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V&E Climate Change Program

Carbon Capture and Storage and Federal Legislative Proposals

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I. Introduction

This report surveys steps being taken to develop the legal and regulatory framework for carbon capture and storage (CCS). Amid the dire warnings of severe weather and rising temperatures, scientist, engineers, policymakers and others are searching for ways to reduce greenhouse gas (GHG) emissions.[1] While no single solution exists, the development of CCS technologies may play an important role in America's energy future. The development of CCS can be part of the solution to satisfying both our energy needs and our global climate change concerns.

CCS is important to the economy and the environment. For the foreseeable future, the U.S. will continue to rely heavily on fossil fuels for energy and transportation needs. The United States has significant coal reserves, enough to satisfy current demand for over 200 years, and coal provides the fuel for 51 percent of U.S. electricity generation.[2] Under GHG limits, CCS allows the continued use of coal as a vital energy feedstock while mitigating emissions of CO_2. Moreover, through use for enhanced recovery in depleted oil and gas reservoirs, CO_2 can contribute to energy security by decreasing the nation's need for imported oil. Furthermore, not implementing CCS could cause domestic economic decline. Without deployment of CCS capabilities, the U.S. could see a projected decline in GDP of $400 to $800 million in a carbon-constrained world.[3]

Establishing a legal and regulatory framework for CCS is necessary for widespread use of this technology. Precedents from the oil and gas industry provide a basis for a legal and regulatory framework for CCS, but more is needed in dealing with issues unique to CCS including subsurface ownership and property rights issues, short- and long-term liability, classification of CO_2 and appropriate measurement, monitoring, and verification requirements. The report (i) begins with an overview of CCS and the processes and technologies involved in capture, transport, and storage; (ii) overviews EPA and IOGCC approaches to regulating CCS, (iii) summarizes state action on CCS; (iv) discusses key legal issues surrounding CCS; including property rights and liability issues; and (v) considers the role of federal legislation on key matters impacting the deployment of CCS, including regulatory, financial and liability matters.

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1 Howard J. Herzog, *What Future for Carbon Capture and Sequestration?* Environmental Science and Technology, Apr. 2001, at 158.

2 Global Climate Change and U.S. Law 708 (Michael B. Gerrard ed., 2007) [hereinafter Gerrard, Global].

3 The Future of Coal Under Carbon Cap and Trade: Hearing before the Select Comm. on Energy Independence and Global Warming, 110th Cong. (2007) (statement of David Freudenthal, Governor of the state of Wyoming), *available at* http://globalwarming.house.gov/tools/assets/files/0015.pdf.

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In short, whether CCS is a viable option to reduce emissions of CO_2 and other greenhouse gases, and mitigate the affects of climate change, depends on the legal and regulatory framework established to govern its deployment. While states are likely to play a significant role in the deployment of CCS, at least some form of federal regulation is likely to be necessary to assist in managing liability issues and providing incentives for CCS development.

II. What Is Carbon Capture and Storage?

Carbon capture and storage is defined as a process consisting of the separation of CO_2 from industrial and energy-related sources, transport to a storage location and long-term isolation away from the atmosphere.[4]

CCS is a relative newcomer to climate change policy discussions, but it has quickly attained a prominent role.[5] The technology for capturing, transporting, and storing CO_2 underground is already being used in commercial applications like hydrogen and natural gas processing. The costs of CCS (especially carbon capture technologies) remain somewhat high, but combining CCS with enhanced oil and gas recovery can significantly defray costs while expanding fossil fuel production.

CCS technology consists of three components: capture, transport, and sequestration. Capture is currently the most expensive technology and the target of vital research focusing on cost reduction. Transporting CO_2 by pipeline, land, or sea is a well understood and established practice. Millions of tons, mostly from naturally occurring formations, are moved each year by the oil and gas industry for enhanced oil recovery (EOR). Geologic sequestration involves injecting CO_2 into deep underground formations. Additional scientific understanding, practical experience, and legal and regulatory regimes are needed to define best practices and standards for large-scale sequestration.[6]

A. Capture

In order to physically sequester anthropogenic emissions of CO_2, the CO_2 must first be "captured" and then compressed for transport to a storage site.[7] At present, CO_2 capture as an emissions reduction strategy is suitable only for large point sources, *i.e.*, power generators and large industrial plants.[8] Large point sources account for about 40 percent of domestic CO_2 emissions in the United States with the other 60 percent coming from mobile and residential sources.[9] Most attention to date regarding capture technologies has focused on power plants, but capture technologies can also be applied to large, energy-

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4 Intergovernmental Panel on Climate Change, *Special Report on Carbon Dioxide Capture and Storage: Summary for Policymakers* 3 (Bert Metz et al. eds., 2005), *available at* www.ipcc.ch/activity/ccsspm.pdf [hereinafter IPCC 2005 Report].

5 Gerrard, GLOBAL, *supra* note 2, at 707.

6 *See* generally, IPCC 2005 Report, Technical Summary.

7 *Id.*

8 *Id.*

9 U.S. Environmental Protection Agency, Inventory of US Greenhouse Gas Emissions and Sinks: 1990 – 2005 Executive Summary, EPA 430-R-07-002 (Apr. 2007), *available at* www.epa.gov/climatechange/emissions/downloads06/07ES.pdf.

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intensive CO_2 emitting industries, including cement manufacture, oil and natural gas refining, ammonia production, and iron and steel manufacture.[10]

Carbon dioxide has been captured from industrial process streams for 80 years, although most of the CO_2 that is captured is vented to the atmosphere because there is no incentive to store it.[11] Current examples of CO_2 capture from industrial processes include purification of natural gas or natural gas sweetening and production of hydrogen-containing synthesis gas for the manufacture of ammonia, alcohols, and synthetic liquid fuels.

Three basic approaches exist for capturing carbon from fossil fuels — pre-combustion, post-combustion, and oxyfuel combustion. The technology required for pre-combustion capture is widely applied in fertilizer manufacturing and in hydrogen production.[12] The primary method of pre-combustion capture of CO_2 involves processing the primary fuel in a reactor with steam or air prior to combustion to produce a mixture consisting principally of carbon monoxide and hydrogen known as "synthesis gas" or "syngas."[13] The hydrogen becomes a carbon-free fuel to power the plant, while the CO_2 can be compressed for transport and storage.[14]

Although pre-combustion CO_2 capture technology can be applied to natural gas or oil-fired plants, attention has focused on the use of integrated gasification combined-cycle (IGCC) (a pre-combustion technology) technology in coal-fired power plants.[15] In an IGCC plant, the hydrogen fuel generated through gasification of coal is used to power a turbine to make electricity.[16] The heat in the exhaust gases leaving the gas turbine turns water into steam, which is piped into a steam turbine to generate additional power and then the gas turbine exhaust flows out of the stack.[17] Although the initial fuel conversion steps of IGCC (from coal to "syngas") are more elaborate and costly than other forms of CO_2 capture, the higher concentrations of CO_2 in the gas stream and the higher pressure make the separation of CO_2 easier.[18] There are four coal-fired IGCC facilities in the world today, including two in the United States.[19]

Post-combustion capture systems generally use a solvent or a membrane to separate CO_2 from the flue gases produced by combustion of the fuel in air.[20] Post-combustion capture

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10 Gerrard, GLOBAL, *supra* note 2, at 707-708.
11 IPCC 2005 Report, *supra* note 4, at 108.
12 Gerrard, GLOBAL, *supra* note 2, at 708
13 *Id.*
14 *Id.*
15 *Id.*
16 *Id.*
17 Robert H. Socolow, *Can We Bury Global Warming*, SCIENTIFIC AMERICAN 50 (2005) (on file with the author).
18 IPCC 2005 Report, *supra* note 4, Technical Summary at 25.
19 Gerrard, GLOBAL, *supra* note 2, at 708, referring to the Tampa Electric Facility in Florida and the Wabash River Coal Gasification Repowering Project in Indiana.
20 *Id*.

technologies are already commercially available and are used to capture CO_2 from coal and gas-fired plants for use in the food and beverage and chemical-production industries.[21]

The third CO_2 capture technology, called oxyfuel combustion, performs all the burning in oxygen instead of air. After cooling to remove water vapor, the exhaust stream contains about 80 percent to 98 percent CO_2.[22] Oxyfuel combustion is the most advanced of the CCS methods, and although key elements of the oxyfuel process are currently in commercial use, it has not been deployed for CO_2 capture on a commercial scale.[23]

Both pre- and post-combustion systems are capable of capturing 80 percent to 90 percent of CO_2 emissions from power plants. A power plant equipped with a CCS system would need roughly 10 percent to 40 percent more energy and is therefore more costly than a plant of equivalent output without CCS.[24] Power generators, project developers, and financiers will need economic or regulatory certainty before absorbing these costs.

