Hearing

on

Future Options for Generation of Electricity from Coal

U.S. House Committee on Energy and Commerce,

Subcommittee on Energy and Air Quality

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Summary

Coal's future as an option for the generation of electricity will be determined in large part by how societies respond to the problem of global warming, caused predominantly by emissions of carbon dioxide from the combustion of fossil fuels like coal.

A perception that coal use and climate protection are irreconcilable activities has contributed to a policy impasse on confronting the issue of global warming. This impasse will protect neither the coal industry nor the planet. While energy efficiency and greater use of renewable resources should remain core components of a comprehensive strategy to address global warming, development and use of technologies that capture carbon dioxide and store it permanently in geologic repositories could enhance our ability avoid a dangerous build-up of this heat-trapping gas in the atmosphere.

However, because of the long lifetime of carbon dioxide in the atmosphere and the slow turnover of large energy systems we must act without delay. Current government policies are inadequate to deliver economically attractive carbon capture and storage systems in the timeframe we need them. To accelerate the development of these systems and to create the market conditions for their use, we need to focus government funding more sharply on the most promising technologies. More importantly, we need to adopt reasonable binding measures to limit global warming emissions so that the private sector has a business rationale for prioritizing investment in this area.

Further delay in adopting serious efforts to reduce global warming emissions is a decision to commit the next generation to a large and effectively irreversible build-up of heat-trapping gases in the atmosphere. Given what we already know such a decision would not be responsible.

Introduction

Mr. Chairman and members of the Subcommittee, thank you for inviting me here today to testify on behalf of NRDC, the Natural Resources Defense Council, on the subject of "Future Options for Generation of Electricity from Coal."

Coal is an abundant fuel both in the U.S. and in a number of other countries. We have used coal to our economic advantage in the U.S., fueling our industrial growth from the first years after the War of Independence and in the past century helping to bring electricity to nearly every home and hamlet in our country. There is no denying that our use of the coal that eons of biological and geological processes bequeathed us has brought great benefits.

There is also no denying that our use of coal has caused great harm to the health of workers, the general public and the environment. As a society we have decided to tackle many of the health and environmental problems caused by coal's use and we are doing a good job addressing a number of these problems. Indeed, the U.S. leads the world in addressing many of the problems caused by coal's use. But there is one problem from coal that we as a society have not yet decided to take on in a serious manner.

I refer of course to the problem of carbon dioxide emissions resulting from coal as it is used today. As you know, carbon dioxide or CO_2 is the principal global warming gas. Because CO_2 has a long lifetime in the atmosphere, dramatically increased use of coal and other fossil fuels since the industrial revolution has caused a buildup in concentrations of this heat-trapping gas in the thin layer of life-giving atmosphere that surrounds our planet.

Our current policy regarding global warming is dysfunctional: it will not protect the use of coal and it will not protect the planet from global warming. The coal industry must acknowledge, like it or not, that the problem of global warming cannot be denied or wished away. Environmental advocates must acknowledge, like it or not, that the use of coal cannot be wished away. Denial of these facts is not a strategy for success for either group's priorities or for society's interests.

Today I would like to describe why we must not delay in acting to address the problem of global warming. If we wait longer we will eliminate the option for our children to avoid risky levels of global warming gases in the atmosphere—levels that will persist for a century or more after we have decided to do something to lower them. If we act now to chart a reasonable program of clear binding limits on global warming emissions, combined with financial incentives for advanced technologies for energy sources, including coal, we can avert the worst of global warming and provide a more plausible basis for the continued use of coal as a major energy resource.

The Problem

Despite the chaff that is thrown up when global warming is discussed as a political matter, the basic science is well understood. President Bush' Science Advisor, Dr. John Marburger provides an accurate, though not comprehensive summary of our knowledge:

> "Concentrations of greenhouse gases, especially carbon dioxide, have increased substantially since the beginning of the industrial revolution. Careful studies show that around 1750 the concentration of carbon dioxide in the atmosphere was 280 parts per million (ppm) and the concentration today is 370 ppm. The National Academy of Sciences indicates, in a report prepared at the request of the White House, that the

> increase of carbon dioxide is due in large part to human activity, although we cannot rule out that some significant part of these changes is also a reflection of natural variability. And the carbon dioxide increases are expected to result in additional warming of the Earth's surface."[1]

Dr. Marburger describes what we know about what we have done to the atmosphere already. More problematic is what lies ahead. Growth in global population and affluence means large and continuing increases in CO_2 from energy use unless we succeed in deploying energy resources that do not emit CO_2. Figure 1, taken from current forecasts from the U.S. Energy Information Administration and the International Energy Agency, shows that U.S. CO_2 emissions from energy will grow by 40 per cent in the next 25 years and global emissions will grow by nearly 70 per cent in the next 30 years.

