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On behalf of the Center for American Progress

Before the

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Hearing on
The Future of Coal under Carbon Cap and Trade
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We appreciate the opportunity to present testimony before this Committee on how our nation can best deploy Carbon Capture and Storage (CCS) technologies to reduce the carbon footprint of coal-fired power plants. Our testimony is being offered on behalf of the Center for American Progress (CAP), a non-partisan research and educational institute dedicated to promoting a strong, just and free America that ensures opportunity for all.

Robert M. Sussman is a partner at the firm of Latham & Watkins LLP and Ken Berlin is a partner at the law firm of Skadden, Arps, Slate, Meagher & Flom LLP. Both of us have long experience working on climate change and energy policy. Mr. Sussman was Deputy Administrator of the Environmental Protection Agency during the first part of the Clinton Administration. Mr. Berlin is a past Chairman of the Board of the Environmental Law Institute. More detailed biographies for both of us are attached. Our testimony reflects our personal views and those of CAP, not necessarily the views of our law firms or clients.

Summary

A major challenge in addressing the risk of global warming is the potential for a dramatic increase in greenhouse gas (GHG) emissions as a result of a new generation of coal-fired power plants. This challenge exists both in the United States, where abundant coal reserves have created heightened interest in the construction of new coal plants, and in developing countries such as China and India, where demand for energy is growing at a rapid pace and coal-fired generation holds the most potential for meeting these increasing energy needs. Fortunately, there is a potential pathway that would allow continued use of coal as an energy source without magnifying the risk of global warming. CCS technology would enable power plants to capture carbon dioxide (CO_2) emissions from coal-fired plants before they are released into the environment and then to store the captured CO_2 safely in underground geologic formations.

The task facing Congress as it develops global warming legislation is to maximize the likelihood that CCS is widely deployed on an expeditious but realistic timetable and at a cost which is reasonable for the affected industries and electricity consumers. Accomplishing this task successfully will assure coal – a low-cost domestic fuel available in ample quantities – a secure

place in the future U.S. energy mix without exacerbating global warming. Failure would mean that new coal plants add greatly to overall CO_2 emission levels, burdening other sources with greater reduction obligations and jeopardizing attainment of emission reduction targets. If – as is likely – these outcomes are unacceptable to large segments of the public and many policymakers, coal's historic role as a vital energy resource for the electricity supply sector and the U.S. economy would be greatly diminished.

To examine different policy tools for achieving widespread CCS adoption at new plants, we wrote a report published by the Center for American Progress (CAP) in May of this year, *Global Warming and the Future of Coal: the Path to Carbon Capture and Storage.* Last week, CAP published a follow-up report, *The Path to Clean Coal: Performance Standard More Effective than Bonus Allowances.* This new report augments our earlier analysis by examining the bonus allowance set-aside provisions in the Low Carbon Economy Act of 2007, S. 1766. Copies of these reports are attached. Their conclusions and recommendations are fully supported by CAP.

Our analyses conclude that, in their initial stages, the cap-and-trade programs under consideration by Congress are not likely to create carbon prices high enough to eliminate the cost differential between new coal plants with CCS and those without it. As a result, new coal plant developers are unlikely to capture and sequester their emissions until 2030 at the earliest and perhaps not until later. To accelerate CCS deployment, we recommend that Congress adopt an emission performance standard for all new coal plants pegged to the capture efficiency of available technology. This standard would apply to new plants for which construction begins after the legislation takes effect (presumably in 2008) and would provide these plants with a phase-in period to allow for further testing and improvement of the technology before fully implementing it. Under this timeline, CCS systems at covered plants would need to meet the performance standard in 2016 or within four years after the plant becomes operational, whichever occurs later.

An emission performance standard would have several important benefits. It would: :

- Minimize the risk that substantial emissions growth from new coal plants jeopardizes overall emission reduction efforts, particularly as more stringent caps are triggered in the later years of a carbon control regime.

- Overcome the "CCS cost gap" that will prevent deployment until at least 2030 and perhaps even longer under anticipated cap-and-trade legislation.

- Send a clear signal to plant developers and investors that CCS systems are an essential feature of all new coal plants, spurring innovation and cost-reduction by technology vendors and utilities and concentrating public and private resources on the remaining technical, economic and regulatory hurdles to CCS implementation.

- Provide a path toward public acceptance of new coal plants which enables coal to play a secure and important role in the future energy mix.

- Position the U.S. as a leader in developing CCS technology and thereby speed its adoption by the rest of the world.

We are *not* proposing an emission performance standard for existing coal-fired power plants, which do not threaten the same increase in overall CO_2 emissions as new plants which lack CO_2 controls. In our view, existing plants – like other large CO_2 emitters – should be subject to an economy-wide cap-and-trade program which progressively lowers national greenhouse gas emissions. Retrofitting these plants with CCS is an important emission reduction option but the costs and technical challenges it poses are not yet fully understood. At least initially, CCS should not be a preferred compliance strategy for existing plants but should be considered along with other options based on cost-effectiveness.

Our reports recognize that, at the current stage of technology development, CCS-equipped plants are significantly more costly than conventional plants and may well be uneconomic if there is no commercial value to the CO_2 stream which is captured. Closing this cost gap is essential so that (1) investors have incentives to build plants with CCS, (2) coal remains competitive with other fuels, and (3) consumers do not suffer significant electricity price increases. Accordingly, we propose a package of financial assistance that would initially offset 20 percent of total construction costs and a portion of ongoing operating costs. Revenues for this package might be derived from the proceeds of allowance auctions under cap-and-trade legislation, from a national "wires charge" on electricity sales, or from a mix of traditional financial instruments (loan guarantees, tax credits and grants).

This framework for deploying CCS at new coal plants is ambitious and will only be workable with a concerted national commitment to create a sound legal and technical foundation for CCS. Along with a program of large-scale testing, Congress must assure that a regulatory regime is in place for CO_2 transportation and storage as soon as possible. It must also clarify who bears long-term liability for maintaining and operating sequestration sites – a vitally important issue to industry and a potentially serious hurdle to CCS deployment if it is not resolved.