B. Transport

Except when large point sources are located directly above a geologic storage site, captured CO_2 must be transported from the point of capture to a storage site. Before transporting, CO_2 intended for sequestration must be compressed, then dried and purified of hydrogen sulfide to avoid corrosion and make it easier and less costly to transport.[25] CO_2 pipelines today operate as a mature market technology in EOR operations and are expected to provide the primary means of transport for CCS.

The first long-distance CO_2 pipeline came into operation in the U.S. in the early 1970s. Today, over 3,500 miles of pipelines transport more than 40 megatons of CO_2 per year from natural and anthropogenic sources, mainly to sites in West Texas, where the CO_2 is used for EOR.[26] While the CO_2 pipeline infrastructure would have to be expanded to implement a large-scale CCS program, the technology is generally proven.[27]

In some situations or locations, transport of CO_2 by ship may be economical, particularly when moving CO_2 over large distances or overseas.[28] Today, liquefied petroleum gases are transported by marine tankers, and CO_2 can be transported in much the same way.[29] The properties of liquefied CO_2 are similar to those of LPG, and the technology could be scaled up to large CO_2 carriers if a demand for such systems were to materialize.[30]

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21 *Id*.
22 Gerrard, GLOBAL, *supra* note 2, at 709.
23 *Id*.
24 IPCC 2005 Report, *supra* note 4, Summary for Policymakers at 4.
25 *See* Gerrard, GLOBAL, *supra* note 2, at 710; IPCC 2005 Report, *supra* note 4, at 29.
26 Gerrard, GLOBAL, *supra* note 2, at 710.
27 *Id.*
28 IPCC 2005 Report, *supra* note 4, at 30.
29 *Id.*
30 *Id.*

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Road and rail tankers are also technically feasible options; however, they are costly compared to pipelines and ships, except on a very small scale.[31]

C. Storage

Underground geologic storage of CO_2 was suggested as a possible way to mitigate global warming as early as the 1970s, but received little attention until the 1990s.[32] It is now front and center in climate change policy discussions.

Carbon dioxide emissions could be stored underground in geologic formations, such as deep saline or brine formations, oil and gas fields, and coal beds that cannot be mined economically because of their depth or the thickness of the seam. Analysts estimate that in the United States and Canada combined, such reservoirs could hold a total of 1.2 trillion to 3.6 trillion metric tons of CO_2 emissions.[33]

Deep saline formations account for 80 percent of the low-end estimate of geologic storage capacity in the United States and Canada (919 billion metric tons out of 1.2 trillion).[34] Such formations are filled with highly saline water not fit for industrial or agricultural use.[35] The pressures in those formations indicate that they could withstand the injection of CO_2.[36] Some of the CO_2 injected into them would dissolve in the water; the rest would migrate to the top of the formation.[37] Certain deep saline formations in the United States are already used for storage of liquid hazardous wastes.[38]

Oil and gas reservoirs — both those in production and those that are or will soon be abandoned — account for about 7 percent (82 billion metric tons) of the low-end estimate of geologic storage capacity in the United States and Canada.[39] Carbon dioxide is already injected into oil fields for enhanced oil recovery .[40] Once injected into a reservoir, CO_2 expands and pushes oil toward the extraction well. Moreover, given adequate pressure, CO_2 mixes with oil and makes it flow more easily.[41] That technique allows operators to recover up to 25 percent of the oil that remains in an active reservoir after other techniques have been exhausted.[42] It has been used in more than 70 operations worldwide, mostly in the United States (particularly in the Permian Basin of Texas and New Mexico).[43] With EOR, some of the injected CO_2 is eventually pumped up with the oil, but the rest remains in the oil field,

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31 *Id.*

32 Gerrard, GLOBAL, *supra* note 2, at 710.

33 Congressional Budget Office, *The Potential for Carbon Sequestration in the United States* 12 (Sept. 2007), *available at* www.cbo.gov/ftpdocs/86xx/doc8624/09-12-CarbonSequestration.pdf [hereinafter CBO Carbon Report].

34 *Id.*

35 *Id.*

36 *Id.*

37 *Id.*

38 *Id.*

39 *Id.*

40 *Id.*

41 *Id.*

42 *Id.*

43 *Id.*

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where it can be stored once the field stops producing and the wells are sealed.[44] Current research is focused on increasing the amount of CO_2 that is stored. For example, Canada's Weyburn Field is hosting a large pilot project for enhanced oil recovery that analysts anticipate will sequester 20 million tons of CO_2 over its lifetime.[45]

Carbon dioxide can also be pumped into natural gas reservoirs to reinvigorate production, although there is less need for that enhanced recovery technique, because initial recovery processes at gas fields usually remove most of the original gas in place.[46]

Unminable coal seams account for the other 13 percent (156 billion metric tons) of the low-end estimate of geologic storage capacity in the United States and Canada.[47] Coal seams might be able to store several times more CO_2 than natural gas reservoirs of the equivalent volume because of the large surface area of the coal.[48] Typically, methane-rich gas (generated as part of the geologic process that transforms plant material into coal) adheres to the surface of the coal.[49] Commercial efforts to recover that methane generally depressurize the coal bed by pumping out water, but methane can also be displaced by injecting CO_2 into the coal bed.[50] The CO_2 remains sequestered in the coal bed, where it adheres to the surface of the coal at about twice the rate that methane does. Limited field tests have demonstrated the use of CO_2 to recover coal bed methane.[51] The process is being employed in the San Juan Basin of New Mexico as well as in Canada and Poland, although it faces some technological hurdles.[52]

According to the Intergovernmental Panel on Climate Change, well-selected, -designed, and -managed geologic storage sites could trap CO_2 for millions of years and would be likely to retain over 99 percent of their injected CO_2 for at least 1,000 years.[53] Below 800 meters underground, pressure turns CO_2 into a relatively dense liquid, making it less likely to escape a storage reservoir. Still, oil and gas wells could be pathways for CO_2 leakage if they were not properly plugged, and overpressurizing storage reservoirs would risk causing fractures that could damage their structural integrity. In addition, injecting CO_2 into deep saline formations could acidify their contents, dissolving minerals and possibly creating new pathways for CO_2-rich fluid to escape a reservoir.

D. Costs

The stringency of future requirements for the control of GHG emissions and the expected costs of CCS systems will determine to a large extent, the future deployment of CCS

44 *Id.*
45 *Id* at 112.
46 *Id* at 13.
47 *Id.*
48 *Id.*
49 *Id.*
50 *Id.* at 14.
51 *Id.*
52 *Id.*
53 IPCC 2005 Report, *supra* note 4.

technologies.[54] The literature reports a fairly wide range of costs for CCS components. The range is due primarily to site-specific factors, especially the design and operating characteristics of the power plants or industrial facilities using CCS; the type and costs of fuel; the required distance, quantities, and purity of CO_2 to be transported; and the type and characteristics of the underground CO_2 storage.[55]

Analysts estimate the incremental costs of CO_2 capture and compression using an engineering approach (one that considers only direct costs, not opportunity costs).[56] They generally compare the costs of producing electricity at similar plants with and without CO_2 capture, taking into account the added greenhouse-gas emissions that result from the energy required for the capture and compression processes.[57] Analysts then add estimates of transport costs, based on the distance to a potential storage site, and storage costs, based on the type of storage reservoir.[58] Estimates of the economic potential of CCS do not include the effects of the regulatory system that might be set up to implement CCS.[59]

The type of plant used to compare the costs of producing electricity with and without CO_2 capture has a major impact on the resulting cost estimates.[60] Most studies of CO_2 capture in the electricity industry use IGCC plants for the comparison.[61] Estimates based on those plants are generally lower than estimates based on natural gas combined-cycle (NGCC) power plants or on pulverized-coal plants (either new ones or existing plants modified to include capture capabilities).[62]

Estimates of the costs of transporting CO_2 depend largely on the distance to a potential storage site. Given the strong overlap between the locations of existing sources of CO_2 emissions and potential geologic storage sites, transport costs make up a small proportion of overall CCS costs in most studies' estimates.[63] The cost of pipeline transport for a distance of 250 km is typically \$1 to \$8 per ton of CO_2.[64]

Estimates of storage costs vary by the type of storage site. Storage is cheapest when it can generate revenues by facilitating the recovery of energy resources, such as oil. But the potential to take advantage of sites that use enhanced oil recovery or enhanced coal-bed methane recovery is limited.[65] Although the electricity sector represents the largest potential demand for CCS, other sources of emissions (such as cement producers) that have higher CO_2 contents in their emission streams are likely to adopt CCS before electricity generators

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54 *Id* at 41.
55 *Id.*
56 CBO Carbon Report, *supra* note 33, at 15.
57 *Id.*
58 *Id.*
59 *Id.*
60 *Id.*
61 *Id.*
62 *Id.*
63 *Id.*
64 IPCC 2005 Report, *supra* note 4, at 41.
65 CBO Carbon Report, *supra* note 33, at 17.

do.[66] Those other sources might utilize most of the revenue-generating opportunities for CO_2 storage. In addition, there could be a mismatch between the nearly continuous emissions of large amounts of CO_2 from a power plant and the more limited and episodic use of CO_2 in enhanced oil or methane recovery.[67]