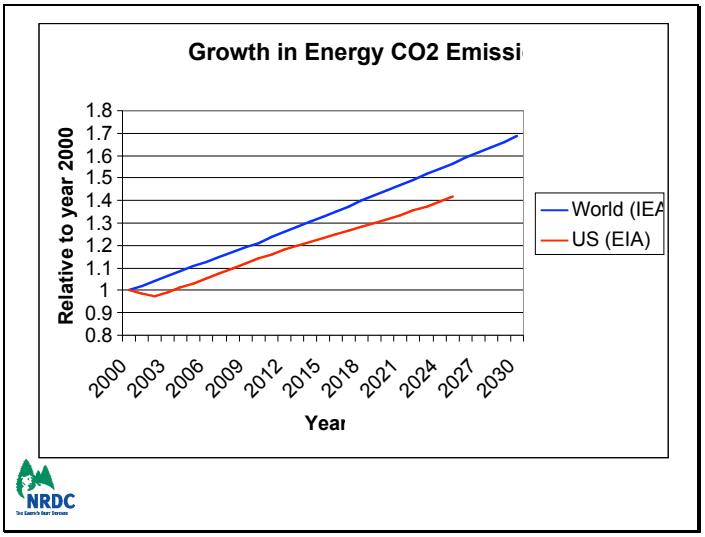

Figure 1

Absent very large changes in world energy systems, we are on our way to doubling CO_2 concentrations from pre-industrial levels before a child born today or a coal power plant built

[1] "The President's Carbon Intensity Reduction Initiative," keynote address by Dr. John Marburger Director, Office of Science and Technology Policy, Executive Office of the President at USDOE Conference on Carbon Sequestration, Alexandria, Va., May 6, 2003

today, retires. A child's retirement may seem like a long way off but given the inertia in energy systems and persistence of global warming emissions in the atmosphere, it is not. If we are to have clean energy resources in place at the required scale and when we need them, we must set the economic and policy forces in motion now.

Managing global warming emissions is a problem of logistics. We understand from the history of armed conflict that large amounts of personnel and materiel cannot be assembled and deployed overnight: months, sometimes years of mobilized effort are required to place these resources where we want them when we want them. Supplying clean energy resources for a growing world is even more challenging.

Figure 2 shows the required "build-rates" of clean energy resources, starting today if we are to keep global temperatures from increasing by more than 2 degrees Centigrade due to manmade emissions of global warming gases.

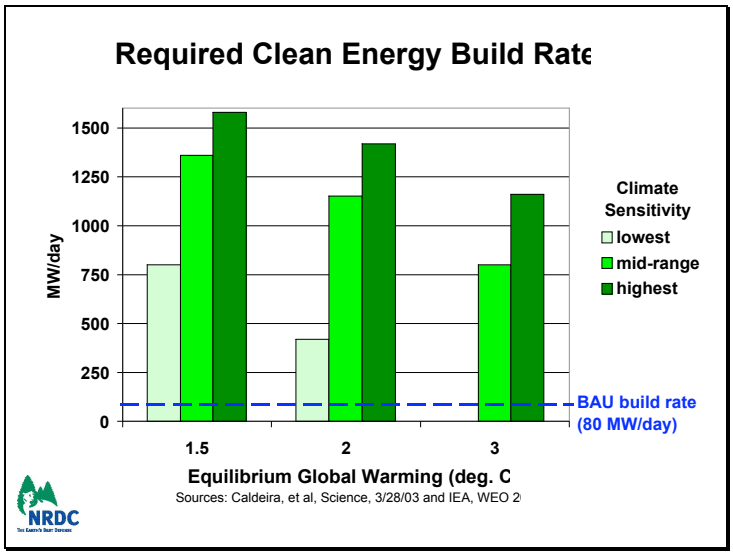

Figure 2

The results, published recently in the magazine *Science,* are sobering: globally we should be building between 400 and 1300 megawatts of zero-carbon-emitting capacity *per day* between

now and 2050 to meet the world's energy needs in that year and avoid a commitment to warming unprecedented in the history of modern human civilizations.[2] Yet the forecasted "clean energy " build rate for the next 30 years is a fraction of that need: only 80 megawatts per day.