The Impact of New Coal Plants on the Success of GHG Emission Reduction Efforts

Why is it urgent to address new coal plants under climate legislation?

For the last 15 years, most new power plants built in the U.S. have been fueled with natural gas. In the last few years, however, coal has again emerged as a fuel of choice for the power sector as natural gas prices hit historically high levels worldwide and as demand for natural gas overtakes available supplies. In the U.S., coal is abundant, representing 27 percent of the world's known reserves, [1] and is less subject to price volatility and supply constraints than petroleum and natural gas. Because demand can be met from domestic sources, coal also offers important energy security benefits to the United States. In contrast, U.S. imports of natural gas are rising, requiring construction of controversial LNG terminals and increasing dependency on major natural gas producers like Russia and Iran with interests hostile to those of the U.S.

While only 11 gigawatts of new coal-fired plants were built in the U.S. from 1991 to 2003, and virtually none from 2001 to 2005,[2] the National Energy Technology Laboratory (NETL) of the

U.S. Department of Energy (DOE) has estimated that 145 gigawatts of new coal-fired plants will be built in the U.S. by 2030.[3] Utilities and other power plant developers have already announced plans to build 151 coal-fired plants with a capacity of 90 gigawatts.[4] Outside the U.S., the projections are more dramatic. Estimates of the worldwide total new construction of coal-fired plants by 2030 are around 1,400 gigawatts.[5]

Few of these new plants in the U.S. are likely to replace existing less efficient coal-fired plants. The Energy Information Administration (EIA) predicts that by 2030 electricity demand in the U.S. will increase by approximately 40 percent,[6] creating a need for increased power generation, and estimates that only about 3.6 gigawatts of coal power plants will be decommissioned by 2025.[7] In the developing world, where economic growth will be higher than in the U.S., almost all of the new coal-fired plants will represent an expansion, rather than a replacement, of capacity to meet soaring energy demand. China, for example, has the world's third largest coal reserves,[8] and is in the process of implementing a massive increase in coal-fired generation to meet growing energy needs.[9]

A major expansion of worldwide coal generation would dramatically increase greenhouse gas emissions. A new 1,000 megawatt (1 gigawatt) coal power plant using the latest conventional pulverized coal technology produces about 6 million tons (5.4 million metric tons) of CO_2 annually.[10] In the absence of CO_2 emission controls, the new coal plants projected to be built globally would generate as much as 8.4 billion additional tons (7.6 billion metric tons) of CO_2 each year (assuming 1,400 gigawatts of new coal-fired plants are constructed). This represents an increase of approximately 30 percent over current total annual world emissions of 25 billion metric tons of CO_2 from the consumption of fossil fuels.[11] Worldwide emissions from these new plants between now and 2030 would be equal to 50 percent of all emissions from all power plants during the past 250 years.[12]

In the United States alone, 870 million tons of CO_2 (790 million metric tons) would be emitted if all of the currently proposed coal plants are built and do not control their emissions.[13] This compares to 2005 annual emissions in the U.S. of about 6 billion metric tons of CO_2 and 7.15 billion metric tons of CO_2 equivalent greenhouse gases from *all* sources.[14] Moreover, new coal-fired plants, once built, will have a projected lifespan of up to 60 years. There will be powerful resistance to retiring them before investors have earned an acceptable return on their investment. These plants would therefore be high CO_2 emitters for decades to come.

Perhaps in the early years of emission reduction efforts, the increased emissions from new coal plants might be offset by a combination of reductions from existing sources and other low carbon activities like methane recovery. But over time, as emission caps become more stringent, with reduction targets of 20, 30 and even 70 percent of current levels by 2050, the added emissions from uncontrolled new coal plants will make it increasingly difficult, if not impossible, to attain overall emission reduction goals.

Will all of the proposed coal plants in fact be built in the absence of climate legislation?

In the U.S., there is growing public opposition to new coal plants, and legal and political challenges to these plants are now routine. The recent proposal by private equity investors to cancel eight coal plants announced by Texas utility TXU Corp. is evidence that public concerns are influencing investment decisions. [15] States like Florida and California are adopting policies which discourage new coal plants because of their climate change impacts.[16] Moreover, with the Supreme Court recently holding that CO_2 is a "pollutant" that can be regulated under the Clean Air Act, activists now argue that new plants cannot be permitted unless emission control technologies are installed to address climate concerns. Recognizing these trends, in July, Citigroup analysts downgraded the stocks of coal companies across the board, maintaining that "prophesies of a new wave of coal-fired have vaporized, while clean coal technologies . . . remain a decade away, or more." [17]

Some plant developers are persisting in the face of these obstacles and a number of new plants are on track to be built on schedule. However, the total number of new plants will probably be substantially smaller than projected a few years ago. Many of those that are built will probably be Integrated Gasification Combined Cycle (IGCC) facilities, which are viewed as offering more cost-effective opportunities for installing CCS systems than pulverized coal (PC) units and enjoy a higher level of public acceptance. Nonetheless, the odds that these facilities will actually capture and store their emissions in their early years of operation are small.

The slowdown in new coal plant construction is not necessarily a positive development. One consequence may be a delay in adding new generation capacity nationwide, which could hurt grid reliability and increase the cost of peak generation as demand for power grows. Another consequence may be to increase reliance on natural gas generation despite price and energy security concerns. It may therefore be in the national interest to adopt a policy framework which eases anxiety about coal plants and creates a regulatory environment that maximizes public acceptance of new coal generation in a carbon constrained world. From this standpoint, timely CCS deployment may reinvigorate the prospects for an expansion of coal capacity in the U.S.

Near-term Prospects for CCS Deployment

There is generally optimism about the feasibility and safety of large-scale capture and underground injection of CO_2 generated by new coal power plants, tempered by a recognition that the technology is evolving and more demonstration projects are needed to lay the groundwork for widespread CCS deployment.