Representative estimates of the cost for storage in saline formations and depleted oil and gas fields are typically between $0.5 and $8.00 per ton of CO_2 injected.[68] Monitoring costs are between $0.1 and $0.3 per ton of CO_2.[69] When storage is combined with EOR, the economic value of CO_2 can reduce the total cost of CCS. Based on 2003 oil prices, EOR with CO_2 storage could yield net benefits of $10 to $16 per ton of CO_2.[70]

Estimates of the incremental costs of carbon dioxide capture and storage for IGCC plants, when using non revenue-generating geologic storage sites, range from about $15 to $50 per metric ton.[71] When those plants can take advantage of opportunities for enhanced oil or methane recovery, the range of costs declines to between -$5 per metric ton (meaning that CCS would save a plant money) and $30 per metric ton.[72] Cost estimates are higher for NGCC plants: about $40 to $90 per metric ton with non-revenue-generating storage and about $20 to $70 per metric ton with enhanced oil or methane recovery.[73]

There are significant uncertainties inherent in the quantitative results from these estimates. The literature indicates that CCS systems are unlikely to be deployed on a large scale in the absence of an explicit policy that substantially limits GHG emissions.[74] With GHG limits imposed, analysts foresee the deployment of CCS systems on a large scale within a few decades.[75] The literature and current industrial experience indicate that, in the absence of measures limiting CO_2 emissions, there are only small niche opportunities for CCS technology to deploy.[76]

III. Regulation of Underground Storage

Although a regulatory framework for addressing the underground storage of CO_2 (non-EOR related) is largely uncharted territory, two regulatory regimes offer competing models addressing underground injection and storage issues – the EPA's Underground Injection Control Program and the Interstate Oil and Gas Compact Commission's state-based

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66 *Id.*
67 *Id.*
68 IPCC 2005 Report, *supra* note 4, at 36.
69 *Id.*
70 *Id.*; in 2003 world oil prices in 2005 dollars were between $30 and $40 a barrel, Source Energy Information Agency, Official Energy Statistics from the U.S. Government, *available at* www.eia.doe.gov/oiaf/aeo/ppt/fig010.ppt.
71 CBO Carbon Report, *supra* note 33, at 17.
72 *Id.*
73 *Id.*
74 IPCC 2005 Report, *supra* note 4, at 43.
75 *Id.*
76 *Id*. at 44.

regulatory framework. Recent developments under both regulatory regimes suggest that the competition between these regimes remains undiminished.

A. EPA Regulatory Framework

At the federal level, underground injection is regulated through EPA's Underground Injection Control (UIC) Program, promulgated under the Safe Drinking Water Act (SDWA). UIC regulations prohibit injection activities that would "allow the movement of fluid containing any contaminant into underground sources of drinking water," if the contaminant may harm sources of drinking water or may "otherwise adversely affect the health of persons."[77] In 1980, Congress amended the SDWA to exempt "underground injection of natural gas for purposes of storage" from the coverage of the UIC Program.[78]

UIC regulations separate injection wells into five separate classes, each subject to different regulatory requirements. In short, Class I wells are used to inject hazardous, industrial, or municipal Waste; Class II wells are used to inject fluids in connection with natural gas storage or conventional oil and gas production; Class III wells are used to inject fluids for the extraction of minerals; Class IV wells are used to inject hazardous or radioactive waste; and Class V is a catch-all category for injection wells not included in Class I through IV.[79]

A state is allowed to assume primary responsibility ("primacy") for implementing and enforcing its underground injection control program, if the state program meets the requirements of EPA's UIC regulations.[80] Currently, thirty-three states have full primacy over underground injection in their state, seven states share responsibility with EPA, and ten states do not have primacy.[81] A state program may regulate beyond the minimum EPA standards; in Nevada, for example, injection is not allowed into any underground aquifer regardless of salinity, which eliminates a potential sequestration option.[82]

While injecting CO_2 in connection with EOR is covered under regulations relating to Class II wells, until recently UIC regulations provided no guidance for CO_2 injection for geologic sequestration or storage projects outside this context. However, in March 2007, EPA issued draft guidance to state regulators and the EPA Regions on issuing permits to pilot geologic sequestration projects as UIC Class V Experimental Technology Wells. The Guidance applies to geological storage projects that are to be permitted as Class V experimental technology wells and provides suggested guidelines for permitting and operating pilot geologic storage projects prior to commercial-scale implementation of CCS.[83]

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77 EPA Underground Injection Control Program, 40 C.F.R. § 144 et seq. (2007).
78 *Id.*
79 *Id.*
80 Massachusetts Institute of Technology, *The Future of Coal: Options for Carbon Constrained* World 56 (2007), *available at* http://web.mit.edu/coal/.
81 *Id.*
82 *Id.*
83 U.S. Envtl. Prot. Agency, Using Class V Experimental Technology Well Classification for Pilot Geologic Sequestration Projects – UIC Program Guidance (UICPG #83) (2007).

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Under the Guidance, EPA has determined that the UIC Class V experimental technology well subclass provides the best mechanism for authorizing pilot geologic storage projects. Class V experimental technology wells are intended to demonstrate unproven but promising technologies. Under EPA's Class V regulations, an injection well that is being used to demonstrate a developing technology is subject to more flexible, yet fully protective, technical standards than those designed for commercially operating facilities.[84] Consequently, EPA encourages state regulators and EPA regions to follow a case-by-case approach to permitting pilot geologic storage projects.

The Guidance provides information for UIC Program managers and permit writers to consider as they evaluate geologic storage project applications and assess the appropriateness of the proposed injection site, the area of review (AoR), and the well's design and construction. It also provides information for permit writers to consider in writing permit conditions related to mechanical integrity testing (MIT); measuring, monitoring, and verification (MMV); and site closure.

Following the release of the Guidance, on October 11, 2007, EPA announced plans to develop geologic storage regulations. Though non-hydrocarbon related geologic storage is not yet commercially available, EPA plans to develop these regulations by the summer of 2008. EPA can choose to regulate geologic storage within existing UIC well classes or develop a new well class for CO_2 injection and storage. The agency announcement has industry support and appears to short-circuit the IOGCC regulatory framework mentioned above. Industry officials have been pushing EPA to regulate CO_2 sequestration wells because they believe federal regulations are necessary to overcome potential liability resulting from the Supreme Court's ruling in *Massachusetts, et al. v. EPA, et al*.[85] Finding that EPA has the authority to regulate CO_2 from mobile sources under the Clean Air Act, the *Mass. v. EPA* ruling has industry concerned about the status of CO_2 as a pollutant. As a result, many industry officials have called on federal lawmakers to provide regulatory certainty to address potential contamination and liability issues.[86]

B. IOGCC Regulatory Framework

In addition to the UIC regime, many states have independent regulatory programs that regulate storing natural gas in underground geologic reservoirs and injecting and storing acid gas. These regimes address many of the regulatory concerns relevant to CO_2 storage — such as reservoir selection, injection and withdrawal parameters, operational requirements, unauthorized releases of stored gas, and pressure limitations.[87] In 2005, the Interstate Oil & Gas Compact Commission (IOGCC), a group of state regulators and industry officials from

84 *Id.*
85 *EPA Rulemaking On CO2 Storage May Circumvent State Efforts*, Carbon Control News, Oct. 12, 2007.
86 *Id.*
87 Gerrard, GLOBAL, *supra* note 2, at 717.

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oil and gas producing states concluded that existing natural gas storage and acid gas injection regimes can and should be adapted to CO_2 storage projects outside the EOR context.[88]

On September 26, 2007, the IOGCC went further and released model state rules and legislation to govern geologic storage of CO_2. The IOGCC document entitled Storage of Carbon Dioxide in Geologic Structures: A Legal and Regulatory Guide for States and Provinces (the "Guide") includes a paper analyzing property rights issues related to underground pore space used for CCS (discussed later); a Model Statute for geologic storage, which contains legislative language necessary to enable a state regulatory agency to implement model rules and regulations; and Model General rules and Regulations for geologic storage.[89]

According to the Guide, the IOGCC believes that the states are best suited to provide legal and regulatory oversight of geologic storage. The IOGCC Task Force notes that states have experience with CO_2 and subsurface storage as principal regulators of EOR, as well as natural gas storage and acid gas disposal. The Guide discusses whether the U.S. EPA might be the best regulatory authority for oversight of geologic storage, concluding that the Model Statute and Rules are a much more comprehensive and flexible framework than the EPA's UIC Guidance discussed above. Going further, the Guide states that "although the UIC Program may be applicable at the discretion of a state program, the current limitations of the UIC program make it applicable only to the operational phase of the storage project.…[G]iven the ownership issue and the proposed long-term "care-taker" role of the states, the states are likely to be best positioned to provide the necessary "cradle to grave" regulatory oversight of geologic storage of CO_2."[90]

Most significantly, the IOGCC strongly believes that treatment of geologically stored CO_2 as waste using waste disposal frameworks rather than resource management frameworks will diminish significantly the potential to meaningfully mitigate the impact of CO_2 emissions on the global climate through geologic storage. The report states:

> "although contaminants and pollutants such as H_2S, NO_X, SO_2 and other emission stream constituents should remain regulated for public health and safety and other environmental considerations, CO_2, which is generally considered safe and non-toxic and is not now classified at the federal level as a pollutant/waste/contaminant, should continue to be viewed in a manner that allows beneficial uses of CO_2 following removal from emission streams."[91]

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88 *See* Interstate Oil and Gas Compact Commission, *Carbon Capture and Storage: A Regulatory Framework for States* 51-53 (2005).

