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CLIMATE CHANGE AND CARBON SEQUESTRATION: ASSESSING A LIABILITY REGIME FOR LONG-TERM STORAGE OF CARBON DIOXIDE

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ABSTRACT

As the world struggles with how to address climate change, one of the most significant questions is how to reduce increasing levels of carbon dioxide in the atmosphere. One promising technology is "carbon capture and sequestration" (CCS) which consists of capturing carbon dioxide (CO_2) emissions from power plants and industrial sources and sequestering them in deep geologic formations for long periods of time. Areas for potential CO_2 sequestration include oil and gas fields, saline aquifers, and coal seams. As Congress and the private sector begin to spend billions of dollars to research and deploy this technology, there has been insufficient attention paid to how to structure legal liability for the short-term or long-term risks associated with the geologic sequestration of CO_2 in connection with CCS. Until now, federal and state legislators, when they have acted at all, have appeared to be in a rush to limit corporate liability for potential harm in order to encourage the development of CCS. We take a different approach. In this Article, we survey the existing environmental law and tort law liability regimes that may cover potential harm from escaping or migrating CO_2. We conclude that while existing liability regimes are insufficient on their own to govern the CCS industry, existing federal and state environmental and tort liability can provide important risk management tools and serve as safeguards to private parties and state and local governments in the event of harm. Thus, state and federal legislation specific to CCS should leave in place this basic liability for full-scale commercial CCS projects. We also propose an adaptive governance model at the federal level for integrating several different compensation mechanisms including bonding, insurance, and pooled federal funding into commercial CCS project management to better provide financial security to investors without destroying existing liability protections for those who may suffer harm from CCS. This proposal offers a starting point for developing a model to integrate and manage liability for the nascent CCS industry.

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INTRODUCTION

One of today's most pressing environmental challenges is climate change,[2] and, particularly, the need to reduce increasing levels of CO_2 in the atmosphere. Achieving the deep emissions reductions necessary to stabilize atmospheric concentrations of greenhouse gases requires a fundamental shift in the way we generate, transport, and use energy.[3] Controlling greenhouse gases is different than managing traditional criteria air pollutants. As the atmospheric lifetime of traditional criteria pollutants (e.g. sulfur dioxide (SO_2) or oxides of nitrogen (NO_x)) is only a few hours or days, pollution control and emission reduction at the source is sufficient for reducing atmospheric concentrations of most criteria air pollutants. Greenhouse gases, however, with long atmospheric residence times, require a dramatically different management strategy.[4] Stabilizing atmospheric greenhouse gas concentrations, the goal of the United Nations Framework Convention on Climate Change,[5] will require reductions in emissions of roughly an order of magnitude and fundamentally change the way society produces and uses energy.

Many studies have focused on technologies that are available for making deep emission cuts within a relatively short period of time.[6] Carbon capture and sequestration ("CCS") is a promising technology that could enable the continued use of inexpensive fossil fuels while dramatically reducing accompanying greenhouse gas emissions. This technology drastically reduces emissions from power plants and industrial sources by capturing CO_2 emissions and injecting them into deep geologic formations, essentially sequestering them underground for long periods of time. Areas for potential CO_2 sequestration include oil and gas fields, saline aquifers, and, potentially, deep coal seams. Natural geologic analogs, like geologic formations containing crude oil, natural gas,

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[2] The term "climate change" (which is often used synonymously with the term "global warming"), refers to "any significant change in measures of climate (such as temperature, precipitation, or wind) lasting for an extended period (decades or longer)." EPA, Climate Change, Basic Information, *available at* http://www.epa.gov/climatechange/basicinfo.html; EPA, Climate Change, Emissions, *available at* http://www.epa.gov/climatechange/emissions/index.html.

[3] *See* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE ("IPCC") FOURTH ASSESSMENT REPORT, WORKING GROUP 1 REPORT, THE PHYSICAL SCIENCE BASIS 138, 512 (2007), *available at* http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-chapter2.pdf.

[4] Greenhouse gases include carbon dioxide, methane, nitrous oxide, and fluorinated gases. *See* EPA, Climate Change, Basic Information, *available at* http://www.epa.gov/climatechange/basicinfo.html; EPA, Climate Change, Emissions, *supra* note __.

[5] *See* United Nations Framework Convention on Climate Change, 1992, Art. 2, at p. 5 ("The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner."), *available at* http://unfccc.int/resource/docs/convkp/conveng.pdf. The U.S. is a signatory to the UNFCCC, but not to the later Kyoto Protocol which establishes targets for greenhouse gas emission reductions.

[6] *See* Stephen Pacala & Robert Socolow, *Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies*, SCIENCE 305, 968-972 (2004); James A. Edmonds, et al, *Modeling Greenhouse Gas Energy Technology Responses to Climate Change*, 29 ENERGY 1529 (2004); ELECTRIC POWER RESEARCH INSTITUTE (EPRI), THE POWER TO REDUCE CO_2 EMISSIONS: THE FULL PORTFOLIO (Discussion Paper Aug. 2007), *available at* http://epri-reports/org/DiscussionPaper2007.pdf.

brine, and CO_2, have proven storage capabilities for millions of years. CCS technologies would attempt to take advantage of these storage capacities to reduce CO_2 emissions to the atmosphere. Worldwide, there are four large-scale CCS projects, each injecting roughly 1 million tons of CO_2 annually.[7]

CCS, of course, is not free of risk. In order for CCS to have a real impact on climate change, projects must sequester millions of tons of CO_2 per year at each individual storage site, with injected CO_2 potentially spreading over tens of square miles for a single project and subsurface pressure effects felt over even greater distances.[8] Moreover, the injected CO_2 should remain in the subsurface for hundreds to thousands of years for significant climate benefit,[9] effectively using the subsurface property in perpetuity. Injected CO_2 will initially be more buoyant than the formation waters into which it is injected, making the possibility of leakage to the near surface or surface a risk that must be managed through site selection, operation, monitoring, and remediation.

In this Article, we focus on the relationship between CCS technologies, risk management, and potential legal liability from CCS projects. We do this with an eye toward how potential liability may help to balance the risks and benefits of CCS and influence patterns of technology deployment. As regards to the mature CCS industry, we focus on clarifying and structuring liability, issues that are crucial for large-scale commercial deployment. Much of the writing on this topic to date has either implicitly or explicitly argued that policymakers should limit or virtually eliminate project operators' liability associated with stored CO_2 in order to encourage development of this potential technology.[10]

We take a different approach. We believe that the current proposals to eliminate liability for CCS projects also eliminate important incentives for project developers to ensure good site selection and responsible management and do not address issues of compensation for potential harm. We acknowledge that special tools to shield a nascent CCS industry from liability may be appropriate for the first dozen CCS projects. We believe, however, that liability under federal and state environmental and tort laws can play an important role with regard to both compensation and public acceptance in any future, comprehensive framework to govern the mature CCS industry.

[7] These projects are Sleipner in the North Sea, run by StatoilHydro; In Salah in Algeria by BP, Sonatrach and StatoilHydro; Weyburn in Canada, operated by EnCana; and Snøhvit in the Barents Sea, operated by StatoilHydro. A comprehensive list of commercial and pilot CCS projects is maintained by the International Energy Agency ("IEA"), *available at* http://co2captureandstorage.info/co2db.php.
[8] Kartsen Preuss, et al., *Numerical Modeling of Aquifer Disposal of CO_2*, 8 SOCIETY OF PETROLEUM ENGINEERS J. 49, 52-53 (2003).
[9] *See, e.g.*, Mihn Ha-Duong & David W. Keith, *Carbon Storage: The Economic Efficiency of Storing CO_2 in Leaky Reservoirs*, *in* 5 CLEAN TECH. & ENVTL. POLICY 181 (2003) (the benefits of sequestration of shorter timeframes is also discussed).
[10] *See, e.g.*, THE INTERSTATE OIL AND GAS COMPACT COMMISSION ("IOGCC"), TASK FORCE ON CARBON CAPTURE AND GEOLOGIC STORAGE, A LEGAL AND REGULATORY GUIDE FOR STATES AND PROVINCES 11 (2007) (proposing, among other things, that after a 10-year period following the closure of the site the operator of the CO_2 storage site would be released from any bonding requirements and liability for ensuring that the site remains a secure storage site would transfer to the state).

We recognize, of course, that existing statutory and common law not specific to CCS are sub-optimal tools for assigning fault or rapidly compensating parties damaged by CCS projects. Thus, we view them as a secondary backstop behind a comprehensive federal framework for CCS. With this in mind, we explore the use of several federal liability management mechanisms (bonding, insurance, or pooled funds) that could help to ensure injured parties are compensated, yet are cognizant that any federal liability management mechanism must also be structured to create incentives for good site selection and responsible management and stewardship. We present a proposal for an adaptive management framework at the federal level that would allow site-specific performance data to be integrated into risk pricing and management of project liability as a potential approach for integrating site information into project management and long-term stewardship.

We believe that the anticipated level of risk from long-term storage of CO_2 can be managed through federal standards to create incentives for rigorous site selection, diligent project management, a well-developed monitoring and verification program, and, in the case of leakage, a site-specific remediation plan. Integrating operational data into site management and risk pricing will allow for an adaptive approach to risk management. For a mature CCS industry, these standards could be enhanced by state laws and environmental statutory vehicles. This, as well as the potential monetary benefits to investors and operators associated with deploying a successful CCS technology, should encourage policymakers to reject premature attempts to shift a significant portion of the risk of liability to states or the public at large.

There are two caveats to this approach. First, given the inherent uncertainties of technology research, development, and demonstration, and the strong governmental role in getting initial CCS projects off the ground, the first dozen or so CCS projects could be encouraged under a shared public-private liability regime if the private sector is willing to share project data and information to aid in the development of a risk-management framework.[11] Second, full-scale commercial projects which are developed after these first "demonstration projects" will likely require some transfer of long-term liability—approximately 15-30 years after project injection has ceased—and a successful monitoring and verification program has demonstrated that the injected CO_2 is stable and behaving as expected.[12] This is due, in part, to the mismatch between the lifetime of firms (tens of years) and the long-term sequestration requirements of CCS (hundreds to thousands of years).

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[11] Elizabeth J. Wilson et al., *Regulating Geologic Carbon Sequestration*, *in* 42 ENVIRONMENTAL SCIENCE AND TECHNOLOGY 2718 (2008). While we do not deal explicitly with structuring liability for the first dozen or so CCS projects, we recognize that shielding these projects from existing statutes and common law provisions could be important for managing their risk exposure and encouraging industry investment in the technology.

[12] Indeed, the proposed European Union Directive for CCS specifies a transfer of responsibility to the member state governments. *See* European Commission, *Proposal for a Directive of the European Parliament and of the Council on the geological storage of carbon dioxide and amending Council Directives 85/337/EEC, 96/61/EC, Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC and Regulation (EC) No 1013/2006,* (2008) available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0018:FIN:EN:PDF.

We recognize that potential liability for harm is only one of many legal and policy issues that will impact the technical, economic, and political feasibility of CCS technology. Other important issues include (1) the nature of the statutory and regulatory framework that will be created to govern all aspects of CCS, including its role within a larger climate policy; (2) government funding and partnerships; (3) the various property rights that currently exist or will be created in the stored CO_2, the subsurface pore-space that will hold the CO_2, and subsurface minerals in the area of the stored CO_2; (4) special considerations for structuring liability for the first dozen demonstration projects; and (5) the financial risk of CO_2 leaking to the surface within a larger policy to reduce greenhouse gas emissions (e.g. a cap and trade program).[13] This Article acknowledges these important issues but will leave them for future analyses. We have chosen to focus on the issue of liability for harm instead of these other key issues because it is often too easy to limit or eliminate potential liabilities before they come into existence in the name of economic progress. We concentrate here on large-scale commercial project liability for a mature CCS industry and focus on the operational and post-closure phases. We recognize that initial CCS projects—federal or commercial—may require different approaches for managing liability. Thus, we hope to provide a balanced response to what we see as recent trends to limit too severely the potential liability of the CCS industry through legislation and to encourage policymakers to consider a different approach.

Part I of the Article provides a brief background of CO_2 sources from the industrial and electric power sector and a description of the potential benefits and risks of CCS. In Part II we outline potential liability for stored CO_2 under federal environmental laws and state common law. As CCS will be deployed into a complex web of pre-existing property rights, legal standards, and case law, better understanding how some of these issues would be resolved is critical in creating the legal structures that will govern any wide-scale use of CCS.

In Part III, we look at actions federal and state policymakers have taken to date in anticipation of CCS deployment. These actions show that lawmakers in states hoping to attract a CCS project have offered to significantly reduce or completely eliminate operator liability for harm associated with stored CO_2 and to transfer that liability to the states themselves. We conclude that such transfers of liability from CCS operators to the states may have significant adverse impacts on safe site-selection and the availability of funds for remediation and compensation in the case of harm to human health and the environment. In this Part, we also consider the potential role of federal preemption of state tort law and regulatory standards. In Part IV, we survey available mechanisms to provide financial responsibility and manage liability risks such as bonding, insurance, selective damage caps, and pooled federal funding. Finally in Part V, we attempt to provide guidance to policymakers at the state and federal levels to address potential liability issues associated with CCS that goes beyond arguing that such liability should be severely limited or eliminated. As we show in this Part, the continuing existence of

[13] For a detailed discussion of the potential property right and liability frameworks associated with stored CO_2, see MARK ANTHONY DE FIGUEIREDO, THE LIABILITY OF CARBON DIOXIDE STORAGE (MIT Ph.D. Thesis Feb. 2007).

liability for harm can help to balance divergent interests and provide important safeguards to complement whatever regulatory regime is created to guide the long-term storage of CO_2. While the federal government ultimately may create a comprehensive regulatory system for CCS that may include some limitations or caps on liability in exchange for a federal system of adjudication or compensation, we believe that exempting CCS projects from environmental and tort liability at this stage is imprudent. This is particularly true when the potential impacts of CCS remain unknown and will continue to remain uncertain for decades. Consistent with these principles, we propose a three-phase framework to manage liability and provide federal funding for remediation and compensation that tracks the life-cycle of a CCS project and accounts for variation among projects based on site-specific risks.

Ultimately, any assessment of risks and benefits of CCS must be put in its proper context. Although there are clearly long-term risks associated with CCS, these must be balanced against the even more significant long-term risks of climate change. As a result, the goal of this Article is to present options for creating liability and funding frameworks that encourage the development of CCS and its corresponding benefits while ensuring that the potential risks of CCS do not fall too heavily on states or individuals that may be vulnerable to harm.

I. Electric Power Generation, Industrial Sources, Greenhouse Gas Emissions, and CCS

This Part describes CCS technology by examining how industrial sources and the electric power sector create greenhouse gas emissions and describing the development of CCS technology to reduce greenhouse gas emissions. It then provides some detail on the CCS projects that exist today and those that are planned for the near future. Finally, this Part introduces some of the potential environmental and public health risks associated with CCS and the long-term storage of CO_2.

A. Electric Power and Greenhouse Gas Emissions

The electric power sector is responsible for 41% of CO_2 emissions from fossil fuel combustion, and 33% of total greenhouse gas emissions in the United States.[14] Of the 2.4 billion metric tons of greenhouse gas emissions a year from the electric power sector, 88% is emitted from coal-fired electric plants.[15] These plants play a crucial role in our energy infrastructure, providing inexpensive base-load electricity generation.[16]

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[14] *See* U.S. Environmental Protection Agency, Inventory of U.S. Greenhouse Gas Emissions 1990-2005 Table ES-3, Table ES-7 (2007), *available at* http://www.epa.gov/climatechange/emissions/downloads06/07CR.pdf. Of the U.S. GHG emissions, roughly 84% is from CO_2 (p. 42).

[15] *Id.* at Table 1-4.

[16] Electricity cannot be stored and must be generated to meet demand. Because electricity demand varies both throughout the day and across different seasons, plants typically are run as either base load or peaking plants. Base load generating plants are plants that run almost continuously. Typically, base load plants—traditionally nuclear or coal—are inexpensive to operate, but more expensive to build. *See generally*

Coal is plentiful in the United States[17] and worldwide,[18] inexpensive relative to other fuel sources,[19] and was the fastest growing fuel in 2006,[20] making it a key energy resource in countries like China and Germany as well as in the United States.

Using coal for electricity generation, however, has also been linked to many environmental ills. Upstream impacts from coal combustion include the adverse environmental effects of mountain-top removal, acid mine drainage, and land subsidence. Downstream impacts from coal combustion include air pollution, acid rain deposition, and, more recently, greenhouse gases implicated in global climate change. Regulations have been developed to manage these impacts with varying degrees of success. Federal law has attempted to address upstream mining impacts through the Surface Mining Control and Reclamation Act of 1977,[21] and regulations promulgated by the Office of Surface Mining.[22] With regard to downstream impacts, early state regulations[23] and the Clean Air Act[24] have led to the successful deployment of technologies to control particulate matter, SO_2 emissions,[25] and NO_x. As reducing CO_2 emissions from coal provides a fundamentally different—and difficult—challenge, the potential benefit of CCS—both in the U.S. and globally—is great.[26]

CCS has been examined in detail in a special report by the Intergovernmental Panel on Climate Change.[27] The IPCC report outlines sources of CO_2, capture

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Stratford Douglas, *Measuring Gains from Regional Dispatch: Coal-fired Power Plant Utilization and Market Reforms*, 27 ENERGY J. 119-28 (2006).

[17] *See* Energy Information Administration Coal Reserves Data, *available at* http://www.eia.doe.gov/cneaf/coal/reserves/chapter1.html.

[18] Coal reserves are especially prominent in North America, Europe and Asia. *See* BP, BP STATISTICAL REVIEW OF WORLD ENERGY 2007, *available at* http://www.bp.com/liveassets/bp_internet/globalbp/globalbp_uk_english/reports_and_publications/statistical_energy_review_2007/STAGING/local_assets/downloads/pdf/statistical_review_of_world_energy_full_report_2007.pdf.

[19] For a good summary of the above data sources see Energy Information Administration ("EIA"), Annual Energy Review 2005 and Monthly Energy Review, *available at* http://www.eia.doe.gov/overview_hd.html; EIA Petroleum Navigator, *available at* http://tonto.eia.doe.gov/dnav/pet/pet_pri_top.asp; EIA Coal News and Markets, *available at* http://www.eia.doe.gov/cneaf/coal/page/coalnews/coalmar.html; MIT Energy Club Units and Conversions Fact Sheet, *available at* http://web.mit.edu/mit_energy/resources/factsheets/Units&ConvFactors.MIT%20EnergyClub%20Factsheet.v8.pdf.

[20] *See* BP, *supra* note 15, at 42.

[21] Surface Mining Control and Reclamation Act of 1977, 30 U.S.C. §§ 1300, *et seq.*

[22] *See* 30 C.F.R. §§ 700, *et seq.*, (specifying conditions and rules for mining coal and other minerals), *available at* http://www.osmre.gov/regindex.htm.

[23] *See* JOEL A. TARR, THE SEARCH FOR THE ULTIMATE SINK: URBAN POLLUTION IN HISTORICAL PERSPECTIVE 219-62 (Univ. of Akron Press 1996) (providing environmental history of pollution control in urban areas).

[24] Clean Air Act, 42 U.S.C. §§ 7401-7671q.

[25] *See* Margaret R. Taylor et al., *Effect of Government Actions on Technological Innovation for SO_2 Control*, 37 ENVTL. SCI. & TECH. 4527-4534 (2003).

[26] *See supra* notes __ - __ (describing difficulty of reducing CO_2 in the atmosphere as compared to other pollutants).

[27] WORKING GROUP III OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, IPCC SPECIAL REPORT ON CARBON DIOXIDE CAPTURE AND STORAGE (Cambridge Univ. Press 2005), *available at* http://www.ipcc.ch/ipccreports/special-reports.htm. The IPCC is a scientific body created under the

technologies, transportation modes, geologic storage and risks, and covers economic potential and cost, along with a description of how CCS could fit within a greenhouse gas inventory and accounting scheme. It finds that CCS could play an important role for enabling deep and relatively inexpensive greenhouse-gas emissions reductions. At a sequestration cost estimated from twenty-five to ninety dollars per metric ton, depending upon the source for CO_2 captured and sequestered, large energy-economic models predict CCS could help to reduce the overall societal cost of deep emission reductions.[28] Table 1 outlines the quantities of CO_2 from various industrial and electric power sources. Emerging technologies for non-conventional hydrocarbons, including oil from tar sands or coal-to-liquids projects are also potential large CO_2 emission sources and candidates for CCS.[29]

TABLE 1: Worldwide Stationary Emission Sources of CO_2[30]

PROCESS	**NUMBER OF SOURCES**	**GLOBAL CO_2 EMISSIONS (MILLION TONS OF CO_2 PER YEAR)**
Fossil Fuels		
Power	4,924	10,539
Cement production	1,175	932
Refineries	638	798
Iron and steel industry	269	646
Petrochemical industry	470	379
Oil and gas processing	Not available	50
Other sources	90	33
Biomass		
Bioethanol and bioenergy	303	91
TOTAL	**7,887**	**13,466**

auspices of the United Nations Environment Programme and the World Meteorological Organization to provide scientific, technical, and socio-economic information on climate change for policy makers, *available at* http://www.ipcc.ch/about/index.htm.

[28] *Id.* at 11. In terms of costs of electricity generation, capture costs are estimated to be the greatest component – 1.8 to 3.4 ¢/kWh for pulverized coal plants; 0.9 to 2.2 ¢/kWh for integrated gasification combined cycle coal plants; 1.2 – 2.4 ¢/kWh for natural gas combined cycle power plants. Transport and sequestration costs range from -1 to 1 ¢/kWh (the negative values are possible if captured CO_2 is sold for use in enhanced oil recovery or enhanced coal-bed methane production. These transport costs would be considerably higher if sequestration sites are not located within a reasonable distance from the plant. *See* Howard Herzog et al., *Costs and Economic Potential*, IPCC SPECIAL REPORT ON CARBON DIOXIDE CAPTURE AND STORAGE 8-1 to 8-37 (2005). Costs of construction materials (cement, steel, and others) have increased markedly, with the estimated cost of power plant construction up 69% since 2005; Keith Johnson, *Premium Juice: Power-Plant Construction Costs Rise*, WALL STREET JOURNAL, (May 27, 2008), *http://blogs.wsj.com/environmentalcapital/2008/05/27/premium-juice-power-plant-construction-costs-rise/*.

