American Public Power Association
1875 Connecticut Ave, NW
Suite 1200
Washington, D.C. 20009
202-467-2900; fax: 202-467-2910
www.APPAnet.org

Carbon Capture and Sequestration
Legal and Environmental Challenges Ahead
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- A White Paper -

Prepared by Marianne Horinko, Executive Vice President, The Global Environment & Technology Foundation for the American Public Power Association (APPA)

Carbon capture and sequestration or storage (CCS) is on the cutting edge of greenhouse gas reduction technology research. CCS is the process by which carbon dioxide (CO_2) is separated and collected from large point sources such as coal power plants and retained in a manner that prevents immediate release into the atmosphere. This retention may be accomplished through a variety of means, such as large-scale botanical plantings or chemical adsorption treatment. This paper, however, is limited to the most common method, geological sequestration, which involves injection of CO_2 into underground geological formations. While CCS could potentially be effective in reducing greenhouse gas emissions, there are still unanswered questions about its long-term effects on human health and the environment, as well as real property and liability considerations.

The scale of CCS necessary to impact greenhouse gas emissions vastly exceeds the historical use of carbon injection practices in enhanced oil recovery (EOR). The purpose of carbon injection in EOR has been to displace fossil fuel to allow recovery; carbon sequestration is merely a byproduct of that recovery process. Generally speaking, CO_2 used in EOR is locally available from commercial, food grade CO_2 sources and not from utility or manufacturing plants. Sometimes the CO_2 used by the oil and gas recovery EOR operations is available locally through naturally occurring sources in the ground.

For example, to reduce the 2.5 billion tons of CO_2 annually emitted by United States power plants by ten percent (250 megatons) would require extensive deployment of CO_2 emission capture technologies at 25 plants.[2] Commercial-level CCS deposits are likely to be extensive, intersecting with preexisting mineral, water, and private property rights. In addition, the environmental liability associated with such practices has not been widely litigated, adding a layer of business uncertainty to the use of CCS as a viable technique. The legal frameworks surrounding existing EOR practices are focused on injection and

[1] This paper contains slight adaptations from the April 2007 version for APPA—primarily in the footnotes.
[2] Based on Energy Information Administration statistics. Assuming that a one gigawatt power plant produces 10 million tons of CO_2 annually.

typically maintain only limited long-term storage and monitoring components due to their small scale. Commercial-level CCS projects would require a reliable and transparent regulatory framework based on sound analysis of the unintended consequences to human health and environmental assets. The injection of CO_2 from power plants into any appropriate geologic formation would also require, first, considerable breakthroughs in carbon separation technology at the power plant. This is a step that, generally speaking, EOR sites do not require. [3]

The purpose of this white paper is to introduce environmental and legal issues that may require additional research before large-scale CCS can be implemented safely and effectively in the public power utility sector.

Human Health and the Environment

Despite the successes of EOR or tertiary recovery of oil and gas using CO_2 injection, leakage from embedded CO_2 deposits could result in the endangerment of ecological and human health given the scale of the utility sector's emissions. A better understanding of these impacts is necessary in order to take precautionary steps to mitigate them or avoid them entirely.

- Prolonged exposure to elevated concentrations of CO_2 can be harmful to human respiratory and central nervous systems.
- The release of large volumes of high concentrations of CO_2 can result in the suffocation of humans, animals, or plants above ground. For instance, natural CO_2 long-term seepage destroyed 40 hectares of trees on Mammoth Mountain in the Eastern Sierra Nevada mountain range in California.[4]
- Leakage from injected CO_2 could migrate into Underground Sources of Drinking Water (USDWs). Migrating CO_2 deposits may alter the pH of subsurface groundwater or displace potable water resources by forcing saline waters to merge with fresh water formations.
- According to the U.S. EPA, 44 percent of all U.S. drinking water is from groundwater, a considerable increase from only 5 years ago when most U.S. drinking water was from surface water sources.
- Current research suggests that injecting carbon into saline aquifers poses a threat to groundwater because of brine contamination.[5] Since it is not clear how large-scale CCS activities would address this concern, additional research is required considering the growing reliance on groundwater for use as drinking water.
- CCS could potentially cause displacement of native fluids and chemical constituents, movement of possible hazardous substances, or potential leaching of naturally occurring metals and minerals mixed in the CO_2 injection.

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[3] Complete explanation of separation technology issues available. See L. D. (Doug) Carter, Carbon Capture and Storage From Coal-based Power Plants: A White Paper on Technology, American Public Power Association, 22 May 2007.