89 *See* Interstate Oil and Gas Compact Commission, *Storage of Carbon Dioxide in Geologic Structures: A Legal and Regulatory Guide for States and Provinces* (2007), *available at* www.iogcc.state.ok.us/docs/MeetingDocs/Master-Document-September-252007-FINAL-(2).pdf.

90 *Id.* at 12.

91 *Id*. at 11.

These broad philosophies served to guide the IOGCC Task Force in developing the Model Statute and Model Rules which comprise the regulatory framework for developing geologic storage and supporting the commercialization of CCS.

As stated earlier the Model Statute is designed to give a state regulatory agency the jurisdiction and authority to administer and enforce laws, rules, and regulations concerning geologic storage. The Model Statute speaks in broad language leaving the details to the associated Model General Rules and Regulations. The scope of both the statute and rules is limited to non-EOR projects and the statute expressly states, "nothing in this [statute] shall apply to the use of carbon dioxide as a part of or in conjunction with any enhanced recovery methods where the sole purpose of the project is enhanced oil or gas recovery."[92]

In addition to addressing permitting of storage facilities and the regulation of drilling and operational activity, most significantly the Model Statute and Model Rules comprising the "Regulatory Framework" address the acquisition of property rights to the planned storage facility and long-term liability issues. Due to the volume of CO_2 to be sequestered, control of the necessary storage rights is required to promote the orderly development and maximum utilization of the storage facility. In the U.S., with the exception of federal lands, the acquisition of storage rights are considered property rights, which are generally functions of state law. The Regulatory Framework stipulates that a storage facility must be approved by the State Regulatory Agency (SRA) before it can be used to store CO_2, and requires that the SRA find that the operator has obtained the consent of the majority of property owners having property interest in the storage facility or intends to use eminent domain or other enforcement/police powers to acquire any remaining interest. The Model Statute includes Section 5 which empowers a storage operator to exercise the right of eminent domain to acquire the surface and subsurface rights and interest necessary or useful for the purpose of operating the storage facility, and protects this right from future invasion by other entities with similar eminent domain power.

The Regulatory Framework also addresses long-term liability by establishing a Carbon Dioxide Storage Facility Trust Fund and a two stage Closure Period and Post-Closure Period. The fund is created by a tax or fee levied on the storage operator and is designed to operate during the Post-Closure Period to provide the financial resources necessary for the state to engage in future monitoring, verification and, if necessary, remediation activities to repair or prevent surface leakage or subsurface migration. During the Closure Period, which can last for ten or more years after cessation of storage operations, the statute anticipates that the storage operator remains liable for continued monitoring of the site, any operational bonds and remediation long enough to support a reasonable expectation of mechanical integrity of the storage facility. After the Closure Period and upon a showing by the storage operator of mechanical integrity, the SRA issues a certificate of completion and the ownership of the remaining project including the stored CO_2 transfers to the state.

The intent of this provision, transferring ownership to the state is to provide a methodology whereby the operator and the generator of the CO_2 can be released from future liability.

92 *Id.* at 35.

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The IOGCC in promulgating these model rules felt that releasing the operator and generator from liability would be necessary to encourage the timely development of a CCS industry. However, this aspect of the regulatory framework has received some criticism. Some feel that such a release from liability is premature and overbroad preferring instead to evaluate liability issues on a case-by-case basis.[93] In a recent speech to the Energy Council, a collection of 11 energy intensive states focused on energy and related policy, the Governor of Wyoming, Dave Freudenthal, rejected the idea of states assuming the liability for CO_2 storage facilities at any time.[94]

While the IOGCC liability limitation proposal is not the only means of addressing long-term liability issues, industry watchers generally agree that long-term liability represents a significant challenge to the development of a commercial CCS industry. Other methods of addressing long-term monitoring and liability include: legislative assumption of liability by the state; a governmental insurance fund along the lines of the federal flood insurance program; private insurance funded through premiums; a Price-Anderson Act analog, that provides federal protection to the storage operator and CO_2 generator; the Federal Superfund Model; the Federal Oil Pollution Act of 1990 model; acquisition by the state of storage rights through private purchase; and making the generators of CO_2 the responsible party under a Resource Conservation and Recovery Act model.

IV. State Initiatives

States have taken a variety of action from passing voluntary state certification programs to adopting legislation and rules that govern CCS. Whether to avoid federal preemption or provide certainty for investors, traditional energy states like Texas, Wyoming, North Dakota, New Mexico, Kansas, California, and Pennsylvania have taken the lead in developing the legal and regulatory framework required to commercialize CCS. This is appropriate since many of the unresolved issues regarding CCS relate to state common law issues such as ownership of subsurface pore space, ownership of emplaced CO_2, and long-term in situ liability. Three states have had a particularly significant early impact in the evolution of CCS regulatory approaches, including New Mexico, Wyoming, and California.

A. New Mexico

In April 2007, New Mexico Governor Bill Richardson signed a bill promoting clean energy projects through tax credits and rate recovery from investments in infrastructure, and in June, the New Mexico, Energy, Minerals and Natural Resources Department (EMNRD) released a report entitled "Carbon Dioxide Sequestration: Interim Report on Identified Statutory and Regulatory Issues." Taken together these measures propelled the state of New Mexico into the forefront of developing a legal and regulatory framework for a commercial CCS industry.

Signed into law on April 3, 2007, the Advanced Energy Tax Credit Bill offers the first tax credit in the nation for carbon capture technology. The bill offers up to $60 million in tax

93 *10-year Corporate Liability Proposed for CO2 Storage*, Greenwire, October 10, 2007.

94 The Hon. David Freudenthal, Governor of Wyoming, Address at the Energy Council (October 27, 2007) (available in author's files).

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credits for up-front spending on CCS projects. The bill also allows utilities that invest in clean energy projects such as IGCC or oxyfuel combustion to pass through extra costs of building these facilities to consumers through “rate recovery.”

Released June 27, 2007, the ENMRD “interim” report has had a wide-ranging impact on dialogue surrounding CCS. The report highlights several complex questions that must be resolved to provide the regulatory certainty required to facilitate the development of a commercial CCS industry. The questions highlighted include the appropriate division of responsibilities between energy and environmental agencies; resolution of property rights issues; and the degree of environmental oversight and liability protection provided by the state. The final report was due December 2007. The report also wades in to the waste vs. commodity debate, suggesting that policymakers will face having to decide whether CO_2 is a waste or a commodity. The report states, “[t]he definition or characterization of CO_2 as either 1) an industrial product or commodity, or 2) a by-product for waste disposal may have significant effects on public acceptance and perception, as well as potential economic consequences affecting project feasibility and liability.”

B. Wyoming

Not far behind New Mexico, Wyoming legislators have held hearings on proposed CCS legislation. The draft legislation on “Carbon Capture and Sequestration” and “Ownership of Subsurface Voids” was discussed at a hearing before the Wyoming Joint Judiciary Interim Committee on August 23-24, 2007. Wyoming legislators were motivated by their position as a leader in coal production and the need to maintain primacy in the area of CCS and avoid federal preemption.[95]

The draft legislation does not require carbon sequestration; rather it provides a framework for how sequestration could occur and attempts to make Wyoming an option for carbon sequestration. The “Ownership of Subsurface Voids” bill codifies the American Rule of subsurface ownership where the right of ownership of the subsurface void space resides with the surface estate owner.

The “Carbon Capture and Sequestration” bill is more extensive and addresses a variety of issues. Many provisions of the bill are based on an IOGCC conceptual regulatory framework. The bill calls for regulation by the Wyoming Oil and Gas Conservation Commission (OGCC); addresses permitting and certification requirements for storage facilities; bonding requirements; project closure requirements; and migration of injected CO_2. Moreover, ownership of injected carbon dioxide and the right of eminent domain for storage operators is addressed in other provisions of the bill.

In addition to considering legislation, Wyoming has taken other tangible initiatives to promote CCS through its Wyoming Pipeline Authority and Wyoming Infrastructure

95 *See* Wyoming Joint Judiciary Interim Committee Minutes August 22 & 24, 2007 *available at* http://legisweb.state.wy.us/2007/interim/Jud/MINUTES/min0823.htm.

authority which recently announced a public-private partnership to build an IGCC plant with carbon sequestration.

