Surveying the Risks of Carbon Dioxide: Geological Sequestration and Storage Projects in the United States

by Donna M. Attanasio

Donna M. Attanasio is a partner with White & Case LLP.

Editors' Summary

Electric generation projects that are coupled with carbon capture and geological sequestration and storage (GS) are likely to offer energy companies new opportunities, once the technological hurdles are surmounted and commercial viability is shown. At the same time, these projects pose challenging risk assessments issues for potential equity investors and debtholders. National standards for GS are developing slowly and without a comprehensive framework. Some states have laws more conducive to GS development than others, and therefore certain projects may have significant location-based legal advantages over others. In all cases, because the law is evolving, potential GS projects in the United States have a level of legal risk requiring careful assessment and understanding before investment.

[Author's Note: The author thanks Jennifer Maul and Susan Dashiell for their research assistance and Neal McAliley, Earle O'Donnell, Sandra Warren, and Tanya Willacy for their helpful comments and support.]

The development of technologies for the geological sequestration and storage (GS) of carbon dioxide (CO_2) poses new opportunities and new, very challenging risk assessment issues for potential equity investors and debtholders. This Article provides a broad overview for companies and investors to help them understand the current legal framework under which GS is moving forward in the United States.

As discussed herein, once the technological hurdles are surmounted and commercial viability is shown, electric generation projects that are coupled with carbon capture and GS technologies (shortened here for ease of reference to GS Gen Project) are nearly certain to find a market niche within the electric generation industry. Certain states have already imposed rigorous CO_2 emission limitations on new baseload generation units and provided "safe harbors" for generation that uses GS. Further, the feasibility of using carbon injections for enhanced oil recovery is already proven, and the development of technologies to facilitate the capture, delivery, and storage of carbon, coupled with possible financial incentives to reduce emissions (cap-and-trade programs or taxes), will make its use for this purpose more attractive. However, assuming the technological risks are overcome, successful deployment of a new technology still requires a stable and supportive legal structure. In the United States, national standards for GS are developing slowly and without a comprehensive framework. Currently, some states have laws more conducive to development of GS than others, and therefore certain projects may have significant legal advantages over others based on their location. In all cases, because the law is evolving, potential GS projects in the United States have a level of legal risk that requires careful assessment and understanding before investing.

I. Background

The growing acceptance of the view that anthropogenic greenhouse gas (GHG) emissions must be reduced has unleashed a torrent of activity—from legislative measures to industrial innovations—aimed at accomplishing the goal through multi-pronged approaches that include reduced energy use, increased use of renewable fuels and nuclear power, and renewed emphasis on the development of new technologies such as fuel cells and mechanisms to harvest tidal power. The capture and geological sequestration of GHGs is often identified as a critical part of that effort. For example, a 2008 European Union (EU) report asserted: "[W]e cannot reduce EU or world CO_2 emissions by 50% in 2050 if we do not also use the possibility to capture CO_2 from industrial installations and store it in geological formations (carbon dioxide capture and storage, or 'CCS')."[1] Indeed, "[r]esearch on, and promotion, development and increased use . . . of carbon dioxide sequestration technologies" are among the measures explicitly identified in the Kyoto Protocol for promoting sustainable development.[2]

Electric utilities are often looked to as a natural market for GS projects because they emit significant quantities of GHGs. According to the International Energy Agency, "[e]lectricity production accounts for 32% of total global fossil fuel use and around 41% of total energy-related CO_2 emissions."[3] In 2007, over 71% of total electricity production in the United States came from oil, coal, and gas-fired generation.[4] While energy efficiency and conservation measures and increased reliance on renewables, including nuclear power, are making inroads in the quest to reduce use of fossil fuels, growth of these alternatives is slow and our reliance on fossil fuels is deep-seated. Thus, if GS can be deployed successfully in the near term to reduce CO_2 emissions from power plants, it may offset some of the pressure to reduce fossil fuel use for electric generation by providing a clean alternative to fuel switching.

GS is particularly attractive to U.S. markets when coupled with coal-fired generation. Coal has favorable attributes, particularly its relatively low delivered cost. The United States has abundant domestic coal supplies without national security concerns and domestic coal production is a source of U.S. jobs. In 2007, over 48% of electricity production in the United States was coal-fired.[5] Coal-fired generation is also important to the EU and to the burgeoning electric power sector in China.[6] Indeed, China's production of electricity from coal is greater than that of the United States.[7] Worldwide, coal-fired generation accounts for 63% of all fossil-fueled electricity production.[8] Thus, commercially viable GS technology coupled with coal use could become another "green" option for electric utilities seeking (or required by law) to reduce their carbon footprint.

Some U.S. states have already imposed requirements that encourage or compel utilities to purchase "clean" energy and, in several cases, qualifying projects include those using GS. For example, Washington State has enacted legislation imposing GHG emissions limits on new baseload generation (built by, or under a long-term contract to, a state utility) of 1,100 pounds per megawatt hour or a lower state average, but:

> The following greenhouse gases emissions produced by baseload electric generation owned or contracted through a long-term financial commitment shall not be counted as emissions of the power plant in determining compliance with the greenhouse gases emissions performance standard: (a) Those emissions that are injected permanently in geological formations. . . .[9]

Similarly, California's SB 1368 requires GHG emission limits on any baseload generation unit to which a state utility makes a long-term financial commitment, but does not include sequestered gases as emissions when determining whether the generation unit meets the limit.[10] Michigan recently enacted legislation that imposes a renewable portfolio standard requirement on utilities and allows a portion of the requirement to be met with credits from an "advanced cleaner energy system," which is defined, in part, as "[a] coal-fired electric generating facility if 85% or more of the carbon dioxide emissions are captured and permanently geologically sequestered."[11] Thus, thanks to regulatory fiat, market interest in GS Gen Project already exists.

Various types of federal legislation have been enacted to encourage investment in GS projects. In 2008, legislation was enacted providing tax credits for owners of facilities that capture not less than 500,000 metric tons of CO_2 during the taxable year.[12] The credit is \$20 per metric ton if the CO_2 is disposed of in secure geological storage (under federal criteria that have yet to be established), or \$10 per metric ton if the CO_2 is used for tertiary injection in an enhanced oil or natural gas recovery project meeting certain specified criteria.[13] In addition, a program to grant investment tax credits for certain clean coal projects was expanded in 2008 to explicitly include projects using carbon capture and sequestration technologies

1. 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, COM(08)18 final at 2 [hereinafter EU Proposal].
2. Kyoto Protocol to the United Nations Framework Convention on Climate Change, Dec. 10, 1997, U.N. Doc. FCCC/CP/197/L.7/Add. 1, art. 2, §1(a)(iv), *reprinted in* 37 I.L.M. 22, 32 (1998).
3. Peter Taylor et al., Int'l Energy Agency, Energy Efficiency Indicators for Public Electricity Production From Fossil Fuels 5 (2008). Data based on 2005.
4. Edison Elec. Inst., Statistical Yearbook of the Electric Power Industry 37 tbl.4.2 (2008). Note that numbers cited are preliminary.
5. *Id.*
6. In 2004, approximately 50% of GHG emissions were from the United States, China, and the EU (19%, 17%, and 13%, respectively). Pew Center on Global Climate Change, International Annual CO_2 Emissions, http://www.pewclimate.org/facts-and-figures/international/annual-emissions (last visited Mar. 5, 2009) (citing.Int'l Energy Agency, CO_2 Emissions From Fossil Fuel Combustion (2006), and EPA, Global Anthropogenic Non-CO_2 Greenhouse Gas Emissions: 1990-2020 (2006)).
7. Int'l Energy Agency, Key World Energy Statistics 25 (2008). Data cited is for 2006.
8. Taylor et al., *supra* note 3, at 7.
9. Wash. Rev. Code §80.80.040(7)(a) (2007).
10. Cal. Pub. Util. Code §8341(a), (b), (d)(5) (2007).
11. Mich. Comp. Laws §460.1003 (2008). *See* Jonathan Rickman, *Michigan Re-Regulates Power Market in Boon for State's Utilities*, The Energy Daily, Oct. 14, 2008, at 1, 3.
12. Emergency Economic Stabilization Act of 2008, Division B, §115(a), Pub. L. No. 110-343, 122 Stat. 3765, 3829-31 (amending the tax code to add §45Q) [hereinafter Financial Bailout Package]. The credit was modified by the American Recovery and Reinvestment Act of 2009 to specify that CO_2 that is used for enhanced oil recovery must remain permanently sequestered to qualify for the credit.
13. *Id.*

and the funding allocation for the program was increased to $2.55 billion.[14] The American Recovery and Reinvestment Act of 2009 established a 30% tax credit for certain qualified advanced energy projects, and projects that re-equip, expand, or establish a manufacturing facility for the production of property designed to capture and sequester CO_2 are among the types of projects that may qualify for the $2.3 billion in credits potentially available.[15] In addition, numerous interest groups are advocating additional GS incentives for inclusion in a comprehensive energy and climate change bill for consideration by the 111th Congress. Thus, again, legislation is providing incentives for investment with more incentives potentially to come, but as discussed below, the regulatory requirements for siting, constructing, and operating such projects are still inchoate.