I hope this fact demonstrates the basic policy irrelevance of the argument over how rapidly the climate will warm due to manmade emissions. The *Science* study shows that even if the climate only warms at the slowest warming rate in the literature, we are not building anywhere near enough low-carbon energy resources to avert a change in the earth's climate that is potentially calamitous.

The Opportunity

Secretary of Energy Abraham has said the following about our options to address this problem:

> "Until a few years ago, there were basically only two ways to address the challenge of global climate change. One was to produce and use energy more efficiently. The second was to rely increasingly on low-carbon and carbon-free fuels.
>
> We have made great strides in energy efficiency. We have made substantial progress in bringing down the costs of renewable energy, and we are working to reestablish the nuclear power option. But when you look at most credible projections for escalating energy use around the globe in the next century - and you predict the rising levels of carbon emissions likely to result - you come to an inevitable conclusion: energy efficiency and alternative energy, alone, may not be enough to stabilize global concentrations of carbon dioxide. Not unless you assume that all nations of the world --

[2] K. Caldeira *et al*., "Climate Sensitivity Uncertainty and the Need for Energy Without CO_2 Emission," *Science* **299,** 2052 (2003). To put a 2 degree Centigrade warming in context, recall that the global average temperature during the last ice age was only 5 degrees cooler than today.

> developed and developing -- undertake a massive overhaul of their energy infrastructures in a relatively near - and relatively quick -- time frame.
>
> I'm not here to offer a detailed assessment of the practicability of those assumptions, but I'm inclined to think the odds are strongly against them."[3]

There is much in Secretary Abraham's statement I would agree with: energy efficiency and renewable energy resources are the core components of a successful strategy to keep global warming emissions from spiraling out of control. We need to do much more to meet our growing energy requirements by increasing our use of these resources. But a clear-eyed look at the deployment rates for renewable and efficiency resources to date raises a serious question whether we will in fact use them at the scale and in the time frame required to keep global warming emissions from becoming a runaway problem.

That concern alone causes me to believe it would be wise to rapidly determine how much we can rely on capture and geologic[4] storage of CO_2 from fossil energy resources like coal as a third tool to cut global warming emissions—a third horse in a troika if you will. There would be technical and policy benefits from proving out the approach of CO_2 capture and storage (CCS). Supplementing efficiency and renewable energy with CCS to meet growth in energy needs has the potential for avoiding the otherwise enormous forecasted increases in global CO_2 emissions. CCS also has the potential for decoupling the politics of coal from the politics of global warming. It is understandably difficult for the producers, shippers and users of coal to acknowledge the reality of global warming if they believe that doing so is a death sentence for their current line of business. And leaders of nations like the U.S., China, India, Russia, Australia, to mention just a few, that have large coal reserves, have resisted effective measures to

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[3] Remarks of Energy Secretary Spencer Abraham to the National Coal Council on November 21, 2002.

[4] Other concepts, such as biomass storage and ocean disposal, apart from presenting large ecosystem risks, do not prevent fossil carbon from being added to the total carbon in the biosphere thus inevitably increasing atmospheric carbon levels.

curb global warming, in part due to concerns about the economic and energy implications of limiting the use of their coal resources.

If we want to make CCS available as an option we need policy action to make it happen. While the components of CCS all have been demonstrated technically in first or second generation form and are in limited commercial use, mostly outside the electricity sector, the private sector today does not have an adequate economic rationale for making the investments to optimize capture technologies, to prove out the viability of geologic storage, or to incur the costs of storing CO_2 once captured. I believe a combination of publicly-funded financial incentives and a schedule of market-based limits on CO_2 emissions is the policy package needed to achieve these objectives. The current policy approach of an expensive but still limited research, development and demonstration program will not give us the results we need in the time we need them.

The Imperatives of Time and Scale

For CCS to play a significant role in avoiding carbon emissions in the next few decades we need to do a lot in a short amount of time, compared to the usual pace of energy system development. Growth in global demand for energy, commitments to new coal-fired capacity, and the aging U.S. coal fleet all place a premium on accelerating our efforts to deploy commercially viable energy plants amenable to CO_2 capture and to conduct numerous, rigorously monitored full-scale geologic storage demonstrations.

