Realizing the Potential of Carbon Capture and Storage Technology

Written Statement submitted to the House Committee on Energy and Commerce,
Subcommittee on Environment and Hazardous Materials

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Introduction

The Coal Utilization Research Council (CURC) is an association of coal stakeholders which has the primary purpose of fostering programs of technology research, development, demonstration, and deployment of technologies to enable the continued economic and energy security benefits that derive from coal use, in a manner that is consistent with the nation's environmental policies and goals. CURC members include major U.S. coal companies, coal-using electric utilities, manufacturers of power plants and power plant environmental control systems, major universities with engineering programs related to coal technologies, and major coal-related associations or institutes including the National Mining Association, Edison Electric Institute, the National Rural Electric Cooperative Association, and the Electric Power Research Institute (a list of members is attached). Our major focus is on coal-based power production, because that sector consumes over 90% of U.S. coal production, but our members are also involved in technologies that convert coal to substitute natural gas, chemical feedstocks and liquid transportation fuels. In recent years CURC's highest priority has been the research, development, demonstration and deployment of carbon capture and storage (CCS) technologies.

This written statement focuses upon the need for coal in supplying reliable, low-cost, environmentally acceptable, energy to American consumers and the need to successfully address concerns about global warming impacts associated with the use of coal.

Adequacy and costs of electricity capacity in the U.S.

The U.S. power sector is showing signs of serious stress. In reports issued in May and June of this year, the Federal Energy Regulatory Commission (FERC) pointed to increasing use of relatively costly natural gas and declining electric capacity reserve margins. FERC has predicted 60-120% increases in wholesale electricity prices this summer compared to last summer.[1] These reports followed last winter's report by the North American Electric Reliability Corporation (NERC) that reliability of electricity supply in the U.S. had declined, and would fall below industry standards of acceptable reserves on both U.S. coasts by 2009.[2]

Attempts to construct coal-fueled power generation have been met, in many instances, with opposition by non-governmental entities and deepening concerns over costs and CO_2 impacts by government entities. During 2007, over 30 proposed coal-based power plants were postponed or cancelled. Proposed plants were stopped by Public Utility Commission objections to escalating costs (or potential future costs related to CO_2 emissions), or by environmental permitting agency objections to CO_2 emissions, even in the absence of CO_2 regulatory requirements. The general response has been to propose the construction of natural gas-based power plants that are less costly to construct, easier and quicker to obtain necessary government permits, and emit about one-half the CO_2 of a coal-based power plant. But these generating plants will use a fuel that currently costs more than five times as much as coal. The DOE/Energy Information Administration predicts electricity price increases of 15% by the end of 2009, but utilities in a number of states have already registered rate increase requests of 20-30%, and most of these have cited escalating fuel prices.[3]

The economic challenge of climate change mitigation must somehow be accommodated in this already highly volatile marketplace.

CCS technology is critical to meeting the nation's climate goals

The CO_2 emissions from coal (about 33% of U.S. manmade CO_2 emissions) and natural gas-based power (natural gas-based electricity also contributes to the U.S. total CO_2 emissions – about 6% of the total) constitute a large percentage of overall CO_2 emissions even while these fossil fuels contribute, by far, the largest percentage of available electric capacity to the Nation's power grid. Those CO_2 emissions can be reduced by improving generation efficiency, or by improving end-use efficiency, but a major reduction will require the widespread adoption of carbon capture and storage (CCS) technology. CCS technology involves two steps: separation and compression of CO_2 at the power plant, and transport and storage of CO_2.[4]

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[1] 2008 Summer Market and Reliability Assessment, Item No.: A-3, Federal Energy Regulatory Commission, May 15, 2008; and Increasing Costs in Electric Markets, Item No.: A-3, FERC, June 19, 2008.

[2] 2007 Long-Term Reliability Assessment: 2007-2016, North American Electric Reliability Corporation, October 2007.

[3] Short Term Energy Outlook, July 2008, USDOE Energy Information Administration. Price Jolt: Electricity bills going up, up, up, USA Today, June 20, 2008.