C. California

Most analysts agree that California has taken the lead in climate change law at the state level with Assembly Bill 32 (AB 32), California's pioneering Global Warming Solutions Act of 2006. AB 32 seeks to return GHG emissions in California to 1990 levels by 2020, requiring a reduction of approximately 25 percent from current levels. To some industry and environmental groups, CCS is seen as a tool to reduce future CO_2 emissions and help the state meet its climate change mitigation goals. To that end, the state released a 147-page report on long-term geologic CO_2 sequestration strategies.[96] The report, Geologic Carbon Sequestration Strategies for California was prepared in response to a 2006 law, AB 1925 and requires various California state agencies to consult with environmentalists, industry groups, and academic experts on "recommendations for how the state can develop parameters to accelerate the adoption of cost-effective geologic sequestration strategies for the long-term management of industrial carbon dioxide."[97]

The report addresses the potential for geologic storage in the state, capture technologies, site characterization, monitoring and verification, risks and risk management, remediation and mitigation, the economic impact of CCS, and regulatory and statutory issues. The report acknowledges that while technical challenges remain to CO_2 sequestration, the primary barriers to advancing geologic sequestration projects lie within the statutory and regulatory arena. "Demonstration projects and further technical evaluations and studies are needed, in part to guide development of regulations and statutes that are appropriate for carbon capture and sequestration," the report says.[98]

The report outlines ownership and property rights issues surrounding CCS. The report notes that the interplay among ownership interests and provisions for public good and how these diverse interests should be accommodated for the purposes of long-term geologic storage is an area of complexity. According to the report the salient ownership issues involve property ownership and the acquisition of property rights. The report addresses the uncertainty of long-term liability and stewardship, particularly concerns regarding liability during the post-closure phase of CO_2 sequestration. "For industry, the concerns associated with this open-ended liability include the consequent inability to obtain insurance for the project, the potential to incur remediation costs related to CO_2 migration and/or leakage at some point in the distant future, and the disincentive that these potential costs may have on investment today in CO_2 geologic storage."[99] The report notes that the current UIC Program does not adequately address post-closure activities, including long-term liability and reviews other

96 *California Report May Revive Bill for C02 Storage Rules*, Inside EPA's Carbon Control News Sept. 26, 2007 *available at* http://carboncontrolnews.com/index.php/ccn/show/california_report_may_revive_bill_for_co2_storage_rules/.

97 California Energy Commission, Geologic Carbon Sequestration Strategies for California 132 (2007), *available* at www.energy.ca.gov/2007publications/CEC-500-2007-100/CEC-500-2007-100-SD.PDF.

98 *Id.* at 2.

99 *Id.* at 9.

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mechanisms for handling these issues including those employed by the competing FutureGen states of Illinois and Texas,[100] and those used in analogous programs like the Price-Anderson Nuclear Industries Indemnity Act and the National Flood Insurance Program.

D. More State Initiatives

Although this survey is not meant to be comprehensive, it is worth noting that other states are waving the CCS banner as well. For instance, North Dakota is considering the Model Rules developed by the IOGCC. Texas recently adopted legislation including CCS as a component of clean energy and is drafting rules that will provide tax incentives for using anthropogenic CO_2 for EOR. To receive the tax incentive, operators must receive a state certification demonstrating a reasonable expectation that 99 percent of the CO_2 can be sequestered for 1000 years. Kansas passed a law requiring the Kansas Corporation Commission to establish rules and regulations for geologic storage by July 2008 and providing tax incentives for CCS machinery and equipment. If Kansas meets its July 2008 target, it will be the first state to implement CCS regulation.

V. Legal Issues for Geologic Storage

Whether CCS is a viable option to reduce emissions of CO_2 and other greenhouse gases and mitigate the affects of climate change depends on the legal and regulatory framework established to govern its deployment. The process of assessing and developing these regulations and statutes has just begun at an international and national level. As noted above, New Mexico and California have released assessments of the scope of regulatory and statutory issues related to CCS and along with others note CCS presents a novel set of legal issues. This section examines some of the key legal issues impacting CCS.

A. Sub-surface Property Rights

Property rights often determine who has or will have access to a project site and are therefore a crucial aspect of any CCS project and must be defined in order to encourage investment and properly regulate the storage site.[101] The clarification of access and property rights issues is important from both the regulatory and legal perspectives, as each can have significant impacts on the future costs, public acceptance, and feasibility of geologic storage.[102]

The three main property interests relevant to CCS are surface owners (injection facilities and monitoring stations), sub-surface owners (storage reservoir, pore space, mineral rights, water rights), and the owner of the CO_2 itself.[103] Most of the unresolved property rights issues relate to sub-surface ownership. Although a full discussion is beyond the scope of this paper,

[100] Both Illinois and Texas passed legislation giving the state title to the injected CO2 and consequently the state assumes liability. The legislation is specific to the FutureGen project and does not apply to commercial CCS projects.

[101] Semere Solomon, et al., *A Proposal of Regulatory Framework for Carbon Dioxide Storage in Geological Formations*, 5 (2007) (prepared for or International Risk Governance Council Workshop).

[102] Elizabeth J. Wilson & Mark A. de Figueiredo, *Geologic Carbon Dioxide Sequestration: An Analysis of Subsurface Property Law*, 36 Envtl. L. Rev 10114, 10115 (2006).

[103] Solomon, et al., *supra* note 101, at 5.

it is worth noting that property rights issues related to sub-surface storage rights are largely governed by state law, which continues to evolve.

Natural gas storage provides a relevant analog for understanding the evolution of subsurface property rights. Natural gas is stored underground in depleted oil and gas reservoirs, salt caverns, or suitable natural aquifers to provide for the increased market demand during the winter months.[104] Natural gas storage law largely affirms that the surface estate owner also owns the subsurface storage pore space. However, mineral owners could also have a substantial future interest, even after presently recoverable minerals and gas have been extracted.[105] Therefore, in developing natural gas storage projects, both surface and mineral rights holders have been traditionally included.[106]

Moreover, the judiciary has indicated that ownership of injected natural gas rests with the operator that injects it.[107] If the same principle applies for geologic sequestration, the operator injecting the CO_2 would retain ownership of the CO_2 as well as the associated liability.[108] However, stored natural gas is a valuable commodity that is recovered, while CO_2 would be sequestered for hundreds to thousands of years, a distinction that warrants consideration and has significant implications for project development and finance.[109]

B. Acquisition of Property Rights

Because of the large volumes of carbon dioxide involved, development of large-scale geologic storage projects will require control of the reservoir and associated pore space used for CO_2 storage. As previously stated, the use of reservoirs and associated pore space is considered a property right in the United States and must be acquired from the public or private owner. In the U.S., with the exception of federal lands, the acquisition of subsurface storage rights is generally a function of state law and such property rights can be acquired through purchase, lease, other means of transfer, or through eminent domain or field unitization.

Currently, eminent domain and field unitization are tools used to acquire property rights in the recovery of hydrocarbons. To facilitate development of underground natural gas storage facilities, gas companies are permitted to use the power of eminent domain. Unitization is usually undertaken in the oil and gas industry to facilitate efficient secondary recovery operations after primary production has been curtailed. CCS can benefit from both mechanisms in order to develop large and legal geologic storage sites. However questions remain regarding the applicability and public acceptance of these tools where geologic storage is concerned.

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104 *See* Steven D. McGrew, *Selected Issues in Federal Condemnations for Underground Natural Gas Storage Rights: Valuation Methods, Inverse Condemnation, and Trespass*, 51 CASE W. RES. L. REV. 131, 138-40 (2000).

105 Wilson & Figueirido, *supra* note 102, at 10122.

106 *Id.*

107 *Id.* at 10123.

108 *Id.*

109 *Id.*

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1. Eminent Domain

The Natural Gas Act of 1938 (the "Act") provides for eminent domain for the construction of interstate natural gas pipelines.[110] The judiciary later interpreted the Act to include the construction of underground storage facilities.[111] Thus, if a gas company is unable to directly contract with property owners for storage rights, it can still obtain subsurface rights for storage by initiating condemnation procedures in a state or federal court.[112] For storage operations that are not interstate, state legislation must grant eminent domain power to establish storage operations.[113] With deregulation of the gas market, many of the firms now managing natural gas storage are private and legal definitions of just compensation and public good are still evolving.[114] The geologic storage of CO_2 faces public use challenges in that there is low public awareness, risks accrue locally while the benefits are global, and storage operators are likely to be private entities.

2. Unitization

Unitization of oil and gas fields is a discretionary power of a state agency, necessary to ensure maximum mineral recovery and limit waste.[115] With "field unitization," oil or gas field leases are combined, thereby creating a field-wide operation.[116] Statutes allow voluntary unitization by contract, and most producing states also have a "compulsory joinder of interest," requiring that once a certain percentage of owners have agreed to unitization, then the unit is created.[117] Under a unitized field, concerns over liability are reduced, because production and profits are shared by all unit members, and the field is managed in order to optimize resource recovery.

