CLIMATE CHANGE POLICY PARTNERSHIP

From Carbon Capture to Storage: Designing an Effective Regulatory Structure for CO_2 Pipelines

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Executive Summary

The large number of fossil fuel–fired power plants in operation, combined with the large reserves of domestic coal and concerns about energy security, suggest that efforts to reduce GHG emissions must focus not only on zero-emitting energy resources such as wind, solar, and nuclear power, but also on addressing emissions from existing and new fossil fuel–fired power plants. For this reason, a set of emerging technologies that could allow power plants and manufacturing facilities to capture their CO_2 emissions before they are released into the atmosphere and store them in geologic formations—collectively referred to as carbon capture and storage (CCS)—is receiving significant attention from policymakers and the private sector.

Large-scale adoption of CCS to mitigate CO_2 emissions will depend on the construction of a CO_2 pipeline network capable of transporting the captured emissions to sequestration sites. A nascent CO_2 pipeline network already exists to provide the gas to oil fields, primarily in the Permian Basin in Texas, for enhanced oil recovery operations. A drastic expansion of this network will be necessary to accommodate wide-spread use of CCS technologies.

The Surface Transportation Board (STB) and the Federal Energy Regulatory Commission (FERC) are responsible for pipeline regulation on the federal level for issues other than pipeline safety. The STB has limited authority over interstate pipelines transporting "a commodity other than water, gas, or oil." The FERC has authority over interstate pipelines carrying natural gas or oil, although the specific regulatory powers differ for the two types of pipelines. In each circumstance, post-construction pipeline safety is governed by the Department of Transportation's Office of Pipeline Safety (OPS).

The OPS has specific jurisdiction over CO_2 pipelines. Regulation of pipeline construction, transportation rates, and operation of CO_2 pipelines—especially CO_2 piped as a waste product destined for storage—falls into a gray area at the federal level. It is generally accepted that the STB has jurisdiction over CO_2 pipelines, but that authority has not been tested. Furthermore, the limited regulatory regime covering CO_2 pipelines occurred by default and not as a result of a deliberate congressional or administrative decision. Instead, the legal framework that granted jurisdiction over oil and natural gas pipelines to the FERC and jurisdiction over other pipelines carrying other commodities to the STB was established long before the concept of CCS existed. Given the rapid expansion of CO_2 pipelines expected in the coming years as industry begins deploying CCS technologies to reduce GHG emissions, it is prudent for regulators to take a fresh look at the appropriate regulatory structure(s) to govern CO_2 pipelines.

In particular, Congress should clarify the agency with primary oversight of pipeline construction and operation, and provide the appropriate level of regulatory authority to that agency. The FERC's authority over natural gas pipelines (as opposed to its authority over oil pipelines) provides an effective model for facilitating the construction and operation of a national CO_2 pipeline network. For example, eminent domain authority will likely be necessary to allow pipeline companies to quickly acquire land for rights-

of-way. Prior approval for constructing and decommissioning pipelines would provide certainty to CO_2 emitters investing in CCS technologies that they will have long-term access to pipelines. Federal authority over transportation rates and preemption of state law would remove the prospect of pipeline operators facing multiple regulatory structures.

The pipeline safety regulatory structure appears to be effective, as pipelines already provide the safest method of transporting hazardous liquids and gases. Congress should consider mandating leak detection and reporting in order to address both the safety issues presented by piping CO_2 near high population areas and to detect fugitive emissions for environmental purposes.

Finally, lawmakers will need to consider how to address liability for fugitive emissions from pipeline leaks under a cap-and-trade system. This issue is unique to pipelines carrying CO_2 from facilities subject to a GHG emissions limit.

This paper provides an overview of the federal pipeline regulatory structure and the challenges associated with expanding the network to accommodate large-scale deployment of CCS technologies. It then examines the authority of the federal agencies responsible for pipeline regulation and recommends certain changes to the regulatory structure to facilitate the construction and operation of a safe nationwide CO_2 pipeline network. Finally, the paper discusses options for addressing fugitive pipeline emissions under a cap-and-trade system.