[29] *See* Matthew L. Wald, *Search for New Oil Sources Leads to Processed Coal*, N.Y. TIMES (July 5, 2006).

[30] *See* IPCC SPECIAL REPORT ON CARBON CAPTURE AND STORAGE, SUMMARY FOR POLICYMAKERS SPM-3 (worldwide large stationary CO_2 sources with emissions greater than 0.1 million tons per year).

B. *How CCS Works*

CCS projects must capture CO_2 from power plants or industrial sources and transport it[31] to a geological sequestration site. The CO_2 is then injected deep underground—at depths greater than roughly one kilometer—into geological formations, such as depleted oil and gas reservoirs, saline aquifers, and unminable coal seams.[32] Injecting CO_2 into an injection well is essentially the reverse of pumping oil or water from a confined aquifer. The injection pressure must exceed the formation pressure, and the CO_2 fills the permeable pore space within the sedimentary rocks, essentially trapped by less permeable rock layers which impede upward fluid migration. CO_2 will be sequestered either as a gas, a dense supercritical gas, or a liquid.[33] Depending on reservoir temperature and pressure injected, in almost all circumstances, except deep ocean subsurface sequestration, CO_2 will be less dense than the brine present in the reservoir.[34] This makes buoyancy flow an important force governing supercritical CO_2 behavior in the subsurface. The life-cycle of a geological storage project will likely progress from site selection, characterization, and demonstration and regulatory review (1-10 years); active CO_2 injection and well closure (20-30 years); post-closure monitoring (15-30 years); and long-term stewardship (hundreds of years).[35] Regulatory reporting, monitoring, and necessary remediation activities take place throughout the life-cycle.[36]

Because injected CO_2 will initially be more buoyant than the waters in the geological formation, injected CO_2 will have the tendency to move both upwards and laterally within the subsurface. This behavior is an important consideration for modeling and monitoring subsurface behavior and development of risk management plans. Due to geological heterogeneity, CO_2 behavior in the subsurface will vary between sequestration sites. Importantly, after active injection of CO_2 ceases, CO_2 stored underground will become more secure over time with CO_2 trapped in rock capillaries and as geochemical reactions dissolve CO_2 in formation waters (centuries), and eventually convert it to minerals like calcium carbonate (millennia).[37] Thus, an effective geologic sequestration site will keep large volumes of a buoyant fluid underground for centuries to millennia.

Although the idea of injecting CO_2 into the subsurface for the purpose of controlling greenhouse gas emissions may be new, the practice of injecting CO_2 into the subsurface for other purposes is not. For decades, oil producers have injected CO_2 into

[31] *See* IPCC, *supra* note __, at 179-94.
[32] *Id.* at 31-36. *See generally* Sam Holloway, *An Overview of the Underground Disposal of Carbon Dioxide*, ENERGY CONVERSION AND MANAGEMENT 38 (Supplement): S193-S198 (1997); Sam Holloway, *Storage of Fossil Fuel-Derived Carbon Dioxide Beneath the Surface of the Earth*, 26 ANNUAL REVIEW OF ENERGY AND THE ENVIRONMENT 145-166 (2001).
[33] CO_2 is considered a supercritical fluid at temperatures greater than 31.1°C and 7.38 MPa (critical point). *See* CRC HANDBOOK OF CHEMISTRY AND PHYSICS Table II, F-89 (60th ed. 1979); Robert G. Bruant et al., *Safe Storage of CO_2 in Deep Saline Aquifers*, 36 ENVTL. SCIENCE & TECH. 240A-245A (2002).
[34] Stefan Bachu, *Sequestration of CO_2 in Geological Media: Criteria and Approach for Site Selection in Response to Climate Change*, 41 ENERGY CONVERSION MGMT. 953, 967 (2000).
[35] Elizabeth J. Wilson et al., *supra* note __.
[36] *Id.*
[37] Preuss et al., *supra* note __, at 52-53.

the subsurface to increase oil production from depleted fields. This process, known as "enhanced oil recovery" or EOR, is in widespread use in West Texas, where approximately 30 million tons of CO_2 are injected into the ground annually, resulting in a total of 600 million tons injected—though not stored for sequestration—in that area since 1985.[38] While supporters of CCS hold up the success and safety of CO_2 injection for enhanced oil recovery purposes, it is clear that CO_2 storage for purposes of controlling greenhouse gas levels in the atmosphere will have fundamentally different risks and be several orders of magnitude larger.[39] The MIT "Future of Coal" study states, " If 60% of the CO_2 produced from U.S. coal-based power generation were to be captured and compressed to a liquid for geologic sequestration, its volume would about equal the total U.S. oil consumption of 20 million barrels per day,"[40] highlighting the massive volumes of CO_2 involved in a large-scale carbon capture program.

Several CCS projects are underway or planned in Canada, the United States, and other countries.[41] Today, four projects each inject roughly one million metric tons of CO_2 per year. Three capture and inject the CO_2 produced from natural gas production projects: Sleipner in the North Sea and Snøvhit in the Barents Sea inject CO_2 captured from produced natural gas deep below the seafloor; and In Salah, in Algeria, injects the captured CO_2 into a deep gas formation.[42] The fourth project in Saskatchewan injects and monitors CO_2 for the Weyburn enhanced oil recovery project and injects and monitors CO_2. The CO_2 injected in this project is captured from a coal gasification plant in Beulah, North Dakota, and transported by pipeline over an international border.[43] Other demonstration projects are planned in Australia, Europe, Abu Dhabi, and the United States.[44]

C. Potential Risks of CCS

For CCS to enable continued use of fossil fuels and simultaneous deep emission reductions, it must be deployed on a scale far beyond what exists today. To do this the risks must be adequately managed and the technology must be integrated into a larger legal and regulatory scheme. Of key import are (1) the volume of the CO_2 to be injected—a 1,000 Megawatt power plant produces from 4-6 million tons per year; (2) the fact that CO_2 will initially be more buoyant than the subsurface saline formation water;

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[38] RICHARD C. MAXWELL ET AL., OIL AND GAS 13-14 (8th ed. 2007) (discussing enhanced recovery technology); Steven D. Cook, *Researchers Optimistic on Prospects for Successful Carbon Capture, Storage*, DAILY ENV. REP. No. 94 at A-1 (BNA May 16, 2007) (discussing the use of enhanced oil recovery in Texas as a current example of subsurface injection of CO_2).

[39] *See* U.S. Environmental Protection Agency, Guidance Document, Using Class V Experimental Technology Well Classification for Pilot Geologic Sequestration Projects, UIC Program Guidance (UICPG #83) at 2 (March 1, 2007) (stating that "[w]hile injection of fluids, including CO_2 into the subsurface, e.g., for enhanced oil recovery (EOR) and enhanced gas recovery (EGR), is a long-standing practice, injection of CO_2 [for CCS] is an experimental application of this existing technology.").

[40] MIT, THE FUTURE OF COAL xi (2007).

[41] See the International Energy Agency, CO_2 Capture and Storage R, D&D Database, *available at* http://www.co2captureandstorage.info/search.php.

[42] *Id.*

[43] *Id. See also* Dakota Gasification Company, (2008) http://www.dakotagas.com/Companyinfo/index.html.

[44] *See* International Energy Agency, *supra* note __.

and (3) the need for injected CO_2 to remain in the subsurface for hundreds to thousands of years. If all of the 1.5 billion tons of CO_2 produced from U.S. coal-fired power plants were captured, transported and injected for CCS, it would be equivalent to roughly one-third of the natural gas transported by pipelines in the U.S. each year.[45]

The IPCC report on CCS estimates that for well-selected sites, over 99% of injected CO_2 is very likely (probability between 90 to 99%) to remain underground for over 100 years.[46] While the probability for leakage to the surface appears low for well-selected sites, and potential leakage manageable, identifying potential risks for CCS and developing management strategies will help to ensure predictable technology deployment. With respect to global climate change, small surface leaks may be tolerated, but excessive (greater than 0.01% to 1% per year) CO_2 leakage back to the atmosphere will diminish the climate benefits from sequestration.[47]

Although CCS risks are in some ways similar to other industrial activities like enhanced oil recovery, several additional factors require integration of CCS into a set of enhanced regulatory and institutional frameworks.[48] The risks from CCS are associated both with the sheer volume of injected material, as well as the specific properties of CO_2.[49] CCS risks will vary through the lifecycle of a CCS project and are affected by local and regional geology, site history, and will likely decrease after injection ceases as formation buoyancy pressures naturally decrease.[50] Initially, buoyancy flow could drive CO_2 upward through undetected faults or abandoned well bores, making site selection

[45] *See* MIT, *supra* note __, at ix.
[46] *See* IPCC *supra* note __. at 14 ("Observations from engineered and natural analogues as well as models suggest that the fraction retained in appropriately selected and managed geological reservoirs is very likely to exceed 99% over 100 years and is likely to exceed 99% over 1,000 years. For well-selected, designed and managed geological storage sites, the vast majority of the CO_2 will gradually be immobilized by various trapping mechanisms and, in that case, could be retained for up to millions of years. Because of these mechanisms, storage could become more secure over longer timeframes.").
[47] *See generally*, Minh Ha-Duong & David W. Keith, *Carbon Storage: The Economic Efficiency of Storing CO_2 in Leaky Reservoirs*, CLEAN TECHNOLOGIES AND ENVIRONMENTAL POLICY 181-89 (2003); Stephen W. Pacala, *Global Constraints on Reservoir Leakage*, SIXTH INTERNATIONAL CONFERENCE FOR GREENHOUSE GAS CONTROL TECHNOLOGIES, KYOTO, JAPAN (2002); Robert P. Hepple & Sally M. Benson, *Implications of Surface Seepage on the Effectiveness of Geological Storage of Carbone Dioxide as a Climate Change Mitigation Strategy*, SIXTH INTERNATIONAL CONFERENCE ON GREENHOUSE GAS CONTROL TECHNOLOGIES, Kyoto, Japan 30 (2002). Factors affecting the range of "tolerable leakage" from CCS projects are linked to (1) the level of atmospheric stabilization desired; (2) how carbon intensive the future energy system is; and (3) how much CO_2 is sequestered in CCS projects and the projected benefit of early but imperfect storage.
[48] Sally Benson et al., *Underground Geological Storage, in* IPCC SPECIAL REPORT ON CARBON DIOXIDE CAPTURE AND STORAGE, *supra* note __, at 196-276.
[49] Elizabeth J. Wilson & David Gerard, *Geologic Sequestration Under Current U.S. Regulations, in* CARBON CAPTURE AND SEQUESTRATION: INTEGRATING TECHNOLOGY, MONITORING, REGULATION 169-93 (Elizabeth J. Wilson & David Gerard, eds. 2007).
[50] In several modeling simulation studies, complete dissolution of the CO_2 in the formation water is predicted on the order of 5,000-100,000 years, depending on the formation. *See* Erik Lindeberg & Per Bergmo, *The Long-term Fate of CO_2 Injected Into an Aquifer,* SIXTH INTERNATIONAL CONFERENCE ON GREENHOUSE GAS CONTROL TECHNOLOGIES, KYOTO, Vol. I, 489-94 (John Gale and Yoichi Kaya eds. 2003); J. Ennis-King, & L. Paterson, *Rate of Dissolution Due to Convective Mixing in the Underground Storage of Carbon Dioxide, in* SIXTH INTERNATIONAL CONFERENCE ON GREENHOUSE GAS CONTROL TECHNOLOGIES, KYOTO, Vol. I, 507-10 (John Gale & Yoichi Kaya eds. 2003).

and characterization particularly important. As injected CO_2 will be trapped in a rock matrix, large surface releases are unlikely, but at high concentrations (greater than 30%) CO_2 could cause immediate human death from asphyxiation[51] or health effects from prolonged exposure of high concentrations of CO_2 (above 3% concentration).[52] Slow CO_2 seepage into the near subsurface could also harm flora and fauna, and potentially cause local disruptions of ecology or agriculture.[53] There are also a number of potential risks associated with injected CO_2 even if it remains underground, including displacement of saline groundwater into potable aquifers, contamination of hydrocarbon resources, pressure changes causing ground heave, and even triggering seismic events—though these risks likely will be small with properly-managed sites.[54] Experience with remediation of leaking well-bores is well developed and approaches for remediation of undetected faults is possible, but potentially more costly.[55]

Thus, there are a range of potential risks associated with long-term storage of CO_2, including groundwater contamination, surface ecological damage, harm to human health, geologic hazards, and damage from hydrocarbons where CO_2 injection is linked with enhanced oil recovery operations.[56] From a doctrinal perspective, it is useful to distinguish between (1) protecting human health and the environment and (2) protecting against tortuous interference with property rights. While these risks appear low overall, are inherently site specific and, most importantly, seem to be manageable, ensuring that CCS projects protect human and environmental safety is an important component of the future program's success. Thus, CCS risk ultimately will need to be linked to legal liability in some form and be managed within the context of both existing and future state and federal laws.

D. Storage Capacity and CCS Projects

Estimated worldwide storage capacity for CCS is large, as shown in Table 2 below. A U.S. Department of Energy (DOE) report released March 27, 2007 indicates underground storage capacity of 3,500 billion metric tons across the U.S. and Canada for storing CO_2 and other greenhouse gases produced at power plants and other industrial

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[51] *See* Sally M. Benson et al., Lessons Learned from Natural and Industrial Analogs for Storage of Carbon Dioxide in Deep Geological Formations, Lawrence Berkeley National Laboratory, LBNL-51170 (2002).

[52] *See* Kay Damen et al., Health, Safety and Environmental Risks of Underground CO_2 Storage – Overview of Mechanisms and Current Knowledge, 74 CLIMATIC CHANGE 297 (2006); SALLY M. BENSON ET AL., LESSONS LEARNED FROM NATURAL AND INDUSTRIAL ANALOGUES FOR STORAGE OF CARBON DIOXIDE IN DEEP GEOLOGICAL FORMATIONS, EARTH SCIENCES DIVISION, E.O. LAWRENCE BERKELEY NATIONAL LABORATORY, BERKELEY, 135 (2002).

[53] *See* Prasad Saripalli et al., *Risk and Hazard Assessment for Projects Involving the Geological Sequestration of CO_2, in* SIXTH INTERNATIONAL CONFERENCE ON GREENHOUSE GAS CONTROL TECHNOLOGIES, *supra* note __, at 511-16.

[54] Benson et al., *supra* note __, at 293-96.

[55] *See generally* Yingqi Zhang et al., *Vadose Zone Remediation of Carbon Dioxide Leakage from Geologic Carbon Dioxide Sequestration Sites*, 3 VADOSE ZONE JOURNAL 858-866 (2004).

[56] Elizabeth J. Wilson et al., *Liability and Financial Responsibility Frameworks for Carbon Capture and Sequestration*, WORLD RESOURCES INSTITUTE ISSUE BRIEF 1, 3-4 (Dec. 2007).

sources.[57] Estimates are that the Powder River Basin in Wyoming alone may have the capacity to sequester 13.6 billion metric tons of CO_2.[58] Compared directly with the 1.5 billion tons of CO_2 emitted from coal-fired power plants annually in the U.S., storage capacity is plentiful. Some electric power industry representatives believe that carbon capture and sequestration could reduce power plant emissions by one-quarter in 2030.[59] Federal energy personnel have testified in Congress that at the current rate of energy production and use, the United States and Canada have the capacity to store all of the CO_2 emissions they produce over the next 175 to 500 years.[60] Physical storage capacity, however, is just one factor that will influence CCS deployment; state laws, liability, and risk also will affect the viability of CCS project deployment.

Table 2: Potential Global Storage Capacity for Different Reservoir Types[61]

RESERVOIR TYPE	**LOWER ESTIMATE OF GLOBAL STORAGE CAPACITY (BILLIONS OF TONS OF CO_2)**	**UPPER ESTIMATE OF GLOBAL STORAGE CAPACITY (BILLIONS OF TONS OF CO_2)**
Oil and gas fields	675	900
Unminable coal seams	3-15	200
Deep saline formations	1000	Uncertain, possibly 10,000

As detailed in Part I.B., there are four, existing, small-scale CCS projects worldwide.[62] Over the past several years, however, federal and state governments and the private sector in the United States have focused significant amounts of money and attention on a large-scale CCS project known as "FutureGen." Although recent political decisions place the project's viability in significant doubt, the size and scope of the project demonstrate the federal government's commitment to large-scale CCS in general. Specifically, in 2005, the U.S. DOE began an initiative to build the world's first integrated sequestration and hydrogen production research power plant. This project was designed as a $1.5 billion public/private partnership made up of member power

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[57] *See* U.S. DEPARTMENT OF ENERGY, CARBON SEQUESTRATION ATLAS OF THE U.S. AND CANADA (2006), *available at* http://www.netl.doe.gov/technologies/carbon_seq/refshelf/atlas/index.html; Lawrence J. Speer, *DOE Finds Large Capacity for Storing Carbon Dioxide Across U.S., Canada*, DAILY ENVT. REP. No. 60 at A-5 (BNA March 29, 2007). *See also* ERIC WILLIAMS, ET AL., CARBON CAPTURE, PIPELINE AND STORAGE: A VIABLE OPTION FOR NORTH CAROLINA UTILITIES?, WORKING PAPER, NICOLAS INSTITUTE FOR ENVIRONMENTAL POLICY SOLUTIONS AND THE CENTER ON GLOBAL CHANGE, DUKE UNIVERSITY (March 8, 2007), *available at* www.nicholas.duke.edu/institute/carboncapture.pdf.

[58] *See* Dustin Bleizeffer, *State has Vast Capacity for CO_2 Sequestration*, CASPER STAR TRIBUNE (April 5, 2007).

[59] Steven D. Cook, *Power Industry Officials Disagree on Future, Feasibility of Carbon Capture, Storage*, DAILY ENVT. REP. No. 186 at A-1 (BNA Sept. 26, 2007).

[60] *Id.*

[61] *See supra* note __. Estimated storage capacity for different geological storage sites, including non-economic sites. These numbers would increase 25% if currently "undiscovered" oil and gas fields were included.

[62] *See supra* note __, and accompanying text.

companies working with DOE to build the world's first coal-based, zero-emission electricity and hydrogen production facility.[63] The federal government committed to provide 74 percent of the project costs while private sector partners agreed to provide the remaining 26 percent.[64]

As part of the project, the FutureGen partnership evaluated four candidate sites in Illinois and Texas and, in December 2007, selected Matoon, Illinois.[65] According to the FutureGen partnership, the site was selected because the town could offer clean legal title to the site for both the plant and the site for CO_2 injection, it has ready access to plentiful water, and the geology of the site is suitable for CO_2 injection.[66] The FutureGen Environmental Information Volumes also found the risks to human health and the environment at the candidate sites to be extremely low.[67] In January 2008, however, DOE announced that it was withdrawing support for the FutureGen project in favor of supporting multiple commercial-scale power plants across the country.[68] The reasons given for withdrawal were the rising costs associated with the project, and recent technological advances that would allow broader commercial-scale deployment than was envisioned with FutureGen.[69]

Putting FutureGen aside, Congress and DOE have been attempting to authorize significant funding for CCS projects across the country. Competing House and Senate bills in 2007 each provided nearly $1.5 billion in funding for research and development of CCS.[70] In October 2007, DOE awarded $197 million in funding to three regional carbon sequestration partnerships in connection with pilot projects to store 1 million tons or more of CO_2 in deep saline reservoirs to test the feasibility of long-term CO_2 storage.[71] The money will be spent on these projects over ten years in the Great Plains states,[72] the Southeast,[73] and the Southwest.[74] The projects will cost $318 million, with private

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[63] FutureGen Industrial Alliance, 2008, http://www.futuregenalliance.org/.

[64] Steven D. Cook & Michael Bologna, *Illinois Site Chosen for FutureGen Project Amid Warnings of Possible Restructuring*, DAILY ENVT. REP. No. 243, at A-3 (Dec. 19, 2007). *See also* FutureGen Alliance, *available at* www.futuregenalliance.org/about/siting.stm.

[65] Cook & Bologna, *supra* note __.

[66] *Id. See also* FUTUREGEN ALLIANCE, FINAL SITE SELECTION REPORT (Dec. 18, 2007) (discussing FutureGen project, the incentives provided by state and local governments to attract the project, and analysis of the site selection process), *available at* http://www.futuregenalliance.org/news/fg_final_site_selection_report.pdf.

[67] *See* FutureGen *Industrial Alliance, Environmental Information Volumes*, (2007) *available at* http://www.futuregenalliance.org/news/evi.stm.

[68] See Steven D. Cook, *DOE Pulls Support for FutureGen Project, Will Fund Carbon Capture at Multiple Sites*, DAILY ENVT. REP. No. 20, at A-1 (BNA Jan. 31, 2008); U.S. Department of Energy, Press Release, *DOE Announces Restructured FutureGen Approach to Demonstrate CCS Technology at Multiple Clean Coal Plants* (Jan. 30, 2008), *available at* http://www.energy.gov/news/5912.htm.

[69] *Id.*

[70] Dean Scott, *Combined Incentives, Regulation Needed to Spur Carbon Sequestration, Markey Says*, DAILY ENVT. REP. No. 173 at A-4 (Sept. 7, 2007).

[71] *DOE Funds Three Large-Scale Projects to Test Feasibility of Carbon Dioxide Storage*, DAILY ENVT. REP. No. 196 at A-7 (Oct. 11, 2007).

[72] This project is the Plains CO_2 Reduction Partnership led by the Energy & Environmental Research Center at the University of North Dakota. *Id.*

[73] This project is the Southeast Regional Carbon Sequestration Partnership. *Id.*

partners providing the balance of the funds. In January 2008, DOE funded a fourth project in the Midwest to inject 1 million tons of CO_2 one mile below the earth's surface within the Illinois basin.[75]

Many recognize, however, that such subsidies alone will not be sufficient to spur commercial deployment. Instead, commercial deployment will follow federal and/or state law that establishes regulatory limits on greenhouse gas emissions, coupled with a sufficiently high and stable price on CO_2, which together will provide an incentive for new technology to meet those limits.[76] For instance, the States of California and Washington have enacted legislation setting greenhouse gas emission performance standards for electric utilities beginning January 1, 2007 in California and July 1, 2008 in Washington.[77] In both states, the laws allow utilities to exempt from their emissions calculations those emissions that are injected permanently into geologic formations or otherwise permanently sequestered by other approved means.[78] Thus, even more than federal or state financial incentives, it is caps on greenhouse gas emissions that will explicitly establish a price for CO_2 and will encourage utilities and others to invest in CCS in order to meet those caps.