The importance of administrative powers to create units and the role of unitization in protecting an operator from liability are key considerations for geologic storage. Creating a large reservoir for resource recovery or storage is not a new concept, and there is inherent tension between individual and collective rights when unitizing oil or gas production fields or establishing a natural gas storage site through eminent domain.[118]

C. Liability

Next to access and property rights issues, liability is one of the most essential legal and regulatory issues facing CCS projects, impacting their costs and public acceptance. The legal liability that private firms could face due to leakage of carbon dioxide from reservoirs remains uncertain, but could significantly affect the viability of CCS as a long-term

[110] 15 U.S.C. §717f(h) (2005).
[111] *See* Steven D. McGrew, *supra* note 104, at 138-40.
[112] *Id.*
[113] *Id.*
[114] *Id.*
[115] *See* Hemingway, Law of Oil and Gas § 7.13 (3d ed. 1991).
[116] *Id.*
[117] Wilson & Figueiredo, *supra* note 102, at 10118.
[118] *Id*. at 10119.

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emissions reduction technology.[119] If liability imposes significant risks or costs, firms may be deterred from engaging in geologic storage.[120]

Legal standards of liability provide the vehicle by which a plaintiff can bring a cause of action regarding liability for geologic storage. A person adversely affected by the injection, migration or release of geologically stored CO_2 could assert a claim under a theory of negligence, strict liability, and other causes of action.[121] Under strict liability, a person is held liable for the harm their activity caused, regardless of whether reasonable care was used.[122] Strict liability can be imposed by either the judiciary or the legislature. A person potentially affected by the migration or release of CO_2 also could attempt to assert a claim of trespass. For a trespass to occur there must be the unauthorized entry of some “thing” upon the land of another.[123] Other potentially applicable legal standards include breach of an “implied warranty of fitness for a particular purpose,” a liability that exists under contract theory and product liability.

1. Short-Term/Operational Liability

Liability for CO_2 geologic storage can be examined in two stages – operational liability and long-term liability. Operational liability refers to the environmental, health, and safety risks associated with CO_2 capture, transport, and injection.[124] The liability associated with these risks has been successfully managed in the oil and gas industry for acid gas injection, enhanced oil recovery, natural gas storage, and CO_2 transport.[125]

2. Long-Term Liability

By far the more significant issue for CCS is long-term liability. Three types of liability issues are relevant for long-term CCS projects: environmental, in situ, and trans-national liability (not dealt with here). Environmental or climate liability is associated with CO_2 leakage from the storage site that may affect the global climate by contributing to atmospheric CO_2 concentrations.[126]

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119 M.A. De Figueiredo, D.M. Reiner and H.J. Herzog, *Framing the Long-Term In Situ Liability Issue for Geologic Carbon Storage in the United States*, Mitigation and Adaptation Strategies for Global Change, 10: 647-657, (2005), *available at* http://sequestration.mit.edu/pdf/Framing_the_Long-term_Liability_Issue.pdf.

120 *Id.*

121 *Id.*

122 *Id.* at 648.

123 *See e.g., Railroad Comm’n v. Manziel*, 361 S.W.2d 560, 567 (Tex. 1962).

124 Kate Robertson, Jette Findsen & Steve Messner, *International Carbon Capture and Storage Projects Overcoming Legal Barriers*, National Energy Technology Laboratory, DOE/NETL-2006/1236 (June 23, 2006) at 12.

125 Figueiredo et al., *supra* note 119, at 648.

126` Kate Robertson et al., *supra* note 124, at 13.

In situ liability involves leakage or migration into other geologic formations where it may contaminate groundwater, oil and gas, or other minerals resulting in health, environmental, or ecosystem damage.[127]

Given the complexity of liability, carbon capture and storage can be dealt with on four levels: the federal government, state government, industry, and the firm.

On the federal level, a "liability cap," such as that under the Price-Anderson Act may be a double-edged sword for carbon storage.[128] Although it would provide industry with some certainty as to the financial liability associated with any leakage, a liability cap could harm carbon storage from a public perception standpoint.[129] Liability caps are quite rare and are generally reserved for areas of real catastrophic risk[130] that are likely to stigmatize carbon storage by associating its risks with those of high-level nuclear waste and terrorism.[131]

States can also bear liability. The Low Level Radioactive Waste Policy Act, as amended in 1985, which dictates that states are responsible for the disposal of low-level radioactive waste generated within their borders (42 U.S.C. § 2021b *et seq.*) allows states to enter into compacts to control access to disposal facilities.[132] The unintended effect of the Act has been that no new low level radioactive waste facilities have been built, largely because no state regulatory agency will approve a disposal facility within its borders.[133] The example of low-level radioactive waste shows that liability regimes may discourage storage.[134]

Industry as a whole may be able to bear liability for carbon storage, and some insurance companies may be willing to bear the risk.[135] Insurance companies will favor situations where risk categories can be pooled, or where the likelihood of accidents can be predicted.[136] The availability of insurance will depend on assessments of the risk of carbon dioxide leakage from a geologic reservoir.[137] Although research assessing the general environmental, health and safety risks of geologic carbon storage has commenced, risk assessments will be needed on a site-by-site basis.[138] Whether a firm can even be insurable for long-term liability will depend on the predictability of risk and the extent of potential damages.[139]

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127 *Id*.
128 Figueiredo et al. *supra* note 119, at 652.
129 *Id.*
130 *Id.*
131 *Id.*
132 *Id.* at 653.
133 P. Murray & D. Spence, *Fair Weather Federalism and America's Waste Disposal Crisis*, 27 Harv. Envtl. L. Rev. 71-103.
134 Figueiredo et al., *supra* note 119, at 653.
135 *Id*. at 654.
136 *Id.*
137 *Id.*
138 *Id.*
139 *Id.*

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D. Definition/Classification of CO_2

If geologic storage of CO_2 is to be encouraged, any regulatory framework must consider how anthropogenic CO_2 it to be defined, giving weight to public attitudes and thresholds for risk or perceived risk, and industry concerns for economic burdens.[140]

CO_2 can either be classified as an industrial product/commodity or as a waste product or pollutant. This distinction is important because industrial projects typically are subject to less stringent regulations than waste disposal projects.[141] Industry groups engaged in EOR activities tend to advocate classifying CO_2 as an industrial product while regulators concerned with long-term environmental and health impacts of CO_2 lean toward defining it as a waste product.[142]

Currently, CO_2 used for enhanced resource recovery is considered an industrial product, because the CO_2 is used to extract oil, gas, or methane resources.[143] As an industrial product, anthropogenic CO_2 is a commodity, with a value. If captured CO_2 used for EOR changes classification from a waste to an industrial product at some point between capture and transportation to injection, there may be potential operational, economic, and regulatory implications for the feasibility of using captured CO_2 for EOR operations.[144]

E. Monitoring and Verification Requirements

Standards for the measurement, monitoring, and verification (MMV) of injected CO_2 are crucial to any regulatory or legal framework for CCS because they provide for the collection of vital data on containment, reactivity of CO_2 with surrounding well materials, seismic activity, leakage, and long-term storage, which are necessary for establishing who is liable in the event of leakage or disruption.[145]

There are few established guidelines for the specific kinds of monitoring that should be done for CCS in the short- and long-term, including who should be doing the monitoring, for how long a site should be monitored.[146] Guidelines currently used for MMV of CCS projects are often based on those used in natural gas storage and liquid and hazardous waste injection.[147] In general, monitoring of stored CO_2 focuses on two dimensions: lateral migration of CO_2 and vertical leakage of CO_2 outside the storage area. A variety of MMV techniques are being

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140 New Mexico Energy, Minerals, Natural Resources Department, *Carbon Dioxide Sequestration: Interim Report on Identified Statutory and Regulatory Issues* 9 (2007), *available at* www.emnrd.state.nm.us/OCD/documents/InterimReportCO2Sequestration.pdf.

141 Kate Robertson et al., *supra* note 124, at 7.

142 *Id.*

143 *Id.*

144 California Energy *Commission, Geologic Carbon Sequestration Strategies for California* 132 (2007) *available at* www.energy.ca.gov/2007publications/CEC-500-2007-100/CEC-500-2007-100-SD.PDF.

145 Kate Robertson et al., *supra* note 124, at 11.

146 *Id.*

147 *Id.*

applied and reviewed in active projects, but a consensus of the most appropriate techniques has not been reached.[148]

VI. Federal Legislation

The foregoing discussion demonstrates that the regulatory environment for CCS is evolving. EPA and IOGCC are advocating different approaches, and various states are pursuing individual agendas. Federal action can provide a measure of consistency to regulatory approaches. It also can provide financial incentives and liability protections that complement, or even supplant, state approaches.

Despite the costs, the potential for CCS as a viable emissions reduction strategy has not been ignored by federal policymakers. Members of the 110th Congress are introducing climate change legislation at a faster pace than any other Congress. Over one hundred bills addressing climate change have been introduced this Congress. Several bills addressing CCS have been introduced, and most of the broader proposals to address climate change include provisions addressing CCS. Even portions of the energy bill include provisions specific to CCS. This section addresses three broad categories of federal legislation that could impact CCS: climate change legislation, CCS-specific legislation, and relevant provisions in recent energy legislation.