[4] C.D. Farrar, M.L. Sorrey, W.C. Evans, J.F. Howle, B.D. Kerr, B.M. Kennedy, C.-Y. King, and J.R. Southron, "Forest-killing Diffuse CO_2 Emission at Mammoth Mountain as a Sign of Magmatic Unrest," *Nature* 376 (1995): 675-678.

[5] Brian McPherson and Peter Lichter, *CO_2 Sequestration in Deep Aquifers*, http://www.netl.doe.gov/publications/proceedings/01/carbon_seq/7a2.pdf.

- If the CCS process is responsible for discharge of a pollutant or hazardous substance (such as arsenic) into or upon navigable waters, this may incur administrative and/or civil penalties under the Clean Water Act (CWA).[6]

Property Rights

The legal mechanism for securing property rights for large carbon sequestration sites may currently be ineffective in many states, leading to unforeseen costs and delays. It also may lead to tensions between large-scale CCS projects and individual property rights.

- Since sub-surface land can be privately owned in the United States, CO_2 injection into geologic formations may require permission from all private owners of intersected sub-surface property. A proposed deposit for a FutureGen zero-emissions plant site may require property rights from 69 individual property owners.[7]
- Compulsory unitization laws for oil and gas production operations, currently used in some states to compel private property owners to permit large oil and gas sub-surface projects when a high percentage of affected property owners do accept, may be used extensively for enhanced oil recovery-related CCS.
- For non-oil and gas production projects, the use of eminent domain laws, currently used for sub-surface natural gas storage fields, may be necessary for CCS projects. Widespread use of local and state eminent domain laws for CCS may be politically difficult, given the public backlash against eminent domain driven by the Supreme Court case *Kelo v. New London*.[8]
- There is currently a significant level of uncertainty in predicting migration and movement of large CO_2 deposits in large geologic formations. Without further research, the scale of property right acquisition for CCS projects will remain high, as industry participants will seek to minimize liability from property trespass claims related to sub-surface trespass, geological surveying, and deposit monitoring.
- This scientific uncertainty may interfere with the availability of liability insurance for CCS project participants. If insurance companies cannot accurately calculate the risk of CO_2 damages, or future potential environmental liability, they may decline to offer coverage to public power utilities. Some public power utilities may not have the insurance coverage thought to be sufficient to handle the perceived risks for geologic sequestration or storage of CO_2.
- The utilization of regional land use controls to ban large-scale CCS projects near valuable natural resources may be an obstacle to implementing projects in viable locations.

General Regulatory Framework

The current federal and state regulatory framework may be insufficient for ensuring a fair resolution in the event of leakage damage to human health or private property.

- Currently, CO_2 has not yet been classified as a pollutant or a hazardous substance. If embedded CO_2 is not classified as such, then federal environmental statutes may lose

[6] CWA § 101

[7] Elizabeth Wilson and Mark de Figueiredo. "The Impact of Liability on the Adoption and Diffusion of Carbon Capture and Sequestration Technologies," page 6.

[8] 545 U.S. 469 (2005).

protection from CO_2 leakage damage, since these laws were created to assess and assign responsibility for damage from hazardous substances. However, CO_2 could ultimately be classified as a pollutant, especially if large-scale implementation of CCS leads to negative impacts on environmental media. This classification would have a significant legal impact and would likely increase the costs associated with CCS activities.

- There is uncertainty in the governance of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) over private property damage cases that are caused by sequestered CO_2. No carbon injection subsurface trespass legal precedents exist, and there is scientific uncertainty of embedded CO_2 impacts.
- If the CCS process causes a release or substantial threat of a release of any pollutant that may present an imminent and substantial danger to the public health or welfare, liability will likely attach under CERCLA.[9]
- If area-wide contamination is the result of CCS activities, potential parties could be held liable under CERCLA. To the extent that specific provisions of the CWA and the Safe Drinking Water Act (SDWA) are incorporated into the applicable or relevant and appropriate requirements (ARARs), those standards could then govern the remedial activities of a CERCLA cleanup.
- In the case that CCS results in collateral damage to natural resources, responsible parties could be made liable under the Natural Resources Damage Assessment (NRDA).
- The existence of citizen suit provisions, especially with respect to water laws in the Western U.S., introduces another level of uncertainty because any regulatory balance can be altered by a citizen bringing suit because of a lack of prosecutorial diligence, whether actual or perceived.
- In nuisance tort cases or other grievances related to CO_2 leakage, the potentially responsible parties under CERCLA are unclear. Federal and state government regulators, carbon injection operators, and public power generators of CO_2 may all be candidates for some portion of liability under the "joint and several liability" provision in the CERCLA statute's "cradle to grave" liability scheme.
- There may be legal difficulty in assigning responsibility for seismic disruption damages caused by carbon injection due to scientific uncertainty and lack of a legal precedent.
- In the case of natural seismic action leading to future CO_2 leakages, assigning liability based on fault may be impossible and lead to difficulty in handling the resultant damages.

