families that are having to pay those higher increased prices for electricity to light and heat their homes or to run factories?

Mr. CHRISTY. Yes. I think anyone who sees their utility bill rise would feel the effect and it wouldn't be good for them.

Mr. GRIFFITH. And of course, we have got not just this regulation but lots of other regulations that are putting pressure on those prices, and then of course you have all these folks that are out of work because it is not just the 1,200 folks that are going to be laid off by Alpha Natural Resources, which, by the way, is headquartered in my district, but it is also all the other coalmines that have laid off people, sometimes 20 at a time, 30 at a time that people aren't necessarily noticing and then the people who are laid off from suppliers, joint manufacturing, other suppliers to the coalmines, the railroads that may not have had the effect yet but will have the effect, etc., and so you are going to have more and more people who are unemployed because we are insisting upon—for a negligible result, we are insisting upon taking our economy and throwing it in the trashcan for a negligible result on carbon footprint in the world and we are sending our jobs overseas to other countries and we are watching as they gain the wealth, and when there comes a time when there is a technology that may make things better, we won't have the money to buy that technology because we will have sent all of our wealth overseas.

Thank you, Mr. Chairman, and I yield back.

Mr. GARDNER. The gentleman yields back. The chairman recognizes himself for 5 minutes.

Thank you to the panelists for the opportunity to be here today and your testimony. Several years ago when Congress was considering its first greenhouse-gas bill, I received a letter from a couple of local rural electric associations that were talking about the price impact that that particular regulation would have on their customers. In fact, according to one analysis in northeastern Colorado, they determined that an average farmer, the average sprinkler cost for a farmer would increase by about $2,000 per sprinkler. This is a big pivot irrigation system, 160 acres. Now, if you are a farmer in eastern Colorado, you don't just have one pivot irrigation system; you have got five, maybe ten. That is $2,000 each. Maybe you have more. And so we are talking about considerable costs being added under their estimate from the rural electric association that that particular regulation would have on their customers' operations.

And so Mr. McCullough, or was it Mr. Hilton, that you mentioned rate increase of 20 percent. Is that correct?

Mr. HILTON. In Mississippi.

Mr. GARDNER. In Mississippi. And I would be curious to see if Mr. Trisko, are you hearing anything through the various businesses that you work with on rate increases?

Mr. TRISKO. Chairman, we understand that the Kentucky Public Commission has decided a number of cases. Now, this is for prospective Clean Air Act regulations for hazardous air pollutants and the like, not this proposed regulation, and the rate increases are on the order of 16 to 18 percent.

Mr. GARDNER. Mr. McCullough?

Mr. MCCULLOUGH. Yes, I would agree with that. We recently pulled down an order for a new scrubber for a plant in Kentucky that would have impacted customers there by over 30 percent.

Mr. GARDNER. Mr. Voyles?

Mr. VOYLES. Yes, as I have said in my testimony, the compliance plans that we recently got approved for the Utility MACT Rule and the New Source—the National Ambient Air Quality Standards are impacting our ratepayers by up to 14 and 18 percent, not counting anything on carbon.

Mr. GARDNER. And to follow up on Mr. Griffith's questions as well, these are costs that are passed on to your customers, your consumers. Is that correct, Mr. Hilton?

Mr. HILTON. Ultimately, of course.

Mr. GARDNER. Mr. Voyles?

Mr. VOYLES. As well as we have said before, we not only pass it along to all of our ratepayers but it passes along to the commercial industry so the food prices are impacted, McDonald's prices are impacted, everybody's prices are impacted.

Mr. GARDNER. And who does that affect the most disproportionately in our society? People on a fixed income, poor?

Mr. VOYLES. It certainly presents some significant challenges for fixed income.

Mr. GARDNER. Mr. McCullough, what happens to American business competitiveness with the rate increases of 20 percent, 18 percent, 14 percent?

Mr. MCCULLOUGH. Obviously, it further disadvantages them. We have seen that in our territory with especially aluminum smelters who—the Century aluminum plant in West Virginia went out of business with the recession and recently Ormat in our home State of Ohio has just announced that they are going to decrease their production.

Mr. GARDNER. Dr. Lashof, what happens to an economy where rates are increasing by 20 percent, the poor being hurt and those on fixed incomes are being hurt disproportionately?

Mr. LASHOF. Well, Mr. Chairman if we could return to the specific proposal that EPA has put forward, it would not cause any rate increases.