Consider the issue of new coal plant construction. As figure 3 shows, today's global coal-fired electric generating capacity is about 1000 gigawatts (one gigawatt is 1000 megawatts: the size of one very large power plant). U.S. coal-fired capacity amounts to just over 300 gigawatts of this

total. The International Energy Agency (IEA) forecasts that between now and 2030 over 1400 gigawatts of new coal capacity will be constructed.

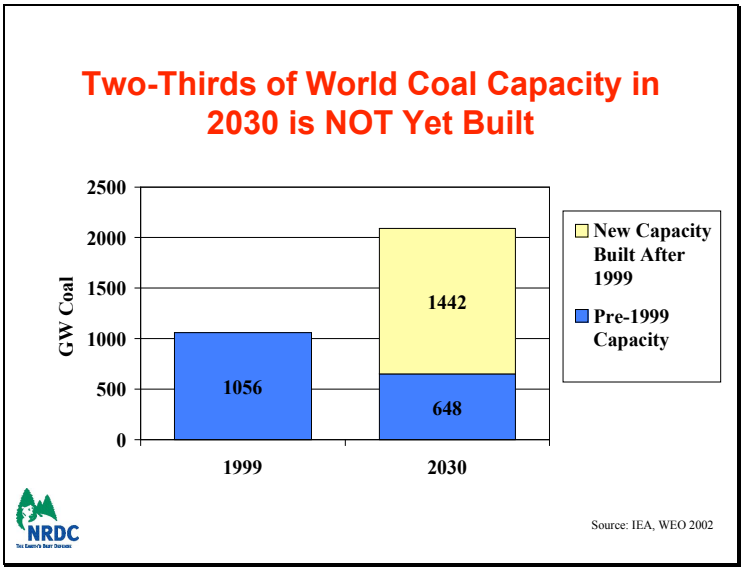

Figure 3

The IEA forecast is a challenge and an opportunity. If all of this forecasted capacity is built using conventional technology it would commit the planet to total carbon emissions approaching 140 billion metric tonnes over the lifetime of these plants, unless one assumes that they are backfit with carbon capture equipment at some time during their life. To put this number in context, it amounts to half the estimated total cumulative carbon emissions from all fossil fuel use globally over the past 250 years! If we build any significant fraction of this new capacity in a manner that does not enable capture of its CO_2 emissions we will be creating a "carbon shadow" that will darken the lives of those who follow us.

Yet a forecast is not destiny. We can avoid this very large carbon commitment by a combination of efficiency, renewable energy and designs for new fossil plants that are capable of capturing their CO_2. Because these plants are not built yet, we have more options than we do with existing

plants. Yet, as with all market opportunities, the market does not wait for the product. If the CCS product is not proven in time, the market will choose something else. As figure 4 shows, the rate of new capacity will grow every decade between now and 2030. We are likely already too late to shape the design of much of the new capacity being built in this decade. But by stepping up our efforts now, we can influence the market choice for the nearly 500 gigawatts of new coal capacity in the next decade and 700 gigawatts of additional capacity in the decade that follows that.

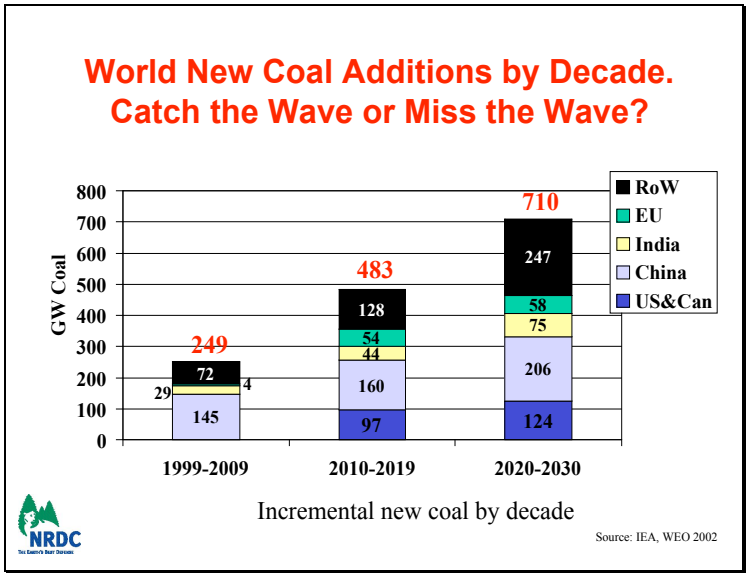

Figure 4

Next consider the issue of aging U.S. coal capacity. It too represents a market challenge and opportunity. As figure 5 shows, by 2015 (just 3 years after the current administration's carbon intensity checkpoint), nearly one-third of the current U.S. coal fleet will be more than 50 years old; about one-tenth will be older than 60 years. In 2025 two-thirds of today's coal capacity will be older than 50 years.