Geological Sequestration

During CCS operations, CO_2 is compressed to a supercritical liquid, transported by pipeline to an injection well and then pumped underground to depths sufficient to maintain critical pressures and temperatures. The CO_2 seeps into the pore spaces in the surrounding rock and its escape to the surface is blocked by a caprock or overlaying impermeable layer. In some types of formations, the CO_2 may dissolve in water and react with minerals in the host rock to form carbonates, becoming permanently entrained. Long-term sequestration of CO_2 is possible in depleted oil and gas reservoirs, unminable coal seams, basalt structures, and deep saline aquifers. The latter are believed to be ubiquitous at depths generally below one kilometer and are estimated to underlie at least one-half of the area of inhabited continents.[18] These deep saline formations have the greatest capacity to store CO_2 and would play a critical role in any large-scale CCS program.

There is considerable experience in the U.S. with underground injection of liquids and gases.[19] Over 100,000 technically sophisticated and highly monitored injection wells are currently employed to pump fluids as much as two miles below the earth's surface.[20] U.S. CO_2 pipeline transmission is also well-established, with CO_2 pipelines in use since the early 1970s, the longest of which runs for approximately 500 miles.[21]

Similarly, CO_2 has long been pumped into the ground in oil and gas fields to improve extraction of these fuels. CO_2 injection has occurred extensively in the Permian Basin of West Texas and East New Mexico, plus several other areas of the U.S. and Canada, as part of enhanced oil recovery (EOR) operations. Currently 71 active CO_2-EOR projects inject, use and store 43 million tons/year of CO_2, 11 million tons/year (9.9 million metric tons/year) of which comes from industrial sources.

Of particular note is EnCana's CO_2-EOR sequestration project in the Weyburn Field of Saskatchewan, Canada. The CO_2 is created in North Dakota and goes through a 200-mile pipeline to reach the Weyburn Field. The EnCana project in combination with the nearby Apache project currently injects 2.5 million metric tons of CO_2 annually into the Weyburn Field and expects to sequester a total of 51 million metric tons of CO_2 by project end.[22] Overseas, the two most visible CO_2 capture and storage projects (not involving CO_2-EOR) are at the Siepner Field in the North Sea by Norway's Statoil ASA and the InSala Field in Algeria by Britain's BP plc. Each of these projects currently injects about 1 million tons of CO_2 per year into a saline formation either above or below the producing natural gas reservoir.

The large scale sequestration projects now underway provide reassuring evidence that leakage from CO_2 storage formations is unlikely. Long-term experience with EOR in oil and gas fields is also reassuring. The geology of these fields is well-known and their sealing potential well-established; they have been storing oil and gas for millions of years.[23] Despite the importance of additional testing, experts are confident that large-scale sequestration will be safe, feasible, and cost-effective. Thus, after reviewing the key questions of subsurface engineering and surface safety associated with carbon sequestration, a recent MIT study concludes:

> There do not appear to be unresolvable open technical issues underlying these questions. Of equal importance, the hurdles to answering these technical questions well appear manageable and surmountable. As such, it appears that geological carbon sequestration is likely to be safe, effective, and competitive with many other options on an economic basis.[24]

Available data also provide confidence that there is ample underground capacity in the U.S. and most other areas of the world to sequester the CO_2 output from projected levels of fossil fuel combustion. DOE recently released its first Carbon Sequestration Atlas of the United States and Canada based on a preliminary survey of potential sequestration reservoirs by its seven regional sequestration partnerships. The Atlas concludes that approximately 3,500 billion tons of CO_2 storage capacity exists in North America (mostly in deep saline formations) at diverse locations across the country.[25] A 2006 report by the Battelle Institute on U.S. sequestration capacity reaches remarkably similar conclusions, estimating total U.S. capacity of 3,900 gigatons of CO_2 and finding that usable formations underlie parts of 45 states and two thirds of the land mass of the contiguous 48 states.[26] This capacity would be sufficient to store the CO_2 emissions of the 145 projected new coal plants in the U.S. for several centuries. A third report published in 2005 by the Intergovernmental Panel on Climate Change, entitled *IPCC Special Report on Carbon Dioxide Capture and Storage*, likewise concluded that there is considerable worldwide geological storage capability for CO_2.[27] The IPCC also concluded that it is likely that the CO_2 retained in underground formations will likely exceed 99 percent of the quantity injected over 1,000 years.[28]

It is widely agreed that a comprehensive survey of storage capacity is needed to improve the accuracy of existing estimates. Notwithstanding uncertainties in estimation, there is little doubt that most regions of the U.S. are endowed with ample geological formations suitable for sequestration. Thus, underground CO_2 storage opportunities are likely to be within close proximity (zero to 250 miles) to the majority of coal plants that would be built, although some coal-dependent states may need to transport CO_2 for longer distances in order to sequester it.[29]

CO_2 Capture Technology

The separation and capture of CO_2 at large coal-fired power plants pose larger economic and technical challenges than the transportation and sequestration of CO_2 and account for the bulk of the costs of CCS. The dominant coal generation technology in the world today is pulverized coal (PC), in which coal is ground to fine particles and then injected into the furnace with combustion air; the flue gas from the boiler contains CO_2 and other combustion byproducts, which are treated to remove certain pollutants (nitrogen oxides or NO_x, and sulfur dioxide or SO_2) and then released to the air. The CO_2 can be captured from the flue gas following combustion at these plants by absorption into an amine solution, from which the absorbed CO_2 is then stripped via a temperature increase and cooled, dried, and compressed into a supercritical liquid.

IGCC plants are able to capture CO_2 emissions more cost-effectively than PC plants using current technology because IGCC technology does not rely on direct combustion but instead converts the carbonaceous feedstocks, by way of gasification, into a clean gas called syngas. A phase shifter can be used to convert carbon monoxide gas to carbon dioxide in the presence of steam at the end of the syngas refining stage and to separate the CO_2 stream from the syngas before combustion. Because CO_2 concentrations are higher and pressure is lower when CO_2 is captured pre-combustion, the energy required for CO_2 separation is smaller for IGCC units than for PC units. The carbon capture rate at IGCC plants is currently believed to be around 85 percent.

