NRDC BRIEF
March 2007

No Time Like the Present

NRDC's Response to MIT's 'Future of Coal' Report

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Summary

MIT's report on the Future of Coal correctly recognizes the imperative for prompt action on global warming and the critical role that use of carbon dioxide (CO_2) capture and geologic storage (CCS) must play in reconciling protection of the climate with expected global dependence on coal. Yet the report's examination of policies to promote immediate deployment of CCS systems is incomplete and it fails to address the most urgent problem facing U.S. policymakers: what CO_2 performance requirements should be applied to proposed new coal power plants?

While the facts set forth in the report provide ample justification for a recommendation to require all proposed new coal plants to capture CO_2 for geologic disposal, the report is silent on this question.

Rather than recommending performance requirements to capture and store CO_2 from all new coal plants, the report proposes an incomplete policy response that would likely fail to prevent the construction of new high-emitting coal plants and result in much larger taxpayer costs and higher abatement costs when climate protection policies are adopted. The report recommends that government grants be made to energy companies to fund use of CO_2 capture at a few new coal plants, that government fund several large-scale geologic injection projects, and that Congress not "grandfather" new proposed power plants from future CO_2 control legislation. While each of these recommendations is a useful complement to a direct requirement for new coal plants to use CCS, by themselves they are inadequate.

Based on leaks of early drafts of the report's executive summary, industry proponents of old-technology coal plants that will not capture CO_2 are already claiming the MIT study suggests that CCS systems are not ready for use at proposed new coal plants. MIT's Howard Herzog, one of the MIT study participants, in a November 2006 presentation, provides a more accurate summary of the facts:

> *"Is CCS feasible? Yes, all major components of a carbon capture and sequestration system are commercially available today. Why is CCS use limited today? It is almost always cheaper to emit to the atmosphere than sequester. Therefore, opportunities are limited to niche areas until carbon policies are put in place."*

The report states there is no reason for Congress to delay adoption of a carbon emission control policy and finds that construction of new supercritical pulverized coal plants without CCS "will raise the cost of future CO_2 control." Yet the report fails to recommend (or even discuss) the most obvious direct policy measure—a requirement that new coal plants employ CCS.

Is CCS Ready for New Coal Plants to Use Today?

While the Findings and Recommendations chapter of the MIT report states there is no reason for Congress to delay adoption of a carbon emission control policy and finds that construction of new supercritical pulverized coal plants without CCS "will raise the cost of future CO_2 control," the report's Executive Summary inconsistently suggests that the choice of whether to apply CCS should be left to private sector developers:

> "From the standpoint of a power plant developer, the choice of a coal-fired technology for a new power plant today involves a delicate balancing of considerations. On the one hand, factors such as the potential tightening of air quality standards for SO_2, NO_x, and mercury, a future carbon charge, or the possible introduction of federal or state financial assistance for IGCC would seem to favor the choice of IGCC. On the other hand, factors such as near-term opportunity for higher efficiency, capability to use lower cost coals, the ability to cycle the power plant more readily in response to grid conditions, and confidence in reaching capacity factor/efficiency performance goals would seem to favor the choice of super critical pulverized coal (SCPC). Other than recommending that new coal units should be built with the highest efficiency that is economically justifiable, we do not believe that a clear preference for either technology can be justified." (Executive Summary, p. xiv)

The critical flaw in this excerpt, which we expect will be widely quoted by conventional coal plant developers, is that it implies that the only rational approach to new coal plant investments is to permit private developers to choose between two different types of coal plants, both of which release their CO_2 rather than capturing it. However, the premise of significantly delayed requirements to control CO_2 emissions that underlies this discussion is inconsistent with other findings in the report that CCS is ready for application today and that there is no reason for Congress to delay adoption of limits on CO_2 emissions.

Is it technically feasible for new coal power plants to capture and sequester their carbon? The MIT study itself supports an affirmative answer. The study finds that commercial capture systems exist:

> "Of the possible approaches to separation [with pulverized coal plants], chemical absorption with amines, such as monoethanolamine (MEA) or hindered amines, is the commercial process of choice." (page 24)

> "In applying CO_2 capture to IGCC […] a weakly CO_2-binding physical solvent, such as the glymes in Selexol, can be used to separate out the CO_2. Reducing the pressure releases the CO_2 and regenerates the solvent, greatly reducing the energy requirements for CO_2 capture and recovery compared to the MEA system." (page 34)

The study also finds that "large-scale CO_2 injection projects can be operated safely" (Executive Summary, p. xii). The study notes that existing projects do not employ the rigorous monitoring that is needed for a fully implemented CCS program and that permitting regulations need to be written. However, if begun now, these requirements can be developed in a few years, shorter than the period required to plan, finance, and build new coal plants now in preliminary development stages. Such requirements will need to be adopted to carry out the large demonstration injection projects recommended by the report in any case. As the report states, "What is needed is to demonstrate an integrated system of capture, transportation, and storage of CO_2, at scale. This is a practical goal but requires concerted action to carry out" (Executive Summary, p. xi) Rather than carry out a set of demonstrations unconnected to newly built coal plants, the obvious alternative is to integrate the construction of new coal plants with the initial large-scale injection projects.