Mr. GARDNER. My question to you is, if rates increase by 20 percent, for a variety of reasons that have been mentioned, what happens to our economy? What happens to the poor? What happens to people on a fixed income?

Mr. LASHOF. It depends what else is happening in the economy. If people are using energy more efficiently, their costs might go down, which we have seen in many, many States that have invested in energy efficiency. You can't just look at rates.

Mr. GARDNER. If people that have low income are able to buy something that is more energy-efficient, that will help them?

Mr. LASHOF. Yes, and if we provide—and technology is improving on the efficiency side.

Mr. GARDNER. OK. So if people on a fixed income, are poor can afford to buy something new, then that will help them?

Mr. LASHOF. Well, as pollution also imposes more severe costs on poor people, they are exposed to it more, so the benefits of air-pollution regulations in fact go to the low-income people. So the EPA is actually required to look at costs and benefits when they propose regulations.

Mr. GARDNER. We have actually heard testimony in this committee before where they have failed to do an adequate analysis on cost and benefits, and this is, I think, one of the frustrating parts of this entire debate. Nobody doubts that we can do a better job when it comes to energy efficiency. There is no doubt about that. Nobody doubts that we have incredible opportunities in new energy. But the problem is, when we have regulations that come down from agencies that increase cost on developing energy, on consuming energy, it hurts our economy and it hurts the people who are most vulnerable in our society, and that seems to get left out of this entire debate is the people who are affected disproportionately are poor and low income because it hurts the economy and it hurts their ability to lift themselves and their families out of the position that they are in.

I see that my time is expired as well, and thank you very much to the panelists for being here, the witnesses for your time and testimony today. And with that, this hearing is adjourned.

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

[Material submitted for inclusion in the record follows:]

Questions for the Record to John R. Christy
Energy and Power Subcommittee Hearing, 20 September 2012
From: The Honorable Ed Whitfield

During your testimony, you said that we do not know enough about the climate even to predict heat waves and other extreme events. You made particular reference in your oral testimony to the journal Nature. Would you please elaborate what this Nature article reported?

Response:

An editorial from *Nature* magazine was published the same day of the hearing with the title "Extreme Weather – Better models are needed before exceptional events can be reliably linked to global warming" (*Nature*, 20 September 2012, vol 489, pg 335-6.) I was unaware of the article until the hearing day, so was unable to include it in my written remarks, but did so in my oral presentation. The emphasis in the article agrees with my statement that our level of understanding about the climate system is so low that we cannot predict nor attribute unusual events to human emissions of greenhouse gases. The article discusses the problem that current climate models are not "fit to inform legal and societal decisions" without further "enormous research" because at present they are not ready for such tasks.

The article notes that extreme events "have complex causes, involving anomalies in atmospheric circulation, levels of soil moisture and the like." The comments of one scientist at a recent workshop on the topic indicated "the coarse and mathematically far-from-perfect climate models used to generate attribution claims ... are unjustifiably speculative, basically unverifiable and better not made at all." Not all participants felt this way, however *Nature* reported that, "None of the industry and government experts at the workshop could think of any concrete example in which an attribution might inform business or political decision-making." In other words, industry and government would prefer an accurate forecast over the notion of attributing that forecast to a particular cause. Unfortunately, the ability to make accurate forecasts is a long way off.

My written presentation gave evidence that models as yet are not capable of even replaying the past climate, much less that of the future.

John R. Christy
The University of Alabama in Huntsville
8 Oct 2012

THIS WEEK

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Through the gaps

A 20-year campaign of scientific fraud says as much about the research community as it does about the perpetrator. The system that allowed such deception to continue must be reformed.

Many questions are provoked by the shocking case of Yoshitaka Fujii, the Japanese anaesthesiologist who seems likely to set a record for the highest number of retracted papers by a single scientist. His entire list of publications has come under scrutiny: his trail of deception seems to have wound through almost 200 scientific articles over 20 years. Twenty years! How could it go on for so long?

As the News story on page 346 details, Fujii seems to have fabricated multiple studies wholesale, in some cases inventing participants. Nobody noticed — not his collaborators, funders, home institutions or journal editors. Or at least, nobody took action.

In retrospect, as in all cases of scientific fraud, the bulk of the questions will, rightly, focus on how to make sure that it cannot happen again. That, and why so much time passed before anyone investigated how Fujii was publishing clinical studies at impossible speed.