Long-Term Stewardship and Liability

Assignment of liability associated with leakage and migration of CO_2 deposits and resulting public health or environmental impact is further complicated by the extended time frame of carbon storage, which may exceed the lifespan of industry participants. For example, determining which party is responsible for the CO_2 monitoring at a power plant after the plant is decommissioned or retired is difficult.

- The existing legal framework for EOR carbon sequestration has insufficient long-term storage and monitoring controls for large-scale CCS projects.

[9] CERCLA § 104

- The continuous existence of a viable entity is questionable under the current legal framework. It is still an open question whether long-term liability should rest with a public or private entity. To ensure the future economic burden associated with the CCS site will not rest on the public as a whole, issues of long-term stewardship, land use controls, and data tracking will need to be addressed.
- Assignment of liability in CO_2 releases is especially difficult if the companies that managed the injection and monitoring no longer exist or if they utilize subsidiaries to limit liability.
- Additional research is required to improve scientific knowledge of carbon storage, which would help to inform the liability debate.
- Plugged CCS injection sites will require effective long-term stewardship performed by a government or private entity. A detailed framework must be firmly established in the U.S. Environmental Protection Agency's (EPA) Underground Injection Control Program, which provides governance for CO_2 injection under the SDWA.[10]
- Although geologic sequestration currently meets the statutory definition of "underground injection" in section 1421(d)(1) of the SDWA, EPA is currently evaluating Department of Energy (DOE) pilot projects to determine if changes to the regulations are required for long-term CCS.
- Since EPA currently has the statutory mandate to protect underground sources of drinking water and aquifers, the unknown results of these DOE pilot projects leaves legal uncertainty with respect to the future of CCS activities.

Further Research

This white paper is intended as an overview of potential environmental and legal issues that could arise in a large-scale CCS operation. It is meant to promote further research and discussion of these areas before large-scale CCS implementation can provide one of the many technological solutions to constraining carbon from existing or future power plants. A pressing need for reducing greenhouse gas emissions and halting their effect on climate change is driving the current political impetus to institute commercial-level CCS on a short time frame. However, for commercial CCS to effectively reduce emissions and mitigate the effects of climate change, a comprehensive plan and effective regulatory framework that respect potential obstacles and adverse impacts are essential.

Technical and economic barriers to implementing commercial-level CCS are substantial, but they are also currently under significant scrutiny. The legal and environmental challenges of CCS should be analyzed and addressed with similar vigor in order to promote effective and sustainable practices in the United States. Research on these aspects will inform cost-benefit analyses of CCS in relation to other methods being developed to mitigate climate change, allowing for optimal distribution of public and private resources.

[10] Testimony of Acting Assistant Administrator William Wehrum and Assistant Administrator Ben Grumbles, U.S. Environmental Protection Agency. *Subcommittee on Energy and Air Quality, United States House of Representatives*, 6 March 2007.

Marianne L. Horinko is the Executive Vice President of the Global Environment & Technology Foundation (GETF). Prior to joining GETF, she served as Assistant Administrator for the Office of Solid Waste and Emergency Response (OSWER) at the U.S. Environmental Protection Agency from 2001 to 2004, and Acting EPA Administrator in 2003. She led the emergency responses to the 9/11 attacks, anthrax contamination, and the Columbia Space Shuttle disaster. She brought new approaches to environmental protection using partnerships, flexibility, and innovation. The Brownfields program, signed into law by President Bush in 2002, embodies these goals. During the first Bush Administration, Ms. Horinko was Attorney Advisor at EPA. Subsequently, she served as President of Clay Associates and practiced environmental law at Morgan, Lewis & Bockius, a national environmental policy firm, where she assisted in the creation of the RCRA Policy Forum. She graduated from the University of Maryland (analytical chemistry) and Georgetown University Law School.

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