II. CCS AND LIABILITY FOR HARM TO HUMAN HEALTH AND THE ENVIRONMENT

The scope, scale, and duration of any large-scale commercial CCS project will influence the potential for liability associated with CO_2 leakage, and other adverse impacts on resources, human health and the environment. This Part focuses on liability for harm associated with the post-closure and long-term sequestration of CO_2, as opposed to liability associated with active injection of CO_2 in the CCS project itself. It concludes that the potential liability associated with long-term stewardship of CO_2 is an issue which must be addressed, and will be subject to significant debate by federal and state policymakers wishing to encourage CCS deployment. These debates will center on how best to establish in advance where tort liability, financial responsibility, and ownership interests will rest as between corporate developers, state and federal governments, and other interested parties.

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[74] This project is the Southwest Regional Partnership for Carbon Sequestration coordinated by the New Mexico Institute of Mining and Technology. *Id.*

[75] Michael Bologna, *Energy Department, Midwest Partners Launch Carbon Sequestration Project in Illinois Basin*, DAILY ENVT. REP. No. 3, at A-1 (Jan. 7, 2008). The project is a joint effort by the Midwest Geological Sequestration Consortium, the Illinois State Geological Survey, and Archer Daniels Midland Company. *Id.*

[76] Scott, *supra* note __ (citing Rep. Edward Markey (D-Mass.)).

[77] CA PUB. UTIL. CODE § 8341(d)(5); WASH. REV. CODE ANN. § 80.80.040.

[78] *See id*. *See also* Rick Valliere, *State Lawmakers Briefed on Development of Carbon Capture, Storage Initiatives*, DAILY ENVT. REP. No. 151, at A-3 (Aug. 7, 2007) (discussing efforts by legislatures in Texas, Wyoming, California, and Maine to provide regulatory approval for CCS projects and to use CCS technology as an offset in setting caps on greenhouse gas emissions); Western Governors' Association, *Clean and Diversified Energy Initiative*, *available at* http://www.westgov.org/wga/initiatives/cdeac/progress-renewable.htm (discussing legislative efforts to create clean energy policies, including through CCS).

Before any widespread, large-scale implementation of CCS technologies, there likely will be statutes and regulations governing all aspects of the CCS process. This regulatory framework is critical to creating technology and safety standards to guide development, manage risk, and protect human health and the environment. The intense focus on this future regulatory structure, however, should not lead policy makers to eliminate or overlook the role of existing liability regimes, particularly state tort law and federal environmental law, in providing a backstop to guide behavior and compensate injured parties. Existing tort and federal environmental law can be an important tool to create incentives for proper site selection, sound management, and ensure damages are covered. The following Sections survey the existing liability landscape before turning in subsequent Parts to new, potential liability regimes that would be specific to CCS.

A. Federal Statutory Relief for Harm to Human Health and the Environment

Since the 1970s, Congress and state legislatures have enacted far-reaching legislation to reduce or eliminate air and water pollution, govern the generation, storage, and disposal of solid and hazardous waste, and create a regulatory system to review, classify, and regulate a host of pollutants and hazardous chemicals. This Section does not attempt to provide a full discussion of the existing environmental laws that may govern the long-term storage of CO_2.[79] Instead, it focuses solely on the Resource Conservation and Recovery Act ("RCRA")[80] and the Comprehensive Environmental Response, Compensation, and Liability Act ("CERCLA").[81] These statutes have the most direct application to the underground storage of CO_2. This is based on the potential classification of stored CO_2 as a "waste" or "hazardous substance" under these laws as well as the fact that CERCLA allows private parties and state and local governments to bring tort-like claims seeking monetary recovery for costs associated with the remediation of contamination, including contamination of private land or resources.[82] Thus, these laws may act as important gap-fillers in any federal regulatory system governing CCS. It is important to keep in mind, however, that RCRA, CERCLA and other existing environmental laws are not the ideal vehicles for either regulating stored CO_2 associated with CCS or providing monetary or injunctive relief in case of harm arising from CCS. Instead, a federal regulatory framework that also includes a significant state role should be created to establish regulatory standards for CCS as well as mechanisms for private enforcement and compensation in case of harm.

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[79] Prior papers that have attempted to do so include DE FIGUEIREDO, *supra* note __, and Jeffrey W. Moore, *The Potential Law of On-Shore Geologic Sequestration of CO_2 Captured from Coal-Fired Power Plant*s, 28 ENERGY L.J. 443 (2007).

[80] 42 U.S.C. § 6901-6992k.

[81] 42 U.S.C. §§ 9601-9675.

[82] *See* 42 U.S.C. § 9607(a) (setting forth prima facie case for recovery of response costs under CERCLA).

1. RCRA

The Resource Conservation and Recovery Act ("RCRA")[83] was enacted in 1976 to provide, among other things, a comprehensive "cradle-to-grave" regulatory system for identifying, listing, and tracking hazardous wastes; setting standards for the generation, handling, storage, and disposal of hazardous wastes; and assisting states with the management of solid wastes from active facilities.[84] Section 7002 of RCRA authorizes suits by any person to restrain anyone who has contributed or is contributing to the past or present handling of any solid or hazardous waste that may present an imminent and substantial endangerment to human health or the environment.[85] Such suits are not authorized until the potential plaintiff provides 90 days notice of the suit to the defendant, the EPA, and the state in which the alleged violation occurs; and are not authorized if EPA is already "diligently prosecuting" an action involving the alleged endangerment or the defendant is already engaged in an EPA-approved cleanup.[86]

Under RCRA, private parties can use Section 7002 to obtain injunctive relief to address contamination as well as attorneys' fees and expert costs resulting from the disposal of solid or hazardous wastes.[87] In such a suit, the plaintiff need not establish an emergency situation but only that there is a reasonable prospect of potentially serious harm.[88] Relief can include an order that the defendant is responsible for site investigation, monitoring, testing costs, cleanup costs and an order barring further endangerment but does not include money damages, such as the plaintiff's past cleanup costs.[89]

RCRA's provisions thus may provide liability for harm arising from the long-term storage of CO_2, if stored CO_2 is determined to be a solid or a hazardous waste and may also impose stringent handling, storage, and disposal requirements on the CCS process. RCRA defines solid waste as including "any garbage, refuse, sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semisolid or contained gaseous materials, resulting from industrial, commercial, mining, and agricultural operations, and from community activities."[90] This definition likely includes stored CO_2 in connection with CCS operations because the CO_2 is arguably "discarded material," is in "gaseous" or "liquid" form, and results from industrial or commercial activities. It is possible that

[83] 42 U.S.C. §§ 42 U.S.C. §§ 6901-6992k. RCRA is sometimes also referred to as the Solid Waste Disposal Act, the name of the federal law governing solid waste issues prior to the RCRA amendments to that Act in 1976. RCRA was substantially revised in 1984 by the Hazardous and Solid Waste Amendments. *See* PERCIVAL ET AL., *supra* note __, at 317.
[84] *See* PERCIVAL ET AL., *supra* note __, at 319-31 (discussing RCRA's requirements).
[85] 42 U.S.C. § 6972(a).
[86] *See* 42 U.S.C. § 6972(b)(2).
[87] *See* 42 U.S.C. § 6972(e) (authorizing award of attorneys fees and expert fees to prevailing party).
[88] *See* Maine People's Alliance v. Mallinckrodt, Inc., 471 F.3d 277 (1st Cir. 2006) (noting the courts have liberally construed the term "imminent and substantial endangerment" to include a reasonable prospect of future harm).
[89] *See* Mehrig v. KFC Western, Inc., 516 U.S. 479 (1996) (CERCLA, not RCRA provides framework for past recovery of cleanup costs).
[90] *See* 42 U.S.C. § 6903(27).

EPA will exclude CO_2 from the definition of solid waste (as it has done for domestic sewage, certain mining wastes, and certain nuclear materials covered by other laws), or that the stored CO_2 can qualify for a recycling exemption if it is seen as being stored for later use in enhanced oil recovery operations or for other purposes.[91] Likewise, there has been some effort within the industry to encourage Congress, federal agencies, and states to classify CO_2 as a "commodity," thus avoiding a classification as a "waste" and bringing it outside the scope of RCRA.[92] Without such actions by EPA—or other legislation—it is likely that stored CO_2 meets the definition of a solid waste.

Hazardous waste is defined as a subset of solid waste that: (1) exhibits a hazardous characteristic (such characteristics includes ignitability, corrosivity, reactivity, and toxicity); (2) is a "listed" hazardous waste meaning EPA has placed it on a list of hazardous wastes; (3) is a waste mixed with a listed waste ("mixture rule"); or (4) is a waste "derived from" a listed waste ("derived from rule").[93] CO_2 is not a listed hazardous waste and it seems unlikely that CO_2 alone would be considered a hazardous waste, although co-injection with other waste stream constituents (e.g. hydrogen sulfide (H_2S)) could cause it to be defined so.[94] It is also possible EPA would exclude stored CO_2 from the definition of hazardous waste, as it has done with incinerator ash and, more applicably, for wastes produced during the exploration, development, and production of crude oil, natural gas, and geothermal energy.[95]

Although there remains significant regulatory uncertainty with regard to the status of stored CO_2 under RCRA, without specific action by Congress or EPA it is likely CO_2 is at least a solid waste under RCRA, and if injected in a mixed stream with listed (and

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[91] *See* PERCIVAL, *supra* note __, at 329-31 (discussing RCRA solid wastes and exclusions from the definition of solid waste); Moore, *supra* note __, at 471-72 (discussing same in context of stored CO_2 and noting that EPA and the courts have determined that injected CO_2 does not qualify for the natural gas exemption to RCRA). *See also* Robert L. Glicksman, *Pollution on the Federal Lands III: Regulation of Solid and Hazardous Waste Management*, 13 STAN. ENV. L.J. 3, 42, 58 (1994) (discussing statutory and administrative exemption from hazardous waste requirements for mining, mineral processing, and oil and gas wastes).

[92] *See, e.g.*, Kipp Coddington & Bob Reynolds, *Carbon Dioxide Poised for a Comeback*, AMERICAN COAL, Issue 2, at 58-59 (American Coal Council 2006) (discussing what "label" to place on CO_2 stored or injected for hydrocarbon recovery for purposes of environmental liabilities). *See also* Kipp Coddington, *A Model CCS Code: Establishing the Regulatory Framework & Incentives to Enable Technology Deployment*, Conference Proceedings, at 7-8 (proposing model federal legislation that would create a federal insurance program for CCS but requiring that states define CO_2 as a "commodity" and not a "waste" or a "pollutant" in order to participate in the federal program); IOGCC, *supra* note __, at 32 (proposing model regulation stating that "carbon dioxide is a valuable commodity to the citizens of the state," thus potentially undermining protection under federal environmental laws).

[93] *See* 42 U.S.C. § 6904(5); PERCIVAL ET AL., *supra* note __, at 341-45 (discussing hazardous wastes).

[94] *See* 73 Fed. Reg. 43492, 43503 (July 25, 2008) (stating in EPA proposed rule under UIC program for CCS owners or operators will need to characterize their CO_2 stream as part of their permit application to determine if the injectate is hazardous based on the potential for hazardous constituents to be present in the injectate); City of Chicago v. Environmental Defense Fund, 511 U.S. 328 (1994) (regarding the mixing of municipal solid waste and incinerator ash and generation of hazardous waste).

[95] *See* PERCIVAL ET AL., *supra* note __, at 330-31, 347 (discussing and listing EPA exclusion of certain wastes from definition of solid waste or hazardous waste); Regulatory Determination for Oil and Gas and Geothermal Exploration, Development and Production Wastes, 53 Fed. Reg. 25,446, 25,447 (July 6, 1988). H2S is also exempted under this provision.

non-exempted) contaminants,[96] potentially a hazardous waste. If that classification is accurate, then Section 7002 of RCRA provides a right of action for injunctive relief to compel the remediation of any migration or release of stored CO_2 that presents an imminent and substantial endangerment to human health and the environment.[97] Notably, RCRA has been used successfully by plaintiffs where the disposal that caused the endangerment happened years or decades earlier; it is the present nature of the harm rather than the disposal that matters.[98] On the other hand, RCRA's regulations applicable to solid waste (Subtitle D regulations) are not nearly as strong as those applicable to hazardous waste (Subtitle C regulations). Indeed, RCRA's solid waste regulations are less of a federal regulatory program and more of a modest program of financial assistance to encourage the state to engage in area-wide waste management planning.[99] As a result, although RCRA is a potential vehicle for establishing liability associated with harm to human health and the environment resulting from the long-term storage of $CO_{2,}$, it is a crude tool with which to do so.

2. CERCLA

CERCLA, also known as "Superfund"[100] was enacted in 1980 to create a federal framework to address the problems associated with the existence of hazardous substances in the environment. Unlike other environmental laws that govern the generation, management, and disposal of hazardous materials and waste, CERCLA provides a cost-recovery vehicle for the federal government, state and local governments, and private parties to recover costs associated with contamination that occurred in the past, often decades ago, during a time when there were few requirements associated with the disposal of hazardous substances.[101] Specifically, CERCLA provides that any private or government entity may sue to recover for any "release"[102] of a "hazardous substance,"[103] from a "facility,"[104] that results in "response costs,"[105] so long as those costs are incurred

[96] Under current regulation, a CO_2 and H2S stream from a hydrocarbon associated project—where the H2S is an exempted waste--would be treated differently than the same stream from an industrial project injecting into a saline formation. *Id.*
[97] *See* 42 U.S.C. § 7003.
[98] *See* Main People's Alliance v. Mallinckrodt, Inc., 471 F.3d 277 (1st Cir. 2006); City of Toledo v. Beazer Materials & Services, Inc., 833 F. Supp. 646 (N.D. Ohio 1993); Gache v. Town of Harrison, 813 F. Supp. 1037 (S.D.N.Y. 1993).
[99] *See* PERCIVAL ET AL., *supra* note __, at 324-26 (comparing Subtitle C and Subtitle D provisions of RCRA and describing Subtitle D as "a largely non-regulatory program to encourage states to improve their management of *nonhazardous* solid waste") (emphasis in original).
[100] The term "Superfund" is from the five-year, $1.6 billion Hazardous Substances Response Trust Fund created to finance cleanups at CERCLA's inception. *See* 28 U.S.C. § 9507 (establishing fund). Superfund is funded by special taxes on oil and chemical companies and other businesses and supplemented by general revenues, as well as cleanup costs recovered from responsible parties. *See* SUSAN M. COOKE & CHRISTOPHER P. DAVIS, THE LAW OF HAZARDOUS WASTE: MANAGEMENT, CLEANUP, LIABILITY AND LITIGATION § 12.03[3] (2004) [hereinafter "COOKE"].
[101] *See generally* Alexandra B. Klass, *From Reservoirs to Remediation, The Impact of CERCLA on Common Law Strict Liability Environmental Claims*, 39 WAKE FOREST L. REV. 903, 920-23 (2004) (discussing CERCLA's liability provisions).
[102] 42 U.S.C. § 9601(22) (defining "release").
[103] 42 U.S.C. § 9601(14) (defining "hazardous substance").
[104] 42 U.S.C. § 9601(9) (defining "facility").

in a manner consistent with the "National Contingency Plan."[106] Liability under CERCLA is retroactive, joint, and several and is imposed on current as well as past owners and operators of "facilities" where there has been a release of a hazardous substance, as well as on those who have generated or transported hazardous substances.[107] The broad nature of the liability coupled with the ability of private parties to recover under CERCLA has made CERCLA a powerful vehicle to recover costs associated with contamination resulting from a wide-range of harmful substances.

CERCLA, however, only allows recovery by private parties for money spent on the investigation and remediation of a release of hazardous substances; it does not allow private parties to recover damages associated with lost profits, diminution in value to property, personal injury, lost rents, punitive damages, or other damages associated with contamination of property or the environment.[108] By contrast, some state superfund statutes, such as those in Alaska, Minnesota, and Washington, allow recovery for personal injury, lost profits, diminution in value to property, attorneys fees, expenses, or other losses stemming from the contamination of property or harm to human health and the environment.[109]

In order for CERCLA to apply to any releases[110] of CO_2, however, the stored CO_2 must be a "hazardous substance." CERCLA defines a hazardous substance as including any substance designated as hazardous by EPA under CERCLA and/or various other environmental statutes such as the Clean Air Act, the Clean Water Act, and the Solid Waste Disposal Act.[111] As CO_2 is non-toxic at low concentrations and is not a listed waste, CERCLA likely does not apply to current CO_2 injection activities unless recognized hazardous substances are present. Additionally, if CCS is associated with hydrocarbon production, CERCLA also contains a "petroleum exclusion" which states that petroleum and natural gas are not hazardous substances.[112] Finally, CERCLA typically does not apply to hazardous substances sold as "useful products" (as opposed to

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[105] 42 U.S.C. § 9601(25) defining "response").

[106] *See* 42 U.S.C. § 9607(a) (setting forth prima facie case for CERCLA recovery); Klass, *supra* note __, at 920-23 (discussing CERCLA's liability provisions).

[107] *See* 42 U.S.C. § 9607(a). *See also* ROBERT V. PERCIVAL ET AL., ENVIRONMENTAL REGULATION: LAW, SCIENCE, & POLICY 370-71 (5th ed. 2006) (discussing retroactivity of CERCLA's liability provisions).

[108] Klass, *supra* note __, at 923.

[109] *See, e.g.,* ALASKA STAT. § 46.03.422(a), 46.03.824, and 46.03.822(m) (allowing cost recovery and broadly defined damages as well as costs of containment and cleanup in connection with the release of hazardous substances); MINN. STAT. §§ 115B.05, 115B.14 (allowing recovery for personal injury, lost profits, diminution in value to property and other damages associated with the release of hazardous substances as well as reasonable costs and attorneys fees); WASH. REV. CODE § 70.105D.080 (allowing recovery of expenses and reasonable attorneys fees in connection with cost recovery actions).

[110] CERCLA defines a "release" as any spilling, leaking, pumping, pouring emitting, emptying, discharge, injecting, escaping, leaching, dumping, or disposing into the environment. 42 U.S.C. § 9601(22). CERCLA defines "environment" as including the navigable waters, the waters of the contiguous zone, and the ocean waters as well as any other surface water, ground water, drinking water supply land surface or subsurface strata, or ambient air within the United States or under the jurisdiction of the United States. 42 U.S.C. § 9601(8). Based on these definitions, stored CO_2 that migrates to the surface or migrates laterally in the subsurface strata would likely qualify as a "release" under CERCLA.

[111] *See* 42 U.S.C. § 9601(14) (defining "hazardous substance").

[112] *See id*. *See also* Klass, *supra* note __, at 937 & n.139 (discussing CERCLA's petroleum exclusion).

those arranged for disposal) which would mean that CERCLA might not cover stored CO_2 if it was classified as a "commodity" rather than a waste.[113] Most important, CERCLA does not define CO_2 as a hazardous substance and neither does any other federal environmental statute. EPA has stated, however, that if an injected CO_2 stream contains mercury or other substances that are classified as hazardous substances, or if the CO_2 stream were to react with groundwater to produce a hazardous substance such as sulfuric acid, the injected CO_2 stream may be subject to CERCLA liability.[114]

While CERCLA (and most state analogs) do not appear to cover CO_2 on its own, applying CERCLA's liability framework to CCS risk management allows us to examine the implications of such an approach. The retroactive nature of CERCLA was critical to its success because much of the conduct and contamination it was attempting to cover was perfectly legal at the time it took place. Thus, the lack of standards in the past required a super-charged liability statute in order to cast as wide a net as possible, both with regard to the number of potential defendants and the nature of the conduct that could form the basis for recovery. Congress was particularly concerned with "orphan sites" where the property was subject to significant contamination but those companies or individuals responsible for the contamination were long gone (through death, dissolution, or bankruptcy).[115] Congress thus imposed liability on current owners of property even if they did not "cause" the harm and also created the "Superfund," a federal trust account funded through taxes on the chemical industry, to provide funding for cleanups.[116] Congress also provided that the statute of limitations for cost recovery actions under CERCLA does not even begin to run until a cleanup begins, thus eliminating that defense for most potential defendants.[117]

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[113] *See* Pneumo Abex Corp. v. High Point, Thomasville & Denton R.R. Co., 142 F.3d 769, 775 (4th Cir. 1998) (considering the following four factors to distinguish between a sale of a useful product and a disposal of a hazardous substance: (1) the intent of the parties as to whether the materials were to reused entirely or reclaimed and then reused; (2) the value of the materials sold; (3) the usefulness of the materials in the condition in which they were sold; and (4) the state of the products at the time of transfer); A & W Smelter and Refiners, Inc. v. Clinton, 146 F.3d 1107, 1112-13 (9th Cir. 1998) (remanding case for factual determining of whether ore containing gold, silver, and small amounts of lead was a useful product or a waste, the different being whether the materials is the producer's principal business product or a by-product that the producer intends to get ride of); M. STUART MADDEN & GERALD W. BOSTON, LAW OF ENVIRONMENTAL AND TOXIC TORTS 627-28 (3rd ed. 2005) (discussing lack of CERCLA coverage for sale of "useful" products); *infra* note __ and accompanying text (discussing efforts to classify stored CO_2 as a commodity to avoid application of CERCLA and other environmental laws). CO_2 pipeline safety is regulated under the Hazardous Liquid Pipeline Act of 1979.

[114] *See* 73 Fed. Reg. 43492, 43504 (July 25, 2008) (discussing potential CERCLA liability for injected CO_2 in proposed rule to create federal requirements for CCS under the UIC program).

[115] *See* PERCIVAL, *supra* note __, at 429-30 (discussing "orphan" shares under CERCLA); Klass, *supra* note __, at 926-27 (discussing legislative history of CERCLA which justified "the need for federal legislation to address what was seen as a major crisis of abandoned hazardous waste facilities.").

