Health and Safety Risks of Carbon Capture and Storage

John Fogarty, MD, MPH
Michael McCally, MD, PhD

CARBON CAPTURE AND STORAGE (CCS) IS A TECHnology being developed in an attempt to slow global warming. In theory, CCS would prevent carbon dioxide produced from coal-fired power plants from reaching the atmosphere by capturing and storing it permanently underground. The scale of this proposal is remarkable, requiring the capture of tens of billions of tons of carbon dioxide from thousands of coal and gas power plants throughout the world.[1]

Although carbon dioxide has been injected underground to enhance oil recovery from old wells, the use of the technology to permanently store carbon dioxide is still in a demonstration phase. Carbon capture and storage may receive billions of dollars of taxpayer support in pending energy legislation, the American Clean Energy and Security Act passed by the US House of Representatives in June 2009.[2]

Despite widespread political support for the technology, important and unanswered questions remain regarding CCS development. What risks to human health and safety are involved? How will CCS projects affect water quality in aquifers? Can CCS at scale really work and can carbon dioxide storage be made permanent? The risks are substantial and to our knowledge have not been considered in the promotion of CCS technology.

Carbon Capture and Storage

Carbon dioxide is the most significant of the greenhouse gases causing global warming, and more than one-third of carbon dioxide emissions in the United States comes from coal-fired power plants. Consequently, many earth scientists and lawmakers have called for a ban on new coal plants unless carbon dioxide is captured and contained. The coal industry consequently has launched a media campaign promoting "clean coal" based on the premise that with CCS global warming can be buried.[3]

Carbon capture and storage would involve collecting carbon dioxide emissions from coal plants and transfering them as high-pressure liquid carbon dioxide to underground geologic formations, including oil fields, coal beds, and other geologic formations. The scope of the project is huge—requiring construction of massive infrastructure of facilities, pipes, and pumps dedicated to capturing, pressurizing, transporting, and injecting carbon dioxide underground.[1] The International Energy Agency estimates that for CCS to have a significant effect in slowing global warming, there must be 6000 CCS projects each storing a million tons of carbon dioxide per year in operation by the year 2050.[4]

Health Risks

The potential health risks of CCS include asphyxiation of humans and animals, compromise of safe drinking water supplies, in addition to the well-known cardiorespiratory disease and mortality consequences of continued coal combustion.

High concentrations of carbon dioxide interfere with cellular metabolism and are lethal to humans and animals. Under normal circumstances, carbon dioxide is a trace gas composing less than 0.04% of gases in ambient air. Concentrations of carbon dioxide of more than 7% to 10% pose an immediate threat to human life. Elevated partial pressures of carbon dioxide in the blood cause carbon dioxide narcosis with delirium, somnolence, and coma.[5]

When released in large quantities, carbon dioxide accumulates at ground level in natural depressions and closed spaces because it is heavier than air. A large inadvertent release of carbon dioxide (as must be considered in a nationwide, full-scale CCS program) would pose significant risks for asphyxiation to humans and animals in surrounding areas. A number of case reports document human fatalities in atmospheres of high carbon dioxide concentration.[6]

In 1986, an estimated 100 000 tons of carbon dioxide were released from a volcanic lake near Lake Nyos, Cameroon. The carbon dioxide spread over a 15-mile radius from the lake and led to carbon dioxide concentrations of more than 10% in the surrounding communities. More than 1700 individuals died and hundreds more developed skin lesions and memory loss.[7] The carbon dioxide released from this event was equivalent to approximately 1 week of carbon dioxide emissions from a single coal-fired power plant.

See also p 69.

Author Affiliations: Department of Family Medicine, University of New Mexico, Albuquerque (Dr Fogarty); and Department of Preventive Medicine, Mount Sinai School of Medicine, New York, New York (Dr McCally).
Corresponding Author: Michael McCally, MD, PhD, 64 Lodge Trl, Santa Fe, NM 87506 (michaelmccally@comcast.net).

Carbon capture and storage researchers have raised concerns about the ability of geologic formations to hold large amounts of carbon dioxide and acknowledge the possibility of unintentional releases. Acidification effects of carbon dioxide as well as cracks, faults, natural springs, and old wells could allow dangerous amounts of carbon dioxide to escape.[8] Proposals for full-scale CCS coal plants ought be subject to appropriate risk analysis as part of a required environmental impact statement, including potential amelioration of risk by safety monitoring equipment.

The geologic security or permanence of underground carbon dioxide storage over time also has not been well studied. Geologists have raised concerns for possible leakage based on the type of geologic formation or the presence of existing drill holes at CCS sites.[1]

Contamination of Water Supplies

Injecting carbon dioxide into or near underground aquifers leads to the formation of carbonic acid. Such acidification can dramatically alter water quality by increasing the leaching of contaminants such as arsenic, lead, mercury, and organic compounds. In addition, the injected carbon dioxide may be contaminated with other pollutants from the coal plant emissions. Injection of carbon dioxide directly into oceans in large amounts also would make current problems of ocean acidification worse.[1]

The widespread use of geologic formations as storage for carbon dioxide could compromise not-currently-used aquifers on which future generations may depend for drinking water. Communities across the United States and worldwide are increasingly dependent on aquifers for drinking water as surface water resources are depleted.

Other Problems

Because of its scope, complexity, intrinsic risks, and cost, it is unclear whether CCS can be implemented in time to contribute to the immediate need for greenhouse gas reduction.[1] For example, there are no recognized industrial standards or codes of practice for supercritical carbon dioxide plants and equipment. Liability for inadvertent carbon dioxide release and groundwater contamination is already an issue for CCS developers. It is likely that federal indemnity programs will be proposed to limit corporate liability as is currently done for nuclear power. Such programs will transfer enormous risk and cost from private firms to taxpayers.[9]

Conclusions

The American Clean Energy and Security Act would provide tens of billions of dollars to the coal industry for the development of CCS. These provisions were included in the bill apparently without consideration of the health and environmental risks posed by CCS.

The medical community ought to support actively noncombustion, clean energy policies as a matter of public health. Criteria for such policies have been prepared.[10] Before new coal-fired power plants are approved, the National Academy of Sciences/Institute of Medicine and the Congressional Research Service should conduct careful scientific review of the feasibility, cost, and public safety of commercial scale implementation of CCS. Congress should hold public hearings on the same issues.

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