Featured Article

Emerging Property and Liability Issues for Carbon Sequestration

Contributed by: Mark de Figueiredo and Adeeb Fadil, Simpson Thacher & Bartlett LLP

Introduction

A broad scientific consensus has emerged that the well-documented increases in carbon dioxide (CO2) concentrations in the Earth's atmosphere since pre-industrial times largely have been caused by human activity, especially widespread and increasing fossil fuel combustion worldwide, and that these and other greenhouse gas emissions from human activity have very likely resulted in global warming.[1] A similarly broad consensus has emerged that stabilizing CO_2 concentrations may be crucial, in order to blunt continued global warming and a wide range of profound anticipated climatic effects it may cause.[2] But a major obstacle to such reductions is that fossil fuels currently supply a substantial majority of the energy used around the globe. While energy conservation and carbon-free energy sources are making large strides, projections of our global energy future typically forecast continued widespread fossil fuel use—in the United States, as well as worldwide—far into this century.[3]

Given the continuing prominence anticipated for fossil fuels in the world's energy mix, a range of stakeholders—from some leading environmental advocacy groups, to some major energy providers—have expressed strong interest in carbon capture and sequestration, sometimes called CO_2 capture and storage (in either case, "CCS"). It involves capturing much of the CO_2 that would otherwise be generated from burning fossil fuels, and sequestering it indefinitely from the atmosphere in any of several ways. A form of sequestration that has received considerable attention involves injecting the CO_2, in supercritical form (i.e., having liquid and gas properties), deep underground—into, for example, oil and gas fields, or deep saline formations. Pilot projects in the United States and elsewhere have demonstrated small-scale technical feasibility, but crucial technical questions about CCS remain: e.g., how can the efficiency and costs of CO_2 capture be improved; where are formations suitable for sequestration; and, what impediments are there to an integrated system of capture, transportation and sequestration on a commercial scale?[4]

As attorneys, we have addressed here less exotic, but nonetheless fundamental, questions: how are property rights to the "storage space" for carbon sequestration underground, such as in oil and gas fields and deep saline formations, allocated and obtained; and what corresponding liability issues are presented? Our focus is on the United States.

An Overview of Carbon Sequestration

Carbon sequestration to address global warming is an innovative idea, but the principles underlying the technology are grounded in natural geological processes. Coal, oil and natural gas are hydrocarbons that have been contained in geological formations for millions of years. The optimal reservoirs for carbon sequestration are porous in nature, located over half a mile (one kilometer) underground and have a low-permeability caprock that would prevent leakage of sequestered CO_2. While there are a number of types of reservoirs that are being considered for sequestration, oil and gas fields and deep saline formations have come to be viewed generally as currently offering the most promise.[5]

Carbon sequestration in the United States is likely to begin in oil and gas fields. There is already an extensive CO_2 injection infrastructure in place for enhanced oil recovery, the practice of injecting CO_2 to increase the production of oil. Oil and gas fields are appealing since they have a proven record of storing hydrocarbons for millions of years. There is also a wealth of subsurface data and an extensive federal and state legal and regulatory infrastructure governing CO_2 injection for enhanced oil recovery. But oil and gas fields are geographically limited and enhanced oil recovery projects per se are not believed to offer anything near the storage capacity needed for large-scale commercial carbon sequestration.[6]

While there is less experience with, and less hard and soft infrastructure developed for, CO_2 injection into deep saline formations, they offer the largest potential storage capacity and the broadest geographical distribution among potential geological formations. Deep saline formations are characterized by their containing in their pores water with high concentrations of dissolved salts. The water contained in the formations is not suitable for industrial and agricultural use or human consumption. They have remained largely unexploited, except for some limited use for underground natural gas storage. Worldwide, deep saline formations are estimated to have capacities on the order of thousands of gigatonnes of carbon.[7] As a basis for comparison, 1 gigatonne of carbon per year could be sequestered from 600 large (1,000 megawatt) pulverized coal power plants.[8]

In order to maximize the capacity of the geological formation and maintain security of the sequestered CO_2, CO_2 will be injected in a supercritical state into porous and permeable spaces of the geological formation. Because supercritical CO_2 has a density which is 50 to 80 percent of the density of the water in the formation, the CO_2 will tend to migrate upwards and laterally within the geological formation.[9] Thus it is imperative that the geological formation contain a low permeability caprock that impedes CO_2 migration. In addition to being physically trapped by the caprock, sequestered CO_2 may be contained by capillary forces that cause CO_2 to be retained in the pore space, dissolution of the CO_2 in the in situ waters of the formation (which takes place over decades) and conversion of the CO_2 into carbonate minerals (which takes place over hundreds to thousands of years).[10]