A. Federal Climate Change Legislation

1. Lieberman-Warner – America's Climate Security Act of 2007

Reported from the Senate Environment and Public Works Committee in December of 2007, the Lieberman-Warner "America's Climate Security Act of 2007" (S. 2191) is hailed as an important step in the Senate to begin formal consideration of climate change legislation. Lieberman (ID-CT) and Warner (R-VA) are the Chairman and ranking Member, respecttively, of the Senate Environment & Public Works Subcommittee on Private Sector and Consumer Solutions to Global Warming and Wildlife Protection.

The bill outlines a mandatory, market-based cap-and-trade program that would cover multiple sectors that contribute 80 percent of U.S. GHG emissions.[149] The bill caps GHG emissions in 2012 at 2005 levels. Between 2012 and 2020 emissions would be reduced to 1990 levels and by 2050 to 65 percent below 1990 levels. The bill directly address CCS by providing "bonus" emission allowances for carbon capture and geological storage, financial incentives for zero emission and advanced coal and sequestration programs, and establishing a framework for geological sequestration of carbon dioxide. It is also possible, though not directly contemplated under the bill, that CCS activities could qualify for "early action" emission allowances or as offset projects.

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148 *Id.*; *see also* U.S. DOE, Draft Technical Guidelines for Voluntary Reporting of Greenhouse Gases (1605b) Program, Chapter 1, Part G (2005), *available at* www.pi.energy.gov/enhancingGHGregistry/documents/DraftTechnicalGuidelinesApr15.pdf.

149 S. 2191, 110th Cong. (2007).

First, Title III of the bill contains a measure to set aside 4 percent of allowances through 2030 as bonus allowances for carbon sequestration. Specifically, the bill directs EPA, within three years of enactment, to take 4 percent of the allowances from 2012 through 2030 and place them into a Bonus Allowance Account. EPA is directed to allocate the allowances to reward firms that actually inject CO_2 resulting from electricity generation (or other facilities regulated under S. 2191) into geological formations. The number of bonus allowances that a firm receives for injecting a metric ton of CO_2 underground starts out at 4.5 in 2012 and gradually decreases, until it reaches zero in 2040. These allowances can be traded by the receiving company or used to cover additional emissions.

Additionally, Title IV of the bill establishes the Climate Change Credit Corporation (the "Corporation") to facilitate energy technology deployment. The Corporation uses funds from the auction of emission allowances to provide financial incentives for CCS and other energy technology. The technologies involving CCS include zero or low carbon energy technologies and advanced coal and sequestration technologies. Both technologies take into account the capture and geologic sequestration of CO_2. The bill provides financial incentives for these technologies in the form of production payments, loan guarantees and cost sharing to cover the incremental cost of installing CCS equipment. Moreover, under the advanced coal and sequestration technologies program, funds can be used to support demonstration projects using carbon capture technology and demonstration projects for large-scale geological carbon storage.

Title VIII of the bill calls for establishing a legal framework for the sequestration of carbon dioxide. The legal framework includes provisions for regulating CCS, an assessment of national geologic storage capacity, feasibility studies for construction of CO_2 pipelines and sequestration activities and establishing a task force to study the potential federal assumption of liability for closed geological storage sites. More specifically, Section 8001 of the bill amends the Safe Drinking Water Act to direct EPA to promulgate regulations for permitting commercial-scale underground CO_2 injection within one year of passage and report to Congress every five years on the effectiveness of the permitting program. The regulations must include provisions that provide for the protection of human health and the environment and address long-term liability issues. Section 8002 of the bill requires the Director of the U.S. Geological Survey to develop a methodology for assessing the nation's geological storage capacity. Section 8003 directs the Secretary of Energy to coordinate a study of the feasibility relating to construction of pipelines and geological carbon dioxide sequestration facilities. Among other things, the study must consider regulatory, financing, and technical barriers and mitigation options, market risks, and means to ensure the safe handling and transportation of carbon dioxide. Within six months of enactment the Secretary must submit a report describing the results of the study. Finally, under Section 8004 the bill establishes a public-private task force to propose to Congress, within two years of enactment, a legal framework for the federal assumption of liability with respect to closed geological storage sites.

It is also possible that sequestration activities may qualify for "early action" allowances under the Bill. Under Section 3202 of the bill, EPA shall establish regulations for distributing allowances to facilities that emit greenhouse gases and took actions to reduce those emissions since January 1, 1994. These regulations shall consider verified and credible emission reductions under such programs as EPA's Climate Leaders Program, the voluntary reporting program of the Energy Information Agency, or other qualifying state, regional, or voluntary programs. The ability of CCS activities to qualify for these allowances would depend on their qualifying under these referenced programs and the subsequent EPA regulations.

CCS activities are not currently listed as eligible offset projects (which are identified in Section 2403 of the bill). Project types that are listed as eligible include agricultural and rangeland sequestration, certain land use change and forestry activities, and manure management. However, the bill provides that EPA may identify other offset practices. Whether CCS could qualify depends on the shape of subsequent EPA regulations. Although the bonus allowance provisions appear to be more favorable than the offset provisions for CCS, it is possible that the offset provisions might be able to be used if the bonus allowance pool was unavailable.

2. Low Carbon Economy Act of 2007

Senate Bill 1766 (S. 1766), known as the "Low Carbon Economy Act" by Senators Bingaman (D-NM) and Arlen Specter (R-PA), like ACSA is also an economy wide cap-and-trade bill designed to reduce the country's GHG emissions.[150] S. 1766 would set an initial cap of 6,625 million metric tons of CO_2 equivalent per year in 2012 and decrease it every year approximately 100 million metric tons until 2026. After 2026, the decrease would accelerate to 200 million metric tons per year until 2030, and from 2030 onward the cap would stabilize at 1990 levels of 4,819 million metric tons per year. Contingent upon the status of international efforts, the President may set long-term emissions targets of at least 60 percent below 2006 levels by 2050.

S. 1766 contemplates CCS in several provisions. Similar to ACSA, the bill sets aside CCS bonus allowances. Like ACSA these bonus allowances are distributed to power generation entities that implement CCS projects. Under Section 207 of the bill, the qualifying entity is eligible to receive bonus allowances at a multiplier rate from 2012 through 2040. The bonus allowance multiplier rates remains at 3.5 for five years from 2012 to 2017, then decreases by 0.2 from 2018 to 2031 where it remains at 0.5 from 2032 to 2039 ending in the year 2040. Qualifying projects (which must have begun operation some time from January 1, 2008 to December 31, 2030) can receive annual bonus allowances for the first 10 years of operation. Furthermore, if the bonus allowances available for CCS are insufficient to enable the allocations required under the bill, the additional allowances will be deducted from allowances available for auction. Again these bonus allowances can be traded or used to offset emissions from other sources.

Additionally, within one year of enactment, Section 207 of the Bill requires the President to submit a report to Congress on the environmental, health, and safety issues surrounding the long-term storage of CO_2 in geological formations, including legislative recommendations for addressing liability for release of CO_2 from sub-surface formations.

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[150] S. 1766, 110th Cong. (2007).

S. 1766 also would make CCS projects eligible for emissions offset credits. Under Section 302 of the bill, if the President determines that a regulated entity has sequestered carbon dioxide emissions in a geological formation, the President must provide that entity credits equal to the amount of CO_2 sequestered during the calendar year.

Finally, Section 208 of S. 1766 creates the Energy Technology Deployment Fund (ETDF), which would be funded by revenues from the auction of allowances. Under Section 401, over half of the money available in the ETDF can be used to fund CCS related projects. Project owners can be reimbursed for the project capital and operating costs of the project that are attributable to CCS.

3. Global Warming Pollution Reduction Act of 2007

Senate Bill 309 by Senators Boxer (D-CA) and Sanders (IN-VT) amends the Clean Air Act to set forth provisions concerning global warming pollution emissions. This bill would reduce GHG emissions to 1990 levels by 2012 and to 80 percent below that by 2050.[151] It imposes emissions standards for new power plants after 2011, CO_2 emissions standards for new vehicles, national quotas for renewable fuel use in vehicles and 20 percent renewable portfolio standard (RPS) for retail electricity suppliers in 2020.

Regarding CCS, Section 710 of this bill establishes guidelines and funding for Geological Carbon Dioxide Disposal Deployment Projects. The program provides grants to five entities for the deployment of geologic storage projects. Priority is given to projects that offer geologic diversity, are located in close proximity to a source of carbon dioxide, and work in connection with demonstrations of advanced coal electricity generation technologies. Additionally, under Section 706 of the bill EPA, in implementing any market based program, may provide allowances to entities that undertake geologic sequestration.