Although CO_2 capture is relatively straightforward technically, it poses a major economic challenge. Because of higher capital costs, greater fuel utilization, and lower electricity output, coal plants that capture CO_2 are projected to be more expensive producers of electricity than plants without capture capability. Carbon capture is estimated to account for 83 percent of the total cost of CCS systems, with transportation and storage accounting for only 17 percent of such costs.[30] Table 1 summarizes the results of three recent studies that estimate the economic and performance impacts of adding carbon capture technologies to IGCC and Supercritical Pulverized Coal (SCPC) plants.[31] As Table 1 illustrates, although capture costs will be high with both technologies, IGCC is currently perceived to have a marked advantage over SCPC:

Table 1: Estimated Economic Impacts of Adding Carbon Capture & Sequestration

	IGCC Plants			**SCPC Plants**		
	MIT Study	**Wisconsin Report**	**EPA Report**	**MIT Study**	**Wisconsin Report**	**EPA Report**
Increase in Capital Costs (%)	32%	35%	47%	61%	60%	73%
Decrease Total Efficiency (%)	19%	NA	14%	24%	NA	29%
Increase in Cost of Electricity ($ / MWh)[32]	NA	$ 18	$ 18	NA	$ 33	$ 35
Increase in Cost of Electricity (%)	25-40%	30%	37.5%	60-85%	60%	67%
Cost of Preventing CO_2 emissions ($ per ton)	$ 24	$ 30	$ 28	$ 40	$ 45	$ 51

With the heightened interest in CCS, considerable work is underway in the private sector to improve pre-and post-combustion capture technologies as well as develop a promising oxycombustion capture process for use with PC plant designs. These improvements – which have projected times to commercialization of 5-12 years according to DOE[33] – have the potential to significantly lower the energy penalty (and hence the cost of electricity increase) of carbon capture.

Incentives for CCS Under Cap-and-Trade Programs

The critical question examined in our report *Global Warming and the Future of Coal* is which policy tools will best promote deployment of CCS in an expeditious but realistic timeframe. Our principal conclusion is that, in their initial stages, cap-and-trade programs are not likely to create carbon prices high enough to eliminate the cost differential between new coal plants with CCS and those without it. This would mean that new coal plant developers are unlikely to adopt CCS systems until the emission caps for these programs become sufficiently stringent to significantly increase the price of carbon – probably not until 2030 and perhaps later.

There are considerable uncertainties in any analysis of this type, including predicting the future price of carbon under various legislative scenarios as well as projecting the future costs of CCS and other power generation technologies. Nonetheless, it is instructive to examine the "CCS cost gap" under two recent cap-and-trade proposals:

- S. 280, introduced earlier this year by Senators McCain and Lieberman, would cap emissions at 2004 levels in 2012, 1990 levels in 2020 and 22 percent below 1990 levels starting in 2030. A recent analysis by the Environmental Protection Agency (EPA) found that CO_2 allowance prices (in 2005 dollars) would be $13-15 per ton in 2015, $16-20 per ton in 2025 and $27-32 per ton in 2030.[34] EIA projected similar allowance prices (assuming substantial access to international and domestic offsets) in its own analysis of S. 280. [35]

- S. 1776, introduced by Senator Bingaman and co-sponsors, would reduce emissions to 2006 levels by 2020 and 1990 levels by 2030. Covered entities would need to submit allowances corresponding to the amount of CO_2 they emit or make payments into a special fund at a fixed price for each ton of CO_2 emitted. This "technology accelerator payment" (often described as a safety valve) would start at $12 per metric ton of CO_2 equivalent in 2012 and increase by 5 percent per year above the rate of inflation. An analysis by the National Commission on Energy Policy (NCEP) concludes that the safety valve price will probably not be triggered and that, instead, allowance prices will likely be $5.40 per ton in 2012 and just under $24 per ton in 2030.[36]

As shown in Table 1, three recent studies conclude that IGCC plants with CCS systems would capture and sequester their emissions at a cost of around $30 per ton; other recent estimates indicate that the cost is closer to $40 per ton.[37] PC plants with CCS would remove CO_2 at $40-50 per ton. At these cost levels, it would not be economic to capture and sequester emissions before 2030 under S. 280 or S. 1776. Instead, it would be less costly to build an uncontrolled coal plant and purchase allowances or offsets to cover its emissions. As EPA concluded in its analysis of S. 280, "while CCS is available in 2015, carbon prices rise to a high enough level to make CCS cost-competitive in ~ 2030." [38]

Even if the price of CO_2 allowances reaches a level at which CCS is cost-competitive, there would still be no assurance that new coal plants are equipped with CCS. Given a choice between building an uncontrolled plant and one with CCS at roughly equivalent compliance costs, developers may opt for the traditional technology as opposed to more innovative CCS. This is because there will be non-price barriers to building plants with CCS, including the reluctance of conservative utility executives to invest in new and uncertain technologies, the lower operational and financial risks of building conventional coal plants and the belief that second generation plants are more economical and reliable than first generation plants. Because of these perceived risks, developers could opt for conventional plants even though their nominal costs are no lower and (maybe even higher) than those of plants with CCS systems. In this event, the price of CO_2 allowances might need to reflect a "risk premium" above the cost per ton of CCS plants in order to entice reluctant investors. This could delay widespread CCS deployment beyond 2030, although individual CCS plants could still be economically viable where the captured CO_2 has commercial value – for example, when used in EOR.

An Emission Performance Standard for New Coal Plants

Global Warming and the Future of Coal concludes that the most effective strategy for closing the "CCS cost gap" is to adopt an emissions performance standard for new coal plants, while including existing coal plants in an economy-wide cap-and-trade program.

An emissions performance standard would require new plants to capture CO_2 emissions at the level achievable through the best performing CCS technology (currently in the range of 85 percent). The standard could be expressed as a ratio of the emissions rate to electricity output (CO_2 emissions per kWh), or as a percentage of total CO_2 generated. The standard could initially be applied to new coal plants but later extended to other new large fossil fuel combustion facilities (such as natural gas power plants).