For carbon sequestration to be an effective tool in mitigating CO_2 emissions, enormous quantities of CO_2 will need to be sequestered. A large (1,000 megawatt) pulverized coal power plant generates emissions of approximately 6 million tonnes of CO_2 (0.006 gigatonnes of CO_2 or 0.0017 gigatonnes of carbon) per year. A recent study suggests sequestering one to two gigatonnes of carbon per year by mid-century in order to significantly reduce CO_2 emissions.[11] Depending on a number of characteristics of the geological formation (e.g. permeability, porosity, depth of injection, and the presence of existing substances in the formation), the CO_2 sequestered from a given large coal-fired power plant's lifetime could spread out over an area of tens of square miles.[12] This raises the question of the extent to which the party seeking to sequester the CO_2 will need to acquire rights to the pore space that will be used, as well as the potential consequences for failure to do so.

Pore Space Ownership

Although pore space ownership is only now being considered in the context of carbon sequestration, there is considerable precedent in underground natural gas storage. The natural gas industry has stored natural gas in underground geological formations since the early twentieth century. Underground natural gas storage has traditionally been used to manage the capacity required to meet winter heating demands, with natural gas being injected into geological formations during the summer months and withdrawn during the winter months. Underground natural gas storage is also used to manage the fuel requirements of natural gas-fired power plants. Target geological formations for underground natural gas storage include, among others, depleted oil and gas formations and deep saline formations.

With respect to oil and gas formations, two fundamental issues are: first, whether there has been a severance of the mineral and surface interests; and, second, whether the formation is depleted of minerals (including oil and gas). The mineral interest is the right to explore and remove minerals from the land, while the surface interest consists of all other ownership interests from crust to core. If the mineral interest and surface interest are held by a single owner (i.e., the mineral and surface interests have not been severed), one need only acquire property interests to the pore space from the single owner.

However, it is common for the mineral and surface interests in property containing oil and gas formations to be severed. Typically, ownership of pore space would not have been considered at the time of severance or addressed in the agreement by which the severance was effected. In such a case, there is a split of authority as to who owns the pore space. Some states follow the "English Rule", pursuant to which the owner of the mineral interest owns the pore space even after the geological formation has been depleted of minerals.[13] Other states follow the "American Rule", pursuant to which the owner of the surface interest retains ownership of the pore space after minerals are depleted.[14] It should be noted that whether a formation is "depleted" of minerals is subject to some degree of technical interpretation.

While there is less precedent in acquiring pore space ownership in deep saline formations, the steps for determining property interests are, broadly speaking, comparable to those for oil and gas formations. A particularly notable difference is that some states categorically prohibit underground injection into all geological formations containing water, regardless of salinity. In such states, the use of deep saline formations for carbon sequestration would not be permissible. For example, Nevada would not allow carbon sequestration unless its underground injection laws were amended;[15] one study of carbon sequestration in Nevada explains the rationale is that all aquifers are a potential source of water for municipal, industrial or agricultural use, and even saline waters may be considered for use through desalination methods.[16]

There have been recent developments on the state level on the issue of pore space ownership and carbon sequestration. In 2008, the Wyoming legislature passed House Bill 89, which clarifies ownership of pore space. As of July 1, 2008, the ownership of all pore space in all strata below the surface lands and water is vested in the owners of the surface interest.[17] Conveyance of mineral interests will not convey pore space ownership unless explicitly stated.[18] In short, Wyoming has adopted the American Rule by legislation. The Wyoming statute explicitly addresses mineral interest rights, noting that it does not alter the common law as it relates to mineral estate rights, and that the mineral estate owner's rights to reasonable use of the surface for mineral exploration and production are not limited unless the owners of the mineral estate and sequestration rights are parties to a conservation easement.[19]

Pore space ownership has also been the subject of regulatory studies and guidance. The Interstate Oil and Gas Compact Commission (IOGCC), a multi-state agency which counts over half the States in the United States as members, recently prepared an extensive survey of property rights issues concerning carbon sequestration; it recommended that carbon sequestration statutes and rules should declare that carbon sequestration is an important activity for the public interest, clearly identify the surface owner as the person with the right to lease pore space for carbon sequestration, and protect other stakeholders from potential damage attributable to carbon sequestration activities.[20] A report by the New Mexico Energy, Minerals, and Natural Resources Department notes that while the common law on the issue is somewhat unsettled, the New Mexico Supreme Court has indicated a preference that the pore space belongs to the surface owner.[21] Other states have also recently prepared reports or memoranda noting that pore space ownership is an issue in need of resolution.[22]