Capturing and Sequestering Carbon Is Possible Today

Capture of Carbon from Power Plants

The 2005 Intergovernmental Panel on Climate Change (IPCC) special report on Carbon Dioxide Capture and Storage groups processes to capture or separate CO_2 from power plant gas streams into three categories: post-combustion, pre-combustion and oxyfuel combustion. Today pre-combustion capture is the most economic option but other approaches show promise as well.

Pre-combustion capture is applicable to processes that gasify coal. Coal gasification is widely used in industrial processes, such as ammonia and fertilizer production around the world. Hundreds of such industrial gasifiers are in operation today. Integrated Gasification Combined Cycle (IGCC), used for electric power production, is a relatively recent development—about two decades old and is still not widely deployed.

Commercially demonstrated systems for pre-combustion capture from the coal gasification process are used in industrial plants to separate CO_2 from natural gas and to make chemicals such as ammonia. Due to lack of CO_2 control policies, most such systems simply release the separated CO_2 to the air. An example where the CO_2 from coal gasification is actually captured rather than vented is the Dakota Gasification Company plant in Beulah, North Dakota, which captures and pipelines more than one million tons of CO_2 per year from its lignite gasification plant to an oil field in Saskatchewan. ExxonMobil's Shute Creek natural gas processing plant in Wyoming, which strips CO_2 from sour gas and pipelines several million tons per year to oil fields in Colorado and Wyoming, is another large industrial example.

Today's pre-combustion capture approach is not applicable to the installed base of conventional pulverized coal in the United States and elsewhere. However, it is ready today for use with IGCC power plants. The oil giant BP has already announced an IGCC project with pre-combustion CO_2 capture at its refinery in Carson, California. The MIT executive summary statement that "[t]here is no operational experience with carbon capture from coal plants and certainly not with an integrated sequestration operation." (Executive Summary, p. xiii), is not correct as the Dakota Gasification plant shows.

The principal obstacle for broad application of pre-combustion capture to new power plants is not technical, it is economic: under today's laws it is cheaper to release CO_2 to the air rather than capturing it. The MIT report states that "at present Integrated Gasification Combined Cycle (IGCC) is the leading candidate for electricity production with CO_2 capture because it is estimated to have lower cost than pulverized coal with capture" (Executive Summary, p. xiii). This is backed up in the main body of the study, which quotes the respective costs of electricity from a supercritical pulverized coal plant with capture and an IGCC with capture as 7.69 cents/kWh and 6.52 cents/kWh (p. 30).

Commercial post-combustion CO_2 capture systems have been applied to very small portions of flue gases from a few coal-fired power plants in the United States that sell the captured CO_2 to the food and beverage industry. However, industry analysts and the MIT report state that today's systems, based on publicly available information, involve much higher costs and energy penalties than the principal demonstrated alternative, pre-combustion capture. New and potentially less expensive post-combustion concepts have been evaluated in laboratory tests and some, such as ammonia-based capture systems, are scheduled for small pilot-scale tests in the next few years. Under normal industrial development scenarios, if successful such pilot tests would be followed by larger demonstration tests and then by commercial-scale tests. These and other approaches should continue to be explored.

Oxyfuel combustion is also in the early stages of development. Pilot studies for oxyfuel processes have been announced. As with post-combustion processes, absent an accelerated effort to leapfrog the normal commercialization process, it could be significant number of years before such systems begin to be deployed broadly in commercial application.

Capturing emissions from new power plants is perfectly feasible. Is it possible then to sequester the CO_2 in geologic formations? We examine that question below.