The Phase-in Process for a Performance Standard

Under our proposal, an emissions performance standard requiring CO_2 capture and storage would not take effect immediately upon enactment of legislation. Rather, there would be a phase-in process because of the need for additional practical experience with large-scale sequestration, further technical refinement and cost-optimization of capture technologies, and creation of an effective legal and regulatory framework for long-term underground CO_2 storage. Assuming that legislation is enacted in 2008, all plants beginning construction thereafter would be subject to the emission performance standard but would not be required to begin capturing and sequestering their emissions until 2016 at the earliest. As a rule of thumb, all new plants would have at least four years lead-time from initial operation before complying with the standard. For example, a plant beginning operation in 2012 would start complying by 2016, while one beginning operation in 2016 would start complying by 2020. Over time, the four-year shakedown period would be reduced as experience with CCS grows. For example, by 2025, plants might get only one year after beginning to produce electricity before CCS systems must be up and running.

We recognize that a target date of 2016 for implementing CCS at all new coal plants is challenging. However, there is a growing consensus that CCS systems will be ready for widespread commercial deployment by 2020 if not earlier.[39] Thus, requiring CCS operation starting in 2016 would be an ambitious but achievable goal which underscores the national commitment to controlling emissions from new coal plants.

To the extent some utilities consider a 2016 compliance date overly aggressive, our report proposes giving plant developers a limited option (from 2008 to 2011) to begin constructing traditional coal plants that do not capture and sequester CO_2 provided they offset on a one-to-one basis their CO_2 emissions by one or more of the following steps:

- Improving system-wide efficiency and lowering CO_2 emissions at existing plants
- Retiring existing coal or natural gas units that generate CO_2 emissions
- Constructing previously unplanned renewable fuel power plants representing up to 25 percent of the generation capacity of the new coal plant.

Similar approaches have been announced recently by utilities building new coal plants.[40]

Benefits of an Emission Performance Standard

An emission performance standard would have several important benefits.

First, early across-the-board application of CCS – the most promising and perhaps only viable emission control technology for new coal plants – would minimize the risk that substantial emissions growth from these plants jeopardizes overall emission reduction efforts, particularly as more stringent caps are triggered in the later years of a carbon control regime.

Second, by providing an expedited timetable for implementing CCS, an emission performance standard would overcome the "CCS cost gap" that will prevent deployment until at least 2030 and perhaps even longer under anticipated cap-and-trade legislation. With a firm 2016 target date for implementation, a performance standard offers an element of certainty that would otherwise be lacking under a cap-and-trade program, where multiple uncertainties (such as the price of allowances, the cost of CCS and the reluctance of conservative utilities to invest in innovative technologies without a "risk premium") make the timing and scope of CCS implementation difficult to predict or control.

Third, a national target date for capturing and storing CO_2 at new plants would send a clear signal to plant developers and investors that CCS systems are a required feature of all new coal plants. This would spur innovation and cost-reduction by technology vendors and utilities by concentrating resources on the remaining technical, economic and regulatory hurdles. It would also provide public utility commissions (PUCs) with a stronger basis for authorizing CCS-equipped plants; otherwise, PUCs could conclude that conventional cost plants are less costly and risky for ratepayers until the price of carbon increases substantially.

Fourth, plants with CCS would enjoy public acceptance and would not carry the stigma of uncontrolled plants with high CO_2 emissions. Thus, resistance to new coal generation, which is now derailing many proposed plants, would abate, enabling coal to play a more secure role in the national energy mix.

Finally, it is in the economic interest of the U.S. to take the lead in developing CCS technology and thereby speed its adoption by the rest of the world. Successfully deploying CCS in the U.S. will create domestic jobs and give U.S. companies that develop these systems a leadership position in satisfying the demand for clean coal in other countries, helping them capture a major share of the billions of dollars that will be spent worldwide on coal plants between now and 2030.

Retrofitting of Existing Coal Plants

The emission performance standard would *not* apply to existing coal-fired power plants. These facilities do not pose the same risk of dramatically increasing overall CO_2 emissions over several decades as new uncontrolled plants. Thus, the logic of requiring the best available control technology carries less weight for existing plants than for new ones. At the same time, existing plants obviously need to be controlled and – like other large CO_2 emitters – should be subject to an economy-wide cap-and-trade program which progressively lowers national greenhouse gas emissions. Retrofitting these plants with CCS should be an important emission reduction option under this program but not a required compliance strategy since the costs and technical challenges of CCS retrofits are not yet fully understood and other reduction strategies (including energy efficiency and renewable energy technologies) may be more cost-effective.

Drawbacks of CCS Incentive Programs

In our two reports, we compare the certainty of an emission performance standard with other approaches that that create incentives for the construction of CCS plants but do not require adoption of CCS technology. One such approach is the program of bonus allowances that would be authorized by Senator Bingaman's bill, S. 1766. This program would use bonus allowances to offset the cost differential between plants with CCS and uncontrolled coal plants and thereby attempt to persuade utilities to build CCS plants although they are not required to do so.

We demonstrate in *The Path to Cleaner Coal* that the emission performance approach is more effective and less costly than a bonus allowance program for a number of reasons. First, because their value depends on future market conditions, bonus allowances are an imprecise tool that could either provide inadequate incentives to plant developers or overshoot the mark and provide them with unjustified windfalls. Second, because CCS would not be required, bonus allowances would not only need to close the cost gap between plants with and without CCS systems but include a premium to overcome non-price barriers such as industry reluctance to assume the risk of new technologies. This would inflate costs unnecessarily, as our analysis of S. 1766 shows. Finally, utilities will probably not sell bonus allowances in the open market but use them to offset emissions from existing plants or even from new plants without CCS systems. This would delay emission reductions from the utility sector, put upward pressure on allowance prices and increase emission reduction obligations and costs for other industrial sectors.