Acquisition of Pore Space

Absent legislative authorization to the contrary, pore space ownership for carbon sequestration may only be acquired by voluntary methods: i.e., negotiation with the interest owners to acquire sequestration rights to the formation. This contrasts with the approach that has been taken for underground natural gas storage. The Natural Gas Act provides authority to acquire subsurface property interests through eminent domain when storage is in conjunction with the interstate transportation of natural gas.[23] With respect to carbon sequestration, the IOGCC has developed model rules and regulations in which it has proposed the use of existing or analogous underground natural gas storage eminent domain powers or oil and gas unitization processes for acquisition of pore space of a geological formation.[24]

Potential Liability Issues

Broadly speaking, there are two sources of liability relevant to the carbon sequestration and acquisition of pore space ownership rights: geophysical surface trespass and geophysical subsurface trespass.[25] Although we are not aware of reported litigation with respect to pore space ownership in the carbon sequestration context, case law has developed concerning geophysical surface trespass and geophysical subsurface trespass claims in hydrocarbon recovery and storage and subsurface injection operations. Geophysical surface trespass is the use of the surface to conduct seismic and geophysical operations where exploration rights have not been obtained. For example, seismic monitoring would be used for site characterization (i.e., the determination of whether a geological formation would be suitable for sequestration) and for monitoring injected CO_2. Any unauthorized seismic monitoring could result in geophysical surface trespass liability.[26] Presumably the same approach would apply with respect to geophysical surface activities relating to carbon sequestration.

Geophysical subsurface trespass, which is relevant to the operational and post-injection phases of sequestration, would occur due to the underground intrusion of injected CO_2 into areas where pore space ownership has not been acquired. Under such a cause of action, there could also be recovery for any damage to hydrocarbon resources due to the subsurface migration and commingling of the CO_2 with the native oil and gas.[27] Notably, the Texas judiciary has developed the "negative rule of capture" for secondary oil recovery operations (water flooding), which provides that less valuable substances injected into a geological formation may migrate and replace more valuable substances without resulting liability.[28] The IOGCC has noted that the negative rule of capture turns on the fungibility of resources being produced, and the implications for carbon sequestration remain open to debate.[29]

Implications of Proposed EPA Regulations

In July 2008, the U.S. Environmental Protection Agency (EPA) proposed regulations for carbon sequestration injection wells and operations under the EPA's Underground Injection Control (UIC) Program.[30] The UIC Program was created pursuant to the Safe Drinking Water Act to assure that underground injection activities would not endanger underground sources of drinking water. The proposed regulations create a new class of injection wells for carbon sequestration (Class VI wells), and provide specific requirements for the siting, operational, injection and post-injection phases of operations. Existing regulations governing CO_2 injection wells used for hydrocarbon recovery (Class II wells) and pilot projects (Class V wells) remain the same. The proposed underground injection regulations note that the Safe Drinking Water Act does not provide the EPA with authority to develop regulations for all areas related to carbon sequestration, including "determining property rights (i.e., to permit its use for [carbon sequestration] and for possible storage credits) [and] transfer of liability from one entity to another".[31]

Conclusion

There is strong interest in carbon sequestration to achieve the emission reductions necessary to stabilize CO_2 concentrations. Resolution of pore space ownership and related liability issues for carbon sequestration are key prerequisites for successful adoption of the technology. Legal approaches to such issues may, to varying degrees, be adapted from existing laws and regulations governing similar activities, such as enhanced oil recovery and underground natural gas storage. But it remains to be seen how the law on many aspects of these issues will ultimately develop.

Mark de Figueiredo is an associate at Simpson Thacher & Bartlett LLP, in the firm's Corporate Department and Energy and Infrastructure Group. He received his J.D. from the University of Virginia School of Law and his Ph.D. from the Massachusetts Institute of Technology. He can be reached at (212) 455-2956 or mdefigueiredo@stblaw.com.

Adeeb Fadil is a senior counsel at Simpson Thacher & Bartlett LLP, in the firm's Corporate Department, Energy and Infrastructure Group, and Environmental Practice Group. He received his J.D. from the Yale Law School and his B.A. from the University of Virginia. He can be reached at (212) 455-7070 or afadil@stblaw.com.

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[1] *See generally* Intergovernmental Panel on Climate Change, Summary for Policymakers, *in Climate Change 2007: The Physical Science Basis*, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (2007).