[116] *See* MADDEN & BOSTON, *supra* note __, at 622 (discussing creation of Superfund). *See also supra* note __.

[117] *See* 42 U.S.C. § 9613(g)(2) (statute of limitations for CERCLA). By contrast, state common law claims for relief such as nuisance, negligence, trespass, or strict liability generally are subject to state statutes of limitation that begin to run with the defendant knew or should have known of the harm to the property, which is often long before a cleanup begins on the property. *See infra* notes __ - __ and accompanying text (discussing statutes of limitation for common law claims).

There are some obvious differences and similarities between the goals of CERCLA and the realities of a CCS regulatory regime. First, there will undoubtedly be many more safeguards in place in connection with the injection and storage of CO_2 than there were with regard to the handling and disposal of hazardous substances in the decades prior to CERCLA. Thus, there may be no immediate concerns with regard to orphan sites. Moreover, there are significant potential climate benefits associated with CCS as compared with virtually no benefits associated with the abandoned hazardous waste sites that led to CERCLA. Thus, the draconian liability framework established to address CERCLA sites may be out of place in the context of CCS. On the other hand, CCS operators envision storing CO_2 for hundreds of years, which means that harm may not occur until long after the original operators are gone.[118] Thus, even if regulatory safeguards are created, unforeseen long-term problems associated with the storage of CO_2 in large amounts raises significant uncertainty with regard to the success of any regulatory structure.

In sum, CERCLA, like RCRA is a crude tool to apply directly to CCS operators, particularly in light of the fact that CO_2 is not inherently the type of "hazardous substance" Congress envisioned when it enacted CERCLA. Nevertheless, a federal liability statute tailored to CCS that includes some of the signature elements of CERCLA (creation of a national fund, a private cause of action, retroactive, strict, joint, and several liability, and perhaps a limitations period tied to cleanup) should not be dismissed out of hand. If the CERCLA liability model were applied to the long-term storage of CO_2, public and private actors that suffer injury would be able to take advantage of strong liability and funding provisions to facilitate remediation and to provide compensation for public and private harm.

B. Recovery for Harm under State Law

In many ways, in comparison to federal environmental statutes, state law, and particularly state common law, has the potential to provide non-federal actors more comprehensive relief from harm related to the long-term storage of CO_2, but also is at most risk of preemption by any forthcoming federal regulatory framework on CCS.[119] Unlike the federal environmental statutes, which either do not give states or private parties the right to seek monetary recovery or, in the case of CERCLA, allow only for recovery of response costs, the state common law claims discussed below are available to private parties, local governments, and states to recover for a fuller range of harms associated with leakage from stored CO_2. These remedies include compensatory damages, punitive damages, and injunctive relief not available under most federal and state environmental statutes.[120] This means that the common law may play a significant role in creating liability for the long-term storage of CO_2. At the same time, however, it

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[118] Harm is most likely to occur during the active injection of CO_2 rather than hundreds of years into the future. *See supra* note __ and accompanying text (discussing studies showing CO_2 will become more secure in subsurface as time goes on).
[119] *See infra* Part III.B (discussing federal preemption of state law).
[120] See, e.g., Michael D. Axline, *The Limits of Statutory Law and the Wisdom of Common Law, in* CREATIVE COMMON LAW STRATEGIES FOR PROTECTING THE ENVIRONMENT 63, 67-68 (Denise E. Antolini & Clifford L. Rechtschaffen eds. 2007).

is state common law that is most vulnerable to arguments by industry or federal regulators that Congress should preempt the availability of such claims through federal legislation.[121] The potential claims of trespass, negligence, nuisance, and strict liability, along with potential damages and statutes of limitation, are discussed below, followed by a discussion in Part III of related federal preemption issues.

While these claims do not constitute the universe of potential state law claims that could result in liability associated with the long-term storage of CO_2, we focus on these claims because they provide potentially the broadest scope of relief and will significantly affect CCS project siting and technology deployment. Not only do these claims allow the possibility of monetary relief (damages for harm) and injunctive relief (an order to cease storage operations or remediate pollution) but they also need not be based on arguments that the defendant breached a duty of care (negligence) or violated a statute or permit (negligence per se). As a result, in the absence of preemption by federal or state statute, the common law claims discussed below provide a basis for liability that is independent of the safety and environmental protection standards that may be set by Congress, state regulators, or administrative agencies. In the initial years of CCS project deployment, such claims could affect decisions on project siting and risk management.

1. Property rights, fugitive resources, and trespass

As far back as the middle of the 19th century, there have been disputes over who owns subsurface oil and gas, when interference with oil and gas constitutes a trespass, and who owns oil and gas that has been recovered and then re-injected into the subsurface for storage or enhanced oil recovery purposes.[122] The body of common law that had developed around these issues forms a potential basis of liability for the long-term storage of CO_2.[123] While state and federal statutes and regulations will almost certainly create a regulatory system governing these issues, this system will be against a backdrop of the common law, which will inevitably be put to use in interpreting the statutes and filling in the "spaces" within the statutes.

In the early days, courts found it difficult to apply traditional ideas of ownership to substances that could not be seen from the surface and moved underground on their own accord. As a result, early courts often drew analogies to legal doctrines governing ownership of water, wild animals, and other "fugitive resources."[124] This resulted in a body of case law which held that a landowner did not own oil and gas located beneath her land until it was reduced to "possession." Such law also held that an owner lost title to

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[121] *Id.*

[122] A "trespass" is generally defined as a physical and unauthorized invasion of the property of another where the entry is either intended by the defendant, caused by the defendant's recklessness or negligence, or the result of the defendant's carrying on an ultrahazardous activity. *See* HENDERSON ET AL., THE TORTS PROCESS 380-81 (2003).

[123] For a more detailed discussion of the property rights associated with injected gas in the context geologic storage of CO_2 see Mark A. de Figueiredo, *Property Interests and Liability of Geologic Carbon Dioxide Storage*, *in* CARBON CAPTURE AND SEQUESTRATION, INTEGRATING TECHNOLOGY, MONITORING AND REGULATION 243 (Elizabeth J. Wilson & David Gerard eds. 2007).

[124] *See* OWEN L. ANDERSON ET AL., HEMMINGWAY OIL AND GAS LAW AND TAXATION 29-30 (4th ed. 2004).

oil or gas if it was reinjected (placed back "into the wild") for storage purposes and that the owner was not liable for trespass of that oil or gas on neighboring property because of the lack of ownership.[125] This denied the landowner any protectable property interest in oil or gas being drained to other tracts and also discouraged the use of underground storage reservoirs as a safe and economic means of holding oil and gas after production. As stakeholders and courts developed more sophisticated knowledge about the movement of oil and gas, most courts rejected the analogy to wild animals and held that once previously extracted oil or gas is stored in defined underground reservoirs, title to the oil or gas is not lost and remains with the person or company placing the oil or gas in storage.[126]

Once that shift occurred, the question arose under what circumstances the owner of re-injected oil or gas would be liable for trespass or other tort liability if the oil or gas migrated and interfered with neighboring property or persons. In several cases, courts have held that that a trespass is not actionable in the absence of damage and that a trespass is not actionable where public policy favors the injection.[127] In these cases, the courts found that public policy supported unitization of areas for oil and gas recovery and secondary recovery operations because both techniques promoted the efficient collection of oil and gas, prevented waste, and avoided the drilling of unnecessary wells.[128]

Courts considering trespass claims arising from CCS operations will be forced to look to the precedent created in traditional oil and gas operations. Just as courts moved away from the analogies to wild animals as public policy began to favor re-injection and storage of oil, gas, and water, courts will be called upon to adopt new common law frameworks to address stored CO_2. What this will look like remains to be seen, but it may be that public policy favoring reduction of greenhouse gas emissions might weigh in favor of applying liability sparingly as a common law matter, as has been done in the past with traditional oil and gas operations. As shown above, courts in the past have refused to find an actionable trespass where unitization of oil and gas fields and secondary recovery were seen as public benefits that outweighed the plaintiffs' private trespass claims.[129] Thus, there is always the possibility that courts would utilize a similar cost benefit analysis in the case of CCS, concluding that the climate benefits of CCS outweigh

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[125] *Id.* *See also* Hammonds v. Central Kentucky Natural Gas Co., 75 S.W.2d 204 (Ky. Ct. App. 1934) (no trespass claim because owner of gas lost title to gas once it was injected into the subsurface).

[126] *See, e.g.,* Texas American Energy Corp. v. Citizens Fidelity Bank & Trust, 736 S.W.2d 25 (Tex. 1987) (overruling *Hammonds*, discussing limitation of analogy to wild animals, and citing cases in other jurisdictions that had rejected *Hammonds*); Elizabeth Wilson & Mark A. de Figueiredo, *Geologic Carbon Dioxide Sequestration: An Analysis of Subsurface Property Law*, 36 ELR 10114, 10121 (Feb. 2006) (noting that *Hammonds* is not currently followed in the United States, that gas companies retain ownership of injected gas, and that trespass can occur if gas migrates).

[127] *See* West Edmonds Salt Water Disposal Ass'n v. Rosencrans, 226 P.2d 965 (Okla. 1950) (injector not liable for damages or injunctive relief for injection of salt water into existing salt water formation that extended under neighboring property because neighbor could not establish damage); R.R. Comm'n v. Manziel, 361 S.W.2d 560 (Tex. 1962) (no liability for authorized injection into adjoining subsurface property because of public policy favoring injection of salt water for secondary recovery of oil); Phillips Petroleum Co. v. Stryker, 723 So. 2d 585 (Ala. 1998); ANDERSON ET AL., *supra* note __, at 160.

[128] *Id.*

[129] *Id.*

trespass claims, at least in cases where the trespass cannot be said to have interfered directly with the plaintiff's ability to use the minerals or surface.

Such a "balancing" is far less likely, however, in a case of significant harm to human health and the environment. It may be that the sheer volume of injected CO_2 associated with CCS may cause courts to pause before weighing the costs and benefits of stored CO_2 in the same way as has been done for the injection of CO_2 in connection with traditional oil and gas recovery. Indeed, in the cases discussed above where the courts rejected the trespass claims, the plaintiffs could not show any actual harm, which made it easier for the courts to disregard those claims in favor of the public policy benefits of encouraging the efficient recovery of oil and gas. Although the public policy of reducing greenhouse gas emissions favors CCS operators, courts cannot so easily disregard the purpose of tort law to provide for redress of private harms in the face of significant injury to persons or property.

2. Negligence and negligence per se

Traditional claims for common law negligence and negligence per se also provide a potential basis for liability for harm arising from stored CO_2 in connection with CCS operations. To establish liability under a common law negligence theory, a plaintiff must establish by a preponderance of the evidence that the defendant owed a duty of care to the plaintiff, that the defendant breached that duty of care, that the defendant's breach of the duty was the actual cause and the proximate cause of the plaintiff's harm, and that the plaintiff suffered damages (based on injury to person or property) as a result of the defendant's conduct.[130]

In the context of harm from stored CO_2, the primary issues of concern would be whether the defendant took reasonable care under the circumstances with regard to storing CO_2 and whether the defendant caused the harm. With regard to the first issue, there are various formulations of reasonable care. The Restatement (Second) of Torts provides that where an act is one a reasonable person would recognize as involving a risk of harm to another, "the risk is unreasonable and the act is negligent if the risk is of such magnitude as to outweigh what the law regards as the utility of the act or of the particular manner in which it is done."[131] In determining the utility of the actor's conduct, courts and juries are to consider the social value the law attaches to the interest to be advanced or protected by the conduct, the extent to which this interest will be advanced or protected by the conduct, and the extent of the change that such interest can be

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[130] *See* 1 DAN B. DOBBS, THE LAW OF TORTS § 114, at 269 (2001).

[131] RESTATEMENT (SECOND) OF TORTS § 291. *See also* RESTATEMENT (THIRD) OF TORTS: LIABILITY FOR PHYSICAL HARM § 3 (Proposed Final Draft No. 1, 2005) ("A person acts negligently if the person does not exercise reasonable care under all the circumstances. Primary factors to consider in ascertaining whether the person's conduct lacks reasonable care are the foreseeable likelihood that the person's conduct will result in harm, the foreseeable severity of any harm that may ensue, and the burden of precautions to eliminate or reduce the risk of harm."). *See also* JAMES A. HENDERSON, JR. ET AL., THE TORTS PROCESS 157 (7th ed. 2007) ("The general standard applicable in most negligence cases is one of reasonable care under the circumstances.")

adequately protected by another less dangerous course of conduct.[132] In determining the magnitude of the risk, courts and juries are to consider the social value the law attaches to the interests which are imperiled, the extent of the chance the actor's conduct will cause an invasion of the interests of another, the extent of harm likely to be caused to the interests imperiled, and the number of persons whose interests are likely to be invaded if the risk takes effect in harm.[133]

As is evident, every negligence case involves a balancing of social costs and social benefits associated with the defendant's conduct. Putting aside any defenses to liability based on contributory negligence, assumption of the risk, other actions by the plaintiff that could have resulted in the harm, or statutory immunities, it may be very difficult for a plaintiff to establish precisely what as a matter of common law is the standard of care for selecting a storage site, injecting CO_2, and monitoring it for hundreds of years. Although negligence claims are certainly asserted in cases involving environmental harm,[134] in any case dealing with new technologies in a new industry, it can be difficult to establish that the defendant breached a duty of care. In such cases, the defendant can argue that it was engaging in "state of the art" practices or technologies for that time, even if the technology has since developed in a manner that makes the activity far safer than in the past.[135]

As for causation, establishing the causal link between injected CO_2 and harm could be challenging. For instance, if several parties were simultaneously injecting CO_2 into the same geological formation and influencing formation pressure, assigning blame for harm could prove exceedingly difficult. Additionally, this point raises the larger question of geological basin scale management, important both for projects with multiple operators injecting into a single basin and where several geologic sequestration formations cross state lines (e.g. the Mt. Simon formation in the Illinois Basin or the Frio Formation on the Gulf Coast).[136]

Moreover, negligence claims can open the door to defenses that are not otherwise available in traditional environmental harm cases such as assumption of the risk, contributory/comparative negligence, immunities, and shorter statutes of limitation.[137]

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[132] RESTATEMENT (SECOND) OF TORTS § 292.
[133] RESTATEMENT (SECOND) OF TORTS § 293.
[134] *See, e.g.,* James B. Witkin, *Common Law Causes of Action for Environmental Claims, in* ENVIRONMENTAL ASPECTS OF REAL ESTATE AND COMMERCIAL TRANSACTIONS 41, 60-63 (James B. Witkin ed. 2004) (summarizing various environmental cases involving common law negligence claims).
[135] *See, e.g.*, New Jersey Dept. of Env. Prot. v. Ventron, 468 A.2d 150 (N.J. 1983) (finding no negligence in release of mercury into a stream because even though the defendant's actions were unreasonable, unwarranted, and unlawful under present standards, they were within the standards acceptable at the time they occurred).
[136] While not dealt with here specifically, basin-scale coordination could become increasingly important with large-scale commercialization of CCS. If an injection formation crosses state lines, coordination of information, and laws across state lines will become important, highlighting the need for a consistent federal set of standards and resolution of liability concerns.
[137] *See, e.g.,* Denise E. Antolini and Clifford L. Rechtschaffen, *Common Law Remedies: A Refresher, in* CREATIVE COMMON LAW STRATEGIES FOR PROTECTING THE ENVIRONMENT 11, 30-35 (Denise E. Antolini & Clifford L. Rechtschaffen eds. 2007).

Thus, negligence is an available common law theory of recovery for cases involving harm from stored CO_2, but will present potentially difficult, fact-intensive issues surrounding whether the defendant's conduct breached the standard of care in place at that time.

Plaintiffs often are more successful in establishing negligence under a theory of negligence per se. Under negligence per se, a plaintiff can establish negligence if he or she can show that the defendant violated a statute "designed to protect against the type of accident the actor's conduct causes and if the accident victim is within the class of persons the statute was designed to protect."[138] One of the comments to the proposed draft Restatement (Third) of Torts on negligence per se states that "courts, exercising their common law authority to develop tort doctrine, not only should regard the actor's statutory violations as evidence admissible against the actor, but should treat that violation as actually determining the actor's negligence."[139] The doctrine of negligence per se applies not only to state statutes but also federal statutes and federal and state administrative regulations.[140] Since the 1970s, courts have used newly enacted state and federal environmental statutes and regulations to help define the duty of care in common law negligence cases to serve as a basis for negligence in negligence per se cases.[141]

Although few statutes and regulations exist today that set specific standards of conduct with regard to the storage of CO_2, Congress, state legislatures, and federal and state agencies are likely to create a significant body of law in this area if CCS technology moves forward. If that is the case, plaintiffs harmed by stored CO_2 can look to violations of those standards to assert claims of negligence per se to obtain traditional common law relief that includes compensatory damages, punitive damages, and injunctive relief.

3. Nuisance

While the trespass claims discussed above represent one classic, property-based tort, nuisance law provides another means for holders of property rights to recover for harm resulting from the long-term storage of CO_2. Nuisance law is based on the principle that a defendant may not engage in activity that unreasonably interferes with public rights or a private party's interest in land. Nuisance law underlies much of environmental law, and has been used by private and public parties to obtain injunctive and monetary relief from air, water, soil, and noise pollution resulting from industrial and commercial activities such as landfills, sewage treatment plants, oil refineries, quarries and the like.[142]

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[138] *See* RESTATEMENT (THIRD) OF TORTS § 14 (Proposed Final Draft 2005).
[139] *See* RESTATEMENT THIRD OF TORTS § 14 cmt. c (Proposed Final Draft 2005).
[140] *Id.*, cmt. a.
[141] *See* Klass, *supra* note __, at 585 (discussing use of negligence per se in environmental cases and citing decisions).
[142] *See* WILLIAM H. RODGERS, JR., ENVIRONMENTAL LAW § 2.1 at 112-113, 114-15 (2d ed. West 1994) (stating that to "a surprising degree, the legal history of the environment has been written by nuisance law" and detailing the various types of nuisance actions that have been brought in connection with harm arising from various industrial and commercial activities).

There are two types of nuisance: private nuisance and public nuisance. A public nuisance is an "unreasonable interference with a right common to the general public" and may only be asserted by a public body (such as a state or local government) or by a private party who has suffered a unique or special injury that differentiates his or her harm from that suffered by the general public.[143] A private nuisance is a "nontrespassory invasion of another's interest in the private use and enjoyment of land" and may be brought by anyone with an ownership or possessory interest in land.[144] Generally, for an activity to be a nuisance, the invasion of the private use and enjoyment of land must be (1) intentional and unreasonable or (2) unintentional but negligent, reckless, or subject to strict liability because it is an abnormally dangerous activity.[145] An invasion is unreasonable if the gravity of harm outweighs the utility of the actor's conduct or the harm caused by the conduct is serious and the financial burden of compensating for this and similar harm would not be unreasonable.[146] Once a nuisance is established, the court balances the benefits of the alleged nuisance activity, the harm to the plaintiff and others, and other equitable factors to determine whether the defendant should pay damages to the plaintiff or whether the plaintiff is entitled to completely enjoin the conduct causing the nuisance.[147]

Notably, even lawful operations that result in harm to public resources or private property can be enjoined or subject to damages based on nuisance. In 1998, a Washington state court found that a pulp mill operating lawfully pursuant to a wastewater discharge permit was liable under a private nuisance theory for $2.5 million in damages to nearby potato farmers using irrigation water from the aquifer contaminated by the defendant's operations.[148] Also in 1998, the Court of Appeals for the Ninth Circuit upheld a lower court injunction against a metal tube manufacturer under a public nuisance theory where the defendant's dumping of hazardous chemicals resulted in contaminating a subterranean aquifer.[149]

In the context of the long-term storage of CO_2, migrating or leaking CO_2 that harms nearby soil, surface water, groundwater, mineral, or other resources, or interferes with human health could constitute either a public or private nuisance. This could result in an injunction requiring remediation of any harm caused by CO_2 or preventing the

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[143] *See* RESTATEMENT (SECOND) OF TORTS §§ 821B, 821C.
[144] *See* RESTATEMENT (SECOND) OF TORTS §§ 821D-828 (setting forth principles of private nuisance).
[145] *See* RESTATEMENT (SECOND) OF TORTS § 822. For a discussion of activities that are considered "abnormally dangerous," see *infra* notes 130-137, and accompanying text.
[146] *See* RESTATEMENT (SECOND) OF TORTS §§ 826-27.
[147] *See* RESTATEMENT (SECOND) OF TORTS § 936 (setting forth balancing factors for injunctions); DAN B. DOBBS, LAW OF REMEDIES § 5.7(2) (discussing judicial discretion in balancing benefits and harms in nuisance cases).
[148] Tiegs v. Watts, 954 P.2d 877, 883 (Wash. 1998) (stating that pollution caused by the defendant constituted a nuisance even if the state had approved the discharge).
[149] California v. Campbell, 138 F.3d 772 (9th Cir. 1998) (upholding lower court injunction finding that pollution of subterranean percolating waters caused by dumping of hazardous chemicals was a public nuisance). *See also* Denise E. Anolini & Clifford L. Rechtschaffen, *Common Law Remedies: A Refresher, in* CREATIVE COMMON LAW STRATEGIES FOR PROTECTING THE ENVIRONMENT 23-30 (Rechtshaffen & Antolini eds. 2007) (discussing theories of private and public nuisance and describing cases in which courts granted injunctions and awarded damages under nuisance theories for polluting activities).

continued storage of CO_2.[150] It could also result in an award of monetary damages for harm associated with the release. Such injunctive or monetary relief could be awarded under a nuisance theory even if the CCS project or storage area was in full compliance with all federal or state permits.[151] In determining whether a nuisance exists and the appropriate remedy, a court may balance the harm to the plaintiff against the benefits of stored CO_2. Under such a balancing, it may be that the public interest associated with storing CO_2 would be significant if the technology is seen as playing a significant role in efforts to reverse climate change. On the other hand, a court could also find that it is more equitable for the CO_2 owner or operator to bear the risks and at least pay damages for the harm, even if the stored CO_2 is allowed to remain.[152]

In sum, harm to human health, the environment, or private property from the migration or release of stored CO_2 would seem to fit fairly easily within a public or private nuisance framework, taking into account challenges surrounding causation and barring any Congressional actions to preempt such claims as part of federal legislation governing CCS and the storage of CO_2.[153] Even if a nuisance claim for such harm is possible, however, most courts would balance carefully the benefits of CCS and CO_2 storage against the nature of the harm before finding either that a nuisance exists or determining the appropriate remedy for the nuisance.