Offsetting Economic Impacts

An emissions performance standard would increase the price of electricity because of the reduced plant efficiency and increased construction and operational costs associated with carbon capture technology. As shown in Table I, this increase is estimated by the state of Wisconsin, MIT, and EPA to be on the order of 20 percent to 40 percent for IGCC plants with CCS units and considerably higher for CCS-equipped SCPC units.[41]

The predicted higher costs of electricity from plants with CCS units may be ameliorated by several factors. First, for some power plants, the injection of CO_2 in oil or gas wells will increase production of these fuels, creating a revenue stream that partially or totally offsets the increased costs of capture and storage. Second, with advances in technology, IGCC and PC plants will achieve an even greater energy efficiency advantage over conventional PC plants now in service, offsetting a greater portion of the loss of efficiency from carbon capture. Third, the technology for capturing carbon will itself become more cost effective, imposing less of an efficiency penalty on electricity generation. (Experience with other emission reduction programs has shown that, because of technological innovation, actual compliance costs turn out to be lower than predicted by government or industry before-the-fact). Finally, in the initial years, new plants would provide only a relatively small portion of the power generated by the utility sector, with the balance coming from lower-cost existing plants. Thus, when spread across the entire U.S. rate base, the increases in electricity rates would be negligible.

Nonetheless, a strong case can be made for coupling an emission performance standard with a program of financial assistance to utilities that closes the cost gap between CCS systems and non-CCS generation. Without financial assistance, the combination of a declining cap for existing plants and a CCS requirement for new plants would disproportionately burden power generation systems that rely heavily on coal. Since the benefits of CCS systems in preventing CO_2 emissions will be realized by all regions, the costs should arguably be borne equally at the national level and not be imposed solely on regions that produce or use coal. Moreover, there is a strong national imperative to develop CCS technologies as quickly as possible so that CCS plants can play a role in meeting energy demand growth and start replacing older inefficient coal-fired plants in a carbon-constrained world. Programs that reduce the financial risks and uncertainties of building CCS plants in the early years can secure commitments from otherwise reluctant investors and assure that coal remains a vital and viable part of the national fuel mix.

Global Warming and the Future of Coal recommends providing plant developers with a package of financial incentives, including tax credits and grants, that cover the added costs of building and operating coal-fired power plants with CCS systems under a cap-and-trade program. The size of these incentives would reflect the difference between the prevailing CO_2 allowance price and the cost per ton of capturing and storing plant emissions. As this difference narrows because of rising allowance prices or reductions in the costs of CCS, the level of financial assistance to the plant developer would decline proportionately. Thus, plants built in the early years would receive more assistance than plants built later on.

A number of the proposed climate bills require the auctioning of emissions allowances, with the auction revenues used to fund new technologies or to offset the costs to industries and consumers of climate-related requirements. One use for auction revenues could be to offset the higher costs of coal plants that employ CCS systems. Under a cap-and-trade program, owners of existing coal plants would be heavy allowance purchasers because of their large CO_2 emissions. Redistributing auction revenues to these owners if they build low carbon coal plants would serve the dual purposes of reducing their need for allowances (by helping to retire high-emitting plants) and providing economic relief to their customers (by cushioning them from increases in the cost of electricity).

As an alternative to auction proceeds, an incentive program for CCS plants could be funded by a uniform per kilowatt “wires charge” on retail electricity sales implemented at the federal level or by diverting a portion of general tax revenues. Phasing out existing federal subsidy programs for “clean coal” could reduce the overall demand on these funding sources.

As a starting point for discussion, *Global Warming and the Future of Coal* proposes that financial incentives for CCS plants should initially cover 20 percent of total construction costs (including the base-plant and add-on CCS capability) plus an ongoing subsidy for operating costs. This 20 percent cost recovery would be available for all new coal plants for which construction is commenced between now and 2012. The share of construction costs eligible for recovery would then begin dropping until the incentives are phased out. The cost of such a program would likely be in the range of $36 billion spread over 18 years, or about $2 billion a year, based on projections that 80 gigawatts of new coal-fired capacity with CCS systems will be built between now and 2025. Additional subsidies to cover operating costs would be available to the extent these costs exceed the costs of power from a plant that does not capture and sequester emissions. This subsidy might take the form of a $/kW production tax credit which is adjusted over time.

We welcome feedback on our proposal and encourage further analysis and modeling to determine how best to design a program of financial incentives that closes the CCS "cost gap" and stimulates investments in new CCS-equipped plants but is cost-effective and narrowly targeted.

Creating the Legal and Technical Foundation for CCS

Importantly, a national target date for capturing and storing CO_2 at new coal plants will not be achievable without a parallel effort to create a durable and credible legal and technical foundation for CCS. This is a job for Congress and it should receive the highest priority.

Energy legislation passed earlier this year in both bodies would significantly accelerate the research and development programs required for CCS to be successfully deployed on a widespread basis. As recommended in the MIT report, this legislation would authorize a small number of federally funded demonstration projects for different carbon capture technologies at IGCC and PC plants.[42] It would also authorize, in keeping with another MIT recommendation, a concerted demonstration program to determine the large-scale viability of different types of underground storage repositories and to assess the likelihood and scale of CO_2 leakage. Finally, a comprehensive inventory of potential storage reservoirs, building on existing DOE efforts, would be conducted.

Congress has made less progress in providing new authority and funding to EPA to develop a regulatory regime that establishes guidelines for sequestration site investigation, selection and permitting, monitoring of emissions and modeling of underground CO_2 migration and issuance of permits to entities responsible for CO_2 transportation and storage. This gap should be closed as soon as possible, perhaps before comprehensive climate legislation is enacted.

Since CO_2 injection at most sites will end after two or three decades, clearly defined liability and ownership rules will be required to delineate who bears long-term responsibility for effective CO_2 storage and remedial action if leaks occur at these sites. Some states, such as Texas, have decided to transfer ownership of post-injection sites to government bodies, but most other states have yet to set liability rules. Congress must develop a national liability framework for CCS sites as soon as possible. The absence of such a framework has created – and will create – substantial impediments to investment in CCS, notwithstanding general agreement that the risks to health and the environment of long-term CO_2 storage are probably negligible.

Conclusion

Bold action by the U.S. Congress to put in place an emission performance standard for new coal-fired power plants would demonstrate leadership in addressing global warming and build a technological and regulatory foundation that countries such as China and India could emulate as they attempt to tackle the risk of global warming without stifling economic growth. It would speed development and deployment of CCS technology in the U.S. and around the globe and prevent emissions growth that would jeopardize attainment of emission reduction goals. Finally, an emission performance standard that requires CCS systems for all new coal plants would assure coal a secure and important role in the future U.S. energy mix by establishing a clear path forward for coal in a carbon constrained world.