[2] *See generally* Intergovernmental Panel on Climate Change, Summary for Policymakers, *in Climate Change 2007: Impacts, Adaptation and Vulnerability*, Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (2007).

[3] *See, e.g.*, Energy Information Administration, *International Energy Outlook 2008: Highlights* (2008), *available at* http://www.eia.doe.gov/oiaf/ieo/highlights.html.
[4] *See, e.g.*, Massachusetts Institute of Technology, *The Future of Coal: Options for a Carbon-Constrained World*, Executive Summary (2007).
[5] Intergovernmental Panel on Climate Change, *Special Report on Carbon Dioxide Capture and Storage* 8 (2005).
[6] Massachusetts Institute of Technology, *supra* note 4, at xii.
[7] Intergovernmental Panel on Climate Change, *supra* note 5, at 34.
[8] Massachusetts Institute of Technology, *supra* note 4 at xii.
[9] Intergovernmental Panel on Climate Change, *supra* note 5 at 31.
[10] *See generally id*.
[11] Massachusetts Institute of Technology, *supra* note 4, at xi.
[12] Robert H. Socolow, *Can We Bury Global Warming?*, Sci. Am., July 2005, at 51.
[13] *See, e.g.*, *Cent. Ky. Natural Gas Co. v. Smallwood*, 252 S.W.2d 866 (Ky. Ct. App. 1952). The case was overturned thirty-five years later, but not on the issue of pore space ownership. *Tex. Am. Energy Corp. v. Citizens Fid. Bank & Trust Co.*, 736 S.W.2d 25 (Ky. 1987); *see also* Interstate Oil and Gas Compact Commission, *Storage of Carbon Dioxide in Geologic Structures: A Legal and Regulatory Guide for States and Provinces* 19 (2007).
[14] *See, e.g.*, *Tate v. United Fuel Gas Co.*, 71 S.E.2d 65 (W.Va. 1952).
[15] Nev. Rev. Stat. § 445A.465.
[16] Jonathan G. Price et al., Nevada Bureau of Mines and Geology, Report No. 51, *Preliminary Assessment of the Potential For Carbon Dioxide Disposal by Sequestration in Geological Settings in Nevada* 20 (2005).
[17] Wyo. Stat. § 34-1-152(a).
[18] Wyo. Stat. § 34-1-152(b).
[19] Wyo. Stat. § 34-1-202.
[20] Interstate Oil and Gas Compact Commission, *supra* note 13, at 23.
[21] New Mexico Energy, Minerals, and Natural Resources Department, Oil Conservation Division, *A Blueprint for the Regulation of Geologic Sequestration of Carbon Dioxide in New Mexico* 15 (Dec. 1, 2007).
[22] *See, e.g.*, California Energy Commission & California Department of Conservation, *Geologic Carbon Sequestration Strategies for California: Report to the Legislature* 130 (2008); Memorandum from Todd Everts to the Energy and Telecommunications Interim Committee Members, re: Analysis of Geologic Storage of Carbon and Storage Ownership Interest Issues in Montana (Oct. 24, 2007).
[23] 15 U.S.C. § 717f(h); *see also Schneidewind v. ANR Pipeline Co.*, 485 U.S. 293, 295 n.1 (1988).
[24] Interstate Oil and Gas Compact Commission, *supra* note 13.
[25] It should be noted that carbon sequestration faces a panoply of other liability issues that are beyond the scope of this article. For example, there will be liability associated with leakage beyond allowable performance standards under a given carbon sequestration contract or carbon constraining regulatory regime. There are also a number of potential tortious liability causes of action. Examples include sequestered CO_2 intermixing with underground sources of drinking water, environmental degradation human health impacts, or property damage due to induced seismicity. *See, e.g.*, Mark de Figueiredo, *The Liability of Carbon Dioxide Storage* (Mass. Inst. of Tech. 2007).
[26] For an example of a geophysical surface trespass cause of action, see, e.g. *Ohio Oil Co. v. Sharp*, 135 F.2d 303 (10th Cir. 1943).
[27] For examples of geophysical subsurface trespass causes of action, see *Greyhound Leasing & Financial Corp. v. Joiner City Unit*, 444 F.2d 439, 440 (10th Cir. 1971); *Chance v. BP Chemicals*, 670 N.E.2d 985 (Ohio 1996).
[28] *R.R. Comm'n of Tex. v. Manziel*, 361 S.W.2d 560 (Tex. 1962).
[29] Interstate Oil and Gas Compact Commission, *supra* note 13, at 22.
[30] 73 Fed. Reg. 43492 (July 25, 2008).
[31] *Id*. at 43495.