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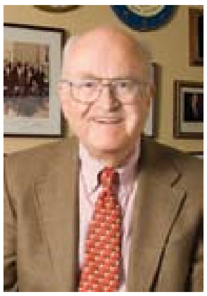
Toward "Climate Friendly" Coal



A. James Barnes, Professor
School of Public and Environmental Affairs
barnesaj@indiana.edu

Kenneth R. Richards, Associate Professor
School of Public and Environmental Affairs
kenricha@indiana.edu

Peer Reviewers:
John W. Clark, Former Senior Executive and Policy Advocate, U.S. EPA and Adjunct Professor, School of Public and Environmental Affairs;
John Rupp, Assistant Director for Research, Indiana University Geological Survey;
and J.C. Randolph, Professor, School of Public and Environmental Affairs

Introduction

The challenge of formulating effective policies that regulate the generation of electricity is immense. The U.S. generates fully half of its electricity by coal. Although supplies of coal are plentiful, conventional methods of burning coal produce carbon dioxide (CO_2), a greenhouse gas linked to climate change. Recent bills in Congress, as well as President Obama's proposed program, have set the goal of reducing CO_2 emissions by 80 to 85 percent by 2050.

Energy conservation, nuclear power, natural gas, and renewable sources can supply some of the future needs, but most experts agree that coal will continue to play a crucial strategic, economic, and perhaps even expanding role in the nation's generation portfolio.

The most promising way to meet this challenge may be to implement "carbon capture and storage" (CCS) systems, a method that isolates or "captures" carbon dioxide, compresses it, and pumps it underground for safe, long-term storage, a process also known as "geological sequestration."

In this issue of *SPEA's Policy Insights*, we suggest some key recommendations for consideration that can guide the development of policies governing CCS implementation. These include:

1. Employ CCS only if it is a cost-effective solution for reducing greenhouse gas emissions.
2. Be careful in the design of incentives for CCS.
3. Involve states in the design of CCS regulations, particularly with respect to property rights and liability.
4. Be sensitive to the complex and often emotional politics of CCS.

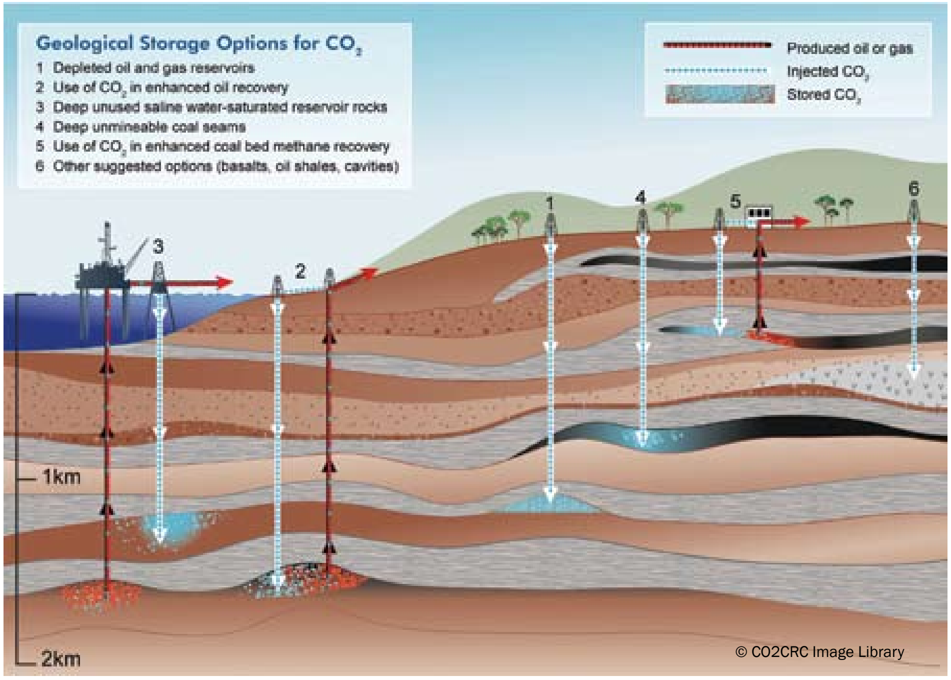
Policy analysts, social scientists, and lawyers must work with scientists, engineers, and technologists to design public policies that will encourage the demonstration and deployment of CCS systems that are safe, effective, and affordable.

How CCS Might Work

The concept of CCS sounds simple enough: capture the carbon dioxide from electric power plants, transport the CO_2 to a storage site, and inject the CO_2 into a safe location deep underground. A handful of pilot projects have already shown that many aspects of the practice are technically feasible, but there are not yet any large-scale, commercial demonstrations of CCS technologies at a coal power generation facility.

For nearly two decades, the U.S. Department of Energy has been working with industry and the research community to develop technologies to separate CO_2 from the

Methods for Storing CO_2 in Deep Underground Geological Formations



exhaust stream of coal combustion plants. An even more promising approach is to "gasify" coal into a synthetic gas and capture the relatively pure CO_2 byproduct stream.