Again, we appreciate this opportunity to present our views to the Committee.

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Endnotes

1 The Nat'l Coal Council, Coal: America's Energy Future, at xii, (March 2006), *available at* http://nationalcoalcouncil.org/report/NCCReportVol1.pdf. In 2005, U.S. coal consumption totaled 1.1 billion short tons. Energy Info. Admin., U.S. Coal Supply and Demand: 2005 Review, at 7 (April 2006), *available at* http://www.eia.doe.gov/cneaf/coal/page/special/feature05.pdf. In 2004, the United States accounted for nearly 20 percent of global demand, second only to China (approximately 34 percent). Int'l Energy Agency, World Energy Outlook 2006, at 127 (Nov. 2006) (hereafter WEO 2006 report). The demonstrated coal reserve base – approximately 500 short billion tons – is projected to last for over 100 years, even at elevated consumption levels. The Nat'l Coal Council, Coal: America's Energy Future, at 2 (March 2006), *available at* http://nationalcoalcouncil.org/report/NCCReportVol1.pdf.

2 Ben Yamagata, Clean Coal Opportunities in Electric Power Generation (February 8, 2006) (unpublished PowerPoint presentation of the Coal Utilization Research Council) (on file with authors).

3 DOE Nat'l Energy Tech. Lab., Tracking New Coal-Fired Power Plants: Coal's Resurgence in Electric Power Generation (May 1, 2007) (unpublished PowerPoint presentation) (on file with authors), *available at* http://www.netl.doe.gov/coal/refshelf/ncp.pdf [hereinafter, the NETL Tracking Report].

4 *Id.*

5 WEO 2006 report, *supra* note 1, at 493; Yamagata, *supra* note 2 (estimating 1400 gigawatts based on data from the International Energy Agency and Platt's database).

6 Energy Info. Admin., Annual Energy Outlook 2007, at 82, *available at* http://www.eia.doe.gov/oiaf/aeo/pdf/trend_3.pdf.

7 Energy Info. Admin., International Energy Outlook 2005, at 51, *available at* http://www.stat-usa.gov/miscfiles.nsf/85e140505600107b852566490063411d/d0d08407366b117d85257157006fae32/$FILE/IEO2005_ch007.pdf.

8 Energy Info. Admin., Energy Information Sheets: Coal Reserves (Aug. 2004), *available at* http://www.eia.doe.gov/neic/infosheets/coalreserves.htm.

9 Coal currently accounts for two-thirds of China's primary energy supply. Although the government has indicated its desire to decrease its coal usage, China is still predicted to drive over half of the growth in worldwide coal supply and demand in the next 25 years and coal will likely account for more than 50 percent of the country's energy supplies in the year 2030. *See* James Katzer et al., The Future of Coal: Options for a Carbon-Constrained World MIT Interdisciplinary Study (2007) (hereafter The MIT Study) at 63. *See also* The Fourth Assessment Report, Working Group III, Summary for Policy Makers (May 5, 2007). Prepared by the Intergovernmental Panel on Climate Change (stating that two-thirds to three-quarters of the increase in energy CO_2 emissions between 2000 and 2030 is projected to come from developing countries (e.g. those that are not "Annex I" countries or parties as defined in the IPCC report) [hereinafter, IPCC Fourth Assessment Report].

10 Robert Socolow, "Can We Bury Global Warming?," *Scientific American*, July 2005, at 50. *See also* The MIT Study, *supra* note 9, at ix (stating one 500 megawatt coal-fired power plant produces approximately 3 million tons per year of CO_2).

11 See WEO 2006 Report, *supra* note 1 at 73. The total world emissions figure is for CO_2 emissions from the consumption of fossil fuels only and relates to the year 2003.

12 Socolow, *supra* note 10, at 52 (estimating that coal plants accounted for 542 billion tons of CO_2 emissions from 1751-2002 and will account for 501 billion tons of CO_2 from 2002-2030).

13 Energy Info. Admin., Emissions of Greenhouse Gases in the United States 2005, at 13 and ix (Nov. 2006), available at ftp://ftp.eia.doe.gov/pub/oiaf/1605/cdrom/pdf/ggrpt/057305.pdf [hereinafter EIA 2006 Report].

14 *Id*. at 29.

15 TXU initially proposed building 11 traditional coal-fired plants in Texas. In light of strong public opposition to the plants, TXU later cancelled plans for eight of these plants as part of the terms of a

buyout deal with a private equity group led by Kohlberg Kravis Roberts and the Texas Pacific Group. It subsequently announced plans to build two IGCC plants in Texas. Kurt Fernandez, "TXU, Buyout Partners Announce Plans for Two Carbon Dioxide Capture Plants," *BNA Daily Environment Report*, Mar. 12, 2007, at A-9.

[16] California has adopted legislation making it effectively impossible to enter into new contracts importing electricity from coal plants lacking CCS. With the support of Governor Crist, regulators in Florida have rejected a number of proposed coal plants and utilities are now looking to other forms of generation to meet demand growth.

[17] As quoted in *Coal Rush Reverses, Power Firms Follow*, by Steven Mufson, Washington Post, September 4, 2007.

[18] Robert H. Williams, "Climate-Compatible Synthetic Liquid Fuels from Coal and Biomass with CO_2 Capture and Storage," Princeton Envtl. Inst., Princeton Univ., at 7 (Dec. 19, 2005) (unpublished PowerPoint presentation) (on file with authors), *available at* http://www.climatechange.ca.gov/documents/2005-12-19_WILLIAMS.PDF.

[19] Except as otherwise indicated, the facts about sequestration were provided by Vello Kuuskraa of Advanced Resources International, Inc. ARI is the lead consultant on the EnCana project described in the text.

[20] EPA Underground Injection Control Program, http://www.epa.gov/safewater/uic/whatis.html (last visited March 27, 2007).

[21] *See* http://www.kindermorgan.com/business/co2/transport_cortez.cfm.

22 Email from Vello Kuuskraa, President, Advanced Resources Int'l, to Kenneth Berlin, Partner, Skadden, Arps, Slate, Meagher & Flom LLP (Apr. 30, 2007) (on file with authors).