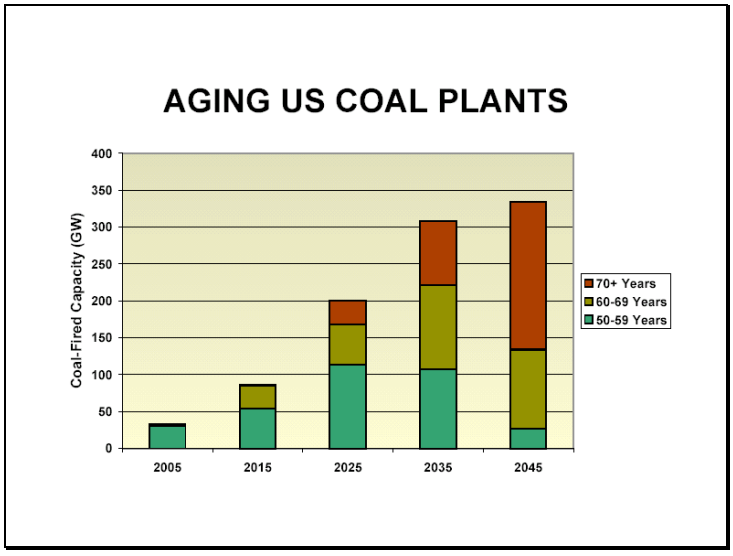

Figure 5

We don't have any experience with running large plants longer than 50 years, so prediction of retirement is difficult. But it is likely that as these plants age an increasing fraction of this capacity will be replaced with something new. Both the coal market and our ability to control global warming depend greatly on the answer. If we do not develop CCS technologies in time to meet this market demand, we will be playing a game of technological chicken that either the coal industry or the planet's climate will lose. On the one hand this capacity could be replaced by renewable energy or natural gas; an outcome that would help protect climate but not one that the coal industry would like. On the other hand the coal industry might succeed in replacing this capacity with new carbon-emitting coal plants. Though I consider it unlikely such plants could receive financing, this outcome would exacerbate global warming.

Finally, consider the scale of deployment of CCS needed to get the U.S. on a path consistent with stabilizing global warming emissions at levels less than double pre-industrial levels. DOE's National Energy Technology Lab (NETL) has published a Sequestration Roadmap that assesses

the contribution that CCS could make to an emissions path that gradually slows and then stops growth in U.S. global warming emissions.[5]

NETL's Roadmap scenario assumes a path for U.S. global warming emissions that meets the administration's "carbon intensity improvement" goal between now and 2012, then grows at one-half the EIA reference case forecast until 2020, and then flattens from 2020 to 2050, the end of the NETL scenario period. Figure 6 shows U.S. CO_2 emissions under the NETL Roadmap: in 2020 about 200 million metric tonnes of carbon reductions are needed and by 2050, over 1.6 billion metric tonnes of reductions from reference growth projections are needed.

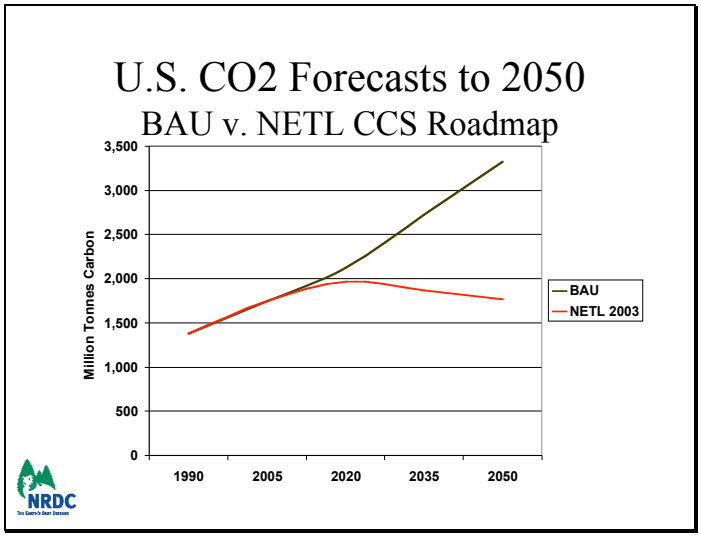

Figure 6

To achieve this level of reductions NETL assumes a combination of enhanced efficiency and renewable energy use, storage of CO_2 in forests and soils, and a significant amount of geologic storage of CO_2 captured from industrial gas streams. As figure 7 shows, under the NETL Roadmap CO_2 reductions from CCS amount to about half of the achieved reductions in 2020 and avoids over 1 billion metric tonnes of CO_2 by 2050 compared to the reference case.