[4] CCS, in this statement, can refer to both the storage of CO_2 into deep geologic formations as well as the use of CO_2 in the recovery of crude oil referred to as enhanced oil recovery (EOR). Also references to CCS, in the context of possible government incentives, can also include CO_2 captured from coal to liquid fuels, chemicals, industrial feedstocks or substitute natural gas.

The significance of CCS technology to achieving climate goals was demonstrated in a massive study published this year by the International Energy Agency (IEA), an arm of the (spell out acronym)OECD. The study, Energy Technology Perspectives: 2008, identified technologies necessary to meet a global reduction in greenhouse gas emissions of 50% below current levels by 2050. CCS technologies were associated with 20% of the total reduction required, and the IEA stated that, "There is an urgent need for the full-scale demonstration of coal plants with CCS." In EPA's analysis of S.2191, the Lieberman-Warner climate bill (as initially introduced), that Agency determined that CCS was critical to controlling overall compliance costs. More recently, Senator Bingaman emphasized the need to pursue CCS technology and stated, "We need to invest in this technology agenda immediately, even before the implementation of a cap-and-trade system, so we can figure out right away if our caps are based on technically viable options …."[5]

In other words, if CCS cannot be made to work, it is not coal use that is in jeopardy, it is the climate goals that many (including many in Congress) are seeking to achieve.

CCS risks to groundwater

On July 15, EPA proposed rules to regulate CO_2 storage through the Underground Injection Control (UIC) program.[6] The major potential impacts of CCS on underground sources of drinking water (USDW) were identified as: leaching of metals and mobilization of other contaminants by CO_2 or dilute carbonic acid formed from CO_2, and contamination of drinking water by pollutants in the CO_2 injectant stream (the CO_2 itself is not a problem). In other words, if these impacts were to occur they would most likely be the result of an improperly managed geologic storage facility in which CO_2 leaked from its designed containment area and reached an USDW. Both the rules recently proposed by the US EPA and model State regulations developed by the Interstate Oil and Gas Compact Commission (IOGCC) include provisions for selecting storage sites which have a high probability of retaining injected CO_2. These proposed programs also include requirements for periodic or continuous monitoring of conditions underground to detect and mitigate unexpected leaks before the CO_2 would ever reach valued USDW resources.

It should be noted that the Intergovernmental Panel on Climate Change (IPCC) has concluded that, "Observations from engineered and natural analogues as well as models suggest that the fraction [of stored CO_2] retained in appropriately

[5] Finding the Path Forward on Climate Legislation, speech to NDN, Sen. Jeff Bingaman, July 9, 2008.
[6] EPA press release and Notice of Proposed Rulemaking are available at: http://yosemite.epa.gov/opa/admpress.nsf/bd4379a92ceceeac8525735900400c27/d35b72dfe481043b85257487005e47cd!OpenDocument .

selected and managed geological reservoirs is very likely to exceed 99% over 100 years and is likely to exceed 99% over 1,000 years."[7] Experts from around the globe agree that once properly stored, the likelihood of any significant leakage of CO_2 is miniscule.[8]

Major barriers to CCS deployment

CURC believes that there are four major barriers to deployment of CCS technologies.

- The first is that the needed capture technology, which exists and has been used in the petrochemical industry, has never been deployed on a commercial scale with power generation. Integrating these CCS systems, which can consume 15-30% of the energy used at a power plant, with the basic power plant system is challenging.
- The second barrier is that we have very limited experience with storing large volumes of CO_2. The four largest commercial scale projects in the world, taken together, are approximately the storage rate required for 85% capture on one large coal-fired power plant.[9] EPA confirms what the Department of Energy and others have reported, that there are vast potential resources within the North American continent to store as much as 3,900 billion tons of CO_2; current annual CO_2 emissions for all U.S. sources are approximately 6 billion tons so there is potentially hundreds of years of storage capacity available.
- The third barrier is high cost. The four CO_2 storage projects cited above are all non-power applications in which the separation of CO_2 from other gases is part of the basic process of energy production or conversion, and creates very little additional cost. For power production, the addition of a CCS system, using currently available technology, can double the cost of electricity generation, compared to a basic pulverized coal power plant that could be constructed today without CCS.

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[7] Carbon Dioxide Capture and Storage, IPCC, 2005.