A. Background: Development of GS

Carbon sequestration can take the form of terrestrial sequestration, e.g., planting trees, oceanic sequestration, or geological sequestration. Geological sequestration occurs through physical trapping of CO_2 under the earth's surface, below or within material that prevents its further migration, and through geochemical trapping when the CO_2 interacts with other substances to form solid carbonate minerals.[16] Wells may be situated under the seabed as well as under dry land.[17]

Geological carbon injection used for enhanced oil recovery has a well-established history in the United States and elsewhere. The United States currently uses 32 million tons per year of CO_2 for enhanced oil recovery, and the CO_2 is believed to remain stable once injected, provided the original pressure of the geological formation is not exceeded.[18] However, the concept of injecting CO_2 underground specifically for the purpose of permanent storage is a direct result of global attention on CO_2 as a GHG. This newer practice will compel the construction of wells explicitly for the purpose of injection and puts more emphasis on the need to assure the long-term stability of stored CO_2. Practical experiences with injecting CO_2 for the purpose of long-term storage and empirical evidence of its stability over the long term are still scant. However, three large-scale projects, the North Sea Sleipner project, Canada's Weyburn Field project, and the project at In Salah in Algeria are generating data that provide promise for the future.[19]

The Sleipner project was launched in 1996 by Statoil to sequester excess amounts of CO_2 separated from natural gas extracted from the Sleipner field in the North Sea.[20] Injection was pursued as a means to mitigate tax liability that would have been imposed by the Norwegian government had the project adhered to the typical industry practice of venting unwanted CO_2 into the atmosphere. The tax liability would have been particularly severe since the Sleipner field gas deposits have unusually high CO_2 concentrations of about 9%.[21] The Utsira saline aquifer into which the CO_2 is injected is believed to have a capacity of 600 billion metric tons, enough to store all anthropogenic CO_2 for the next 20 years.[22]

The Weyburn project, in which CO_2 emitted from the Great Plains synfuel plant in the United States is transported by pipeline to Canada and used for enhanced oil recovery, has been operating since 2000 and was expanded in 2005 into an adjacent oil field.[23] Although the benefit of enhanced oil recovery was a motivating factor, the project offered the opportunity to demonstrate that CO_2 "waste" from an energy facility could be used in a productive manner. Further, since the geological substrata at Weyburn have been studied and documented since 1955, when oil production commenced at Weyburn, the area is well-suited for studying changes occurring during and after injection activity.[24] Study activity at Weyburn is aimed at assessing criteria for siting carbon sequestration projects, wellbore integrity, storage monitoring, risk assessment and storage mechanisms, and data validation and management.[25]

---

14. *Id.* §111(c)(3)(C) (amending §48A of the tax code).
15. American Recovery and Reinvestment Act of 2009, Division B, §1302, Pub. L. No. 111-5, 123 Stat. 115, 345-48 (amending the tax code to add §48C).
16. Federal Requirements Under the Underground Injection Control (UIC) Program for Carbon Dioxide (CO_2) Geologic Sequestration (GS) Wells, Proposed Rule, 73 Fed. Reg. 43492, 43494 (July 25, 2008) [hereinafter UIC NOPR].
17. The U.S. Environmental Protection Agency (EPA) has urged the U.S. Congress to amend the Marine Protection, Research, and Sanctuaries Act to permit sequestration under the seabed and to implement changes made to the 1996 London Convention on ocean dumping. *Id.* at 43497.
18. U.S. Dep't of Energy (DOE), Geologic Sequestration Research, http://www.fossil.energy.gov/programs/sequestration/geologic/index.html (last visited Apr. 6, 2009).
19. UIC NOPR, *supra* note 16, at 43498 ("no documented cases of leakage from these projects"); Commission Staff Working Document: Accompanying Document to the Communication From the Commission to the European Parliament and the Council Supporting Early Demonstration of Sustainable Power Generation From Fossil Fuels: Impact Assessment, SEC(08)47, at 16 (reporting Sleipner and Algeria have met with "good results"); Statoil Carbon Dioxide Storage Prized, http://www.statoil.com/statoilcom/SVG00990.NSF?OpenDatabase&artid=01A5A730136900A3412569B90069E947 (Dec. 18, 2000) (claiming success for Sleipner project based on 1999 studies). In addition, DOE conducted injections in 2002 to 2003 in a depleted oil field in New Mexico to further study how the CO_2 is absorbed into and contained in rocks that previously succeeded in containing oil deposits until such time as they were extracted. *First Geologic Sequestration Field Test in U.S. Underway in New Mexico*, Fossil Energy Techline (U.S. DOE, Washington, D.C.), Mar. 20, 2003 [hereinafter *New Mexico Field Test*], http://fossil.energy.gov/news/techlines/2003/tl_sequestration_strata1.html.
20. Statoil, *supra* note 19. The CO_2 is injected into a sandstone formation approximately 2,600 feet below the ocean floor (a substrata distinct from the lower depths from which the natural gas is extracted), displacing salt water in the pore space. The project has been closely monitored and studied to assess the movements of CO_2 in a saline aquifer. Schlumberger Ltd., Global Climate Change and Energy: Case Study: Sleipner—A Carbon Dioxide Capture-and-Storage Project, http://www.seed.slb.com/en/scictr/watch/climate_change/sleipner.htm (last visited Mar. 5, 2009) [hereinafter Schlumberger, Sleipner].
21. Schlumberger, Sleipner, *supra* note 20.
22. *Id.* A metric ton (or tonne) is equal to 1.102311 short tons or 0.9842065 long tons. Nat'l Inst. of Standards & Tech., Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices app.C, at C-10 (2008), *available at* http://ts.nist.gov/WeightsAndMeasures/Publications/upload/AppendC-09-HB44-FINAL.pdf.
23. Nat'l Energy Tech. Lab., U.S. DOE, Carbon Sequestration Through Enhanced Oil Recovery 1 (2008) [hereinafter NETL, Oil Recovery], *available at* http://www.netl.doe.gov/publications/factsheets/project/Proj282.pdf.
24. Schlumberger Ltd., Global Climate Change and Energy: Case Study: The Weyburn Oil Field—Enhanced Oil Recovery, http://www.seed.slb.com/en/scictr/watch/climate_change/weyburn.htm (last visited Mar. 5, 2009). The CO_2 is transported by pipeline from the United States to the Weyburn field in Saskatchenwan province, Canada. The CO_2 produced by Great Plains is only about 96% pure, and the impurities present in the stream, particularly hydrogen sulfide, improve its efficacy as an agent for enhanced oil recovery. *Id.*
25. NETL, Oil Recovery, *supra* note 23, at 2-3.

The newest of these three projects, the In Salah project in Algeria, commenced in 2004 in conjunction with a natural gas extraction operation and is expected to store up to 1.2 million metric tons of CO_2 per year.[26] In Salah uses injection as an alternative to venting, as does Sleipner, but the project was not undertaken to gain a direct commercial benefit such as tax reduction. Rather, the project is expected to expand the knowledge base related to GS, which may enhance acceptance of GS as a GHG mitigation strategy.[27]

Although to-date results for long-term storage are promising,[28] many technological and scientific questions remain under study, including the following:

- Developing technologies for cost-effective capture of CO_2. In 2008, the U.S. Department of Energy (DOE) announced a $36 million grant to 15 projects intended to address "five areas of interest for CO_2 capture: membranes, solvents, sorbents, oxycombustion (flue gas purification and boiler development), and chemical looping."[29]
- Gaining a better understanding of how CO_2 physically moves through substrata after injection, and the stability of storage over the long term.
- Assessing the chemical interactions of CO_2 injected underground with surrounding materials while in storage, which requires an underlying assumption regarding the purity of the injected CO_2 (and possible development of purity standards for CO_2 at the time of injection).
- Evaluating the risks to humans and the environment from inadvertent discharges of the stored CO_2.