[5] NETL, *Carbon Sequestration, Tehchnology Roadmap and Program Plan*, March 12, 2003.

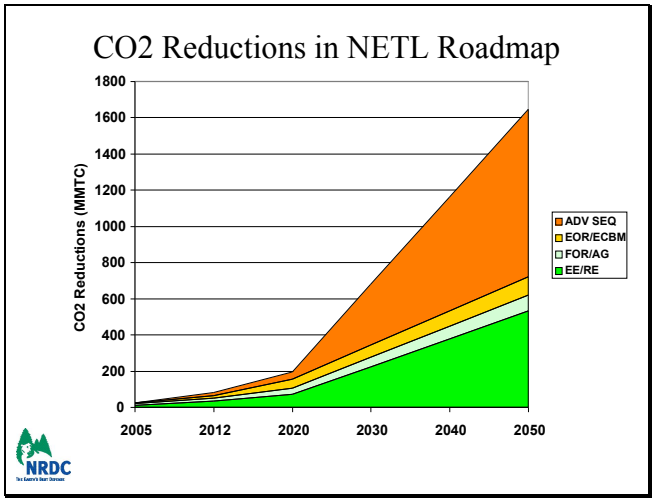

Figure 7

As I will discuss below, to preserve the option of stabilizing global warming emissions at prudent levels, we will need even more than this amount of reductions from U.S. reference case forecasts. Yet, given the policies now in place, it is very questionable that even the reductions assumed in the NETL Roadmap will occur. Capturing and storing the amounts of CO_2 assumed in the NETL Roadmap will require building a significant amount of coal-based generating capacity that is equipped with CCS technology. There are large benefits to be gained by accelerating the use of CCS as is assumed in the Roadmap but to cause that to happen, it will be necessary to adopt new policies to engage the private sector in making the significant investments required.

Figure 8 shows the amount of coal-based generating capacity that would need to be equipped with CCS technology after 2020, assuming those sources provide the bulk of the captured carbon after that date. In 2020 about 20,000 megawatts (about 60 medium-sized generating units) of CCS-equipped coal capacity would be needed: a modest amount compared to what is required in the following decade but large considering that DOE is proposing a $1 billion effort to build one

such plant (FutureGen) that would come on line toward the end of this decade. Going from one plant operating around 2008 to perhaps 50 operating in 2020 is likely to happen only if supported with a combination of government financial support and government policies that provide a business incentive, by limiting CO_2 emissions on a reasonable but clear schedule.

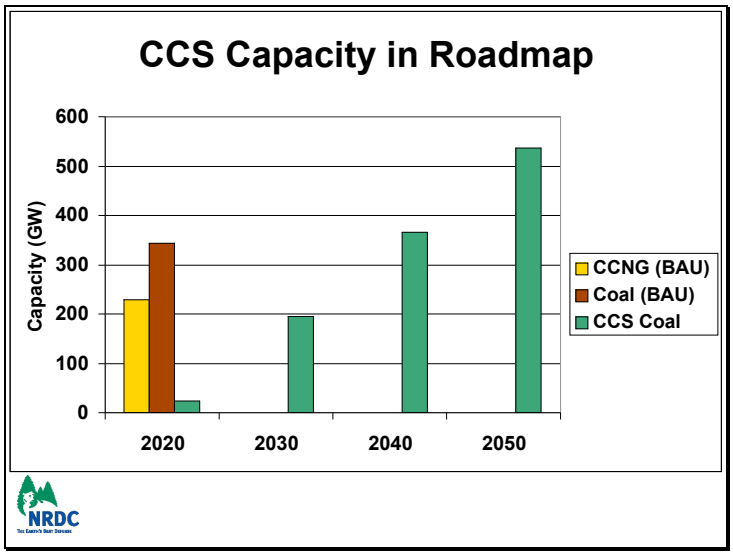

Figure 8

Even more striking in figure 8 is the amount of coal-based capacity that would need to use CCS in the years following 2020: 200 gigawatts by 2030 (two-thirds of today's coal plant total) and over 300 gigawatts by 2040.