[8] Moreover, for over 15 years, acid gases (including CO_2 and much more hazardous hydrogen sulfide) have been injected into saline geologic formations in western Canada. The Alberta Research Council and Energy & Utilities Board report that, "By the end of 2003, approximately 2.5 Mt CO_2 and 2.0 Mt H2S have been successfully injected into deep hydrocarbon reservoirs and saline aquifers in western Canada. … No safety incidents have been reported in the 15 years since the first operation …." These injection and storage operations are smaller than those needed for electric power plants and the Canadian report cited the need for assessing long-term containment and large-scale operations. From: Overview of Acid-Gas Injection Operations in Western Canada, Bachu (Alberta Energy and Utilities Board) and Gunter (Alberta Research Council), Proceedings of the 7th International Conference on GHG Control Technologies, IEA GHG Programme, 2005.

[9] These projects include: Sleipner, which captures 1 million tonnes per year of CO_2 from natural gas production in the North Sea; Weyburn, which captures 1.7 million tonnes per year from substitute natural gas production from coal in North Dakota; In Salah, which captures 1 million tonnes per year from natural gas production in Algeria; and Snohvit, which captures 0.7 million tonnes per year from natural gas production in the Barents Sea.

- The fourth barrier is the absence of a regulatory framework governing storage of CO_2.

Regarding this last barrier, two potential regulatory frameworks have received attention. The first is the aforementioned EPA proposed rule on UIC. That rule is focused almost entirely on potential impacts on USDW, as it must be since it draws its authority from the Safe Drinking Water Act. The second is a set of model legislation and model implementing regulations developed by the Interstate Oil and Gas Compact Commission (IOGCC).[10] The IOGCC package is much broader in scope than the EPA proposed rules because it includes its own enabling legislation specifically tailored for CO_2 storage systems. The IOGCC proposed rules draw from two decades of state regulatory and industry experience with compression, transport, and injection of (primarily natural) CO_2 for enhanced oil recovery.

Recommendations to overcome barriers to CCS deployment

CURC believes that two actions are needed over the next couple of decades to overcome the four principal barriers to CCS deployment that are identified above.[11] The first action is that we must act <u>now</u> to provide financial incentives that result in immediate deployment of a limited number of CCS-equipped power plants or synfuel facilities equipped with currently available CCS. Without hands-on experience integrating CCS technology with power plant technology, and the associated experience with large-scale CO_2 storage systems in multiple geological formations, technology will not reach a full-deployment capability. Industry, regulators and the public need this early experience to validate our ability to address CO_2. In addition, early CCS projects – undertaken now – will assist in realizing cost reductions via this "learn by doing" effort.

We need to recognize that CCS deployment will be a "crawl, walk, run" process, rather than one in which we begin by "running." This technology maturation process – first crawl, then walk, and finally, run -- has several important implications for policy makers. One immediate policy implication is that government financial incentives should not be predicated or conditioned on achieving high fractions of CO_2 capture, like 85% or 90% capture. Such a significant percentage requirement is tantamount to running when we do not yet know how to crawl. It is true that we need experience with large-scale storage, but that can be better accomplished with a requirement for a significant annual storage tonnage, such as one million tons per year of CO_2 storage.

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[10] <u>Storage of Carbon Dioxide in Geologic Structures – A Legal and Regulatory Guide for States and Provinces</u>, IOGCC, September 25, 2007.

[11] It is not intended to assert that the adoption and successful pursuit of these two programs will thereby be sufficient to insure the continued long-term use of our Nation's coal resources nor the widespread commercial use of these technologies. Adoption of these programs will best insure that CCS technologies will have been developed and initially deployed, widespread commercial use may require additional programs or assistance.

Another policy implication is that we need a flexible interim set of rules for CO_2 storage for those willing to be the "first adopters" of CCS projects. It needs to be emphasized that the proposed EPA rules only cover one aspect of the needed legal framework, that is, the injection of CO_2 into underground storage reservoirs. In addition, these rules will apply well into the future and for vast tonnages of stored CO_2 and given this importance and longevity the actual adoption of these rules may be years away. For those early adopters of CCS projects that are coupled to coal-based energy conversion projects wishing to go forward now, we need an interim approach that addresses both EPA's concerns as well as broader legal and regulatory uncertainties that are outside EPA's legislative authority. CURC is very mindful of the absolute need to protect the public and USDW, that will be achieved presumably through the adoption of some form of the proposed EPA regulations for CO_2 injection as well as state or federal adoption of "how to" procedures as reflected, in part, by such model legislation and regulations as developed by the IOGCC. Again this process to be accomplished correctly may require years to complete. And, it should be emphasized that it is far preferable "to get it done right than to get it done quick."