Once at the storage site, operators must inject the huge volume of compressed CO_2 into a deep geological setting where it will be secure from leakage and will not damage mineral resources. Companies will also need to conduct risk assessments to guarantee the viability of the technology. As the technology matures over time, effective policy (including the cost of carbon) must take into account the fact that the risk (and the cost) may decrease.

Fortunately, the energy industry has already perfected many of the technical aspects of the practice. They have acquired practical experience with CO_2 injection, confinement, and risk management for an entirely different purpose: enhanced recovery of oil and gas from previously developed petroleum fields. Building on this experience, and with adequate research, development and real-world demonstration, it is possible to successfully deploy CCS on a large-scale basis.

It Must Be Cost-Effective

The integration of CCS into the electricity generation process will involve higher costs. In fact, studies suggest that CCS could increase the cost of electricity by as much as 40 percent or more. For CCS to have any meaningful effect on reducing the amount of CO_2 emitted by the generation process, the scale of deployment, including the percentage of CO_2 captured, must be massive.

For policy issues, the critical question is whether CCS is less costly than employing alternative methods to reduce CO_2 emissions. Even at the low end of the current cost estimates (\$40-\$90 per ton of CO_2), CCS looks rather pricey.

So why are we even discussing this as a technology option?

- First, the costs might decline substantially with more research and operational experience. Over time, costs could decline significantly – some predict by 50 percent or more by 2030.

- Second, to reach an 80 to 85 percent reduction in CO_2 emissions, we could exhaust all of the lower-cost options and still need to employ CCS. But there is probably enough storage space in the United States to store all CO_2 potentially produced if we consumed our entire coal reserve. In other words, CCS is our backstop technology. When Congress develops climate legislation, it should design a system that encourages the use of the least costly option first.

Congress Must Carefully Design Incentives for CCS

If Congress treats CCS as a legitimate, emissions-reducing practice, then energy producers facing a price on CO_2 emissions will investigate the cost-effectiveness of CCS compared to deploying alternative emission-reducing technologies. Some economists recommend taxing CO_2 emissions or capping CO_2 emissions in a regime that permits emitters to "trade" pollution allowances. Under either market-based instrument, an economic incentive for CCS will emerge, though the size of the incentive will control the future of CCS.

One option would provide "bonus allowances" for deploying CCS. Not only would developers avoid allowance requirements for the CO_2 they stored geologically, they might also receive as many as four more emissions allowances for having used this new technology. These programs reward operations, but CCS is a capital-intensive operation. Depending upon the price of allowances and the cost

Cost of New Central Electricity-Generating Technologies

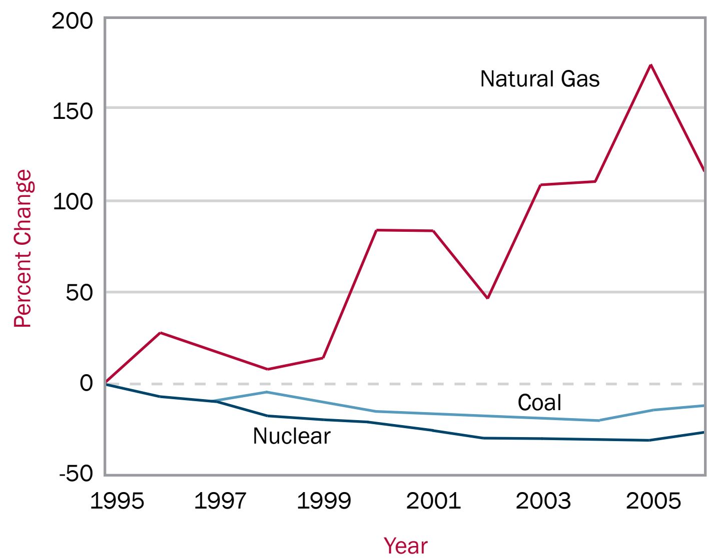
Technology	*Base Cost in 2008 \$2007/kW)*
Conv Gas/Oil Comb Cycle	\$917
Wind	\$1,797
Scrubbed Coal	\$1,923
Conventional Hydropower	\$2,038
Advanced Nuclear	\$2,873
Coal Gasification and Sequestration	\$3,172
Photovoltaic	\$5,750

Source: Energy Information Administration, 2009 of CCS operations, this could lead to some counterproductive incentives. For example, if the operating cost (i.e., excluding capital cost) is only twice as much as the value of an allowance, but firms receive four bonus allowances, they might over-produce electricity in an effort to acquire the allowances.

It would be better for the government to provide support for the demonstration of CCS at coal plants if it expects carbon prices to remain low for the next decade. For example, the Energy Policy Act of 2005 provides a 20-percent subsidy of the capital costs of gasification technologies.

The justification for the federal government's underwriting research and early capital investments in CCS is that it is important for the country to learn about the technology – its costs, challenges, and potential improvements. But this also means that rigorous and open evaluation systems, with data made available to all interested stakeholders, should accompany all projects underwritten by the government.