4. Strict liability for abnormally dangerous activities

Unlike nuisance doctrine, which requires a balancing of benefits and harms to establish liability, the common law doctrine of strict liability allows for liability even where the defendant did not intend to interfere with a legally protected interest or did not act unreasonably or breach any duty of care in causing the harm.[154] Instead, the justification for imposing liability is that where the defendant has engaged in an activity for profit that causes harm, the defendant is in the best position to bear the loss under principles of justice.[155]

In most jurisdictions, a defendant is strictly liable for harm to public health or the environment under either the doctrine of *Rylands v. Fletcher* or for activities that are

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[150] For a discussion of potential difficulties establishing causation, see *supra* notes __ - __ and accompanying text.

[151] *See* Michal D. Axline, *The Limits of Statutory Law and the Wisdom of Common Law, in* CREATIVE COMMON LAW STRATEGIES FOR PROTECTING THE ENVIRONMENT, *supra* note __, at 74-76 (discussing how compliance with federal or state statutes or permits is not a defense to a common law claim for relief); Alexandra B. Klass, *Common Law and Federalism in the Age of the Regulatory State*, 92 IOWA L. REV. 545, 583 & n.215 (2007) (same).

[152] *See* Zhang et al., *supra* note __. Remediation techniques can use passive techniques, vertical or horizontal extraction wells and pumping, though remediation depends largely on the site geology.

[153] *See infra* Part III.B.

[154] *See* W. PAGE KEETON ET AL., PROSSER & KEETON ON THE LAW OF TORTS § 75 at 534 (5th ed. 1984).

[155] *See* Klass, *supra* note __, at 907 (citing PROSSER & KEETON, *supra* note __, § 75, at 536; Mark Geistfeld, *Should Enterprise Liability Replace the Rule of Strict Liability for Abnormally Dangerous Activities*, 45 UCLA L. REV. 611 (1998); William K. Jones, *Strict Liability for Hazardous Enterprises*, 92 COLUM. L. REV. 1705, 1712 (1992); Virginia E. Nolan & Edmund Ursin, *The Revitalization of Hazardous Activity Strict Liability*, 65 N.C. L. REV. 257, 297 (1987).

deemed "abnormally dangerous" under Sections 519 and 520 of the Restatement (Second) of Torts.[156] Under *Rylands v. Fletcher*, a defendant is liable if it engages in a "non-natural" or "abnormal" use of the land which results in harm.[157] Under such a standard, it may not be too difficult to establish that the injection of massive amounts of CO_2 into the subsurface is either "non-natural" or "abnormal," at least in parts of the country where there is no history of injecting CO_2 for enhanced oil recovery or other purposes. Even in those states where the subsurface is already used for the storage or use of CO_2 or other substances, the scope and scale of CO_2 injection in connection with CCS may cause courts to pause before finding such storage is either "natural" or "normal." Nevertheless, regional differences with regard to the use of the subsurface may play a significant role in determining whether strict liability is appropriate under the *Rylands* doctrine.

Under the Second Restatement of Torts, an activity is "abnormally dangerous" and thus subject to strict liability based on a judicial balancing of several factors, some of which may make it more difficult for a plaintiff to establish strict liability for the release of stored CO_2 than is the case under the *Rylands* doctrine The factors are: (1) the existence of a high degree of risk of some harm to the person, chattel, or lands of others; (2) likelihood that the harm that will result from the activity will be great; (3) inability to eliminate the risk of harm by the exercise of reasonable care; (4) the extent to which the activity is not a matter of common usage; (5) the inappropriateness of the activity to the place where it is carried on; and (6) the extent to which the value of the activity to the community is outweighed by its dangerous attributes.[158]

Courts have held defendants strictly liable for harm to public health and the environment under both *Rylands* and the Restatement for a broad range of activities that include the release of petroleum or oil that contaminated groundwater, seeping salt water from an oil and gas well that contaminated a water supply, the release of toxic and hazardous wastes from industrial operations and disposal facilities, the release of PCBs from a natural gas pipeline that contaminated neighboring property, the release of pollutants during the blowout of an oil well during drilling, and pollution of water wells by nearby oil wells that percolated on the property.[159] In all, putting aside those jurisdictions that do not recognize strict liability (or only in narrow circumstances), twenty-one out of twenty-seven jurisdictions that have squarely considered the issue have applied the doctrine of strict liability to activities resulting in environmental contamination.[160] Notably, however, Texas and Wyoming, two states that may play a big

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[156] *See* Rylands v. Fletcher, L.R. 3 H.L. 330 (1868); RESTATEMENT (SECOND) OF TORTS §§ 519-20; Klass, *supra* note __, at 904 (discussing strict liability under *Rylands* and the Restatement).

[157] *Rylands*, L.R. 3 H.L. 330 (1868); PROSSER & KEETON, *supra* note 130, at 545-46 (discussing *Rylands* case).

[158] RESTATEMENT (SECOND) OF TORTS § 520. *See also* RESTATEMENT (THIRD) OF TORTS § 20 (Proposed Final Draft No. 1 2005) (proposing to revise the Restatement of Torts on abnormally dangerous activities to provide that an activity is abnormally dangerous if it (1) creates a foreseeable and highly significant risk of physical harm even when reasonable care is exercised by all actors and (2) the activity is not a matter of common usage).

[159] *See* Klass, *supra* note __, at 942-61 (discussing cases).

[160] *Id.* at 957-61.

role in future CO_2 storage, disfavor the doctrine of strict liability or have rejected it entirely.[161]

Whether courts will find the long-term storage of CO_2 associated with CCS to be subject to strict liability under the Restatement factors remains to be seen and, given the significant geologic differences, will likely vary by region or state. Is the storage of large quantities of CO_2 a "matter of common usage" or "appropriate" for its location?[162] It may not be now, but do the demands of addressing climate change alter that equation? Is the answer different in Texas, where injection of CO_2 is more common in connection with enhanced oil recovery operations, than it is in eastern or Midwestern states? Could the answer vary by type of geologic formation and local use? In terms of the value to the community, the value of stored CO_2 may be significant if it has a measurable impact on reducing greenhouse gas emissions. Another important consideration is that, unlike hazardous waste, CCS has an important environmental benefit in reducing atmospheric greenhouse gas emissions. Given this important social value, the argument for strict liability may be weakened.

As may be evident from these questions, different courts in different jurisdictions may reach widely varying results on whether harm from stored CO_2 is subject to strict liability. This is true, however, for most industrial and commercial activities around the country, with different laws applying in different jurisdictions. While there is an argument that CCS and the large-scale storage of CO_2 should be subject to a uniform standard of liability, there is perhaps a more compelling argument that operators should recognize the existence of potential strict liability in multiple jurisdictions, and conduct their operations accordingly but with an eye toward reducing the downside risk consistent with the proposals in Parts IV and V.

5. Damages

Under any of the trespass, nuisance and strict liability theories discussed above, parties responsible for the long-term storage of CO_2 may be liable for remediation costs, diminution in value to private or public property (i.e., stigma damages), lost profits, personal injury, and other damages flowing from harm to human health and the environment. In recent years, there have been significant lawsuits against gasoline producers over contamination from the gasoline additive methyl tertiary butyl ether ("MTBE") which has contaminated numerous municipal and state water supplies. The South Tahoe Public Utility District sued several major gasoline companies in 1998 after MTBE pollution forced it to close many drinking water wells in California and, after a jury trial, the defendant companies agreed to pay $69 million to remediate the

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[161] *See* Wyrulec Co. v. Schutt, 866 P.2d 756, 761 (Wyo. 1993) (holding that Wyoming has consistently imposed a negligence standard rather than absolute liability under the *Rylands* doctrine); Doddy v. Oxy USA, Inc., 101 F.3d 448, 462 (5th Cir. 1996) (stating that Texas rejects strict liability completely); Jones v. Texaco, 945 F. Supp. 1037, 1050 (S.D. Tex. 1996) (same).

[162] *See supra* notes __ - __ and accompanying text.

contaminated wells.[163] New Hampshire filed a similar suit in 2003 and several other public and private parties are also seeking recovery for harm under various common law theories including nuisance, negligence, and strict liability.[164] In May 2008, several gasoline company defendants in multi-district litigation involving MTBE agreed to pay $422 million to 153 public water systems throughout the country as well as 70 percent of any costs to treat newly contaminated wells.[165] These suits show the willingness of courts to find liability under state law and uphold significant damage awards associated with widespread environmental contamination.

Even beyond these high-profile suits, courts are more willing today to award "stigma" damages arising from property contamination in addition to cleanup costs. Environmental "stigma" is defined as an adverse impact on the value of a property based on the market's perception that the property poses an environmental risk.[166] Thus, stigma can attach not only to property that is currently contaminated, but also to property that has a risk of future contamination or property that has been remediated but is still perceived as posing a risk of harm.[167] Although some jurisdictions require some minimal physical impact sufficient to interfere with the owner's use of the land for stigma damages to be recoverable, other jurisdictions recognize that the value of property can decrease through "stigma" simply by being near contamination.[168] Thus, in most jurisdictions, a subsurface invasion of CO_2 or a release of CO_2 to the surface that interferes with use of the property will support stigma damages while in others, any significant release of CO_2 near the property may suffice so long as the release constitutes a trespass, nuisance, abnormally dangerous activity, or other actionable tort.

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[163] Tyler Cunningham, *Oil Companies Settle Lawsuit over MTBE in Lake Tahoe—the Long Running Case Will Not Mark a Legal Precedent Because of the Deal, but Will Surely Have a Wide Impact*, S.F. DAILY J. (Aug. 6, 2002).

[164] *See* Klass, *supra* note __, at 596-97 (discussing MTBE lawsuits); Moore, *supra* note __, at 482-83 (discussing MTBE suits and potential application to contamination from storage of CO_2).

[165] *See* Chris Amico, *MTBE Settlement Could Grow, Lawyers Say*, LEGALNEWSLINE.COM, May 9, 2008, at http://www.legalnewsline.com/news/212199-mtbe-settlement-could-grow-lawyers-say; John Wilen, The Associateda Press, *MTBE Settlement Could Grow if More Contamination Is Found* THE LAW.COM, May 9, 2008, at http://www.law.com/jsp/article.jsp?id=1202421242805.

[166] *See* UNIFORM STANDARDS OF PROFESSIONAL APPRAISAL PRACTICE, Advisory Op. 9, at 143-45 (Appraisal Standards Bd. 2003).

[167] *See* Klass, *supra* note __, at 588-590. *See also* Dealers Mfg. Co. v. County of Anoka, 615 N.W.2d 76, 77 n.1 (Minn. 2000) (environmental risk resulting in stigma damages may be due to fear of potential liability for cleanup costs, potential liability to third parties affected by existing or prior contamination, or concerns regarding the ability to obtain financing for the property) (citing Peter J. Patchin, *Valuation of Contaminated Properties*, 56 APPRAISAL J. 7, 7-8 (1988)).

[168] *Compare* Chance v. BP Chemicals, 670 N.E.2d 985, 993 (Ohio 1996) (requiring some type of physical damage or interference with use to recover stigma damages and holding that a trespass to subterranean rock strata by deepwell injectate is not sufficient) *with Dealers Mfg*., 615 N.W.2d at 79-80 (finding that stigma may exist for a property that is merely in proximity to property that is contaminated because "of the heavy burden on the value of the property due to the perception of risk of liability, or government imposed restrictions on the use or transferability of the property, among other concerns.").

6. *Statutes of Limitation, Repose, and Revival*

For all common law claims, defendants can take advantage of state statutes of limitation which limit the time (often between two and six years) within which a plaintiff may bring a lawsuit for injuries. Because of the long time-frame associated with the storage of CO_2, questions will inevitably arise as to when various causes of action will "accrue," and cause the limitations period to start to run. In particular, an issue may arise over whether a trespass, nuisance, or strict liability claim associated with stored CO_2 is "continuing," thus allowing the plaintiff to maintain an action or successive actions until the contamination is remediated.[169] This issue of whether the wrongdoing is "continuing" arises frequently in cases of environmental contamination, where the illegal conduct ceased decades ago but contamination continues to move through the soil and groundwater, resulting in continuing harm. Thus, is the triggering event the defendant's wrongful conduct or it the harm caused to the plaintiff that may continue decades after the wrongful conduct ceases? Many courts and commentators have argued that proof of continuing harm supports a claim of continuing trespass which prevents the statute of limitations from expiring until the defendant has abated the harm.[170] Other courts, however, have focused on the conduct as the triggering event, rather than the harm, meaning that the limitations period runs from when the plaintiff knew or should have known of the last wrongful act, regardless of whether the contamination continues far into the future.[171]

In the context of CCS, if the wrongful conduct is the improper selection and operation of a storage area or the improper injection of CO_2, it may take years or decades for sufficient CO_2 to migrate and cause harm. Even though the statute of limitations does not begin to run in most jurisdictions until the plaintiff knew or should have known of the wrongful conduct and its impact, it is still possible that the plaintiff might know of the wrongful conduct before the impact on the plaintiff or its property is significant enough to justify bringing a suit. In such a case, whether the wrong is deemed to be continuing is critical to the scope of the defendant's liability. If courts determine that the limitations

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[169] *See* RESTATEMENT (SECOND) OF TORTS § 899, cmt. d (stating that a continuing trespass "confers on the possessor of the land an option to maintain a succession of actions based on a theory of continuing trespass, or to treat the continuing of the thing on the land as an aggravation of the original trespass."); MADDEN & BOSTON, *supra* note __, at 29-31 (discussing the arguments surrounding the relationship between continuing trespass and statutes of limitation).

[170] *See* Nieman v. NLO, Inc. 108 F.3d 1546 (6th Cir. 1997) (holding that under Ohio law, the statute of limitations does not expire because the time period has elapsed from the defendant's last affirmative act of wrongdoing but instead continues based on proof of continuing damages); Jacques v. Pioneer Plastics, Inc. 676 A.2d 504 (Me. 1996) (focusing on the hazardous material that remained on the site rather than the dumping itself in deciding whether the limitations period had run); Hoery v. United States, 64 P.3d 214 (2003) (holding that under Colorado law, continuing migration of contaminants and ongoing presence of contaminates constitute a continuing trespass and continuing nuisance rendering the plaintiff's claim timely); RESTATEMENT (SECOND) OF TORTS §§ 161(1) and 899 (discussing continuing nature of trespass when defendant fails to remove a thing from land that was wrongfully placed there).

[171] *See, e.g.*, Carpenter v. Texaco, 646 N.E.2d 398 (Mass. 1995) (finding plaintiffs' claim for damage due to contamination from leaking petroleum tank was time-barred because they failed to sue within three years of the last instance of unlawful conduct and a continuing nuisance or trespass must be based on "recurring tortious or unlawful conduct, and is not established by the continuing of harmed caused by previous but terminated tortious or unlawful conduct.").

period begins to run when the plaintiff knew or should have known that the CCS operator selected an improper storage site, the CCS operator's liability will be quite limited in duration so long as the CCS does not cause immediate or significant harm. If, however, courts determine that the limitations period continues to run until all harm is remediated, CCS operator liability has the potential to continue long into the future. In all of these cases, of course, the plaintiff must establish causation, which can be difficult in cases where multiple operations over multiple sites are injecting the same substance, or where CO_2 or contaminants react with native rock and potentially affect groundwater in a manner that is difficult to observe and document.[172]

A defense related to a statute of limitations is a statute of repose. While a statute of limitations bars the plaintiff's action at a specified time period after the cause of action accrues (usually from the plaintiff's knowledge or constructive knowledge of her cause of action), a statute of repose bars the plaintiff from bringing an action after a specified number of years past a particular event, such as the date of the sale of a product or the date of improvements to real property.[173] As a result, if a statute of repose applies, a cause of action may be extinguished before the plaintiff's claim ever accrues, because the required number of years has run from the stated event, even if the plaintiff has not yet suffered harm or is not yet aware of the harm.[174] Many states have created statutes of repose in connection with improvements to real property, resulting in the extinguishment of claims against asbestos manufacturers or other manufacturers of toxic products used in construction.[175] The flip side to a statute of repose is a revival statute, which resuscitates claims that have already been barred by the statute of limitations. For instance, the New York legislature in 1986 enacted a statute to revive claims related to exposure to DES, asbestos, chlordane, and polyvinylchloride for one year which had previously expired.[176]

In the context of CCS, federal and state legislators can create limitations periods, repose periods, or revival periods specific to claims involving stored CO_2 if they wish, as Congress has done with claims involving hazardous substances under CERCLA,[177] and as states have done to both protect certain industries in some cases and protect citizens with particular injuries in other cases. In light of the unique concerns associated with CCS claims such as potentially long latency periods prior to knowledge of harm and the difficulties in observing the movement of CCS underground, existing common law

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[172] *See supra* notes __ - __ and accompanying text (discussion causation issues).
[173] *See* MADDEN & BOSTON, *supra* note __, at 939 (comparing statutes of limitation and statutes of repose).
[174] *Id.*
[175] *Id.* at 940-41 (citing cases and discussing challenges to statutes of repose under state constitutions that contain provisions granting citizens a "right to a remedy" or right to access to the courts).
[176] *See* Hymowitz v. Eli Lilly & Co., 539 N.E.2d 1069 (N.Y. 1969) (upholding constitutionality of revival statute). *See also* MADDEN & BOSTON, *supra* note __, at 942 (discussing New York revival statute).
[177] *See supra* note 92 and accompanying text (discussing how CERCLA provides that the statute of limitations for recovery of response costs does not even begin to run until the plaintiff begins remediating the property). CERCLA creates not only a specific limitations period for cost recovery claims under CERCLA but also imposes a discovery rule (for those states that do not have one) on state common law claims for relief. *See* 42 U.S.C. § 9658 (imposing a "federally required commencement date" for state law causes of action defined as the date the plaintiff knew or reasonably should have known that the personal injury or property damages were caused or contributed by the hazardous substance, pollutant, or contaminant).

principles associated with statutes of limitations may be crude tools to govern CCS claims. In the absence of federal or state legislative action on this front, however, courts will be left with the task of determining issues associated with the claim accrual date, whether the harm is "continuing" for limitations purposes, and whether a state statute of repose might apply in the CCS context. This is one area where there is ample common law precedent on which to draw but where a legislatively-tailored solution would appear to be superior.

C. Conclusion

This Part illustrates that there is an existing body of federal and state statutory and common law that may apply to claims for harm associated with the long-term storage of CO_2. As shown above, even under existing doctrines, the challenges of balancing the benefits of CCS with the potential risks must be weighed both locally and within the larger context of climate change. This existing legal structure, however, is not a substitute for the adoption of carefully tailored state and federal regulation governing all aspects of the development of CCS. Existing statutory environmental laws are only crude tools for governing the complicated policy and regulatory issues associated with CCS. As for common law, it certainly has its shortcomings: it is retrospective, it develops slowly and with significant variation across jurisdictions, and thus cannot provide a comprehensive solution to the national problem of climate change or appropriately govern CCS technology.[178] By contrast, CCS-specific laws can consider the unique features of CCS, create regulatory safeguards to guide development, and create a permitting and compliance structure unique to CCS.

This does not mean, however, that the existing statutory and common law liability framework is of no relevance. RCRA and CERCLA are powerful environmental statutes that have been used to address a wide range of issues relating to waste and contamination since they were enacted over 20 years ago. Common law, for its part, can evolve in a reasoned manner somewhat more insulated from interest groups than the political process; reach decisions based on sworn, scientific testimony rather than the generalities often presented in legislative hearings; and can base decisions on individualized factual circumstances.[179] Thus, these sometimes broad and sometimes narrow statutory and common law safeguards are available to serve as an additional incentive for project developers to comply with whatever CCS regulations come into existence, as well as meet basic common law duties. State and federal legislation specific to CCS, discussed in Part III, should leave much of this basic liability framework in place at least until adequate federal or state substitutes s specific to CCS are created.

III. STATUTORY DEVELOPMENTS, COMPETITION, AND LIMITATIONS ON LIABILITY

No federal or state program currently regulates CCS and related storage of CO_2, although CO_2 storage projects may now be permitted pursuant to a March 2007 EPA Guidance Memorandum under EPA's Underground Injection Control ("UIC") Program

[178] *See, e.g.*, Klass, *supra* note __, at 582 (discussing limitations of the common law).
[179] *See id.* at 582 (discussing benefits of the common law).

created under the Safe Drinking Water Act of 1974.[180] EPA has begun the process of developing regulations on the injection of CO_2 under the UIC program, but this regulatory initiative is limited by EPA's statutory authority under the Safe Drinking Water Act and does not address issues associated with long-term liability or property rights.[181] Federal and state legislators, however, are keenly aware of the importance of defining property rights and tort liability in advance of implementing CCS and the long-term storage of CO_2. Although little has been enacted thus far, recent efforts to do so are instructive and show recognition of the importance of tort liability in the development of this new technology. As shown below, much of this legislation attempts to significantly limit project operators' liability for long-term storage of CO_2, compromising the ability of existing laws to provide long-term protection for human health and the environment without first providing any federal or state substitute.