Sequestration of Carbon in Geologic Formations Is Possible

We have a significant experience base for injecting large amounts of CO_2 into geologic formations. For several decades oil field operators have received high pressure CO_2 for injection into fields to enhance oil recovery, delivered by pipelines spanning as much as several hundred miles. Today in the United States a total of more than 35 million tons of CO_2 are injected annually in more than 70 projects. In addition to this enhanced oil recovery experience, there are several other large injection projects in operation or announced. The longest running of these, the Sleipner project, began in 1996. But the largest of these projects injects on the order of 1 million tons per year of CO_2, while a single large coal power plant can produce about 5 million tons per year. And of course, our experience with human-made injection projects does not extend for the 1,000-year or more period that we would need to keep CO_2 in place underground for it to be effective in helping to avoid dangerous global warming. Accordingly, the public and interested members of the environmental, industry, and policy communities rightly ask whether we can carry out a large-scale injection program safely and assure that the injected CO_2 will stay where we put it.

Do we have a basis today for concluding that injected CO_2 will stay in place for the long periods required to prevent its contributing to global warming? The IPCC report concluded that we do, stating that "[o]bservations from engineered and natural analogues as well as models suggest that the fraction retained in appropriately selected and managed geologic reservoirs is very likely to exceed 99 percent over 100 years and is likely to exceed 99 percent over 1,000 years."

The MIT study itself states that:

> "[a]lthough substantial work remains to characterize and quantify these mechanisms, they are understood well enough today to trust estimates of the percentage of CO_2 stored over some period of time—the result of decades of studies in analogous hydrocarbon systems, natural gas storage operations, and CO_2-EOR. […] Additional work will reduce the uncertainties associated with long-term efficacy and numerical estimates of storage volume capacity, but no knowledge gaps today appear to cast doubt on the fundamental likelihood of the feasibility of CCS. […] Our overall judgment is that the prospect for geologic CO_2 sequestration is excellent. We base this judgment on 30 years of injection experience and the ability of the earth's crust to trap CO_2." (p. 44)

Although the report notes the existence of open issues about large-scale deployment, meaning a sequestration program on the order of billions of tons per year, Chapter 4 of the report makes clear that these issues are not obstacles to commencing numerous multimillion tonne per year injection projects today. Rather, the issues mentioned are ones that should be addressed to allow a large-scale program to be implemented in an economically optimized fashion.

The report makes recommendations that include a comprehensive nationwide survey by the United

States Geological Survey to map out storage capacity, the development of a regulatory framework for CCS, the adoption of long-term liability regimes for storage sites, and the acceleration of large-scale sequestration projects of at least 1 million tonnes of CO_2 annually. All of these recommendations can be implemented before the commissioning of new coal power plants now in the development stage.

The Cost of CCS

CCS costs more than conventional power generation. Significantly more capital and equipment is required and the energy penalty that accompanies plants that capture and sequester their carbon is not trivial. However, deployment of CCS will have a minimal effect on the power sector, end-consumers, and the economy as a whole.

With today's off-the-shelf systems, estimates are that the production cost of electricity at a coal plant with CCS could be as much as 40 percent higher than at a conventional plant that emits its CO_2. But the impact on average electricity prices of introducing CCS now will be very much smaller due to several factors.

First, power production costs represent about 60 percent of the price that end-consumers pay for electricity—the rest comes from transmission and distribution costs. Second, coal-based power, which would initially be the source that would utilize CCS, represents just over half of U.S. power consumption. Third, and most important, even if we start now, CCS would be applied to only a small fraction of U.S. coal capacity for some time. Thus, with a properly designed trading approach, the incremental costs on the units equipped with CCS could be spread over the entire coal-based power sector or possibly across all fossil capacity depending on the choices made by Congress. Based on CCS costs available in 2005 we estimate that a low-carbon generation obligation large enough to cover all forecasted new U.S. coal capacity through 2020 could be implemented for about a 2 percent increase in average U.S. retail electricity rates.

The MIT study notes that absent a value for carbon there is no economic reason from the firm's perspective to employ CCS outside niche markets like enhanced oil recovery. However, the study does not demonstrate, or even argue, that a prompt deployment program would result in economically infeasible impacts on electricity prices. The added costs of CCS therefore do not constitute an argument that prompt deployment for new capacity now in the planning pipeline would be economically infeasible.

Regulations Needed for CCS

A regulatory framework is absolutely necessary to assure that CCS does not pose any significant risk to human health or the environment, to assure it is performed to high standards, and to enable the widespread adoption of the technology.

The MIT study clearly calls for such a framework to be developed, and should be commended for doing so:

> "An explicit and rigorous regulatory process that has public and political support is prerequisite for implementation of carbon sequestration on a large scale. This regulatory process must resolve issues associated with the definition of property rights, liability, site licensing and monitoring, ownership, compensation arrangements and other institutional and legal considerations. Regulatory protocols need to be defined for sequestration projects including site selection, injection operation, and eventual transfer of custody to public authorities after a period of successful operation.[…] These issues should be addressed with far more urgency than is evidenced today" (Executive Summary, p. xii).