Percent Change in Real Fuel Prices Relative to 1995



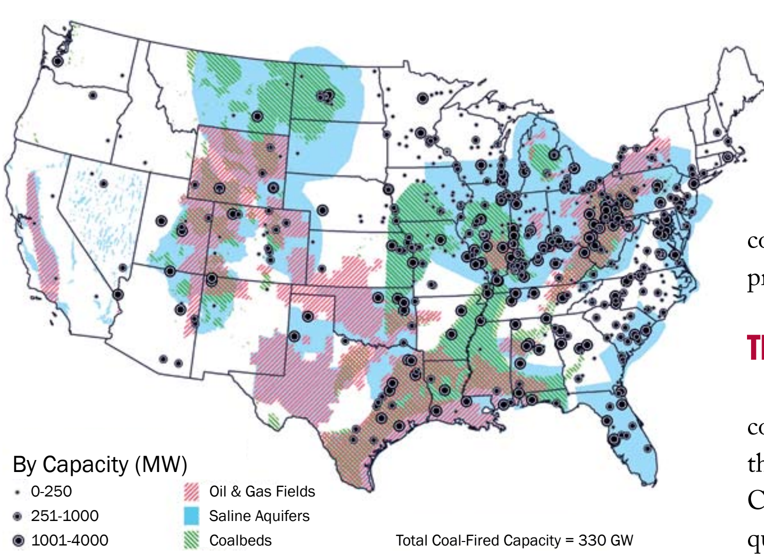
States Must Participate in the Design of Regulations for CCS

While the federal government will bear the primary responsibility for establishing incentives for CCS by controlling the overall emissions of CO_2, it will share with state governments the responsibility for developing regulations to govern the safety, liability, and property rights issues related to the actual implementation of this new technology. Since we don't know much about the risks, costs, and effectiveness of large-scale CCS projects, stakeholders must undertake the initial demonstration projects in a flexible regulatory environment where both regulators and industry learn from experience.

Under the Safe Drinking Water Act Underground Injection Control Program, the U.S. Environmental Protection Agency (EPA) is developing regulations for a whole new class of underground injection wells – those intended for use in the long-term storage of CO_2. Rules will be necessary for how CO_2 capture translates into allowances, site characterization, and injection well design, allowed injection quantities for a given site, reservoir pressure limits, and the purity of the injected CO_2 stream.

But deployment of the CCS technology, especially when it involves onshore injection, could also implicate real property rights, a realm traditionally reserved for the states. While the CO_2 in a CCS operation will be injected into a single or limited number of injection wells, it eventually spreads quite broadly, potentially permeating pore space below the surface owned by thousands of landowners. The potential for conflict between owners of surface and mineral estates on the one hand, and CCS operators on the other, are substantial. States will have to sort out this sticky property rights issue before developers will be comfortable investing the billions of dollars that are likely to be required to build the first CCS-equipped plants.

U.S. Coal-Fired Power Plants (2000)



There are also liability issues. Because only governments can make credible commitments for hundreds of years, it may be necessary for the state (or federal) government to accept the long-term liability of storage sites after they have been closed and secured. The policies (and therefore the associated regulatory constraints) will need to be site-specific, and participating companies will face complex permitting, operational, and closure processes.

The Complex Politics of CCS

The establishment of a CCS operation is likely to be controversial in some places. For example, communities that value the role of coal in the energy system may be more accepting of CCS than those that see coal only as a threat to environmental quality. In the United States, it is not surprising that sites for initially deploying and evaluating CCS-equipped facilities are located in the industrial Midwest rather than on the west or east coasts, where coal is controversial. But even if the coal-intense states initially bear the costs of CCS, for reasons of politics (and arguably fairness), effective policies will need to spread the burden of the cost throughout the nation.

The stances that organized environmental groups take toward the future of CCS are likely to be critical to the future of the technology. Some see the technology as a promising tool in the global fight to slow global climate change. Others worry about the negative environmental effects of coal mining, as greater amounts coal are needed with CCS technology.

Even among industrial interests, the political stances toward CCS may reflect obvious (or quite subtle) economic motivations. Investors in the manufacturing and generation sectors that are dependent on low-cost coal-derived power see CCS as crucial to their returns in a carbon-constrained world. Companies with commercial interests in wind, solar, or nuclear power may fear that CCS will undermine their business opportunities.

Summary

Coal supplies a substantial portion of the nation's electricity needs. If we don't use it carefully, however, coal will exacerbate global climate change by increasing the atmospheric concentration of carbon dioxide.

The most promising path toward using coal in a "climate friendly" manner is the large-scale deployment of CCS. We must resolve critical technical and policy challenges for CCS to operate successfully at thousands of large coal-fired power plants. The stances of the organized environmental movement toward the future of CCS technology are likely to be critical. Regulatory and liability regimes, as well as insurance systems, need to be designed and refined as we gain knowledge from the initial large-scale demonstrations of CCS.

Policy analysts, social scientists, and lawyers will need to work creatively with the technical community to design, implement, and refine sensible public policy.

Further Reading

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James T. Bartis, *Research and Development Issues for Producing Liquid Fuels from Coal*, RAND Corporation, CT-289, September 2007.

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Each issue of *SPEA Insight* highlights a major public policy challenge in the USA or the world, along with analysis by SPEA faculty and other experts that will help policy makers address these challenges.

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