A. Legislative Efforts to Reduce or Eliminate Liability for Harm

At both the federal and state levels, there have been efforts to encourage the development of CCS through the enactment of significant limitations on liability for harm associated with the long-term storage of CO_2. For instance, in 2006, the U.S. House of Representatives considered a bill to authorize and appropriate funds for the FutureGen project[182] "to demonstrate the feasibility of the commercial application of advanced clean coal energy technology, including carbon capture and geological sequestration, for electricity generation."[183] One of the failed amendments to that bill was to allow the Secretary of the Department of Energy to "indemnify the consortium and its member companies for liability associated with the first-of-a-kind sequestration component of the project," with indemnity extending to any legal liability arising out of "the storage or unintentional release, of sequestered emissions."[184] The proposed indemnification contained exceptions for gross negligence and intentional misconduct, and limited the U.S. Government's aggregate liability to $500,000,000 for a single incident.[185]

In 2006 and 2007, the two state finalists for the FutureGen project, Illinois and Texas, were in keen competition for the project which would bring cutting-edge coal research, hundreds of jobs, and a new market for local natural resources including but not

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[180] 42 U.S.C. § 300h(b)(1) ("SWDA"); 40 C.F.R. § 144.1; EPA Guidance Memorandum, *supra* note __.
[181] *See* 73 Fed. Reg. 43492, 43495 (July 25, 2008) (stating in proposed rule that the Safe Drinking Water Act does not providing authority for EPA to develop regulations for all areas relating to CCS, including determining property rights or the transfer of liability from one entity to another); Patricia Ware, *EPA Begins Discussions on Rulemaking for Underground Storage of Carbon Dioxide*, DAILY ENVT. REP. No. 232, at A-11 (BNA Dec. 4, 2007).
[182] *See supra* notes __ - ___ and accompanying text (discussing FutureGen project and DOE decision in January 2008 to withdraw support for the project in favor of other commercial CCS projects).
[183] *See* Energy Research, Development, Demonstration, and Commercial Application Act of 2006, H.R. 5656 (2006).
[184] Amendment to H.R. 5656 offered by Rep. Costello of Illinois (June 27, 2006).
[185] *Id. See also* Department of Energy Carbon Capture and Storage Research, Development, and Demonstration Act of 2007, H.R. 1933 (April 18, 2007) (bill to amend the Energy Policy Act of 2005 to reauthorize and improve the carbon capture and storage research, development, and demonstration program of the Department of Energy).

limited to coal.[186] As part of that competition, both states enacted legislation to enhance their bids as the host site, including offering freedom from tort liability through statutory indemnification and transfer of property rights in CO_2. For instance, Texas enacted legislation in 2006 providing that the state would acquire title to CO_2 captured by a clean coal process, thus releasing the owner of the project from any liability after capture of the CO_2.[187] In 2007, additional bills were introduced in the Texas legislature to strengthen those indemnification provisions and make clear that "once the State of Texas assumes ownership of CO_2, the [FutureGen] Alliance will be protected from tort liability."[188] The purpose of the indemnity provisions were to move "Texas significantly ahead in the national competition for FutureGen because no other state has identified a suitable answer to this important question."[189] Illinois for its part attempted to provide similar assurances to the Alliance. In 2007, Illinois enacted legislation to offer liability protections similar to those enacted in Texas in order to "compete" with Texas and put Illinois "on an even playing field."[190]

Specifically, the Illinois legislation provided that if the FutureGen project was located in Illinois, Illinois would take title to injected CO_2, would obtain at its own expense insurance from private carriers against loss from stored CO_2 if such a policy was available, and would indemnify the FutureGen Operator to the extent liability was not covered by insurance.[191] The only limits on the state's indemnity for the Operator's liability are in cases of intentional or willful misconduct by the Operator or if the loss stemmed from the Operator's failure to comply with applicable state or federal laws, rules, or regulations for the carbon capture and storage of the sequestered gas.[192] The Illinois incentives "package" also included a $17 million direct grant from the Illinois Coal Development Fund, an estimated $15 million sales tax exemption on materials and equipment purchased through local enterprise zones, and $50 million for below-market rate loans through state finance agencies.[193]

Despite the fact that DOE has withdrawn its support for the FutureGen project, the state legislative activity prior to that withdrawal serves as an example of states competing for lucrative government investment. The inverse can also be true, where states or counties actively develop protections to not allow industrial facility development.[194] Notably, while states often set (or fail to set) environmental standards that will cover a wide range of industries (the power industry, the auto industry,

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[186] *See supra* note __ and accompanying text.
[187] *See* TEX. NAT. RES. CODE Ch. 119 (enacted as Tex. H.B. 149 (2006)).
[188] *See* Press Release, Railroad Commission of Texas, *House Energy Committee Unanimously Approves 2007 FutureGen Legislation* (April 11, 2007).
[189] *See* Press Release, Railroad Commission of Texas, *Williams: Legislation Improves Texas Chance to Win FutureGen* (May 16, 2006).
[190] *See* 20 ILCS 1107 (Clean Coal FutureGen for Illinois Act); *See also* Kate Clemens, *Illinois Senate Passes Bill to Help Land FutureGen Plant*, THE NEWS-GAZETTE (March 22, 2007).
[191] *See* 20 ILCS 1107/25.
[192] *See* 20 ILCS 1107/25(g).
[193] Cook & Bologna, *supra* note __ (discussing Illinois legislative incentives and noting that "all the candidate sites came with financial inducements from state and local governments.").
[194] *See generally* Robert Vendenbosch & Susanne Vandenboch, NUCLEAR WASTE STALEMATE (University of Utah Press 2007).

manufacturing) or environmental resources (e.g., air, water, waste) the FutureGen legislation was focused on a specific project that would only be built in one of two candidate states. Such a situation cannot help but encourage competition to be seen as the most "friendly" forum with regard to a host of issues including taxes, land availability, and geography in addition to potential liability. Indeed, prior to the potential sites being narrowed to those in Illinois and Texas, Kentucky had enacted legislation allowing project sponsors to "bypass much of the regulatory process" for siting the facility, so the state would not have "an administrative process that's seen as burdensome."[195] Whether this will hold for future CCS projects—federal or commercial—remains to be seen.

Thus, this type of legislation serves as a caution for the future deployment of commercial CCS projects. If CCS continues to develop, it will likely be on a plant-by-plant basis, with some states potentially in intense competition to be selected as the site, as was the case with FutureGen. For instance, the current DOE proposal calls for a public-private partnership to implement CCS technologies at multiple commercial-scale power plants across the country.[196] While special considerations to manage liability may be appropriate for the first few demonstration projects, mature commercial projects may not warrant special exemptions. Further, the state legislative actions to date should encourage federal lawmakers to ensure that any regulatory structure governing the long-term storage of CO_2 contains standards that act as a floor for future commercial projects, rather than a ceiling. As scholars have shown, while some states may compete based on the least regulations (known as the "race-to-the-bottom"), others have a history of adopting more protective regulations.[197] California currently serves as such an example, acting as leader in regulatory efforts to reverse climate change by reducing emissions from automobiles, power plants, and other sources of greenhouse gases.[198] Such environmental protection efforts should be encouraged.

Existing federal environmental statutes that govern the air, water, and hazardous waste can act as examples of the federal government setting a floor for environmental standards and allowing states to innovate using their regulatory authority and common law.[199] Legislators could use these statutes for guidance in enacting CCS legislation. On

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[195] *See Kentucky General Assembly Passes Bill Aimed at Attracting "FutureGen" to the State*, GLOBAL POWER REPORT (March 30, 2006).
[196] *See* Steven D. Cook, *DOE Pulls Support for FutureGen Project, Will Fund Carbon Capture at Multiple Sites*, 39 ENV. REP. No. 5, p. 200 (Feb. 1, 2008).
[197] *See* PERCIVAL ET AL, *supra* note __, at 104 (explaining the "race-to-the-bottom" rationale and citing scholarly debates on the subject); Kirsten H. Engel, *State Environmental Standard-Setting: Is There a "Race and Is It "To The Bottom,"* 48 HASTINGS L.J. 271, 283 (1997) (stating that the "race-to-the-bottom" in the debate over federal environmental standards refers to a lowering of state environmental standards that also results in a lowering in net social welfare). See also Richard L. Revesz, *Federalism and Environmental Regulation: A Public Choice Analysis*, 115 HARV. L. REV. 553, 579-85 (2001) (rejecting proposition that the states are not effective bodies to enact and implement environmental standards and providing past and current examples).
[198] *See* Klass, *supra* note __, at __ (discussing California's legislative and regulatory initiatives in the area of climate change).
[199] *See, e.g.*, William Buzbee, *Asymmetrical Regulation: Risk, Preemption, and the Floor/Ceiling Distinction*, 82 N.Y.U. L. REV. 1547 (2007) (arguing that the risks of regulatory failure argue for federal

the other hand, when a commercial project is not accompanied by federal research dollars, the siting difficulties which plague much infrastructure development, characterized by 'not in my backyard' attitudes, could emerge for CCS as well.[200] If states choose to use high liability barriers to keep CCS projects out of their territories, eventual CCS project siting—and potential greenhouse gas reduction benefits—could become impossible.

Although there has been some recognition of this problem in recent literature, its solutions fall short of what may be needed to ensure sufficient compensation for public and private harm from the release of CO_2. For instance, the "Coalition for Commodity CO_2," has prepared model legislation to create a federal insurance program for the long-term storage of CO_2.[201] The legislation proposes that the federal government require states to create minimum standards for the injection and storage of CO_2 in order to participate in the federal insurance program.[202] Beyond requiring those minimum state standards (and it is not clear what types of standards would meet the minimum) and creating the federal insurance program, the Coalition argues for a limited federal role in CCS regulation, leaving most major requirements and standards to the states. The Coalition argues that requiring such minimum state standards for participation in the federal insurance program will prevent under-regulation of CCS while still allowing a diversity of state approaches.[203]

This model legislation for setting standards and providing insurance is limited in the protection it provides, however, because it also contains as a requirement for participation in the federal insurance program that the state define CO_2 as a "commodity" rather than a "pollutant" or "waste" to avoid "unlimited" and "unfounded" environmental liability for states and CCS operators.[204] As explained in Part II, CO_2 likely will escape classification as a "waste" or "hazardous substance" under federal environmental laws if it is classified as a "commodity." Thus, there are problems with requiring states to create a regime that makes it impossible for federal or state environmental pollution laws to apply, particularly when the potential impacts of long-term storage of CO_2 remain uncertain and will continue to remain uncertain for decades. The potential for insufficient state regulation and liability is real, which argues in favor of federal participation in creating substantive standards for CCS technology.

standards setting a regulatory floor but not a regulatory ceiling); Robert L. Glicksman, *From Cooperative to Inoperative Federalism: The Perverse Mutation of Environmental Law and Policy*, 41 WAKE FOREST L. REV. 719 (2006) (exploring developments in environmental law at federal and state levels).

[200] For general discussions on the phenomenon, see *e.g.*, Barry Rabe, BEYOND NIMBY: HAZARDOUS WASTE SITING IN CANADA AND THE UNITED STATES (Brookings Institution Press 1994); Michael M. Dear, U*nderstanding and Overcoming the NIMBY Syndrome*, 58 JOURNAL OF THE AMERICAN PLANNING ASSOCIATION (1992). For how siting varies across the country, see Shalini P. Vajjhala, and Paul S. Fischbeck, *Quantifying Siting Difficulty: A Case Study of U.S. Ttransmission Line* Siting, 35 ENERGY POLICY 650 (2007).

[201] *See* Coddington, *supra* note __.

[202] *Id.* at 6.

[203] *Id.* at 5-6.

[204] *Id.* at 7-8. For a discussion of the impact of classifying CO_2 as a "commodity" for purposes of CERCLA and RCRA coverage, see *supra* note __ and accompanying text.

B. Liability and Federal Preemption

All of the federal and state CCS legislation introduced and enacted to date recognizes the significance of existing liability standards that may underlie the creation of new natural resource technologies like CCS to address climate change. CCS will be a significant public/private partnership involving major corporate interests and the federal and state governments, and has massive start-up costs. Under those circumstances, policymakers are rightly attempting to do significant work in advance to allocate rights and determine who will be responsible for liabilities associated with CCS projects and the long-term storage of CO_2. Nevertheless, there are problems with the efforts of Illinois, Texas and their respective lawmakers to provide extremely broad indemnity provisions for liability associated with the long-term storage of CO_2 with regard to incentives for safe site selection as well as compensation for harm. As new projects emerge, one hopes to see a fuller discussion of the risks of CCS and how those risks should be allocated and managed. Releasing the private sector partners from as much liability as possible may not be the only answer.

Moreover, establishing a liability framework does not end with Congressional or agency action enacting statutes and rules on CCS and CO_2 storage. Deployment of the first dozen projects will provide a real-world experience to identify and manage risks, and to develop a risk-based approach to both liability and funding for potential harm. As discussed in Part V, such an approach should ultimately take into account the stage of CO_2 storage (more risk during the injection and closure period than in post-closure period means more operator contribution to pooled funding) as well as the location of CO_2 storage (i.e., storage in reservoirs with less integrity should be required to meet higher standards and contribute more to pooled funding). During the initial creation of the regulatory and liability framework, however, when all eyes focus on the new standards, it is important not to lose sight of the role tort and property law can continue to play, not only as the historic basis of regulation but as a continuing vehicle for creating and applying legal doctrine and creating a set of incentives for CCS site selection and management. Ultimately, state tort and property law can be used to help enforce and complement overarching regulatory, liability, and compensation frameworks that can be created at the federal level.

At the present time, the trend appears to be otherwise. In recent years, industry and federal agencies have relied heavily on the existence of federal standards in the health and safety area to argue to courts that state tort claims to recover for harm arising from actions covered by the legislation are preempted.[205] The Supreme Court has been active in this area, having decided several cases in the last few years involving preemption of state public health, environmental, and safety matters,[206] and is

[205] *See, e.g.*, Catherine M. Sharkey, *Preemption by Preamble: Federal Agencies and the Federalization of Tort Law*, 56 DEPAUL L. REV. 227 (2007) (describing recent efforts by federal public health and safety agencies such as the U.S. Food and Drug Administration, the National Highway Transportation Safety Board, and the Consumer Product Safety Commission to achieve preemption of state regulations and common law claims for relief through the use of amicus briefs and statements in federal regulations).
[206] *See, e.g.*, Bates v. Dow Agrosciences, 544 U.S. 431 (2005) (holding that the federal pesticide law does not preempt all state law claims for damages resulting from pesticide use); Buckman Company v.

considering several more such cases during its 2008 term.[207] In each of these cases, the issue is always one of Congressional intent (i.e., did Congress intend to preempt state law) but in many statutes Congress is silent and even when Congress does include an express preemption clause or an express savings clause (expressing an intent to preserve state law), the scope of such clauses remains subject to significant debate.

Arguments over whether existing federal legislation preempts liability under state law are based on principles of constitutional law,[208] federalism, statutory interpretation, and, in some cases, the level of deference to agency positions arguing in favor of preemption.[209] In the case of CCS, however, Congress will likely consider and perhaps adopt broad federal legislation to govern many aspects of the CCS process in addition to whatever legislation is enacted at the state level. If and when Congress considers such legislation, there undoubtedly will be arguments by industry, and perhaps federal agencies, that any such legislation should preempt state tort remedies in order to provide more settled-expectations to industry and avoid multiple liability standards.

Plaintiffs' Legal Committee, 531 U.S. 341 (2001) (holding that plaintiff injured by medical device could not bring a "fraud-on-the FDA" claim against drug manufacturer consultant because the FDA's regulatory framework for policing fraud preempted attempts to have a state court jury determine such fraud); Sprietsma v. Mercury Marine, 537 U.S. 51 (2002) (holding that Federal Boat Safety Act did not expressly or impliedly preempt common law claims for damages against boat manufacturer for failure to equip boat engine with propeller guard); Geier v. American Honda Motor Co., 529 U.S. 861 (2000) (holding Department of Transportation safety standard enacted pursuant to federal Motor Vehicle Safety Act preempted common law claim for design defect associated with choice of safety restraints); Medtronic v. Lohr, 518 U.S. 470 (1996) (holding that the Medical Device Amendments to the Food, Drug and Cosmetic Act do not preempt state law claims for damages against manufacturer of product that was approved through the Section 510(k) streamlined approval process); Hillsborough v. Auto. Med. Labs., 471 U.S. 707 (1985) (FDA regulations establishing minimum standards for the collection of blood plasma did not preempt a county's local ordinance governing blood plasma centers). *See also* Alexandra B. Klass, *State Innovation and Preemption: Lessons from Environmental Law*, __ LOY. L.A. L. REV. __ (forthcoming 2008) (surveying preemption cases involving public health, safety, and environmental statutes and citing articles discussing recent trends in the law).

[207] *See* Reigel v. Medtronic, __ S. Ct. __ (U.S. Feb. 20, 2008) (holding that common law tort claims concerning a medical device that has undergone "pre-market approval" under the 1976 Medical Device Act Amendments to the Food, Drug, and Cosmetic Act are state "requirements" that violate the Act's express preemption clause prohibiting state requirements "different from, or in addition to" federal requirements relating to the safety or effectiveness of the device); Desanio v. Warner-Lambert & Co., 467 F.3d 85 (2d Cir. 2007) (involving preemption of state law claims against prescription drug manufacturer), *cert granted sub. nom*., Warner-Lambert v. Kent, 128 S. Ct. 31 (Sept. 25, 2007); Altria Group v. Good, __ S. Ct. __, 2008 WL 161478 (U.S. Jan. 18, 2008) (involving preemption of claims under state deceptive trade practices law against cigarette manufacturer); Wyeth v. Levine, __ S. Ct. __, 2008 WL 161474 (U.S. Jan. 18, 2008) (involving preemption of state law product liability claims against prescription drug manufacturer).

[208] The doctrine of federal preemption is based in the Supremacy Clause of the U.S. Constitution which states that "This Constitution, and the laws of the United States which be made in pursuance thereof; . . . shall be the supreme law of the land; and the judges in every state shall be bound thereby, anything in the Constitution or laws of any States to the contrary notwithstanding."). U.S. CONST. art. VI, cl. 2. *See also* Gibbons v. Ogden, 9 Wheat 1, 211 (1824) (Marshall, C.J.) (holding that the Supremacy Clause invalidates state laws that "interfere with or are contrary to" federal law).

[209] *See* Catherine M. Sharkey, *Products Liability Preemption: An Institutional Approach*, 76 GEO. WASH. L. REV. (forthcoming 2008) (discussing how much deference courts should give federal agency pronouncements on the scope of federal preemption of state law).

We caution against such an approach, as Congress has generally not acted to preempt state law in enacting environmental health and safety legislation, even when that legislation is intended to cover nationwide issues such as the nuclear energy industry, or the regulation of air pollution, water, or waste.[210] Even though CCS is new and will require significant federal, state, and private resources to become viable, as the technology matures, it can look to existing and future liability and funding frameworks to create a reasonable certainty of investment without compromising public health, safety, and environmental protection. Such frameworks can be structured to enhance incentives for proper site selection and management for CCS projects. Ensuring that existing liability frameworks are in place for CCS is particularly important at a time when federal agencies often do not have the resources to enforce their own regulations, creating an enforcement vacuum that had historically been filled by state tort law.[211]

Indeed, in 2005, in *Bates v. Dow Agrosciences*,[212] the Supreme Court rejected the argument that the federal pesticide law preempted a broad range of state claims seeking damages for crop damage due to pesticides based not only on the law's preemption language but also on the important role tort law plays in society. The Court recognized that state tort law serves an important role in aiding the exposure of new dangers associated with pesticides, and giving manufacturers "added dynamic incentives to continue to keep abreast of all possible injuries stemming from use of their product so as to forestall such actions through product improvement."[213] The same holds true for the development of CCS. Despite the best efforts of corporate partners and government regulators to ensure the safety of the long-term storage of CO_2, there remains a risk of harm. Project developers will have added incentive to minimize that risk to the public and to the environment if they are aware that private parties who may be harmed have recourse through the environmental and tort liability system rather than solely being accountable to government regulators.[214]

In sum, the development of CCS presents critical concerns of ownership, allocation, and liability in the context of developing a cutting-edge technology with the potential to counteract climate change but that also involves some risk to human health and the environment. The answer to these issues is not to eliminate existing liability frameworks. Instead, it is to provide incentives for good site selection, encourage responsible project management, and recognize and preserve the rights of those who may

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[210] *See, e.g.*, Silkwood v. Kerr-McGee Corp., 464 U.S. 238 (1984) (holding that award of punitive damages under state law for exposure to nuclear materials is not preempted by the Atomic Energy Act); PERCIVAL, *supra* note 84, at 104 ("Preemption of state law has been employed sparingly in the federal environmental laws" and is generally reserved for regulation of products that are distributed nationally); Klass, *supra* note 127, at 570 ("[T]he broad savings clauses in most federal statutes have left ample room for state common law to be a major player in environmental-protection efforts.").
[211] *See supra* notes 75-76 and accompanying text.
[212] 544 U.S. 431 (2005).
[213] Bates v. Dow Agrosciences, 544 U.S. 431, 451 (2005). *But see* Reigel v. Medtronic, __ S. Ct. __ (U.S. Feb. 20, 2008) (finding common law tort claims preempted by express preemption clause of Medical Device Act and focusing on negative rather than positive aspects of common law tort claims).
[214] *See, e.g.*, Axline, *supra* note __ (discussing limitations of statutory law and benefits of common law in optimizing the protection of human health and the environment).

be harmed by CCS projects while at the same time create a market for insurance and other risk-pooling opportunities to allow predictability for stakeholders. Possible approaches to this issue are discussed in Parts IV and V.

IV. MECHANISMS FOR ENSURING FINANCIAL RESPONSIBILITY AND MANAGING LIABILITIES

The previous Parts of this Article make the case for retaining in some form the existing liability protections environmental statutes and the common law provide, at least until they are replaced by CCS-specific substitutes. We recognize, however, that the start-up costs and long-term investment associated with CCS may require tailored solutions to minimize and manage risk. In this Part, we explore different federal, state, and private-sector mechanisms for ensuring financial responsibility and managing potential liabilities. Specifically, we explore bonding, insurance, damage caps, and federal funds which exist for other environmental and complex large-scale technologies and consider their potential effectiveness for CCS. We conclude that these potential solutions in combination hold promise for CCS development and provide a response to arguments that liability under environmental statutes and common law should be preempted or otherwise limited across the board.

A. General considerations

Provisions for financial responsibility and liability during post-closure care and long-term stewardship of CCS projects must balance the global and local risks of CCS with the climate benefits of CCS deployment. If long-term stewardship and liability considerations are too onerous, firms may choose not to invest in CCS; if they are too lax, public and ecological health could be compromised and public confidence in CCS may suffer. As the time-line for CCS projects (hundreds of years to thousands of years) is incongruous with the lifetime of a private entity, legislators and regulators must develop institutional structures to fund and manage CCS risks over the long term. Such structures will likely be temporally segmented, with responsibility passing from private firms to public management for long-term stewardship.[215] Ensuring adequate funds are available during the post-closure and long-term stewardship phases could follow several different formulae,[216] but any approach must guarantee resources are available to cover public monitoring and potential remediation costs and avoid CCS projects becoming an unfunded public mandate.