If we are to create this future we need to send the policy signals now. I submit there is a policy disconnect between the DOE program for CCS and the administration's proposal for addressing air pollution from existing power plants.[6] As you know, the administration's Clear Skies Act contemplates compliance schedules extending to 2018 for these plants. Yet the administration is seeking funding for a DOE program plan that contemplates significant activity to capture CO_2

[6] I will mention the Clear Skies Act only in passing in this testimony, with the hope that NRDC will be afforded an opportunity to present our substantial concerns with this legislation in greater detail at a future hearing.

from this sector in the same time frame. If we want coal-based plants to be using CCS systems by phase 2 of the Clear Skies Act would it not make sense to incorporate carbon management policies into that Act?

Finally, let me observe that the deployment schedule for CCS systems would need to be more rapid than assumed under the NETL Roadmap if planners are to count on it to replace aging U.S. coal capacity. As shown in figure 5, nearly 90 gigawatts of coal capacity will be more than 50 years old in 2015, an amount much greater than the assumed 20 gigawatts of CCS penetration by 2020 in the NETL Roadmap.

Comments on current policy

Current policy to promote development and deployment of CCS systems consists of federal RD&D funding and proposed federal tax credits. I would like to make two points about these provisions. First, the existing and proposed RD&D and tax provisions need more focus on the most promising technologies to enable CCS in the near term. Second, and most important, these publicly-funded financial incentives need to be accompanied by policy measures that will give CO_2 a value in the marketplace in order to assure a timely return on the public's investment and to create incentives for the required private sector investments.

Research, Development and Demonstration

The House Energy bill, H.R. 6, contains proposals for significant expansion of funding for fossil energy RD&D, including a $2 billion 10-year authorization earmarked for the "Clean Coal

Power Initiative." A major issue in the CCPI is the degree to which Congress should ensure this sizable funding program is focused on systems that are capable of capturing CO_2. Given the dominant role that coal use plays in producing global warming emissions and the potential benefits of perfecting methods to capture carbon from coal-based technologies, I would argue that the top priority for federal coal RD&D should be early deployment of carbon capture systems at full commercial scale. But the current provisions are not structured to achieve this objective.

There is a substantial difference in the readiness of different coal conversion systems to employ carbon capture technology. As noted by the National Research Council, gasification technologies produce a stream of comparatively concentrated CO_2 that is amenable to capture at costs and energy penalties that are substantially less than currently known methods applicable to conventional coal combustion technology.

In recognition of this fact, last year's House CCPI provisions required that 80 per cent of the authorized funding be used for demonstration of gasification-based systems. In contrast, this year's bill provides that at least 60 per cent of the funds be used for gasification approaches. While we should not rule out attention to carbon capture from combustion-based coal systems, it appears they are much farther from commercial deployment than are gasification-based approaches. Accordingly, NRDC urges that more of the $2 billion CCPI authorization be dedicated to gasification systems.

The tax credit provisions in pending House legislation, such as H.R. 1213, are even more problematic. Very substantial investment and production tax credits are authorized for coal-based generation plants. Yet, the eligibility conditions for these tax credits are structured so that

substantial amounts of the available funds are directed toward existing coal plants that make only modest improvements in efficiency and control of conventional pollutants. The problem is that such investments will not advance the technology needed to harmonize coal use with global warming concerns. These funds can only be spent once. Allocating funds to patch up existing units rather than buying down the costs of carbon capture technologies is akin to buying aspirin to treat cancer.

Part of the rationale for these tax credit provisions is to keep older, smaller coal plants running to avoid losses in coal production currently going to such plants. Yet, if the public policy purpose is to maintain this production, why not develop a proposal that would repower such older capacity with systems that demonstrate and buy down the costs of carbon capture technology? Such an approach would assure that limited funds are not diverted from the country's top priority needs to provide a short-term palliative.

Policies to engage the private sector

The central flaw in the current policy suite to promote use of low-carbon energy resources, including coal with carbon capture and storage, is the absence of any market-based policy driver

to rationalize private sector investments at the scale required to produce timely solutions to the problem of global warming. As long as government policy is confined to public subsidies and exhortations for voluntary efforts, there is little to no business case to be made for private sector investments at the requisite scale.