B. Research and Development in the United States

In response to the growing concern over global warming, DOE has embarked on a number of programs focused on GS, beginning with a small program in 1997.[30] These programs encompass core research and development activities as well as demonstration and deployment programs.[31] Core research has five areas of focus: "CO_2 capture; carbon storage; monitoring, mitigation, and verification; non-CO_2 greenhouse gas control; and breakthrough concepts . . . ."[32]

Regional Carbon Sequestration Partnerships have been a cornerstone of DOE's demonstration and deployment program.[33] Covering most of the country, these seven partnerships are regional combinations of government agencies (such as DOE and state agencies), academic institutions, and private energy companies. Each partnership pursues its own initiatives and research objectives. Experts from the International Energy Agency have identified DOE's Partnership program, in which 41 states and four Canadian provinces are participating, as the "world's most ambitious" program to advance carbon capture and storage.[34] According to a DOE publication issued on June 5, 2008, the Partnerships have sponsored 25 smaller scale geologic storage tests and are expected to implement seven large-scale projects.[35]

For example:

- In 2007, the Southeast Regional Carbon Sequestration Partnership (SECARB), led by the Southern States Energy Board, commenced a 10-year demonstration project pursuant to which it will inject 1.4 million metric tons of naturally occurring CO_2 annually for a period of 18 months at a site in the lower Tuscaloosa Formation, followed by injections of 100,000 to 250,000 metric tons per year of anthropogenic CO_2 over a period of three to seven years captured from a nearby power plant, and study the result.[36]
- The Midwest Geological Sequestration Consortium is evaluating a methodology for injecting CO_2 into unmined coal deposits to determine if it can effectively displace methane that is bonded to the coal, thereby making the methane (natural gas) available for extraction, using a cyclical or pulsing injection methodology to avoid excess "coal swelling" that limits the amount of methane recoverable.[37]

---

26. StatoilHydro, In Salah—Algerie (Aug. 20, 2007) http://www.statoilhydro.com/en/TechnologyInnovation/ProtectingTheEnvironment/CarbonCaptureAndStorage/Pages/CO2InjectionInSalahAlgeria.aspx. Over time, the CO_2, which is being stored in the same geological formation as the natural gas from which it is being extracted, but at a distance from it, is expected to migrate into the space from which the natural gas is presently being extracted and then to remain captured in that space. *Id.*
27. Iain Wright, CO_2 Geological Storage: Lesson Learned From In Salah (Algeria) (May 20, 2006) (paper presented at Meeting of Subsidiary Body for Scientific and Technological Advice), http://unfccc.int/files/meetings/sb24/in-session/application/pdf/sbsta_may_20th_in_salah_wright.pdf (last visited Mar. 5, 2009); *see also* Fred Riddiford et al., Monitoring Geological Storage:The In Salah Gas CO_2 Storage Project 3 (undated), http://uregina.ca/ghgt7/PDF/papers/nonpeer/529.pdf (last visited Mar. 5, 2009). It is unclear from the literature reviewed whether the project may generate carbon credits or offsets for use by a project with a mandatory emission cap.
28. *See supra* note 20 and accompanying text.
29. Press Release, U.S. DOE, DOE to Provide $36 Million to Advance Carbon Dioxide Capture (July 31, 2008), *available at* http://www.energy.gov/6443.htm.
30. Nat'l Energy Tech. Lab., U.S. DOE, Carbon Sequestration Technology Roadmap and Program Plan 2007: Ensuring the Future of Fossil Energy Systems Through the Successful Deployment of Carbon Capture and Storage Technologies 5 (2007) [hereinafter NETL, Roadmap], *available at* http://www.netl.doe.gov/technologies/carbon_seq/refshelf/project%20portfolio/2007/2007Roadmap.pdf. For example, in 2002 and 2003, DOE injected CO_2 at a rate of about 40 tons per day, and in total about equal to one day's emissions from an average size coal power plant, into a depleted oil field near Hobbs, New Mexico, in order to study how the CO_2 was absorbed into and contained in the rocks. DOE identified this project as the "first major field experiment in the United States to test whether underground geologic formations might be used in the future to entrap carbon gases and isolate them permanently from the atmosphere." *New Mexico Field Test*, *supra* note 18.
31. NETL, Roadmap, *supra* note 30, at 7.
32. *Id.* at 7-8. DOE cites use of ionic liquids and microporous metal organic frameworks (MOFs) for capturing CO_2 as an example of "breakthrough concepts." *Id.*
33. *Id.* at 8. *See also* U.S. DOE, Carbon Sequestration Regional Partnerships, http://fossil.energy.gov/sequestration/partnerships/index.html (last visited Jan. 20, 2009).
34. *IEA Finds U.S. CO_2 Sequestration Program World's Most Ambitious*, Fossil Energy Techline (U.S. DOE, Washington, D.C.), June 5, 2008, http://www.fossil.energy.gov/news/techlines/2008/08019-IEA_Finds_US_CCS_Plans_Ambitious.html.
35. *Id.*
36. S. States Energy Bd., Programs, http://www.sseb.org/AmericanEnergySecurity.htm (last visited Mar. 6, 2009).
37. U.S. DOE, *DOE Regional Partnerships Find New Use for Unmined Coal*, Fossil Energy Techline, July 17, 2008, http://www.fossil.energy.gov/news/techlines/2008/08026-Regional_Partnerships_Tap_Unmined_Coal.html.

- The Southwest Regional Partnership is also exploring enhanced coalbed methane recovery. Its project is sited in the San Juan Basin, which has exceptionally permeable coal. The project relies on high initial coal permeability to address the problem of coal swelling and will desalinate some of the water that is produced as a byproduct of its process for irrigation in order to increase vegetation in the area (terrestrial sequestration).[38]

To encourage such projects, DOE has awarded large multi-million-dollar multi-year grants to certain regional partnerships (accompanied by some matching funds from the involved industries). In May 2008, DOE announced a grant of $126.6 million (to be matched by $56.6 million from industry) for projects in California and Ohio.[39] The California sequestration project, to be led by the West Coast Regional Carbon Sequestration Partnership (WESTCARB), envisions developing a storage site below a 50 megawatt (MW) power plant in Kimberlina, California, and injecting 1 million metric tons of CO_2 over a four-year period.[40] The power plant would use oxycombustion technology to capture CO_2 emissions from a natural gas-fired facility. The Midwest Regional Carbon Sequestration Partnership (MRCSP) will sequester CO_2 produced by an ethanol plant. However, the awarded funds are subject to annual appropriations.[41]

In addition to working through these partnerships, the DOE has been working on facilitating information exchanges on carbon sequestration. In 2003, DOE, along with the U.S. Department of State, spearheaded the creation of the Carbon Sequestration Leadership Forum (CSLF) to bring together world leaders to promote the development on an international level of cost-effective technologies for the cleaning, separating, transporting, and storing of CO_2.[42] In addition, DOE has released, and as recently as November 2008 updated, a carbon sequestration atlas detailing carbon capture and storage potential across the United States and parts of Canada.[43]

In 2003, DOE also announced a $1 billion project dubbed FutureGen. As first conceived, FutureGen was intended to support development of a 275-MW clean coal power plant that would produce electricity and hydrogen using carbon capture and sequestration technology.[44] However, initial funding for the FutureGen project was scaled back in 2008, largely in reaction to the escalating costs of the proposed project.[45] Rather than focus on one plant, DOE has restructured its FutureGen program to support carbon capture and storage at commercial power plants developed by the private sector.[46]

Thus, while geological carbon sequestration still remains in its infancy from a commercial perspective, the body of knowledge has expanded rapidly in the last decade, and DOE and other governmental, academic, and private bodies, nationally and internationally, are taking steps to encourage the further technological innovation that is necessary if sequestration is to fulfill the expectation that it will be a major part of the effort to turn the tide against global warming.

II. Areas of Legal Risks

Early investors in GS projects or GS Gen Projects in the United States face the challenge of a changing legal landscape. If law is still lacking on a critical issue such as substrata rights or unitization, investors face uncertainty as to which risks will be ameliorated by clear laws and regulations in the near future and which will not. Laws addressing crucial questions such as long-term liability have not yet been developed for application to GS projects, except in isolated instances such as the Illinois law discussed below.[47] Even in areas in which law exists or is developing, including national standards for well construction, operation, and capping and long-term liability for contamination to drinking water, investors face the potential for conflicts due to a change in law during project development and operation, unless early entrants are grandfathered against later developed requirements that are incompatible with their project. Some changes in law, for example a change in regulatory approach, may shift basic assumptions underlying the planned project. While it is impossible to avoid these risks entirely, consideration of the particular state in which the project is located and a systemic review of the areas of risk are essential parts of the regulatory due diligence process for such an investment.