Fujii pulled the wool over the eyes of many different people — chief among them, various employers, whom he also falsely claimed had approved his studies, and journal editors. (One editor has publicly issued a mea culpa.) Perhaps most puzzling is that Fujii fooled his co-authors, one of whom published dozens of papers with him. The co-authors say that they had no suspicions; the Japanese Society of Anesthesiologists, which had a key role in exposing Fujii's fraud, is investigating.

But let's be honest. Even assuming that any co-author had suspicions, the current system means that it would not have been easy to raise the alert. It can be difficult to document a colleague's errant ways, and whistle-blowers might put their own careers at risk by angering a senior member of the field.

Those who inform authorities about other types of fraud sometimes get rewards. For example, the US government last week paid out its — and probably the world's — biggest ever payment to a whistle-blower. The former banker, who was jailed for his own role in a tax-evasion scandal, received US$104 million. Observers — especially lawyers — are pointing out that such windfalls might be the only way to encourage more insiders to put their necks on the line, which remains the most effective way to protect against such crimes.

That method is probably unworkable in science. Funders won't have that kind of cash to throw at scientific whistle-blowers. And imagine the uproar, not least in these pages, if whistle-blowers routinely got payouts bigger than the grants available for science projects through competitive peer review.

In the tax-evasion case, the figure was justified because it was only a small fraction of what the US government was able to recoup. But governments should also consider the amount of waste incurred by research fraud, especially when that fraud is carried out over decades and enshrouded in the scientific literature. On financial grounds alone, there are sound reasons for the authorities to increase the resources invested in efforts to limit academic misconduct, without the need to provide monetary rewards.

Japan, for example, could make it easier for whistle-blowers to take their claims to an external body, rather than to their employers. In theory, the country already has such a system. But in practice, agencies at the relevant ministries merely forward claims to the institutions involved, leaving whistle-blowers vulnerable.

"On financial grounds alone, there are sound reasons for the authorities to increase the resources invested in efforts to limit academic misconduct."

In the wake of the latest scandal, there are signs of positive change. The Japanese Society of Anesthesiologists was so frustrated at the lack of an effective whistle-blowing mechanism that it plans to establish one. A group of 23 journal editors deserves credit for effectively, if belatedly, rooting out Fujii's problematic publications. And statistical approaches to evaluating results — such as those used to show that Fujii's data were far too perfect — are becoming more familiar, more readily available and, hopefully, more accepted as a legitimate way to audit published findings and raise red flags where necessary.

It is important to note that although this latest case of fraud seems (again) to be an anomalous, extreme example involving one individual, the problems that allowed it to persist are endemic in scientific communities around the world. It is equally important to say (again) that they must be addressed in comprehensive fashion. ■

Extreme weather

Better models are needed before exceptional events can be reliably linked to global warming.

As climate change proceeds — which the record summer melt of Arctic sea-ice suggests it is doing at a worrying pace — nations, communities and individual citizens may begin to seek compensation for losses and damage arising from global warming. Climate scientists should be prepared for their skills one day to be probed in court. Whether there is a legal basis for such claims, such as that brought against the energy company ExxonMobil by the remote Alaskan community of Kivalina, which is facing coastal erosion and flooding as the sea ice retreats, is far from certain, however. So lawyers, insurers and climate negotiators are watching with interest the emerging ability, arising from improvements in climate models,

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to calculate how anthropogenic global warming will change, or has changed, the probability and magnitude of extreme weather and other climate-related events. But to make this emerging science of 'climate attribution' fit to inform legal and societal decisions will require enormous research effort.

Attribution is the attempt to deconstruct the causes of observable weather and to understand the physics of why extremes such as floods and heatwaves occur. This is important basic research. Extreme weather and changing weather patterns — the obvious manifestations of global climate change — do not simply reflect easily identifiable changes in Earth's energy balance such as a rise in atmospheric temperature. They usually have complex causes, involving anomalies in atmospheric circulation, levels of soil moisture and the like. Solid understanding of these factors is crucial if researchers are to improve the performance of, and confidence in, the climate models on which event attribution and longer-term climate projections depend.

Event attribution is one of the proposed 'climate services' — seasonal climate prediction is another — that are intended to provide society with the information needed to manage the risks and costs associated with climate change. Advocates of climate services see them as a counterpart to the daily weather forecast. But without the computing capacity of a well-equipped national meteorological office, heavily model-dependent services such as event attribution and seasonal prediction are unlikely to be as reliable.