[23] Jon Davis, "Gasification and Carbon Capture and Storage: The Path Forward," Contributing Paper (Pew Center/NCEP 10-50 Workshop) at 1.

[24] The MIT Study, *supra* note 9, at 43.

[25] The Nat'l Energy Tech. Laboratory, Carbon Sequestration Atlas of the U.S. and Canada (March 2007), available at www.netl.doe.gov/publications/carbon_seq/atlas/index.html [hereinafter, The NETL Sequestration Atlas.

[26] Battelle Joint Global Change Research Institute, Carbon Dioxide Capture and Geologic Storage: A Core Element of a Global Energy Technology Strategy to Address Climate Change, at 26-27. (April 2006) [hereinafter the Battelle Report].

[27] Intergovernmental Panel on Climate Change, IPCC Special Report on Carbon Dioxide Capture and Storage, at 11 (Ogunlade Davidson et al. eds., 2005). Both the NETL Sequestration Atlas, *supra* note 30 and the Battelle Report, *supra* note 26, provide higher estimates of CO_2 storage capacity than IPCC. For example, Battelle estimates worldwide storage capacity of 11,000 gigatons. More definitive inventories in the United States and globally will enable this range of uncertainty to be narrowed considerably. For comparison purposes, fossil fuel CO_2 emissions from 1400 gigawatts of new IGCC plants would total 8.4 billon tons per year (at 6 million tons per gigawatt). *See* Socolow, *supra* note 10, at 50 and the MIT Study, *supra* note 9, at ix.

[28] IPCC Special Report on Carbon Dioxide Capture and Storage, *id*. at 31.

[29] A Duke University study, for example, recommended that the most cost-effective way for North Carolina to sequester CO_2 was to build a pipeline that would run 2250 miles and support a CO_2 flow rate of 57 million metric tons of CO_2 per year, sufficient to handle captured emissions from 11 gigawatts of new coal-fired plants. The pipeline alone is estimated at a cost of $5 billion, and according to the study would be cost effective at a CO_2 price of $29 per ton. Eric Williams, et al., *Carbon Capture, Pipeline and Storage: A Viable Option for North Carolina Utilities?* (Working Paper, March 2007), Nicholas Institute for Environmental Policy Solutions and Center on Global Change, Duke Univ. [hereinafter, The Duke Study]. See also Chris Holly, "*Clean Coal's Future in North Carolina Hangs On Big Pipe*, 35 The Energy Daily 71, 1-2 (Apr. 16, 2007) A price of $29 per ton of CO_2 is consistent with other estimates described in the text of the cost at which CCS becomes competitive.

30 MIT estimates the cost of CO_2 capture and pressurization at about $25 a ton and CO_2 transportation and storage at about $5 a ton. The MIT Study, *supra* note 9, at xi.

31 The MIT Study, *supra* note 4, at 30, 36; Mark Meyer et al., *Integrated Gasification Combined-Cycle Technology Draft Report*, Dep't of Nat. Res. Pub. Serv. Comm'n of Wisc. (June 2006), at 31-33 [hereinafter, the Wisconsin Report]; EPA, Environmental Footprints and Costs of Coal-based Integrated Gasification Combined Cycle and Pulverized Coal Technologies, at 5-11 – 5-12 (July 2006) [hereinafter, The EPA Report].

32 The efficiency of IGCC plans is now lower with Western subbituminous and Texas lignite coals, at least with some gasification technologies. As a result, the MIT report indicates that the cost differential between IGCC and SCPC narrows when these coals are used. The MIT Study, *supra* note 9, at 36-37.

33 Carl Bauer, NETL Office of Fossil Energy, *CO_2 Capture Technology : Options and Experiences*, August 8, 2007 PPT presentation (on file with authors).

34 US Environmental Protection Agency, *EPA Analysis of the Climate Stewardship and Innovation Act of 2007, S. 280 in 110th Congress* at 24 (July 16, 2007) [hereinafter, EPA Analysis].

35 EIA, *Energy Market and Economic Impacts of S. 280, the Climate Stewardship and Innovation Act of 2007* (July 2007).

36 National Commission on Energy Policy, *Impacts of the Low Carbon Economy Act of 2007* (July 11, 2007).

37 Standard and Poors, S&P Viewpoint, *Which Power Generation Technologies Will Take the Lead In Response to Carbon Controls?* (May 11, 2007).

38 EPA Analysis, *supra* note 34, at 3.

39 Testimony of Brian Hannegan, *Future of Coal*: *Hearing Before the S. Comm. On Energy and Natural Resources*, 110th Cong. at 3 (March 22, 2007).

40 An example is a March 2007 settlement agreement between Kansas City Power and Light and the Sierra Club relating to its 850 megawatt coal-fired plant under construction in Missouri. The agreement requires Kansas City Power and Light to offset the 6 million tons of CO_2 emissions from the new plant by installing 400 megawatts of new wind power, implementing measures to save 300 megawatts of energy demand and closing or upgrading an older coal-fired plant. Steven Mufson, "Electric Utility, Sierra Club End Dispute: Kansas City Power & Light Agrees to Offset New Coal-Fired Plant's Emissions, *The Washington Post*, March 20, 2007, at D03.

41 *See* The Wisconsin Report, *supra* note 32 at 32 (estimating that costs would increase to over $75 per MWh of energy generated with carbon capture, compared to between $50 and $60 per MWh without carbon capture); The MIT Study, *supra* note 9, at 36 (estimating that the costs for IGCC with carbon capture will be 30 percent to 50 percent over that of SCPC without carbon capture and 25 percent to 40 percent higher than IGCC without carbon capture); The EPA Report, *supra* note 32, at 5-11 (estimating $66 per MWh for IGCC with carbon capture versus $48 per MWH for IGCC without capture and $51 for SCPC without capture).

42 The MIT Study, *supra* note 9, at 100. Consistent with the MIT report, federal financial support for IGCC units without CCS would be phased out because IGCC already has strong commercial backing and the adoption of a generation performance standard requiring CCS will change the economics of new coal plants in IGCC's favor. *Id*.