With concerted effort by an agency with jurisdiction and capability, which we believe is the U.S. EPA, a regulatory framework for CCS can be in place in a few years. For new plants that are closer to construction, there will likely be a need for interim requirements and those should be set forth without further delay.

Policies to Promote CCS

The MIT study recommends government grants to support installation of CO_2 capture at several new coal plants (p. 100).

Although this policy recommendation may make sense as a complement to a requirement for new coal plants to use CCS, by itself it is inadequate and likely to lead to wasted taxpayer expenditures.

Research and development funding as well as direct government subsidies can be useful in assisting a technology's widespread adoption, but cannot substitute for the incentive that a genuine commercial market for CO_2 capture and storage systems will provide to the private sector. Government assistance needs to go hand in hand with policies that will make the adoption of low-carbon generation technologies mandatory. The amounts of capital that the private sector can spend to optimize CCS methods will almost certainly always dwarf what government will provide with taxpayer dollars. To mobilize those private sector dollars, Congress needs a stimulus more compelling than the offer of modest handouts for research.

We have a model that works: intelligently designed policies to limit emissions cause firms to invest money to find better and less expensive ways to prevent or capture emissions.

Where a technology is already competitive with other emission control techniques, for example, sulfur dioxide scrubbers, a cap and trade program like that enacted by Congress in 1990, can result in more rapid deployment, improvements in performance, and reductions in costs. However, a CO_2 cap and trade program by itself may not result in deployment of CCS systems as rapidly as we need. Many new coal plant design decisions are being made literally today. Depending on the pace of required reductions under an emissions cap, a firm may decide to build a conventional coal plant and purchase credits from the cap and trade market rather than applying CCS systems to the plant. Although this may appear to be economically rational in the short term, it is likely to lead to higher costs of CO_2 control in the mid and longer term if substantial amounts of new conventional coal construction leads to ballooning demand for CO_2 credits.

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

Accordingly, we believe the best policy package is a hybrid program that combines the breadth and flexibility of a cap and trade program with well-designed performance measures focused on key technologies like CCS. One such performance measure is a CO_2 emissions standard that applies to new power investments. California enacted such a measure in SB1368 in 2006. It requires new investments for sale of power in California to meet a performance standard that is achievable by coal with a moderate amount of CO_2 capture.

Another approach is a low-carbon generation obligation for coal-based power. Similar in concept to a renewable performance standard, the low-carbon generation obligation requires an initially small fraction of sales from coal-based power to meet a CO_2 performance standard that is achievable with CCS. The required fraction of sales would increase gradually over time and the obligation would be tradable. Thus, a coal-based generating firm could meet the requirement by building a plant with CCS, by purchasing power generated by another source that meets the standard, or by purchasing credits from those who build such plants. This approach has the advantage of speeding the deployment of CCS while avoiding the "first mover penalty." Instead of causing the first builder of a commercial coal plant with CCS to bear all of the incremental costs, the tradable low-carbon generation obligation would spread those costs over the entire coal-based generation system. The builder of the first unit would achieve far more hours of low-carbon generation than required and would sell the credits to other firms that needed credits to comply. These credit sales would finance the incremental costs of these early units. This approach provides the coal-based power industry with the experience with a technology that it knows is needed to reconcile coal use and climate protection and does it without sticker shock.

Misinterpretations of the MIT Report

Some have misread the MIT to suggest that additional research and development is required before we could apply CCS to coal plants now being designed. For example, a recent press report cited a leaked draft of the report's executive summary as follows: "[the study] concludes in a draft version that it is not clear which technology—the so-called integrated gasification combined cycle or pulverized coal—will allow for the easiest carbon capture, because so much engineering work remains to be done". This reference confuses two different issues: is CCS demonstrated today versus which approach to CCS may ultimately prove to be most effective and economical. As discussed above, the MIT report makes clear that demonstrated CCS methods exist today although private firms will not employ them absent a subsidy or a CO_2 emissions performance requirement.

The report urges that no single approach like IGCC should be anointed as the ultimate best system for use of coal with CCS. Adoption of policies that set a CO_2 performance standard now for new plants will not anoint IGCC as the technological winner since alternative approaches can be employed when they are ready. If the alternatives prove superior to IGCC and pre-combustion capture, the market will reward them accordingly. Setting the policy now will create the market that will stimulate competition among competing approaches.