The commercial basis for the proposed project must be understood first, in order to appropriately analyze prospective legal and regulatory risks. Historically, carbon injection activities have been linked with enhanced oil recovery. In these instances, the cost of injecting CO_2 into geological reservoirs is offset by the commercial value of increased oil production. Indeed, the purpose of such activity is to enhance the economic value of the oil field to which carbon storage can be

38. U.S. DOE, *DOE Project Starts CO_2 Sequestration in New Mexico Coalbed*, Fossil Energy Techline, Aug. 4, 2008, http://www.fossil.energy.gov/news/techlines/2008/08031-San_Juan_Basin_CO2_Injection.html.
39. U.S. DOE, *DOE Awards $126.6 Million for Two More Large-Scale Carbon Sequestration Projects*, Fossil Energy Techline, May 6, 2008, http://www.fossil.energy.gov/news/techlines/2008/08012-DOE_Funds_Large-Scale_Projects.html [hereinafter *DOE Award*].
40. *Id*. The power project itself will be privately funded and owned, although it may seek loan guarantees from DOE. *See* Clean Energy Systems, Inc., Frequently Asked Questions, http://www.cleanenergysystems.com/faq.html#28 (last visited Apr. 6, 2009).
41. *See DOE Award, supra* note 39.
42. U.S. DOE, Carbon Sequestration Leadership Forum, http://www.fossil.energy.gov/programs/sequestration/cslf/index.html (updated on Mar. 3, 2009).
43. U.S. DOE, *DOE Announces Release of Second Carbon Sequestration Atlas*, Fossil Energy Techline, Nov. 17, 2008, http://www.fossil.energy.gov/news/techlines/2008/08060-DOE_Releases_Sequestration_Atlas.html; U.S. DOE, *DOE Sequestration Atlas Captures Award for Publication Excellence*, Fossil Energy Techline, Aug. 14, 2008, http://www.fe.doe.gov/news/techlines/2008/08034-Sequestration_Atlas_Wins_Award.html.
44. U.S. DOE, FutureGen Clean Coal Projects, http://fossil.energy.gov/programs/powersystems/futuregen/ (last visited Mar. 3, 2009); U.S. DOE, *DOE Announces Restructured FutureGen Approach to Demonstrate Carbon Capture and Storage Technology at Multiple Clean Coal Plants*, Fossil Energy Techline, Jan. 30, 2008, http://fossil.energy.gov/news/techlines/2008/08003-DOE_Announces_Restructured_FutureG.html [hereinafter *FutureGen Approach*].
45. *FutureGen Approach*, *supra* note 44.
46. *Id.*
47. *See infra* notes 99 to 104. Texas similarly passed statutes that broadly addressed GS as part of its competition with Illinois for selection as a FutureGen site. *See* Tex. Water Code Ann. ch. 5 (2007); Tex. Health & Safety Code Ann. ch. 382 (2007); & Tex. Gov't Code Ann. chs.. 490, 2305 (2007).

a fortuitous consequence (if measures are taken to assure it is permanently sequestered). Future projects may depend on alternative business models that can be broadly categorized as follows:

- *Regulatory Compliance*. GS may be used to meet a regulatory requirement, such as a tax or a compliance obligation, imposed directly on the emitter, as in the case of the Sleipner project. Use of GS as a voluntary alternative to releasing carbon into the atmosphere to avoid or reduce an emissions tax, fee, or penalty will be commercially competitive only if the cost of the regulatory obligation (including any alternative compliance methodology that is of comparable effectiveness) exceeds the cost of sequestration. For example, a tax that is "too low" compared to the cost of GS or the availability of less costly alternatives (such as obtaining emission allowances), will not provide sufficient economic motivation to invest in GS.[48] In this model, the cost of GS is a cost of doing business for a carbon emitter.
- *Enhanced Product*. Alternatively, a GS Gen Project (or other industrial emitter) may propose to bear some or all of the cost of sequestering its CO_2 emissions with the expectation of commanding a higher price for its zero-carbon emissions green output. In this case, the emitter may pay a GS site operator for the service of removing and disposing of the CO_2 "waste," with the cost being borne by the consumers of the green power (or other good produced, in the case of an industrial emitter). This type of model is feasible, for example, in states that have imposed mandates on their electric utilities to meet quotas for renewable and clean energy, or prohibited the construction of coal-fired baseload plants that lack carbon sequestration, notwithstanding the higher cost to ratepayers of zero-carbon power. Here, the cost of GS is transferred to, and absorbed into, another product, such as electric power, for which the purchaser is willing (or required) to pay a premium.
- *Commodity*. As a third alternative, a GS site operator may elect to purchase CO_2 from utility or industrial emitters for the purpose of securing the emissions allowances associated with its sequestration and/or making productive use of the CO_2, for example, for enhanced oil recovery or enhance coalbed methane recovery. In this model, CO_2 has value as a commodity. An Illinois law passed for the purpose of encouraging the siting of a FutureGen project within its state (discussed below), incorporates the concept of CO_2 as having value. The state will assume title to the CO_2, the obligation to sequester it, and the risk associated with its sequestration, and in exchange, receives any value associated with the sale of carbon emission credits. The legislation indicates that the value of the carbon credits is intended to offset part of the cost of sequestration (although the state is not assuming the carbon credits alone would provide a commercial justification for the state's sequestration undertaking).[49] The same model might apply if an emitter that does not have an emissions cap or sequestration obligation elects to sequester, or a carbon-regulated emitter overcomplies, to generate credits. In each of these instances, the CO_2 has an inherent value such that someone will purchase it, either for use as an input to production (enhanced oil recovery) or because the cost of GS is expected to be recouped by securing and reselling carbon credits.
- *Hybrids*. Hybrids of the above models are also possible and indeed may be the most likely to succeed. For example, a generator may find it can produce both CO_2 for sale as a commodity and zero-carbon emissions green power that has an enhanced value compared to "brown" power, and thereby diversify the income stream necessary to cover the additional cost of GS.

Because of the nascent stage of the technology, the range of possible areas of risks for a GS Gen Project is unusually broad. The discussion below is intended to identify areas of legal risk that should be considered by a potential investor. In many cases, the risk is related to a lack of law or the need to conform existing law to a new purpose. The weight given to any particular risk, however, may depend on the business model of the proposed project.

A. Transitional Nature

GS is intended to be a transitional mechanism to facilitate continued use of fossil fuels while cleaner methods of energy production are developed. While the statistics belie the possibility that we are on the brink of eliminating the need for fossil fuels over any reasonable investment horizon, an increase in the supply of GS options (or terrestrial or oceanic storage options) over time as more projects are developed, together with global preferences tending away from fossil-fuel use (stabilizing or putting downward pressure on demand) could affect the long-term need for, and therefore the economic viability of, GS projects, particularly those that are relying on a revenue stream from generating carbon credits. Moreover, to the extent that the economic justification for a particular GS project is linked to enhanced oil recovery, there is a certain irony to using carbon sequestration to produce more fossil fuels, which could affect public perception of whether GS linked with enhanced oil recovery should be accepted as a carbon mitigation strategy. Thus, careful scrutiny must be given to the compatibility of the economic model and expected economic life of the project with evolving technological and regulatory change.

48. For a quantitative analysis demonstrating that a rational investor will delay carbon mitigations if the price on carbon lacks a floor, see Frank C. Graves & Metin Celebi, "CO_2 Price Volatility: Consequences and Cures," The Brattle Group, Inc. (Jan. 2009) *available at* http://www.brattle.com/_documents/UploadLibrary/Upload736.pdf.

49. 20 Ill. Comp. Stat. 1107/25(c).

B. Will GS Be Compatible With the Regulatory Scheme?

Another threshold question is whether GS is compatible with whatever carbon regulation scheme is applicable to the jurisdiction. GS works commercially if the regulation is imposed on downstream emitters, e.g., power plants and distributors, such that sequestration avoids the need to purchase offsets or pay a tax. In contrast, a GS Gen Project would not be compatible with a scheme that taxes the first sale of a fossil-fuel, since the emitter would then bear both the increased cost of the fuel plus the cost of the project needed to separate and store the carbon emissions (in essence resulting in double compliance).[50]

Since the United States does not yet have a national program for carbon regulation, the commercial viability of GS cannot be fully and accurately assessed. However, the regional programs that are developing in the United States, and the prevailing view for a national program, are cap-and-trade programs that regulate emissions at the point of combustion and (not surprisingly) include fossil-fired electric generation plants among the regulated sources. Conceptually, cap-and-trade is compatible with any of the business models discussed above because it allows a regulated emitter to use GS to meet its regulatory obligation and/or allows the generation of credits through voluntary sequestration or overcompliance.

Further, as discussed above, a number of states are explicitly permitting utilities to meet GHG restrictions placed on electric generation by utilizing GS. Such laws make the "enhanced product" business model discussed above possible. These types of laws are good news for an independent power producer developing a GS Gen Project and seeking to attract non-recourse project financing, since it increases the likelihood that the developer can secure a long-term power purchase agreement for sale of its prospective output. In all cases, however, commercial viability will still depend on the actual cost and efficacy of sequestration versus alternatives.