For CCS, augmenting statutory and common law liability within such a tailored regulatory structure is a crucial component of risk management. Shortcomings of relying solely upon general statutory and common law liability are: (1) the ability to detect and

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[215] *See infra* Part V for a discussion of the potentially different stages of operator liability during the CCS life-cycle.

[216] *See* IOGCC, *supra* note __, at 11; Christina Ulardich, *Environmental Impairment Liability Insurance for Geological Carbon Sequestration Projects*, *in* INTERNATIONAL RISK GOVERNANCE COUNCIL WORKSHOP ON REGULATION FOR CCS (March 2007), *available at* http://www.irgc.org/IMG/pdf/IRGC_CCS_SwissRe07.pdf.

assign blame for harm;[217] (2) the potential lack of necessary resources for firms injecting CO_2 to address potential harms; and (3) the time horizon between cause (injection of CO_2) and effect of any damages.[218] As a result of these shortcomings, we turn to different approaches that can both supplement liability frameworks and also provide a compensation mechanism in cases where liability is imposed.[219]

B. Bonding

As a financial assurance mechanism, bonding may be a tool to address post-closure risk management for CCS projects.[220] Bonding has been widely used to enforce contracts and regulatory provisions in a number of different settings, including environmental management purposes such as requiring bonds for municipal landfills, transport of hazardous waste, underground injection and disposal, and others. Bonding allows for the internalization of future damages by requiring an up-front commitment to offset the costs of potential future pollution—often in the form of cash, a letter of credit, a surety bond, or a trust fund or escrow account. The bond is posted up front, but if the firm does not comply, the bond is forfeited and funds are immediately available for remediation efforts. Additionally, the bond shifts the burden of proof from the regulator to the operator and provides public protection up to the amount posted (but not necessarily the amount of the damages).[221] While bonding is promising in environmental settings,[222] there are limits to its use,[223] as explained below, and success has been mixed.[224]

The problems associated with bonding are well-documented.[225] Bonding is costly in terms of imposing liquidity constraints on firms and transaction costs, and becomes more costly as complexity increases. A problem for both liability rules and bonding is the potentially long lag time between the operators' activity (injection of CO_2) and the potential harm (leakage to the surface or resource damage). Also, over long time

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[217] This could be especially important given the multiple effects of CO_2 in the subsurface, latency between injection and harm, and challenges in proving a causal link between CO_2 injection and harm. Current monitoring methodologies are limited in scope with only a few states requiring any post-closure site monitoring. This could be especially important if many actors are injecting CO_2 in one basin. *See generally* David W. Keith et al., *Regulating the Underground Injection of CO_2*, ENVIRONMENTAL SCIENCE AND TECHNOLOGY 39(24): 499A-505A (2005).

[218] *See* David Gerard & Elizabeth J. Wilson, *Environmental Bonds and the Challenge of Long-Term Carbon Sequestration*, __, J. ENVTL. MGMT. __ (forthcoming 2008); Steven Shavell, *Liability for Harm Versus Regulation of Safety* 13 J. LEGAL STUDIES 357-74 (1984); A. H. Ringleb & S.N. Wiggins, *Liability and Large Scale, Long Term Hazards*, 98 J. POL. ECON. 574-95 (1990).

[219] *See* de Figueiredo, *supra* note __, at 67.

[220] Gerard & Wilson, *supra* note __.

[221] *Id.*

[222] *See generally* Robert Costanza & Charles Perrings, *A Flexible Assurance Bonding System for Environmental Management*, 2 ECOLOGICAL ECONOMICS 57-75 (1990).

[223] *See generally* Jason F. Shogren, et al., *Limits to Environmental Bonds*, 8 ECOLOGICAL ECONOMICS 109-133 (1993).

[224] *See* James Boyd, *Financial Responsibility for Environmental Obligations: Are Bonding and Assurance Rules Fulfilling Their Promise?*, RESEARCH DISCUSSION PAPER RFF-DP-41-02, RESOURCES FOR THE FUTURE (2002), *available at* http://www/rff.org/documents/RFF-DP-01-42.pdf.

[225] *See* Boyd, *supra* note __; Shogren, et al., *supra* note __.

horizons, the responsible firm may go out of business, or surety providers are unlikely to underwrite bonds with such uncertainties. Thus, for bonding to be effectively utilized within CCS projects regulators must explicitly define periods of responsibility. Setting the bond amount—balancing costs to the firm and potential public liabilities—is often contentious.[226] Knowing the potential cost of remediation is also essential for setting the bond amount, although firms with extensive resources are likely to comply with cleanup requirements, even if they are higher than the posted bond amount, due in part to reputational effects limiting opportunistic behavior.[227] With experience, establishing the bond amount becomes easier making bonding more applicable in a mature CCS industry. Below we examine the use of bonds for mine site reclamation and to ensure proper closure of underground injection wells. In both contexts, bond use is well-established and experience highlights both the benefits and potential pitfalls of bonds.

For mining, regulations often require post-mining site reclamation. The operator posts a bond to satisfy this condition and if there is insufficient compliance, the firm must forfeit the bond and bond proceeds are used to finance reclamation. Under the Surface Mining Control and Reclamation Act of 1977 bonding is compulsory for coal mining projects. It is also often required for hardrock mining projects on federal lands under Department of Interior (Bureau of Land Management) or Department of Agriculture (Forest Service) regulations. In most cases, states have primacy in regulating hardrock mining activities, and state agencies require some form of environmental assurance, typically a reclamation bond.[228] In the case of hardrock mining, the bond premium is often one to five percent of the face value of the bond. While large firms can secure a surety by posting less than one percent, small firms may face premiums of 15 to 20 percent or higher.[229]

Bonding is also used in underground injection. All injection wells regulated under the U.S. Environmental Protection Agency's Underground Injection Control (UIC) Program and most state regulated oil and gas production wells require bonding to help ensure proper site closure. In the UIC program, an operator must submit a well closure and abandonment plan that identifies steps for closing the well (plugs, cement, cost) and any subsequent post closure monitoring activity.[230] While a performance bond is required to ensure proper plugging and abandonment, in the vast majority of cases no long-term monitoring is required and the bond is released upon well closure. For UIC wells, the bond is released after the operator has satisfied plugging and abandonment procedures established by the regulator.[231] Bond amounts are established by the states,

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[226] Gerard & Wilson, *supra* note __.
[227] *See generally* David Gerard, *The Law and Economics of Reclamation Bonds*, 26 RESOURCES POLICY 189-197 (2000).
[228] *Id.*
[229] Gerard & Wilson, *supra* note __.
[230] *See* 40 C.F.R. §§ 144-146.
[231] *Id.*

and differ significantly across jurisdictions.[232] Criticisms that the bond amount is significantly less than the cost of plugging and remediation abound.[233]

For bonding to be effectively used for long-term stewardship in a CCS project, several conditions would need to be met: (1) the time frame that the bond would cover must be clearly established; (2) the party responsible for damages must be identified; and (3) cost estimates—for monitoring, verification and remediation costs for damage—are needed to set the bond amount. Bonding could be effective when data to estimate CCS project risks is available, potentially in a mature CCS industry. The utility of bonding for CCS is inexorably linked to future regulatory requirements. Key decisions that will determine the role of bonding are linked to the operator's duration of responsibility and scope of responsibility for long-term CCS site care. If, like current UIC injection wells, operator responsibility ends with plugging and closure, bonding will be of limited use in the CCS post-closure period. Bonding, however, could play a role if operator responsibility extends beyond active injection and covers a performance-based post-closure care period. For maximum effectiveness, bonding amounts should be set to reflect differences in site-specific risk and operator performance data. For example, the future CCS bond amount could be linked to the site environmental impact statement, operational performance data (like CO_2 plume stabilization) and the site monitoring plan, as well as potential human or ecological health risks, thus using bonding to support a framework of site-risk management. Bonding works well for short time-frames, but over the 15 to 30 years required for post-closure financial responsibility, bonding could tie up capital and prove less efficient than insurance-based instruments.

C. Insurance

The use of insurance to manage environmental risk, be it operational or catastrophic, is well developed.[234] Both RCRA and CERCLA use pollution liability insurance as a tool to control environmental pollution.[235] Insurance serves to allocate risk through classifying the risk and pricing it, the use of policy exclusions and deductibles, and through the creation of "surrogate regulation," where inspection, risk assessment, and risk management act as a *de facto* impetus towards better management.[236] Conventional private insurance rules of insurability include: (1) a sufficient number of similar and uncorrelated events to allow for risk pooling; (2) clearly calculable losses; (3) loss occurring within a well established time period; (4) frequent enough losses to calculate premiums; and (5) insured party has no incentive to cause loss.[237] CCS might violate several of these conditions: (1), (2), and (4) given both the lack of

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[232] Gerard & Wilson, *supra* note __.
[233] Mark Fesmire, New Mexico Oil Conservation Commission, June 14, 2008 (personal communication with author).
[234] *See* Dan R. Anderson, *Limits on Liability: The Price Anderson Act versus Other Laws*, 45 J. OF RISK AND INSURANCE 651-674 (1978); Martin T. Katzman, *Pollution Liability Insurance and Catastrophic Environmental Risk*, 55 J. OF RISK AND INSURANCE, 75-100 (1988).
[235] Katzman, *supra* note __, at 82, 94.
[236] *See* Kenneth S. Abraham, *Environmental Liability and the Limits of Insurance*, 88 COLUM. L. REV. 942, 949 (1988).
[237] *Id.* at 83.

experience with large-scale CCS and inherent geologic heterogeneity; and (3) given the long time frame for CCS storage. That said, in a recent meeting held by the International Risk Governance Council, representatives from the insurance community stated that they had experience managing all of the environmental risks associated with CCS under their environmental impairment liability coverage, with the exception of climate risk associated with the re-release of CO_2 to the atmosphere.[238]

The development of environmental impairment liability (EIL) addresses many of these factors by considering specific site-by-site policy coverage (unlike Comprehensive General Liability—which is general), and is a relatively recent insurance product, emerging in the London market in the early 1980s.[239] Each site must be independently evaluated for risk. EIL policies are claims-made and 'backward looking'—i.e. they pay claims made on environmental damages that occurred in the past. Such policies are used for both sudden and gradual pollutant events, natural resource damage, RCRA, CERCLA, loss of business, defense of liability, and other types of claims.[240]

Some argue the role of government, both as insurer and risk manager can have some important effects both for correcting private market failures and also establishing operational requirements that limit risk, which, in turn limit liability.[241] The relationship between tort law and EIL has been challenging, as insurance requires some predictability of the tort process, undermined by the large damage awards from hazardous chemical exposure and cleanup, and complex industrial site pollution.[242] Managing legal risk is a key component for insurance to be a useful tool for post-closure CCS. Harmonizing liability and tort law could make the environment more predictable for insurance in CCS.

Insurance could provide a key tool for financial assurance during the post-site closure phase, where the operator is actively involved in monitoring, verification, and potential remediation, and still bears responsibility—and liability—for any potential damages. EIL has experience with all risks posed by a CCS project—with the exception of climate-related risks—and is tailored to site-specific risks, which is important for linking geologic variability within a risk management framework. Thus, EIL emerges as a potentially flexible and appropriate mechanism for ensuring adequate financial responsibility for CCS.[243]

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[238] *See* INTERNATIONAL RISK GOVERNANCE COUNCIL, WORKSHOP REPORT ON REGULATION OF CARBON CAPTURE AND STORAGE 19 (March 15-16, 2007), *available at* http://www.irgc.org/IMG/pdf/Workshop_Report_Regulation_of_Carbon_Capture_and_Storage_March_15_and_16_2007_Washington_final.pdf.
[239] *Id.* at 88.
[240] *See* Katzman, *supra* note __, at 76-77.
[241] *See* de Figuieredo *supra* note __, at 66.
[242] Katzman, *supra* note __, at 89.
[243] Another possibility available to larger firms would be self-insurance, where the firm has a deep enough asset base to cover their risks.

D. Federal Compensation Systems Coupled with Damage Caps

One way to provide more certainty to industry while ensuring some compensation for harm is to create an alternative to the tort process in the form of a pooled federal fund to pay claims, displacing (or preempting) tort law, and setting caps on damages available from the fund. Congress has created these types of specialized funds to displace the standard tort process for certain types of workplace injuries,[244] the federal childhood vaccine program,[245] and nuclear power plants.[246] State workers' compensation statutes apply many of these same principles to workplace injuries on a state-by-state basis.[247] In essence these provisions "provide a political compromise between providing compensation for victims and limiting the financial impact on potentially liable parties."[248] Proponents of selective damage caps on liability argue that they are necessary to manage uncertain risks, protect industry from large jury awards and unnecessary lawsuits and provide a climate for private investment while still providing some compensation for injured parties.[249] Opponents contend liability caps unjustly limit the public's ability to recover full compensation from damages, provide an unfair subsidy to industry, and are fundamentally unjust.[250] Here, we discuss the use of liability limits in the Price-Anderson Act applicable to the nuclear industry. We ultimately conclude that damage caps would not be appropriate for CCS as a general matter, but may be appropriate in early years to encourage pilot projects and initial investment, or to limit long-term risk in the final stage of CO_2 sequestration.

While the nature of risks from CCS and nuclear power are fundamentally different in nature, the Price-Anderson Act is instructive because it developed a mechanism to stimulate investment in civilian nuclear power by blending different risk

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[244] *See, e.g.*, Longshore and Harbor Worker's Compensation Act, 33 U.S.C. §§ 901-944 (providing fixed awards to employees or their dependents in case of employment-related injuries or deaths occurring on navigable waters).

[245] National Childhood Vaccine Injury Act of 1986, 42 U.S.C. §§ 300a-1 to 300aa-34 (creating no-fault compensation program for childhood vaccine-injury victims funded by an excise tax on each dose of vaccine). *See also* Robert Rabin, *The Renaissance of Accident Law Plans Revisited*, 64 MD. L. REV. 698, 706-07 (2005) (discussing federal childhood-vaccine injury program).

[246] *See* Price-Anderson Act, 42 U.S.C. § 2210; Duke Power v. Carolina Envtl. Study Group, 438 U.S. 59 (1978) (discussing Price-Anderson Act).

[247] *See generally*, SCHWARTZ ET AL., PROSSER, WADE & SCHWARTZ'S TORTS 1191-95 (11th ed. 2005) (discussing general features of state workers' compensation laws as providing employees automatic entitlement to certain benefits when she suffers workplace injuries, the irrelevance of fault, a set of cash and medical benefits, waiver of the right to sue the employer in tort, administration of claims by a state commission, and a requirement that the employer secure private insurance, state-funded insurance or self-insurance; FRANKLIN ET AL., TORT LAW AND ALTERNATIVES 816-29 (8th ed. 2006) (discussing generally state workers' compensation laws).

[248] *See* Dan M. Berkovitz, *Price-Anderson Act: Model Compensation Legislation?—The Sixty-three Million Dollar Question*, 13 HARV. ENVTL. L. REV 1, 2 (1989).

[249] *Id.* at 58; AMERICAN NUCLEAR SOCIETY, THE PRICE ANDERSON ACT: BACKGROUND INFORMATION (2005), *available at* http://www.ans.org/pi/ps/docs/ps54-bi.pdf.

[250] *See* Anderson, *supra* note __, at 652; Berkovitz, *supra* note __, at 48 ("Justice dictates that either the persons responsible for an accident or the beneficiaries of the activities creating the risk of the accident should bear he costs of damages resulting from the accident."); Daniel W. Meek, *Nuclear Power and the Price-Anderson Act: Promotion over Public Protection,* 30 STAN. L. REV. 393 (1978).

management instruments into a coordinated framework of coverage.[251] First passed by Congress in 1957 (and recently renewed in 2005), the Price-Anderson Act was envisioned as a temporary provision to stimulate and support the development of civilian nuclear energy by creating funding while at the same time limiting tort liability for nuclear accidents.[252] The Act's original purpose was to limit financial uncertainty arising from nuclear accidents by placing a cap on liability and guaranteeing that citizens could be compensated for damages to person and property.[253] Criticized by opponents as a subsidy to the nuclear industry, Price-Anderson began by limiting liability from potential "extraordinary nuclear occurrences"[254] and creating a tiered structure of financial responsibility combining private insurance, an industry pooled fund, and a cap on total liability. Each nuclear reactor over 10 megawatts is required to have $300 million per plant in insurance.[255] Any additional claims are paid from an industry-funded pool—the Price-Anderson Fund—with each company contributing up to $95.8 million if an accident occurs.[256]

In the event of an accident, companies are required to pay $15 million annually until the claim is met or the maximum reached and now, with 103 operating nuclear power plants, the fund contains approximately $10 billion.[257] Any claims beyond this amount would be covered by funds raised by the Nuclear Regulatory Commission (NRC) from Congress using public monies.[258] In the event of an accident with damages surpassing the total, the NRC would prepare a report for Congress and the courts estimating the damages.[259] The Act indemnifies licensees from any amount over the liability cap[260] and, since amendments in 1988, any nuclear incident—not just extraordinary nuclear occurrences—would fall under the jurisdiction of the federal district courts.[261] Also as part of the 1988 Amendments, however, Congress created a federal cause of action for any action arising from a nuclear incident, divested the state courts of jurisdiction, specifically barred state law claims for punitive damages, and preempted any state law inconsistent with the Act.[262] Subsequent appellate courts have

[251] *See* 10 C.F.R. § 140.
[252] Anderson, *supra* note __, at 651.
[253] *See* U.S. GENERAL ACCOUNTING OFFICE ("GAO"), NUCLEAR REGULATION: NRC'S LIABILITY INSURANCE REQUIREMENTS FOR NUCLEAR POWER PLANTS OWNED BY LIMITED LIABILITY COMPANIES 4-6 (2004), *available at* http://www.gao.gov/new.items/d04654.pdf.; FRANKLIN ET AL., *supra* note __, at 870 (stating that the Act's express intent "was to encourage investment in nuclear energy research and operations by a private sector daunted by the prospect of multimillion-dollar claims.").
[254] *See* 10 C.F.R. §140.83.
[255] *See* 10 C.F.R. § 140.11 (specifying the amounts of protection required).
[256] *See* GAO, *supra* note __, at 4-6.
[257] *Id.* at 4-5.
[258] *Id.*
[259] *Id.*
[260] *See* 42 U.S.C. § 2210(c) (setting forth indemnification provisions).
[261] *See* 42 U.S.C. § 2210(n)(2).
[262] *See* 1988 Amendment to Price-Anderson Act, 42 U.S.C. § 2210(s) (providing that no court may award punitive damages in any nuclear incident covered by the Act); 42 U.S.C. § 2014(hh) (stating that the substantive rules for decision in public liability actions shall be derived from state law unless state law is inconsistent with the Act).

barred other state law claims, reasoning that they are inconsistent with the federal claims standards set forth in the 1988 Amendments.[263]

To date, the Price-Anderson fund has paid out a total of $202 million (with $70 million associated with the 1979 Three Mile Island incident).[264] For proponents, the Act has been key for nuclear industry development and obligated the nuclear plant operators and the industry to hold a higher level of liability insurance coverage than might otherwise be the case, and may, in the event of a large-scale accident end up being cost effective for both the industry and the government.[265] For critics, the Act serves as a public subsidy to the nuclear industry and ends up limiting the ability of affected parties to recover adequate damages.[266]

For CCS projects, the interplay between encouraging technology deployment, protecting human health and the environment, and balancing the role of state and federal law played out under the Price-Anderson Act provides several points for discussion. First, unlike nuclear activities, the potential of a catastrophic accident from CCS projects is low—CCS risks are generally understood and likely manageable.[267] Nevertheless, if liability is still an ongoing concern the blending of site-specific insurance and pooled industry funds could provide both site-tailored risk management and ensure that adequate funds are available to cover damage in the post-closure period. The tiered structure of site and industry responsibility would allow for funds to be available during the post-closure period, and some amount of risk-sharing over different projects. By pooling funds at the national—as opposed to state—level, the pool would also help to spread risk of leakage and damage across different geological formations. Say, for instance, that injection projects in Washington basalts proved particularly leaky. If the fund pool were held at the state level, the fund could be quickly drained of resources, as projects injecting into the same geologic formation may have correlated risk profiles. If not done carefully, however, a pooled risk management structure could present a moral hazard and weaken operator incentives for good-site selection and safe operation.

Second, the tension between state law and federal preemption is a constant theme in cases involving the Price-Anderson Act.[268] For CCS, where potential damages occur

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[263] *See* O'Connor v. Commonwealth Edison Co., 13 F.3d 1090 (7th Cir. 1994) (discussing 1988 Amendments to Price-Anderson Act and finding federal preemption of state standards of care); Nieman v. NLO, Inc. 108 F.3d 1546, 1551 & n.5 (discussing impact of 1988 Amendments on state punitive damages claims and *Silkwood* decision); In re TMI Litig. Cases ("TMI II"), 940 F.2d 832, 854 (3rd Cir. 1991) (holding Price-Anderson Act preempts state law tort claims that are not consistent with federal law). *But see* Cook v. Rockwell Int'l, 273 F. Supp. 2d 1175 (D. Colo. 2003) (holding that federal nuclear safety regulations did not preempt state standards of care in public liability actions); In re Hanford Nuclear Reserv. Litig., 350 F. Supp. 2d 871 (holding that the Act does not require that federal safety standards establish the standard of care and preempt state tort remedies, including state law claims for strict liability).

[264] GAO, *supra* note __, at 5; JOHN DEUTCH ET AL., MIT STUDY ON THE FUTURE OF NUCLEAR POWER 82 (2003).

[265] DEUTCH ET AL., *supra* note __, at 81-83.

[266] *See generally* Berkovitz, *supra* note __; Meek, *supra* note __.

[267] *See supra* Part I.C. Injected CO_2 will be isolated within a rock matrix, trapped by an impermeable sedimentary rock layer.