Some industry developers who are seeking approval to build conventional CO_2 emitting coal plants already have misstated the report's conclusions as justifying their attempts to build new plants without CCS. For example, Sithe Global Power LLC, the developer of the proposed Desert Rock power plant, in a January 2007 brochure, cites the then unreleased report to imply that the report raises questions about "the viability of sequestration technologies":

> "Even if carbon capture technologies become available and affordable, many unanswered questions remain about the viability and impacts of sequestering carbon dioxide. While some technologies in the oil and gas industries use carbon sequestration today for additional development, no long-term storage data is currently available. An upcoming study from energy experts at the Massachusetts Institute of Technology (MIT) to be released in February 2007 is likely to cast further doubt on the viability of sequestration technologies. While Sithe Global and other developers believe the future is promising, carbon sequestration issues still remain a largely unknown factor because of these concerns."

In fact, the MIT report states the authors' "confidence that large-scale CO_2 injection projects can be operated safely," even though current modeling, monitoring, and verification methods do not resolve all relevant technical issues. (Executive Summary, p. xii). Chapter 4 of the report, which discusses geologic storage in detail, states that

- geologic trapping mechanisms "are understood well enough today to trust estimates" made by the IPCC that more than 99 percent of injected CO_2 will likely be retained for at least 1,000 years; and
- "no knowledge gaps today appear to cast doubt on the fundamental likelihood of the feasibility of CCS." (p. 44)

Conclusion: Time Is of the Essence

The study does not examine in any detail the key issue surrounding new coal plant construction: would it be better to vent CO_2 from new coal plants in the next decade or two rather than capture it. The report notes that if significant new coal capacity without CCS is built the costs of CO_2 control programs would increase for all. Another outcome, not discussed in the report, is that such new coal investments will be cited by their owners as reasons to delay the pace of programs to limit CO_2 emissions. That result would foreclose options to stabilize CO_2 concentrations at adequately protective levels.

The report does state that there is no reason for Congress to delay action to limit CO_2 emissions during the CCS demonstration program recommended by the study authors. There are ample reasons to avoid any such delay. If CO_2 performance standards for U.S. coal plants were to be delayed until after the completion of the three to five recommended large-scale sequestration demonstrations, and other countries followed suit, it is likely that broad CCS would not happen until another 20 years of coal capacity had been constructed—an amount of new capacity about as large as current global coal capacity. If that amount of sunk investment in non-capture coal capacity is made, either CO_2 control programs will be much more costly, as the study notes, or worse, politicians will simply fail to put in place effective programs to protect against a climate catastrophe.

The die is being cast for that catastrophe today, not decades from now. Decisions being made today in corporate board rooms, government ministries, and congressional hearing rooms are determining how the next coal-fired power plants will be designed and operated. Power plant investments are enormous in scale, more than $1 billion per plant, and plants built today will operate for 60 years or more. The International Energy Agency (IEA) forecasts that more than $5 trillion will be spent globally on new power plants in the next 25 years. Under IEA's forecasts, more than 1,800GW of new coal plants will be built between now and 2030—capacity equivalent to 3000 large coal plants, or an average of ten new coal plants every month for the next quarter century. This new capacity amounts to 1.5 times the total of all the coal plants operating in the world today.

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

If all 3,000 of the next wave of coal plants are built with no CO_2 controls, their lifetime emissions will impose an enormous pollution lien on our children and grandchildren. Over a projected 60-year life these plants would likely emit 750 billion tons of CO_2, a total, from just 25 years of investment decisions, that is 30 percent greater than the total CO_2 emissions from all previous human use of coal.

The MIT report concludes that retrofits of plants built without CCS are not likely: "[…], retrofitting an existing coal-fired plant originally designed to operate without carbon capture will require major technical modification, regardless of whether the technology is SCPC or IGCC." (Executive Summary, p. xiv)

The IPCC stated in February 2007 that the warming of the plant's climate system is "unequivocal", and that it is attributable to anthropogenic greenhouse gas emissions with more than 90 percent probability. Meanwhile, in its April 2007 release, the Panel reportedly will warn of starvation, water shortages, disease, floods, extinctions, and increased death rates, claiming that "[c]hanges in climate are now affecting physical and biological systems on every continent." We must begin decreasing our greenhouse gas emissions now. The modest costs of deploying CCS today are completely overshadowed by the costs and risks of not doing so.

While the authors of the MIT report decline to say so directly, the information presented in the report supports a straightforward policy recommendation: Congress should require planned new coal plants in the United States to employ CCS without further delay.