C. Cost Recovery

Under the enhanced product model for a GS Gen Project, where the cost of sequestration is intended to be recovered in the cost of the energy produced, the project and its investors bear a regulatory risk associated with rate recovery. The cost of energy and capacity from a GS Gen Project, given the developing state of the technology, must reflect the increased investment in equipment to capture and store the carbon, the loss of fuel conversion efficiency associated with supporting the carbon separation and capture operations, plus the premium required to attract capital to an unproven venture. Logically, the zero-carbon energy should be worth at least the cost of the fossil fuel equivalent plus the cost of offsets over the period of delivery, even before considering the risk premium and, in a market where the clearing price of power is set by gas-fired generation, a coal plant may have "headroom" to absorb some of the extra costs of a GS Gen Project. But the U.S. regulatory scheme for CO_2 is not developed, and even if a cap-and-trade market is assumed, questions such as whether allowances will be allocated or auctioned, the compatibility of the U.S. market with the EU market and other markets as they develop, as well as fundamentals such as the impact of new technological developments on the cost of compliance, all make the pricing issue uncertain. Thus, even if we boldly assume perfect foresight for the market price of fossil-fired power, the added uncertainty of the value of "clean" power makes it impossible to know whether the cost of energy from a GS Gen Project as projected today will prove to be competitive as measured against the cost of clean power from an alternate source at a future point in time.

This is an important point for regulatory risk related to rate recovery. If the GS Gen Project's output is to be sold to consumers under regulated retail rates, and if the cost of the power to consumers is determined after the fact to be above market, there exists a chance for regulatory backlash of some sort. Indeed, the last two decades are littered with proof that when power prices set at one point in time for a future period turn out to be in excess of the market prices in effect during that future period, or otherwise deviate from an expected standard, consumers, regulators, and/or competitors (varying with the circumstances) will challenge the decision and structure that permitted the deviation to occur.[51] Even when regulatory constancy prevails, there is a cost to adjudicating such cases and often long periods of uncertainty while the issue is resolved.

To mitigate this regulatory risk, a utility purchaser of the output from an independent power producer (IPP)-owned GS Gen Project may seek to include a "reg out" clause in the power purchase agreement, which would permit the agreement to be terminated if rate recovery is later denied, even after operations commence. These types of clauses, however, impose an untenable level of insecurity for the project and generally impair financing. The preferable means to manage this risk for utility purchasers from IPP-owned GS Gen Projects[52] is to secure regulatory approval from the utility's state commission for cost-recovery shortly after the contract is executed and before any significant level of investment is made. Early resolution of this rate-recovery issue will likely facilitate

50. David Harrison Jr. et al., *Using Emissions Trading to Combat Climate Change: Programs and Key Issues,* 38 ELR 10367, 10375-76 (June 2008), *available at* http://www.nera.com/image/PUB_ELR_June2008.pdf.

51. Examples include: (1) the backlash against mandated purchases from qualifying facilities at administratively determined avoided costs under the Public Utility Regulatory Policies Act of 1978, which resulted in a threatened bankruptcy by one utility, numerous renegotiations and ultimately a change in law allowing exemptions from the mandatory purchase obligation; (2) the forced renegotiation of many of the early contracts entered into by the California Department of Water Resources following the meltdown of the California market in 2001; (3) the halt to further expansion of retail access after the California crisis; and (4) the outcry following price spikes in the Midwest, *see, e.g.,* Regional Transmission Organizations, Notice of Proposed Rulemaking, 64 Fed. Reg. 31390, 31394 (June 10, 1999) ("For example, during the week of June 22-26, 1998, the wholesale electric market in the Midwest experienced numerous events that led to unprecedented high spot market prices . . . $7,500 per MWh, compared to an average price . . .of approximately $40 per MWh . . . . This experience led to calls for price caps, allegations of market power, and a questioning of the effectiveness of transmission open access and wholesale electric competition." (Citation omitted.)).

52. The possibility that the project might be built as a merchant facility is not considered here as it seems to be among the least likely of the possible scenarios at this time.

financing. Similarly, a utility that invests directly in a GS Gen Project should seek regulatory affirmation of its decision for its intended investment at the earliest possible date. While a state commission may not allow recovery of a utility's investment in a plant that does not prove to be "used and useful,"[53] any affirmation that can be secured early in the process will at least provide a shield against later charges that the decision to make the investment was not prudent. Thus, the availability of an early decision on cost-recovery by state regulators is a significant factor in reducing the investor's regulatory risk.[54]

Even where GS is used to mitigate a direct tax, as in the Sleipner project, the cost-effectiveness of the project depends on the tax rate. If the tax is reduced, or if alternative carbon mitigation measures are permitted, the emitter may elect a more cost-effective mitigation measure rather than using GS over the full period initially anticipated, but the owner of the GS site must still bear the cost of closing and monitoring the GS site. This point merely underscores that the value of GS as a carbon mitigation measure (and therefore the return on the capital investment necessary to construct, operate, close, and monitor a GS site) depends on continuity of the regulatory scheme as well as the competitiveness of alternatives.

D. Measurement and Verification

The ability to claim the value of carbon credits for sequestered CO_2 or a premium price for zero carbon energy relies not only on the successful capture and storage of the carbon emissions, but also on properly recorded and verified evidence of the emissions captured and stored. This may require cooperation of several parties. The emitter will have to be able to reconcile its record of emissions to the amount delivered, either directly to the storage site or to the party providing transportation of the CO_2 to the storage site. The transporter in turn will have to show its compliance and the storage site operator will have to be able to provide verification of quantities sequestered and provide monitoring and verification to show that they remain in place.

Ideally, the investor's due diligence review would assure full accountability for measurement, monitoring, and verification in accordance with applicable standards and that responsibility for losses have been fairly allocated, whether contractually or by law. Ongoing studies will eventually develop best practices for measurement, monitoring, and verification, but measurement, monitoring, and verification standards must be integrated into the applicable regulatory schemes, which are still developing. Moreover, under the current regional patchwork of cap-and-trade programs, the project may need to have duplicative procedures in place if the GS project is accepting CO_2 from emitters in diverse locations and thus attempting to verify the emitters' claims in a manner that meets potentially differing requirements for measurement and verification in different markets. If or when the United States develops national standards and markets for carbon regulation and trading, additional adjustments may be needed to meet the national standards. Thus, until the requirements and standards are more fully developed, the full costs of compliance by a proposed project cannot be fully evaluated.

E. How Green?

Whether a GS Gen Project will be able to generate a stream of revenue from emissions credits separately from those it needs to comply with emissions limitations depends again on still-developing regulatory schemes as well as technology-based performance uncertainty. The regulatory issue in this case is the level at which the generator is allowed to emit CO_2 and other GHGs; and the technological issue is the efficacy of the capture and removal of those GHGs, including CO_2. Whether the latter will only just offset the former or whether the two measures will permit the creation of "excess" credits or allowances from storage could vary from project to project depending on the applicable regulations.

The investor in a GS Gen Project must also consider the repercussions if the GS system fails and the project is unable to meet its clean energy production targets. Will the unit be able to mitigate its losses by selling "dirty" power? This is a multi-level issue since it requires consideration of: (1) whether the project is physically able to generate power while bypassing any nonfunctioning equipment intended for carbon capture and storage; (2) the scope of operation permitted under the project's air permits or other applicable laws; and (3) for a project selling its output under a long-term power purchase agreement, the project's options for sales of "dirty" power to either the contracted power purchaser or a third party.

Lastly, where sequestered CO_2 is used to generate carbon credits, standards are needed to establish the scope of liability and remedies (and to whom they are owed) if at some time later—years or decades, perhaps—the CO_2 escapes back into the atmosphere.[55]

---

53. *See* Duquesne Light Co. v. Barasch, 488 U.S. 299 (1989).

54. State laws can facilitate removal of this risk by providing the regulatory agency with explicit authority to grant rate recovery. For example, Cal. Pub. Util. Code §8341(b)(6) (2007) provides:

> A long-term financial commitment entered into through a contract approved by the [California Public Utilities] commission, for electricity generated by a zero- or low-carbon generating resource that is contracted for, on behalf of consumers of this state on a cost-of-service basis, shall be recoverable in rates, in a manner determined by the commission consistent with Section 380. The commission may, after a hearing, approve an increase from one-half to 1 percent in the return on investment by the third party entering into the contract with an electrical corporation with respect to investment in zero- or low-carbon generation resources authorized pursuant to this subdivision.