Academic economists have recognized that voluntary approaches are inherently less effective in driving improvements, affecting the behavior of only one segment of industry and weakly at that.[7]

Moreover, the National Coal Council, in its May 2003 report to the Secretary of Energy on *Coal-Related Greenhouse Gas Management Issues* acknowledges the lack of private sector incentives under the current policy structure:

> "IGCC may only become broadly competitive with PC and NGCC plants under a CO_2-restricted scenario. Therefore, vendors currently do not have an adequate economic incentive to invest R&D dollars in IGCC advancement. Similarly, power companies are not likely to pay the premium to install today's IGCC designs in the absence of clear regulatory direction on the CO_2 issue."[8]

It is obvious that some mandatory global warming emissions control programs can have adverse impacts on the coal industry. It is less obvious but equally true that the status quo policy is likely to have adverse impacts on the coal industry by failing to create a business case for the technologies that are required to permit continued coal use in a carbon-constrained world. The

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[7] *See, eg,* Lyon, *Voluntary versus Mandatory Approaches To Climate Change Mitigation,* Resources for the Future Issue Brief 03-01, February 2003

[8] National Coal Council, *Coal-Related Greenhouse Gas Management Issues* at 65. May 2003. IGCC means integrated gasification combined cycle; PC means pulverized coal; NGCC means natural gas combined cycle.

policy question I hope this Subcommittee and Congress will address without delay is not whether to adopt a binding program to limit global warming emissions but what program to develop. Further delay will not protect the coal industry and certainly will not protect the planet from global warming.

Conclusion

In conclusion let me return to the NETL Roadmap to make a final point about the cost of delay. While the Roadmap is ambitious in the current policy context, it is much less ambitious than required to preserve options to stabilize global warming concentrations at prudent levels. As shown by figure 9, we will need to do more than stop U.S. emissions growth in 2020 if we are to retain our ability to stabilize concentrations at levels less than double pre-industrial concentrations.[9] Unfortunately, if we cannot do better than the NETL Roadmap we will forfeit the ability to stabilize concentrations at 450 and make it close to infeasible to meet a 550 ppm (double pre-industrial concentrations) level.

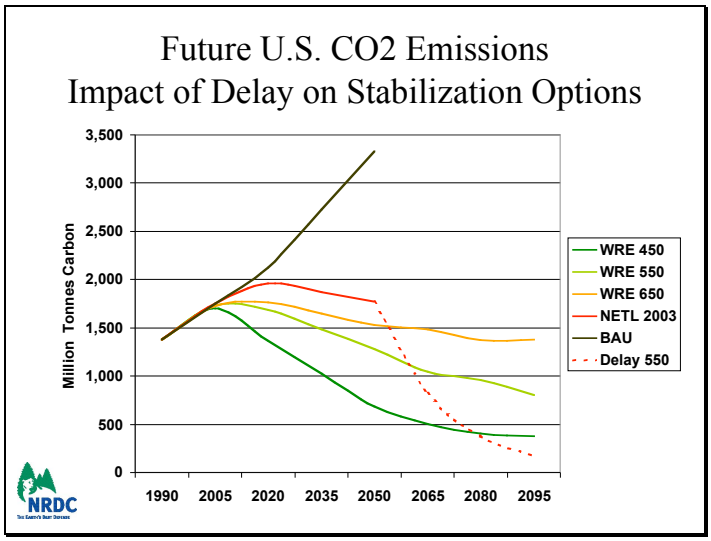

Figure 9

[9] Figure 9 compares the BAU or reference case emissions to 2050 with the NETL Roadmap and, in the three lower curves the U.S. emissions consistent with stabilizing concentrations at 650, 550, and 450 ppm respectively.

Current debate on global warming assumes that we have ample time to wait for more evidence about the speed of future warming and then decide whether and how much to limit emissions. I hope the NETL Roadmap persuades you of the error in this assumption.

We do not have more time to decide the path we will take. If you wait, you are making a decision: you are deciding today to commit the next generation of Americans to a doubling or more of global warming concentrations, with whatever consequences that entails. By not acting you will commit us to that path today. I ask you to ask yourselves, are you confident today that such a future will be benign? If you are not, then the prudent policy is to take reasonable steps that can preserve our ability to follow a safer path.

Thank you for the opportunity to testify. I am pleased to answer any questions you may have.