The CURC proposes an interim program that is predicated upon an assurance to "first adopters" that the long-term liability of stored CO_2 would be transferred to and accepted by government. Initially, a CCS project would be responsible for the storage of CO_2 during operation of the project and for a period of time (e.g. ten years) after cessation of project activities during which the owner or operator would remain responsible for monitoring and verification post-storage shutdown. Without such assurances through some form of interim program, it is difficult to foresee how any initial CCS project, not knowing the "rules of the road" can proceed.

This Committee is urged to become actively involved in the consideration of such an interim program as a necessary step to avoid the delays that will confront the early demonstration and deployment of commercial-scale CCS projects that will otherwise await the installation of a regulatory and liability structure.

A final policy implication is that these pioneering CCS projects will not finish the job. These near-term activities have the potential to greatly accelerate full deployment of CCS technology. However, in order for this technology to be affordable, both in the U.S. and for the high growth coal nations of China and India, we must redouble our commitment to RD&D. This includes research on more efficient coal-based power systems (which emit less CO_2 even without CCS systems), as well as research on lower cost power systems equipped with CCS. Little progress will be registered in mitigation of CO_2 emissions from coal if we fail to develop CCS technologies that are affordable for all major coal using nations. But the larger message here is that it will take time to complete this needed RD&D. If we press for immediate emission reductions from the power sector, we are likely to see utilities abandon coal for natural gas, an action which will meet their early emission compliance needs. However, the reliable and affordable

CCS technology which is ultimately needed for both coal and gas will not receive priority attention under this scenario, and will therefore not be available when it is needed. For more information on this longer term RD&D effort I would refer readers to the CURC-EPRI Roadmap.[12]

All told, CURC estimates that the two technology development programs presented here, the immediate deployment program and the longer term RD&D effort, will cost well over $50 billion, spread over two decades. If we are to be successful Congress must join with industry to jointly provide sufficient time, focus and money to develop and apply those technologies that will allow us to be successful. A sustained partnership of great magnitude will be required.

Conclusions

The following general conclusions can be drawn from the above discussion:

- The U.S. power sector, beginning now, will exhibit sharp increases in prices, compared to previous years. Electricity reliability will deteriorate over the next few years, with a higher probability for blackouts during peak demand periods, beginning in some regions in 2009.
- Coal provides one-half the electric power generated in the U.S. and one-third of the nation's CO_2 emissions. Coal is essential for meeting U.S. power demand, and CCS technology is essential for coal to meet its environmental responsibilities. CCS is also needed for natural gas generating technologies, which contribute a significant portion of U.S. power generation.
- Storage of CO_2 presents two types of risk to underground supplies of ground water: potential contamination by metals and other compounds already in the ground, but mobilized by CO_2 injection or weak acids created by CO_2 injection and migrating to the USDW reservoir; and contamination by trace materials injected along with the CO_2. Both of these risks would only manifest if the CO_2 storage structure were improperly chosen or maintained. Both EPA and the IOGCC have formulated regulations that, if adopted and implemented, would negate that eventuality. The IPCC has concluded that a properly sited CO_2 storage project will have an extremely low probability of releasing CO_2 into rock strata where contamination of ground water could occur.
- CCS is an emerging technology that must overcome significant barriers before it will be available for broad deployment to mitigate CO_2 emissions from the power sector. However, CURC and others have identified those barriers and CURC has proposed a reasoned plan to overcome them. The plan includes immediate deployment of a small number of power plants with existing CCS technology now, and a longer term RD&D effort to produce a sharp reduction in the cost of CCS. CURC believes that a nurturing

[12] CURC – EPRI Roadmap for Advanced Coal Technologies, www.coal.org .

regulatory environment and financial assistance will be needed to ready CCS technology for broad commercial deployment.