55. This issue stems from the potential physical impermanence of stored CO_2. It is distinct from the problem of whether a traded emission allowance, credit, certificate, green tag, or similar product will continue to meet the requirements of a specific program, which is a legal issue generally applicable to any such traded product. For example, the problem of a change in regulation between the trade date and delivery date of an emissions credit is addressed in the "Master Renewable Energy Certificate Purchase and Sale Agreement" developed by the Special Committee on Energy and Environmental Finance of the American Bar Association's Section of Environment, Energy and Resources, the Environmental Markets Association, and the American Council on Renewable Energy (Version 1.0). That agreement proposes the concept of a "Regulatorily Continuing" product. A product that is Regulatorily Continuing under that agreement is one that has been represented by a party as complying with a particular program on both the trading date and the date on which the product is delivered, which imposes on the seller the risk of a change in law between such dates. The issue addressed in the text has a potentially much longer time frame, as a credit for

F. Other Revenues

If the GS Gen Project is depending on government assistance, tax breaks, or other government support, it is also necessary to assess the security of that support. For example, DOE pulled funding from the FutureGen project as originally conceived, leaving its private-sector partners scrambling for support.[56] While FutureGen's experience does not establish a general rule, it highlights the issue. The federal tax incentives adopted in 2008 include clawback provisions.[57] Recent DOE grants to WESTCARB and MRCSP are contingent on annual appropriations.[58] A clear understanding of the strings attached to any government funding, including whether the funds are appropriated and when and how they will be paid, and a contingency plan if they are not available when required, is critical to determining the viability of a proposed project.

G. Proximity and Transportation Risks

Ideally, each GS Gen Project or other emitter of CO_2 would be sited adjacent to, or on top of, a potential GS site, thereby eliminating the need to transport CO_2 over any distance. For some early entrants, this may be the case. For example, the Sleipner and In Salah projects dispose of CO_2 in proximity to their gas production activities, and the FutureGen and first WESTCARB projects are intended to couple power generation and storage at or near the storage site. However, siting of power plants (or other emitters) and GS projects may be driven by other factors. For example, the Sleipner site, which is already developed as a GS site, is expected to be able to hold far more CO_2 than that produced by nearby natural gas or oil production activities. But to utilize this storage, CO_2 would need to be transported to the site. Power plants sited for their proximity to load centers or transmission facilities may not be located near a good GS site. Even if originally sited and developed together, a power plant and GS site may have differing lives. And to the extent that CO_2 is sought for use in enhanced oil recovery, it may need to be imported to the oil field from a distant source, as is the case at Weyburn. A Congressional Research Service (CRS) paper prepared in 2007 identified one study as showing that in the United States 77% of captured CO_2 would be stored in reservoirs under the point of emission and 18% within 100 miles of the point of emission[59] and quoted another as saying that "'the majority of coal-fired power plants are situated in regions where there are high expectations of having CO_2 sequestration sites nearby.'"[60] But other studies cited in the CRS Study noted that centralized reservoirs may be preferable to reduce the risk of leakage.[61]

To the extent transportation is required, the literature generally assumes that pipeline transportation will be the most practical means to do so. However, the CRS Study concludes that the uncertainty at present "implies a wide range of possible pipeline configurations."[62] If allowed to develop on an ad hoc basis, growth is likely to be localized, and then eventually local systems will be linked, following the same pattern of growth as the electric grid with the same inherent weakness of not having been designed for interstate transportation.[63] One alternative is to anticipate and build a long-distance CO_2 network, but there is not presently a structure in place to facilitate growth in that manner.[64]

Some areas of the United States and Canada already have experience with CO_2 pipelines used in conjunction with enhanced oil recovery or for other industrial purposes. The CRS Study states over 5,800 kilometers (3,600 miles) of CO_2 pipelines are in operation today,[65] the oldest of which is a 225-kilometer pipeline that was placed into service in 1972.[66] For comparison, there are over 500,000 miles of pipelines transmitting natural gas and hazardous liquids in the United States.[67] Siting is generally conducted under state law (or, as applicable, regulations governing federal lands) and the ability to use eminent domain is not always clear.[68] The Secretary of Transportation regulates safety, including "design, construction, operation and maintenance, and spill response planning."[69] However, with limited exceptions, regulation with respect to the obligation of carriage, rates, and right to exercise eminent domain are matters left to state regulation.[70]

---

sequestration could be granted decades prior to the time a leak or re-release into the atmosphere occurs.

56. The FutureGen Alliance, a consortium of 13 companies co-developing the FutureGen plant at Mattoon, Illinois, has since received some support from Southern Illinois University. Meg Thilmony, *FutureGen Studies Receive $2 Million in Support*, News-Gazette (Champaign, Ill.), July 3, 2008, *available at* http://www.news-gazette.com/news/local/2008/07/03/futuregen_studies_receive__million_in; *see* Press Release, FutureGen Alliance, FutureGen Alliance Hails Senate Appropriations Committee for Protecting FutureGen at Mattoon Funding (July 11, 2008), *available at* http://www.futuregenalliance.org/news/releases/pr_07-11-08.pdf.
57. Financial Bailout Package, *supra* note 12, §§111(c)(3)(C) (amending §48A of the tax code), 115(a) (amending the tax code to add, inter alia, §45Q(d)(6)).
58. *See DOE Award, supra* note 39 (noting annual appropriation requirement); Jeremy Ogul, *Excess Carbon Dioxide to Be Stored Underground*, Cal. Aggie (Davis, Cal.), May 12, 2008, *available at* http://theaggie.org/article/708; Daniel Weintraub, *Building a Better Power Plant—With No Emissions*, Sacramento Bee, June 3, 2008, at 7B, *available at* http://www.sacbee.com/110/story/983599.html.
59. Paul W. Parfomak & Peter Folger, Cong. Research Serv., Carbon Dioxide (CO_2) Pipelines for Carbon Sequestration: Emerging Policy Issues 6 (2007) [hereinafter CRS Study] (citing Robert T. Dahowski et al., Proceedings of the Fourth Annual Conference on Carbon Capture and Sequestration, A North American CO_2 Storage Supply Curve: Key Findings and Implications for the Cost of CCS Deployment (May 2-5, 2005)).
60. CRS Study, *supra* note 59, at 6 (citing John Deutch et al., The Future of Coal 58 (Mass. Inst. of Tech. 2007)).
61. CRS Study, *supra* note 59, at 6 (quoting Jennie C. Stevens & Bob Van Der Zwaan, *The Case for Carbon Capture and Storage*, Issues Sci. & Tech., Fall 2005, at 69-76).
62. CRS Study, *supra* note 59, at 6.
63. *Id.* at 14.
64. *Id.* at 15.
65. *Id.* at 4 (citing Nat'l Pipeline Mapping System Database, U.S. Dep't of Transp. (2005), https://www.npms.phmsa.dot.gov).
66. CRS Study, *supra* note 59, at 4 (citing Webpage, Kinder Morgan CO_2 Co., Canyon Reef Carriers Pipeline (CRC) (2007), http://www.kindermorgan.com/business/co2/transport_canyon_reef.cfm).
67. CRS Study, *supra* note 59, at 5 (citing Bureau of Trans. Statistics, National Transportation Statistics 2005, tbl.1-10 (2005)).
68. CRS Study, *supra* note 59, at 9.
69. *Id.* at 15.
70. *See* Philip M. Marston & Patricia A. Moore, *From EOR to CCS: The Evolving Legal and Regulatory Framework for Carbon Capture and Storage,* 29 Energy L.J. 421, 449-66 (2008) (addressing the current regulatory framework for safety and economic regulation of CO_2 pipelines as well as practical issues related to potential use, expansion, or conversion of existing CO_2 pipelines used to support enhanced oil recovery (EOR) for non-EOR GS-related transportation).

If a CO_2 pipeline network is required, prior experience and these existing laws provide a foundation on which to build. Some issues will remain to be resolved including a rate system that avoids pancaking (charging multiple separate rates), improved methods for siting, and, to facilitate use, a regulatory system that can provide uniformity in the rates, terms, and conditions of service, such as the Federal Energy Regulatory Commission has imposed on electric transmission owners.[71]

While the issues are not insurmountable, they do need to be resolved and as the CRS Study points out, little attention has been directed to date to the issue of transportation. For the potential investor, transportation due diligence must include at least the following three questions: (1) whether transportation will be available between the sources of carbon and the GS site at the time needed and at reasonable rates, terms, and conditions; (2) how the risk of leakage or loss of the CO_2 during transportation will be addressed;[72] and (3) whether the quality standards imposed by the CO_2 pipeline operator (for purity, pressure, etc.) will be compatible with the project in which the investor intends to invest (a carbon-emitting plant or a GS project), or whether additional investment will be required to adjust the characteristics of the CO_2. In the interim, until transportation and an effective transportation regulatory scheme evolve, a GS project located close to the source of a compatible emitter (one that generates CO_2 in volumes and with quality characteristics consistent with the GS well capabilities) avoids a significant area of risk.