[268] *See supra* Part III.B.

in domains with strong state laws governing groundwater protection, mineral rights, or surface rights, it is easy to imagine the potential tension between state interests and Congress. As CCS projects are likely to be large and given that water and mineral resources are fundamental to other state interests (agriculture, urban development, industry, tax revenues, and others), CCS operators will lobby strongly in Congress (and later in the courts) that federal law should preempt state law claims for damages and perhaps federal environmental laws. For the reasons stated in Part III, the existing state and federal liability framework provides important safeguards for potential harm associated with CCS. Thus, federal legislation should include clear language to preserve state and federal bases for liability and instead focus on limiting operator liability by utilizing pooled funding, bonding, insurance and other methods of assuring solvency in case of claims.

Finally, while the use of a liability cap (such as that in the Price-Anderson Act) provides predictability for firms, it may also undermine the credibility of CCS in the eyes of the public. When CCS-proponents expound on the safety of the technology while simultaneously lobbying for a damage cap, this contradictory position undermines CCS credibility. Significantly, Price-Anderson was originally conceived as a *temporary* aid to overcome uncertainty, not a permanent subsidy to the industry. This precedent cautions against absolute damage caps for CCS claims that do not provide a resort to tort law or statutory environmental law outside available federal funding.

E. Federal Compensation Systems Coupled with Tort Law

Another way of structuring liability and funding is to create a specialized fund for certain types of harm to allow prompt payment of claims but retain the ability of claimants to seek damages beyond funding limits from responsible parties through the tort system. An example of such a system is the Trans-Alaska Pipeline Liability Fund ("TAPL Fund"), now part of the funding available under the Oil Pollution Act ("OPA"). This system provides an important analog for CCS for at least two reasons. First, the OPA reconciles existing regulatory standards and incorporates approaches to liability and risk management depending on the location of the damage. Second, it creates a significant fund for quick payout of claims in case of harm but allows claimants to seek damages in excess of the fund's maximum from liable parties under state or federal tort law. These features make the liability structure for claims associated with the Trans-Alaska Pipeline (and now oil spills in general) particularly relevant for CCS.

Passing the Trans-Alaska Pipeline Authorization Act of 1973 ("TAPAA")[269] involved compromise—reconciling the interests of environmentalists, native Alaskans, and business—and, importantly carried significant provisions which impose liability for oil spills on land and water.[270] Owners of oil paid a 5-cent per barrel charge on oil traveling through the Trans-Alaska Pipeline to finance the Trans-Alaska Pipeline Liability Fund ("TAPL Fund").[271] Under TAPAA, if the incident occurred on water,

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[269] *See* Pub.L. 93-153, Title II, §§ 201 to 206, Nov. 16, 1973, 87 Stat. 584; 61 AM. JUR. 2d *Pipelines* § 8.
[270] Anderson *supra* note __, at 660; *see also* 43 U.S.C. § 1653(c).
[271] 43 U.S.C. § 1653(c)(5).

claimants could recover under strict liability up to $100 million per incident, with the operator paying the first $14 million and the TAPL Fund paying the rest, ensuring rapid payment of claims.[272] Significantly, claimants could seek any remaining amounts not covered by the TAPL Fund from the ship operators under other sources of federal or state law.[273] If negligence or unseaworthiness of the vessel caused the spill, the TAPL Fund obtained subrogation rights associated with payment of the claims and was entitled to seek recovery of the payments from those legally responsible for the spill.[274] After the 1989 Exxon Valdez oil spill the Fund paid out $23 million to Native Corporations and many millions of dollars to other injured parties, and Exxon ultimately reimbursed the TAPL Fund for those amounts.[275]

In 1990, as result of the Exxon Valdez spill, Congress enacted significant amendments to the OPA and brought the TAPL Fund within the jurisdiction of the Act for spills that occurred after 1990.[276] Under the OPA, claimants may recover compensation for damages from the Oil Spill Liability Trust Fund ("OSTLF") on a strict liability basis of up to $1 billion per oil spill incident or the balance in the OSTLF.[277] Under the OPA, the responsible party is liable for payment of damages up to a certain amount based on the size of the vessel, up to a maximum of $350 million per spill at onshore facilities and deepwater ports, and up to $75 million at offshore facilities, plus removal costs.[278] Claimants can seek a wide range of damages under the OSTLF including removal costs, natural resource damages, damage to real or personal property, other economic losses, lost profits, and loss of subsistence use.[279] Between 1995 and 2004, the OSTLF paid out $492.3 million associated with removal costs and claims and recovered $130.6 million from responsible parties.[280] Significantly, the OPA, like TAPAA, includes a strong savings clause which provides that nothing in the OPA should be construed as preempting the authority of any state or political subdivision from imposing additional liability or in any way to affect the obligations or liabilities of any person under RCRA or state law, including common law.[281] As a result, potential claimants can obtain compensation from the OSTLF on a strict liability basis but can also

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[272] 43 C.F.R. §§ 29.7-9.
[273] 43 U.S.C. 1653(c)(1)(1990).
[274] *See* 42 U.S.C. § 1653(c)(8); In re Glacier Bay, 944 F.2d 577, 581 (9th Cir. 1991).
[275] *See* Chenega Corp. v. Exxon Corp., 991 P.2d 769, 791-92 (Ala. 1999).
[276] *See* FRANK P. GRAD, 2 ENVIRONMENTAL LAW § 3.03[i] (2007) (detailing impact of 1990 Oil Pollution Act on TAPAA and TAPL Fund).
[277] *See* 26 U.S.C. § 9509 (amendment to Internal Revenue Code creating OSTL and setting $1 billion per incident limit). *See also* U.S. Coast Guard, Oil Pollution Act of 1990 (discussing funding and noting that the Energy Policy At of 2005 raised the limit of the OSLTF to $2.7 billion), *available at* www.uscg.mil/hq/npfc/About%20Us/opa.htm; U.S. Coast Guard, Oil Pollution Act (OPA) Frequently Asked Questions (stating that Energy Policy Act increased funding for the LSLTF by re-instating the 5-cents-per-barrel tax on imported and domestic oil beginning in April 2006 until the fund reaches $2.7 million. The tax will be discontinued, regardless of fund balance, on December 31, 2014), *available at* http://www.uscg.mil/hq/npfc/About%20Us/opa_faqs.htm#faq3.
[278] *See* 33 U.S.C. § 1004 (setting forth responsible party limits on liability).
[279] *See* 33 U.S.C. § 2702(b). *See also* U.S. DEPARTMENT OF HOMELAND SECURITY, UNITED STATES COAST GUARD, OIL SPILL LIABILITY TRUST FUND (OSTLF) FUNDING FOR OIL SPILLS 7 (Jan. 2006).
[280] U.S. DEPARTMENT OF HOMELAND SECURITY, UNITED STATES COAST GUARD, REPORT ON IMPLEMENTATION OF THE OIL POLLUTION ACT OF 1990 7 (2005).
[281] *See* 33 U.S.C. §§ 2717-2718.

pursue, if they wish, claims for punitive damages or other damages not recoverable under the OPA.

TAPAA and OPA provide a potential model for CCS that includes differentiation of harm based on location (on-shore or off-shore) as well as on a legal and regulatory adaptation to new technology and novel environmental risk. Significantly, the TAPAA and the OPA leave federal and state liability law in place and build a federal compensation scheme on top of it. This allows parties to recover from pooled funds in an expeditious manner and, for those claims not fully covered by the pooled funds, to pursue them in full under federal or state law. As noted above, the plaintiffs in the Exxon Valdez oil spill were allowed to recover quickly against the Fund and then litigate their remaining claims, including the multi-billion dollar punitive damage claim against Exxon that the Supreme Court reviewed under principles of federal maritime law in 2008.[282] A similar compensation regime that does not preempt, or displace, existing federal or state environmental and tort law can serve as a partial model for creating a liability structure for CCS. If such a fund were created for CCS, operators could pay into the fund based initially on tons of CO_2 injected and then, in later years, paying at increased or decreased rates based on a risk-rated ton charge which incorporates site operational data and the risk of leakage after monitoring data has been gathered at the injection site and surrounding areas.[283] These funds would be collected during active site injection, aligning income from injection with long-term care fund collection.

What is unique about CCS, however, is the scale of projects and necessary deployment. A lowered liability cap within a strict liability federal fund for the first dozen or so full-sized CCS projects could help industry to gain the confidence and experience for transition to a full commercial CCS deployment. Such a cap would let first movers manage financial risk of new CCS technologies and serve to more rapidly transition from demonstration projects to commercial deployment. Although claimants could still resort to tort or environmental law to obtain compensation for those claims not covered by the strict liability fund, if the total fund amounts are high enough, and the in-fund liability caps low enough, this may help encourage operator development of initial projects. Care should be taken, however, to ensure such a cap does not become permanent as—in addition to removing normal incentives for responsible operator behavior—it may create a negative public backlash towards CCS which may adversely affect future project siting.

V. Creating a Framework for Managing Liability and Ensuring Long-Term Financial Responsibility for CCS

One of the challenges of managing risk and liability with CCS is the long-term nature of CCS projects. To maximize the climate benefit, CCS projects should store CO_2 underground for hundreds to thousands of years. As the lives of firms are much shorter than the period necessary to ensure public and environmental health protection, a transfer

[282] *See* Exxon Shipping Co. v. Baker, 128 S. Ct. 2605 (2008) (reducing punitive damage award from $2.5 billion to $500,000).
[283] For further discussion of a risk-based, adaptive management approach to funding, see *infra* Part V.

of responsibility from a single firm to a pooled fund held by a private or public entity must occur.

One potential structure would be to adopt a post-closure care program of graduated responsibility which ensures that the CCS project operator is responsible for CCS care for a defined time period after closure. Over the first post-closure phase, the project operator would bear full responsibility for all liability and be required to provide some type of financial assurance. Over the longer-term, stewardship of CCS projects—and funds to ensure remediation—would be transferred to a public or private organization with a pool of resources to ensure public and environmental health are managed over the long term.[284] Bonds, insurance, and selective damage caps (for early pilot projects and the long-term stewardship periods only) could all play a role to ensure CCS risk is managed over the long-term.

Developing a framework to manage CCS project liability requires several conditions to be met: (1) Assign responsibility for damages from a CCS project over a defined time period; (2) Funds must be available for monitoring, remediation, and damage payment throughout the CCS project lifecycle; and (3) The regulatory framework should be adaptive and incorporate site-specific data into CCS risk management. Additionally, regulatory and liability frameworks should be structured to provide incentives for good site selection and operation and an effective monitoring regime. These conditions must be met not only for managing environmental, health, and safety risk but also in order to integrate CCS within a larger climate policy. In the following Sections, we provide more detail on these conditions and propose a potential framework to incorporate adaptive management approaches into a mature CCS industry.

A. Who Is Responsible For CCS Damages and For How Long?

Currently, no party is explicitly tasked with post-closure care of CCS sites, nor is a time period for care yet defined. To use any of the mechanisms specified in Part IV, the regulatory framework must create a defined period of post-closure responsibility and liability which covers monitoring and any necessary remediation activities. For this Article we assume that the CCS life-cycle will follow a pattern of active injection, site closure, post-closure, and long-term stewardship,[285] with monitoring, remediation, and liability responsibility shifting from private to third-party (public or possibly a public-private hybrid) ownership with post-closure to long-term stewardship transition.[286]

Additionally, the regulatory framework must clarify how the transition from private operator to a public entity for long-term stewardship will occur. Many different models are possible. First, there could be a fixed time period of operator responsibility

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[284] Gerard & Wilson, *supra* note __.

[285] *See* Edward S. Rubin et al. *Regulatory and Policy Needs for Geological Sequestration of Carbon Dioxide*, PAPER NO. 156 IN PROCEEDINGS OF THE SIXTH ANNUAL CONFERENCE ON CARBON CAPTURE AND SEQUESTRATION, PITTSBURGH, PA; EXCHANGE MONITOR PUBLICATIONS: PITTSBURGH, 14 (2007).

[286] While for this paper we discuss transfer to a public entity, it is possible that a private or semi-private organization with sovereign durability could play this role as well. *See* Wilson et al., *supra* note __.

(e.g., up to and including 15 or 30 years of post-closure care), at which time project responsibility would be passed to a public entity. This approach, however, might not provide the CCS owner/operator with sufficient incentives for responsible risk management. A better option would be to create a performance-based measure that would initiate the site transfer when, for example, site pressures decrease to a specified threshold and reservoir models accurately predict subsurface CO_2 behavior. We believe that a performance-based measure is preferable as it allows site-specific risk criteria to be incorporated into the decision to transfer responsibility. The advantage of this approach is that it has the potential to provide incentives for good site selection and operation and allows the operator to actively manage long-term liability. Whether the transition metric is time or performance-based, any transition to public responsibility must be accompanied by sufficient funds to cover costs of long-term stewardship. This issue is discussed below.

B. Establishing a System of Financial Responsibility and Assurance over the CCS Life-cycle

Any transition to public responsibility of CCS projects must be accompanied by funds to cover costs of long-term stewardship. In addition to stimulating early CCS demonstration projects through the use of trust funds,[287] several papers[288] have proposed different funding models to ensure resources are available for post-closure and long-term stewardship phases of the CCS life-cycle. The basic model would use normal operational insurance to cover CCS projects during the active injection phase and post-closure phase. Additionally, during the injection phase, a fee would be collected from the owner/operator, based either on a per-ton of CO_2 injected basis or, preferably, a risk-weighted per-ton fee, and pooled to cover costs of long-term stewardship by a public entity. These funds could be held by a public or private entity. This approach has the advantage of synchronizing CCS project income and payment schemes.

We propose development of a three-tiered payment system that covers: (1) the active CO_2 injection phase; (2) the post-closure period; and (3) long-term stewardship. During active CO_2 injection, the CCS project operator holds insurance and site liability and pays into a central fund, as pre-payment for long-term stewardship. This fund pool could be held at the state, geologic basin, or federal level. Having this pool held at a federal level would help to spread risk across different geologic basins. In the second phase, the post-closure period, the operator is still responsible for site monitoring, verification, and necessary remediation, and is fully liable for damages under CCS-specific legislation that is enacted, along with existing federal environmental law, or state common law or statutory law as a backstop. During this phase, bonding or insurance mechanisms could effectively be used to cover monitoring and necessary remediation. These could be held at a project level—again to encourage responsible site operation by the owner/operator, or pooled across different projects if care were taken to manage any

[287] *See generally* Naomi Peña & Edward S. Rubin, *A Trust Fund Approach to Accelerating Deployment of CCS: Options and Considerations*, COAL INITIATIVE REPORTS, WHITE PAPER SERIES, PEW CENTER ON GLOBAL CLIMATE CHANGE (2008).
[288] *See generally* IOGCC, *supra* note __; Ulardic *supra* note __; Peña & Rubin, *supra* note __.

moral hazard. If an industry-funded pool were created, potentially at the basin or federal level, these funds could be used to ensure adequate cover for any damages sustained above individual operator liability caps set within the fund (similar to the OPA).[289] When the CCS site meets pre-determined performance based measures the responsibility for the site then transfers to the third phase. In the third long-term stewardship phase, any necessary monitoring, remediation and damages are funded from the federal pool, financed during the active injection phase by performance-based fees collected from the project owner/operator. This pool could be administered by a public or semi-private entity and would be responsible for ensuring management and data of CCS injection sites is supported and available in perpetuity. The advantage of having this pool financed at the federal, as opposed to state or geologic basin level is two-fold. First, risks of leakage or damage may be correlated with certain geologic formations, and this approach would spread the risk more widely. Second, if this pool were linked to a site-specific damage cap, federal standards would provide a regulatory "floor" for environmental and technical standards. In addition to that floor, however, a comprehensive CCS program would work best if it could also be integrated into existing state regulatory programs, including the state UIC programs,[290] and any other state regulatory standards that provide protection above the federal floor.

C. Creating an Adaptive Regulatory Framework

Because subsurface geology is heterogeneous, the behavior of CO_2 within and between CCS sites—and the resulting risks—will vary substantially. Variation in risk across sites will depend both on CO_2 behavior in the subsurface and surface ecological and human health considerations. It will only be possible to assess geologic site performance (and CO_2 behavior) during and after CO_2 injection. While mapping and modeling of CCS sites will be a major component of siting and permitting, incorporating actual site performance data into CO_2 dispersion models—not currently practiced for underground injection activities—will help operators, regulators, and insurance underwriters predict site performance and manage risk. Such adaptive approaches incorporating actual data into management and subsequent regulation are regularly used in ecosystem management.[291] As experience is gained with early CCS research and development projects, data and methods for more accurate and predictable risk characterization will emerge and inform creation of an adaptive management regime.

To create an adaptive regulatory approach for CCS, site performance data must be integrated into site management and monitoring. We propose development of a modified "true-up," linked to a mechanical integrity test schedule or a performance based schedule.[292] Under this system, every five years (to align with UIC testing requirements) or for a performance-based approach, with any significant project change (extra wells drilled, more CO_2 injected, erratic system performance or other

[289] *See supra* Part IV.E.
[290] *See supra* notes __ - __ and accompanying text (discussing UIC program).
[291] *See generally* KAI N. LEE, COMPASS AND GYROSCOPE: INTEGRATING SCIENCE AND POLITICS FOR THE ENVIRONMENT (ISLAND PRESS 1994).
[292] 40 C.F.R. §146.8(b)(2).

modifications) new and additional site data would be collected and incorporated into site models, verifying the models and providing updated risk assessments and, if necessary allowing operators the chance to change site management. After these "true-up" periods, the amount paid into the long-term stewardship fund would be adjusted to reflect a more accurate level of site risk, with higher-risk sites paying more and lower-risk sites paying proportionally less into the long-term management fund. Such an approach has three benefits. First, additional information will help manage risk over the CCS life-cycle and allow for bond and insurance premiums to be correctly set. Second, additional information gathered during "true-ups" will lower asymmetric knowledge levels between regulators and site operators, which is important for site transfer to public management. Third, if correctly set, risk-based premiums will help to establish incentives for good site selection, responsible management and adequate monitoring and verification. Reservoir experience and knowledge will help to make site performance more predictable and reduce the possibility that site operational permits will be revoked due to poor performance. Indeed, due diligence and adaptive management will help to ensure that real data guide risk models and site management through the entire project lifecycle. Integrating adaptive management approaches with risk management supports a regime with adequate financial responsibility to manage liability and enhances public confidence in CCS technology.

Separate from this phased liability and funding approach is the issue of how to encourage the development of the first CCS "pilot" projects. For those projects, Congress could create a special federal fund with a damage cap that allows claimants to recover on a strict liability basis with the operator paying only the lowered damage cap and the federal government paying the rest. Like the OPA, however, claimants could resort to tort and environmental law for any damages not covered by the fund. So long as enough money is paid into the fund, Congress and operators can limit the amount any one operator may be responsible for any particular claim. By carefully structuring a path towards CCS commercialization—and ensuring that temporary systems to manage liability for pilot projects do not become permanent—Congress could help chart a path toward commercial CCS deployment. Challenges to this approach occur when it is difficult to assign blame for damages—if multiple operators were all injecting into the same geologic reservoir, for example. Additionally, recovering damages through the courts is often time consuming and costly for an injured party. A central fund could help to alleviate these concerns.

In sum, this approach contemplates potential damage caps on operator liability (with associated federal funding for damages or remediation in excess of the cap), for selected CCS pilot projects to encourage technology development. After the first dozen or so projects have been established, CCS project caps would be raised to the risk-based site specific caps described above, and operators would be regulated under a set of federal standards and subject to existing tort and environmental statutory liability (along with liability under any CCS-specific legislation), coupled with pooled federal funding, insurance, and bonding. This system would remain in place until the project began the long-term stewardship phase, at which time any necessary monitoring, remediation and damages would be funded exclusively from the federal pool, financed by the performance-based fees collected during the active injection phase. As a result, the federal government would take on a larger compensation burden in cases of harm in pilot projects throughout the CCS life-cycle, and for the long-term stewardship phase of all CCS projects. This graduated and risk-based structure is designed to both encourage CCS development and ensure incentives are in place to encourage safe site-selection and project operation as well as compensate those who may be harmed by CO_2 storage.

Another possibility for managing liability during the operational and post-closure period not fully explored here would be the creation of a federally-administered fund to pay any damages directly. In areas with multiple operators and difficulty in assigning blame for harm, such an approach could help to ensure that parties were compensated rapidly. Operators would pay into a centrally administered fund (at either the reservoir or federal level) and this central authority could collect damages directly from culpable operators. One drawback of this approach is the potential lack of incentives for owner/operators. This situation creates a potential 'moral hazard' when a common pooled fund is used to pay for individual operator damages. Another risk is underfunding of the compensation fund and the resulting problem with CCS project public perception.

In the end, as with any technology, there are risks associated with CCS and the long-term storage of CO_2. There are also, however, significant risks of climate change. Although there are many possible ways to deal with climate change, CCS is a technology that has the potential to play a major role in addressing climate change before sufficient and economical substitutes for coal can be found. As a result, policymakers should encourage the development of this technology while at the same time taking care not to limit operator liability to such an extent as to remove incentives for responsible behavior or unduly burden human health and the environment.

CONCLUSION

In this Article, we have attempted to create a potential framework to address liability and funding issues associated with the long-term storage of CO_2 in connection with CCS. We propose that states and the federal government can encourage the development of CCS without abandoning or placing significant limitations on existing tort law or statutory environmental law protections. In order to accomplish this, we take advantage of the inherent life-cycle of CCS and the stage of technology deployment on a national basis. We propose a system that uses existing tort and statutory liability for harm associated with CCS as a backstop to comprehensive federal regulations and then places on top of it a funding system consisting of insurance, bonding, selected damage caps (for early pilot projects only) and pooled federal funding to provide protection both for CCS operators and for those potentially harmed by CCS. Such a system can go a long way to decreasing the risks of climate change while managing the local risks of CCS. How liability is structured is important. While the first dozen or so CCS projects may require additional tools to manage uncertain liabilities, we caution against blanket state absorption of liability and blanket pre-emption for commercial CCS projects. Such proposals have the potential to eliminate important incentives for good site selection and responsible management, and do not address issues of compensation for potential damages from CCS projects. As shown above, existing environmental law and tort liability can serve as a backstop to a comprehensive federal regulatory framework, unless and until a substitute system of liability and compensation is created at the federal level. With this in mind, the use of several federal liability management mechanisms (bonding, insurance, or pooled funds) could help to ensure injured parties are compensated quickly as well as create incentives for good site selection and responsible management in place.