At a workshop last week in Oxford, UK, convened by the Attribution of Climate-related Events group — a loose coalition of scientists from both sides of the Atlantic — some speakers questioned whether event attribution was possible at all. It currently rests on a comparison of the probability of an observed weather event in the real world with that of the 'same' event in a hypothetical world without global warming. One critic argued that, given the insufficient observational data and the coarse and mathematically far-from-perfect climate models used to generate attribution claims, they are unjustifiably speculative, basically unverifiable and better not made at all. And even if event attribution were reliable, another speaker added, the notion that it is useful for any section of society is unproven.

Both critics have a point, but their pessimistic conclusion — that climate attribution is a non-starter — is too harsh. It is true that many climate models are currently not fit for that purpose, but they can be improved. Evaluation of how often a climate model produces a good representation of the type of event in question, and whether it does so for the right reasons, must become integral to any attribution exercise. And when communicating their results, scientists must be open about shortcomings in the models used.

"To make this emerging science of 'climate attribution' fit to inform legal and societal decisions will require enormous research effort."

It is more difficult to make the case for 'usefulness'. None of the industry and government experts at the workshop could think of any concrete example in which an attribution might inform business or political decision-making. Especially in poor countries, the losses arising from extreme weather have often as much to do with poverty, poor health and government corruption as with a change in climate. The United Nations is planning to set up a fund with the aim of reducing loss and damage due to climate change, but the complexity of such issues is making negotations difficult.

These caveats do not mean that event attribution is a lost cause. But they are a reminder that designers of climate services must think very clearly about how others might want to use the knowledge that climate scientists produce. That could be a task for social scientists, who have good methods for analysing decision-making and social transactions. They need to be more involved in shaping the production and dissemination of climate knowledge. ■

Return to sender

The bid to halt air transport of lab animals poses an imminent threat to biomedical research.

This week, the campaign group People for the Ethical Treatment of Animals (PETA) will take another step forward in its long-running, and increasingly successful, campaign to halt the transport by air of animals destined for the laboratory. It will announce that FedEx and UPS, the world's two largest cargo carriers, have written to it to affirm existing policies restricting the transport of most lab animals (see page 344). On the face of it, this seems pretty inconsequential. After all, neither carrier moves many research animals, and there are plenty of cargo firms that could make up any shortfall caused by PETA's pressure.

But appearances are deceptive: there could yet be an immediate and highly problematic effect. UPS has also said that it plans to change its policy soon to restrict the transport of amphibians, insects, crustaceans, molluscs and fish — all of which it allows at present. This could disrupt everything from the availability of the important frog model, *Xenopus* — three of whose major US-based suppliers rely on UPS next-day delivery — to the provision of the fruitfly *Drosophila* to international clients by the Bloomington Drosophila Stock Center at Indiana University.

And with PETA increasing the pressure, who is to say whether FedEx would not follow its arch-rival's lead and halt the transport of insects and other lower species? As with UPS, the effect would be huge. To name just a couple: FedEx currently ships fruitflies from suppliers including the Drosophila Species Stock Center at the University of California, San Diego, and Carolina Biological Supply in Burlington, North Carolina. The latter uses FedEx to ship *Drosophila*, along with crayfish, mussels and many other non-mammals, to science teachers.

If this is not enough to make scientists sit up and take notice, they might consider the use of lab rodents, now under threat in India from a PETA campaign to halt the transport of all research animals by Air India. The National Institute of Nutrition in Hyderabad, a major government supplier of specialized mice, relies on the airline. As PETA undertakes a systematic push to target all major cargo carriers, scientists in any country who rely on air freight to deliver rodents should be on notice that their turn may be next. Of course, in the increasingly global world of science it is already, in many senses, everyone's turn.

The pronouncements by FedEx and UPS, together with similar bans on animal movement made previously by airlines and ferry companies, are especially worrying because they indicate that biomedical researchers in many different countries, through reticence and passivity, are losing the battle for the hearts and minds of the public when it comes to the need for, and legitimacy of, animal research. Why else would high-profile companies be willing to indicate, however implicitly, that they want no part in a transportation infrastructure that is crucial to global biomedical science?

If individual scientists wait until they are personally affected — until the day when that mouse carefully bred in Shanghai or Singapore or Stockholm cannot be had for love nor money in San Francisco — it will be long past too late to mount the vigorous, public campaign in defence of animal research that is so sorely called for at this moment.

As researchers join this battle — and join it, they must — they should, as a first step, work through their institutions, academic societies and umbrella groups to make an urgent, articulate, unified case to UPS and FedEx that the shipping of animals, mammalian and otherwise, is essential for both biomedical research and scientific education. ■

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