H. Siting, Operational, and Post-Closure Risks

A December 2007 World Resources Institute Issues Brief by author Elizabeth Wilson and her colleagues identifies three categories of liability associated with GS: those associated with siting, operations, and long-term responsibility.[73] Siting, they note, can raise questions of both geophysical surface trespass (for example, for locating required monitoring and verification equipment) and geophysical subsurface trespass in the event the CO_2 plume migrates into lands where the owner does not have property rights.[74] Unitization statutes (in states where they exist), rights of eminent domain, and state trespass laws are identified as useful legal tools for supporting the task of accumulating the necessary surface and subsurface property tracts and storage fields.[75] With respect to operational liability, the authors consider potential leakage giving rise to claims of nuisance or negligence; damage to groundwater or hydrocarbons that may be governed by existing laws, but which may result in varying degrees of liability from state to state;[76] and geological hazards such as the risk of a seismic event due to subsurface pressure (which the authors note has been categorized as a low-level risk).[77] A report prepared for the California Legislature comes to many of the same conclusions as the World Resources Institute Issue Brief, but also includes among the pre-injection risks concerns with leakages from pipelines, discussed above, and other surface facilities.[78]

Many of these operational and post well-closure issues could be addressed by establishing clear regulatory guidelines based on continuing studies and analysis of the science behind GS and a comprehensive siting, operations, well-closure, and liability framework. However, at present, there is no coherent body of law for GS projects and even where regulations exist, their application to GS is uncertain. For example, the Report to the California Legislature points to a 2004 study that determined "a project developer might need to acquire as many as 15 permits from federal, state, and local authorities."[79] A state-by-state analysis done for WESTCARB found that depending on the reason for injection, the type of geological formation into which the CO_2 was injected, and the state in which the site was located, the injection well might be regulated as a Class I, Class II, or Class V well.[80]

Part of the problem in formulating appropriate statutes and regulations is that the need for legal remedies correlates directly to our understanding of the potential issues. Since the behavior of CO_2 stored underground is still under study, our grasp of the issues that require attention is, as yet, imperfect.

However, in a move forward, in July 2008, the U.S. Environmental Protection Agency (EPA) issued a proposed notice of rulemaking to establish standards for CO_2 geological sequestration wells. EPA proceeded under its authority pursuant to the Safe Water Drinking Act[81] and proposes to regulate CO_2 under its underground injection control (UIC) authority to regulate the injection of a "fluid," not as a pollutant or commodity.[82] Specifically, it proposes regulations for a new category of wells, Class VI wells, for use for long-term CO_2 storage. "Currently, injection wells for carbon sequestration with [enhanced oil recovery or enhanced gas recovery] are being permitted as Class II injection wells (wells that inject waste fluids associated with the production of oil and natural gas). "However, injection wells for all other carbon sequestration projects are being permitted as Class V experimental

71. CRS Study, *supra* note 59, at 13.
72. *See* Cal. Energy Comm'n & Cal. Dep't of Conservation, CEC-500-2007-100-CMF, Geologic Carbon Sequestration Strategies for California: Report to the Legislature 7 (2008) [hereinafter Report to the California Legislature].
73. Elizabeth J. Wilson et al., *Liability and Financial Responsibility Frameworks for Carbon Capture and Sequestration*, WRI Issue Brief, Dec. 2007, at 1, 2-4 [hereinafter WRI Issue Brief].
74. *Id.* at 2-3.
75. *Id.* at 3-5, tbls.1 & 2. "Unitization . . . is a deliberate effort to consolidate all, or a sufficiently high percentage of, the royalty and participating interests in a pool as will permit reservoir engineers to plan operation of the pool as the natural energy mechanism unit which it is." Andrew Derman & Kyle Vollus, *Unitization*, AIPN Advisor (Ass'n of Int'l Petroleum Negotiators, Houston, Tex), Jan. 2002, at 5, *available at* http://www.tklaw.com/resources/documents/Unitization%20(Derman,%20A.).pdf.
76. The authors observe that displacement of valuable hydrocarbons with less valuable substances during secondary recovery operations is viewed as creating liability in California, but not in Texas, underscoring how differing state law can affect project liabilities. WRI Issue Brief, *supra* note 73, at 3, 4 tbl l.1.
77. *Id.* at 3, 5-9.
78. Report to the California Legislature, *supra* note 72, at 7.
79. *Id.* at 118. The Report notes its reliance on earlier work: Sarah M. Wade, Pub. Interest Energy Research, Cal. Energy Comm'n, CEC-500-2008-009, Legal and Regulatory Frameworks, Property Rights and Liability, (2008).
80. WESTCARB Presentation, Jean Young & Mike Bruno, Terralog Technologies USA, Inc., Permitting and Regulatory Issues Compilation: State-by-State Analysis for Geological (Transportation and Injection) and Terrestrial Sequestration, Aug. 2005, http://www.westcarb.org/pdfs/PermitRegIssues.pdf.
81. 42 U.S.C. §§300f to 300j-26, ELR Stat. SDWA §§1401-1465.
82. UIC NOPR, *supra* note 16, at 43496.

technology wells (wells that are not included in any other class and inject non-hazardous fluids)."[83] EPA proposes to grandfather wells that were drilled prior to implementation of the new rules.[84]

As described by EPA, the new rule

> proposes a new class of well and minimum technical criteria for the geologic site characterization, fluid movement, area of review (AoR) and corrective action, well construction, operation, mechanical integrity testing, monitoring, well plugging, post-injection site care, and site closure for the purposes of protecting underground sources of drinking water (USDWs). The elements of this proposal are based on the existing Underground Injection Control (UIC) regulatory framework, with modifications to address the unique nature of CO_2 injection for GS. If finalized, this proposal would help ensure consistency in permitting underground injection of CO_2 at GS operations across the U.S. and provide requirements to prevent endangerment of USDWs in anticipation of the eventual use of GS to reduce CO_2 emissions.[85]

Among other issues, the rulemaking will determine who has authority to implement and administer Class VI well regulations, once promulgated. Under the UIC program, states, territories, and tribes may obtain primacy over Class II wells, that is, authority to implement and administer the program.[86] Where such authority is not sought or granted, EPA retains authority. In its UIC notice of proposed rulemaking, EPA expresses the view that states and tribes are best suited to provide "comprehensive management" of UIC activities.[87] It acknowledges that where a reservoir crosses state boundaries, state primacy may result in conflict, but it contends those issues "are beyond the scope of this rulemaking."[88] Thus, while the EPA rulemaking is an important first step in establishing norms for well siting, drilling, management, and capping, the rulemaking is still in the initial stages, and even after completion of the rulemaking, implementation issues may remain to be resolved.

EPA's actions under the proposed rule would be limited to addressing the protection of underground drinking water.[89] Harms to the air, human health, and ecosystems are not addressed by the proposed rule. For example, the regulations are intended to assure CO_2 is securely stored so as to prevent it from mobilizing contaminants or native brines that might contaminate drinking water or changing groundwater flow, and consequently may also be effective in preventing release of stored CO_2 into the atmosphere, but the risk of atmospheric release is not specifically addressed by the regulations.[90]

EPA identifies risks to underground sources of drinking water as potentially arising from the following: co-contaminates in the injected CO_2, damage to the caprock from drilling that could permit a future release of stored CO_2 into areas where it might threaten USDWs, native brines being forced into drinking water, the potential for injected CO_2 to form carbonic acid that causes metals or contaminates to leach into drinking water, and mobilization of other contaminates.[91]

In contrast, EPA determined there was "minimal risk" of harm to ecosystems, including to mammals, birds, or plants due to concentrations of CO_2 in the air or soil and "minimal" risk of asphyxiation or "other chronic and acute health effects" to humans from sudden releases.[92] It points to measurements taken from a CO_2 leak from an improperly plugged abandoned oil well in Crystal Geyser, Utah, where CO_2 concentrations at ground level were found to be low enough to not endanger humans.[93] Factors such as ground winds that may disperse leaked gas with sufficient rapidity to avoid dangerous concentrations affect the risk of harm from leaks.[94]

EPA acknowledges that releases of CO_2 from Lake Nyos and Lake Monoun in Cameroon have caused asphyxiation. EPA explains that in those cases, the releases resulted from leaks from naturally occurring underground reservoirs of CO_2 that saturated the lake water over many years (which stratified in response to long periods of high ambient temperatures). The CO_2 was released due to a rapid lake turnover, possibly related to volcanic activity, known as a limnic eruption.[95] EPA's "minimal" risk assessment appears rooted in its observation that the unusually high concentration of CO_2 released over a short period was a direct result of the oddity of a sudden lake turnover, whereas a leak through rock or soil would be more diffuse.[96]