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The impact of the foregoing federal climate change legislation on the development of CCS may ultimately be determined by the price legislation sets for carbon and the timeframe for the development of CCS technology. In short, if the price of carbon is set too low, the promise of CCS could languish. Today, a cost driver of about $40 to $60 per ton of carbon dioxide is required to make CCS economically feasible at a large scale. Climate change legislation must also take into account the time required for CCS technology to be deployed. With estimates that commercial CCS technology will take from 5 to 20 years to evolve, some proposals for the pace of GHG reductions under federal bills are optimistic.[152] If caps are imposed at a pace technology cannot handle, those caps may not be feasible. The Lieberman/Warner and Boxer/Sanders bills move faster than predictions for the development of CCS technology. The Bingaman/Specter bill appears more realistic, giving CCS technology time to develop.

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[151] S. 309, 110th Cong. (2007).
[152] *AEP chief sees CCS tech by 2015-2020,* ARGUS AIR DAILY, Aug. 28, 2007 at 3.

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B. Federal CCS Legislation

1. Department of Energy Carbon Capture and Storage Research, Development, and Demonstration Act of 2007

Senate Bill 962, introduced by Senator Bingaman (D-NM) in March 2007, would reauthorize and improve the Department of Energy's CCS research, development, and demonstration program.[153] The bill would amend the Energy Policy Act of 2005 directing the Secretary of Energy to: (1) carry out fundamental science and engineering research to develop and document new approaches to capture and store carbon dioxide; (2) ensure that fundamental research is appropriately applied to energy technology development activities and the field testing of carbon sequestration activities; (3) promote regional carbon sequestration partnerships to conduct geologic sequestration tests involving carbon dioxide in a variety of geological settings including operating and depleted oil and gas fields, unmineable coal seams, saline formations, and deep geothermal systems; and (4) conduct at least seven initial large-volume sequestration tests for geological containment of carbon dioxide.

The bill gives preference to proposals from partnerships among industrial, academic, and government entities, in making competitive awards for field validation and testing activities. Finally, the bill would allocate $315 million over three years to carry out CCS research, development and demonstration activities. As discussed below, portions of this bill were incorporated into the Energy Bill recently signed into law.

2. Carbon Dioxide Pipeline Study Act of 2007

In October 2007, Senator Norm Coleman (D-MN) along with Senator Ken Salazar (D-CO) introduced the Carbon Dioxide Pipeline Study Act of 2007 (S. 2144). Similar to ACSA discussed above, the bill directs the departments of Energy, Transportation, Interior, FERC and EPA to prepare a report and offer recommendations to Congress on the issues that are vital to fostering the development of a CO_2 pipeline infrastructure in the U.S.[154] Specifically, the bill requires the federal departments to prepare a report and make recommendations on a number of issues that will promote the development of a working CO_2 pipeline infrastructure.

The report would consider matters such as technical, siting, financing, or regulatory barriers relating to the construction and operation of carbon dioxide pipelines and sequestration facilities. It would also consider the "market risk" relating to the construction and operation of such pipelines and sequestration facilities, as well as regulatory, financing, or siting options that would mitigate that risk. It would also examine means to ensure the safe handling, transportation of and sequestration of carbon dioxide, as well as preventive measures to ensure the integrity of carbon dioxide pipelines. The bill has been referred to the Senate Energy and Natural Resources Committee.

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153 S. 962, 110th Cong. (2007).
154 S. 2144, 110th Cong. (2007).

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3. National Carbon Dioxide Storage Capacity Assessment Act of 2007

Senate Bill 731 (S. 731) requires the Secretary of the Interior (Secretary), acting through the Director of the U.S. Geological Survey, to develop a methodology for conducting a national assessment of the geological storage capacity for carbon dioxide. The bill sets forth elements for the Secretary to consider in developing the methodology, including the capacity and injectivity of storage formations in all 50 states; an estimate of recoverable oil and gas through CO_2 injection and storage; and risks associated with potential storage formations. The bill requires the DOE and EPA to cooperate with the Secretary to ensure the usefulness and success of the assessment.

The bill requires the Secretary to: (1) provide the heads of stakeholder federal agencies, the heads of state land management agencies, industry stakeholders, and the public with an opportunity to review and comment on the proposed methodology; (2) convene a committee of subject matter experts to review the methodology for capacity and risk estimation; (3) publish a description of the final methodology and issue a public report that responds to the comments received and the methodology review; (4) complete a national assessment of geological storage capacity for carbon dioxide using the methodology; (5) establish a database on the internet accessible to the public that provides the results of the assessment and includes the data necessary to rank potential storage sites for capacity and risk; and (6) report to Congress on the findings of the assessment. The bill authorizes $20 million for four years. As discussed below, portions of this bill were incorporated into the Energy Bill recently signed into law.

C. The Energy Bill

Major legislation amending the Energy Policy Act of 2005 also addresses CCS. At various stages during the 110th Congress, portions of the energy bill included carbon capture tax credits as well as accelerated depreciation for dedicated CO_2 pipelines. However, the final version, the Energy Independence and Security Act of 2007 (H.R. 6), adopted by both the House and Senate and signed by President Bush, jettisoned those provisions. What remains includes provisions of Senator Bingaman's "Department of Energy Carbon Capture and Sequestration Research, Development, and Demonstration Act of 2007," as well as provisions relating to university research and development, programs providing for a national assessment of carbon dioxide storage capacity, and a framework for geological carbon sequestration on public lands.

As discussed earlier, Senator Bingaman's bill calls for the development by DOE of fundamental science and engineering programs, field validation testing, and large-scale carbon dioxide sequestration testing (see "Department of Energy…" above).[155] H.R. 6 adopts those provisions. Additionally, H.R. 6 incorporates provisions of S. 731, the National Carbon Dioxide Storage Capacity Assessment Act of 2007 calling for a methodology for and assessment of the capacity for carbon dioxide storage throughout

155 H.R. 6, 110th Cong. § 701 et seq. (2007).

the U.S.[156] Furthermore, H.R. 6 creates a program to demonstrate technologies for the large-scale capture of carbon dioxide from industrial sources, and authorizes the appropriation of $200 million per year for this purpose for fiscal years 2009 through 2013.[157] H.R. 6 also calls for the establishment of university programs to study CCS and provides up to $10 million in grants for research and development to study CCS using various types of coal.[158]

Finally, H.R. 6 establishes a process for developing a framework for managing geological carbon sequestration activities on public lands.[159] The bill directs the Secretary of the Interior to report to Congress within one year on a recommended framework including proposals for leasing public lands for geological sequestration, mechanisms for public participation, a description of federal leasehold or mineral estate liability issues, recommendations for additional legislation, and identification of legal and regulatory issues specific to land involving split ownership of the surface and mineral estate.

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Most of the legislation reviewed addresses operational and infrastructure needs related to CCS. The federal bills provide for a national assessment of CO_2 storage capacity, funding for large-scale collaborative demonstration projects, evaluation of the CO_2 transport infrastructure needs, tax, and other incentives for CCS projects, and raise the possibility of CCS as an emissions offset protocol. This is the appropriate federal role, as many policy and particularly legal issues related to CCS are largely under state jurisdiction. Consequently, federal legislation does not address ownership of the subsurface pore or void space, mineral rights issues, acquisition of property rights, or ownership of the emplaced CO_2. These issues should be addressed at the state level as they are critical to the development of a commercial CCS industry. However, long-term liability and stewardship issues are unique and may be addressed at either the state or federal level as existing program models have shown.

VII. Conclusion

Establishing a regulatory framework that provides clear legal and financial incentives for CCS projects is necessary for more widespread use of CCS.[160] Federal, state, and regional efforts are underway to address the priority issues of storage, property rights, monitoring, and liability and to provide a clear legal and regulatory framework for CCS deployment. Precedents from the oil and gas industry have helped lay the groundwork for a framework, but further work needs to be done to address CCS-specific issues, especially long-term liability, which, if not addressed, could hamper the development of CCS as a viable means of sequestering CO_2 emissions.[161]

[156] *Id*. at § 711.
[157] *Id*. at § 703.
[158] *Id*. at § 708.
[159] *Id*. at § 714.
[160] Kate Robertson et al., *supra* note 124, at 37.
[161] *Id.*

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As the many efforts that are currently underway to address the need for a clearer legal and regulatory framework progress, government and project developers could work in tandem with these efforts to amend laws and regulations to fit into the framework and make the laws and regulations required for the framework, thus spurring additional large-scale demonstration projects. Continued support for demonstration projects will help increase public awareness, advance the effectiveness of available technologies, refine the legal and regulatory framework, and lead to the development of more advanced technologies. While states are likely to play a significant role in the deployment of CCS, federal standard may be necessary to assist in managing long-term stewardship and spurring regulatory development.

Despite the legal and regulatory hurdles, geologic carbon storage could provide a key technology for transitioning to a lower carbon future for the United States, while allowing for the continued use of domestic fossil fuels, including coal. Parties interested in the deployment of CCS would be well advised to actively monitor federal and state developments on this issue.