However, EPA underplays the catastrophic effect of the Cameroon releases. Contemporary reports of the 1986 Lake Nyos disaster indicate that within hours of the discharge, over 1,700 people and numerous livestock died, and over 3,000 of the people that escaped the toxic gases suffered burns (from the carbolic acid) or other adverse effects.[97] An estimated 20,000 lives were disrupted.[98] The eruption of gases from Lake Monoun two years earlier killed 40 people.[99] Thus, the potential for catastrophic events years after the time a well is capped cannot be lightly pushed aside, and addressing this risk is essential to jumpstart development of full-scale projects in the United States. EPA's licensing measures would establish standards for opening, operating, and managing the GS site, which provide a baseline against which to measure the prudency of the site operator's actions. Further, EPA would require site monitoring during operations and post-closure, which would facilitate early detection and remediation. Monitoring, detection, and prompt remediation will mitigate the

83. NETL Roadmap, *supra* note 30, at 14.
84. UIC NOPR, *supra* note 16, at 43502.
85. *Id.* at 43492.
86. *Id.* at 43497.
87. *Id.*
88. *Id.*
89. *Id.* at 43495.
90. *Id.* at 43497.
91. *Id.*
92. *Id.* at 43497-98.
93. *Id.* at 43498.
94. *Id.* at 43497.
95. *Id.* at 43498.
96. *Id.*
97. Jill Smolowe & B.J. Phillips, *Cameroon the Lake of Death*, Time, Sept. 8, 1986, *available at* http://www.time.com/time/magazine/article/0,9171,962228-1,00.html.
98. *Id.*
99. Richard Black, *Action Needed on Deadly Lakes*, BBC News Website, http://news.bbc.co.uk/1/hi/sci/tech/4285878.stm (last updated Sept. 27, 2005).

risk of a catastrophic event.[100] However, it is not unreasonable to assume the market will still seek additional assurances.

Public funding or government backstops are one means to address this issue. Illinois' effort to attract siting of a DOE-supported FutureGen project provides one model. Illinois' statute, effective July 30, 2007, requires the state of Illinois to accept title to and liability for all CO_2 generated by the FutureGen project and sequestered during the post-injection period.[101] The state would also receive the right to any emission offsets or marketable or tradable rights associated with the CO_2.[102] The state will procure insurance, if available,[103] to protect the FutureGen Alliance (a §501(c)(3) consortium) and its members and their affiliates, directors, officers, employees, and agents (the Operator) from a qualified loss from civil actions "arising out of or resulting from the storage, escape, release, or migration of the post-injection sequestered gas that was injected during the operation of the FutureGen Project by the FutureGen Alliance."[104] It was the legislature's intent to fund the cost, at least in part, from the sale of emission reduction rights or credits.[105] In addition, the state will indemnify the Operator for such qualified losses to the extent not covered by such insurance, subject to certain exclusions, such as for willful misconduct or pre-injection operations of the FutureGen project.[106]

The Illinois structure was adopted explicitly and exclusively to support a first-of-its-kind project, so the question remains whether public financing of long-term liabilities will be essential to success of future projects. Wilson and colleagues discuss the advantages and disadvantages of other possible models for handling long-term liabilities. These include the Resource Conservation and Recovery Act (RCRA),[107] which relies on third-party instruments or self-insurance, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, including the Superfund trust fund),[108] state-established liability programs related to underground natural gas storage; and federal indemnity or insurance programs such as the National Flood Insurance Program[109] and the Price-Anderson Nuclear Industries Indemnity Act,[110] which include government backstops.[111] The authors express concern with placing "[a]rbitrary limits on liability"[112] that might result in a transfer of risk to the public and conclude that an effective program must meet these five criteria:

1. Ensure funds are adequate, if and when needed;
2. Ensure funds are readily accessible;
3. Establish minimum standards for financial institutions securing funds (or underwriting risks);
4. Ensure continuity of financial responsibility, if and when sites are transferred; and
5. Not impose excessive barriers to projects that have public benefits.[113]

In September 2007, the Interstate Oil and Gas Compact Commission (IOGCC), with support from DOE and the National Energy Technology Laboratory, published a framework for the regulation of GS projects.[114] It concludes that "the most efficient methodology" to support monitoring, verification, and remediation activities during the post-closure period of a storage site is to utilize state-operated trust funds.[115] It proposes the trust fund be funded through fees collected from the site operators.[116] The proposed use of a state trust fund solves the potentially difficult issue that the initial site operator may not be viable at the time an issue arises. However, the subsequent uses of the site and the potential contributory responsibility of the original developer and the then-current landowner at the time an issue arises will also need to be addressed as specific laws are developed.

Authors Chiara Trabucchi and Lindene Patton have suggested a comprehensive governmental oversight program that addresses both safety oversight and national funding.[117] They observe that financial risk can be characterized as "skinny tail" or "fat tail" in each instance referring to the loss profile if graphed. A skinny tail indicates that risks have been largely mitigated through sound management practices, such that losses may still be catastrophic if incurred, but have a substantially lowered risk of occurring. Pooling, e.g., insurance instruments or public funds, can be used to manage skinny tail risks, whereas projects with fat tail risks, that is more frequent and catastrophic risks that might be incurred by knowingly undertaking a risky enterprise such as building a GS project in a region that is known to be geologically unstable, cannot be effectively spread.[118] They make the point, with which this author agrees, that a legal and regulatory structure that promotes sound management practices creates the frame-

100. *See* Report to the California Legislature, *supra* note 72, at 7 ("Various monitoring techniques can verify the amount of CO_2 stored, track the CO_2 plume underground, and check for potential leakage from the sequestration formation to the surface.").
101. 20 Ill. Comp. Stat. 1107/20.
102. *Id.*
103. *Id.* §25(a).
104. *Id.* §15 (defining "FutureGen Alliance," "operator," and "public liability").
105. *Id.* §25(c).
106. *Id.* §30(a)(1)-(4).
107. 42 U.S.C. §§6901-6992(k), ELR Stat. RCRA §§1001-11011.
108. 42 U.S.C. §§9601-9675, ELR Stat. CERCLA §§101-405.
109. 42 U.S.C. §§4011-4031.
110. 42 U.S.C. §2210.
111. WRI Issue Brief, *supra* note 73, at 5-8.
112. *Id.* at 8.
113. *Id.*
114. *See* Interstate Oil & Gas Compact Comm'n, Storage of Carbon Dioxide in Geologic Structures: A Legal and Regulatory Guide for States and Provinces, (2007), *available at* http://iogcc.publishpath.com/Websites/iogcc/PDFS/2008-CO2-Storage-Legal-and-Regulatory-Guide-for-States-Full-Report.pdf.
115. *Id.* at 11.
116. *Id.*
117. Chiara Trabucchi & Lindene Patton, Storing Carbon: Options for Liability Risk Management, Financial Responsibility, BNA's WORLD CHANGE CLIMATE REPORT, Vol. 28, No. 170 (Sept. 3, 2008) *available at* http://www.zurich.com/NR/rdonlyres/466AD5B0-3549-4681-91AC-F625BA88AE78/0/BNA_Article_August_2008.pdf. Zurich Financial Services, with which one of the authors is associated, offers Carbon Capture and Sequestration (CCS) Liability Insurance and the Geological Sequestration Financial Assurance. *See* http://www.zurich.com/main/insight/globalinitiatives/globalclimatechange initiative/climateproducts.htm *See also* Reuter's Business Wire, Zurich's Emerging Markets Unit Provides Political Risk Insurance for Carbon Credit Projects (Feb. 20, 2008) at http://www.reuters.com/article/pressRelease/idUS231720+20-Feb-2008+BW20080220.
118. Trabucchi & Patton, *supra* note 117, at 8 n.29.

work for effectively addressing financial risk and assures that financial instruments or public funding mechanisms do not become a mechanism for transferring to others those risks that could be mitigated by developers and users of carbon sequestration projects through better safety and management practices. Moreover, as noted above, a clear regulatory and legal framework is essential for creating a standard against which negligence and liability can be measured.

I. Toward a Better Legal Framework

An inherent problem in fashioning an appropriate legal and regulatory framework for carbon regulation is the tension between comprehensive management and localized control. While it makes sense to build on regulations and structures that already exist, such as unitization laws and the UIC framework, which includes state primacy, a parochial approach to the discrete issues potentially raised by GS projects may lead to gaps and inconsistencies. A comprehensive national framework that sets forth a road map through existing regulations and identifies areas in which new regulations are required, and differentiates between areas for local regulation and national standards, would be useful. The prospect of an interstate or international CO_2 pipeline network, cross-border (state and nation) reservoirs, and national or international markets for CO_2 emission credit products all point toward the need for a high degree of uniformity with respect to CO_2 products and the process of sequestration.[119] However, at present the United States is proceeding region-by-region and state-by-state. An investor's due diligence review of the legal risks for a project must similarly proceed with close scrutiny of regional and state variations and awareness that the legal landscape is still subject to seismic shifts.

119. *Compare* EU Proposal, *supra* note 1 (setting forth a proposed framework for the development of GS by Member states).