I. Introduction

Concerns about climate change and increasing demand for electricity are placing competing demands on the nation's energy sector. State regulators, for example, are beginning to take greenhouse gas (GHG) emissions into account when considering permit applications for new electricity generation facilities. Kansas and Florida have denied permit applications for new coal-fired power plants due to climate concerns.[1] In North Carolina, the Public Utility Commission approved a new coal-fired power plant contingent on the facility's becoming "carbon-neutral" by 2018.[2] In addition, the U.S. Supreme Court's ruling in 2007 that CO_2 is a pollutant under the Clean Air Act has led at least one judge to halt the permitting process for a coal-fired power plant.[3] At the same time, U.S. energy demand is projected to increase by 29% by 2030,[4] and coal provides an inexpensive, abundant domestic energy source.[5]

Fossil fuels supply most of the world's energy, and energy analysts suggest that this will continue as consumption increases.[6] In the United States, coal-fired power plants generate almost half of the nation's electricity—by far the largest domestic fuel source—and 47 new coal-fired power plants are currently in the permitting or construction phase.[7] Natural gas–fired power plants provide an additional 20% of the nation's electricity generation.[8] Together, the U.S. electric power sector emitted almost

[1] Kansas Department of Health and Environment, Press Release: KDHE Denies Sunflower Electric Air Quality Permit, Oct. 18, 2007; Office of Governor Kathleen Sebelius, Press Release: Sebelius Vetoes Coal Bills Once Again, May 16, 2008; Coal's Doubters Block New Wave Of Power Plants, Wall St. Journal, July 25, 2007 (reporting on the decision of the Florida Public Service Commission to deny a permit application to build a 1,960-MW coal-fired power plant based in part on "uncertainty about the future cost to curb carbon dioxide pollution").

[2] N.C. Dept. of Environment & Natural Resources, Air Quality Permit No. 04044T28, Duke Energy Carolinas, Attachment: Greenhouse Gas Reduction Plan (Jan. 29, 2008).

[3] *Friends of the Chattahoochee, Inc. v. Couch*, Sup. Ct. of Fulton Co., Docket No. 2008CV146398 (Jun. 30, 2008) at 6 (citing *Massachusetts v. EPA*, 127 S. Ct. 1438 [2007]).

[4] U.S. EIA, Official Energy Statistics from the U.S. Gov't, Annual Energy Outlook 2008, at 67, Hhttp://www.eia.doe.gov/oiaf/ieo/highlights.htmlH. Global energy consumption is expected to increase by 50% during the same period. U.S. EIA, Official Energy Statistics from the U.S. Gov't, International Energy Outlook 2008: Highlights, Hhttp://www.eia.doe.gov/oiaf/ieo/highlights.htmlH.

[5] *See, e.g.,* Nat'l Energy Tech. Lab., Secure & Reliable Energy Supplies – Realizing the Clean-Energy Potential of Domestic Coal, Hhttp://www.netl.doe.gov/KeyIssues/secure_energy2a.htmlH ("There is more energy potential in America's coal than in all the oil of the Middle East"); Pew Center on Global Climate Change: Coal and Climate Change Facts, Hhttp://www.pewclimate.org/global-warming-basics/coalfacts.cfmH ("Coal can provide usable energy at a cost of between $1 and $2 per MMBtu compared to $6 to $12 per MMBtu for oil and natural gas, and coal prices are relatively stable").

[6] U.S. EIA, Official Energy Statistics from the U.S. Gov't, International Energy Outlook 2008: Highlights, Hhttp://www.eia.doe.gov/oiaf/ieo/highlights.htmlH.

[7] U.S. EIA, Official Energy Statistics from the U.S. Gov't, Electricity Generation, last updated Dec. 2007, Hhttp://www.eia.doe.gov/neic/infosheets/electricgeneration.htmlH; Erik Shuster, National Energy Technology Lab., Office of Systems Analyses and Planning, Feb. 18, 2008 (updated with Revised EIA AEO 2008 March Projections), Hhttp://www.netl.doe.gov/coal/refshelf/ncp.pdfH.

[8] U.S. EIA, Official Energy Statistics from the U.S. Gov't, Electricity Generation, last updated Dec. 2007, Hhttp://www.eia.doe.gov/neic/infosheets/electricgeneration.htmlH.

2,500 million metric tons of carbon dioxide ($MMtCO_2$) in 2007—approximately 35% of the nation's total GHG emissions.[9]

Because power plants typically have a lifespan of at least 40 years, many of the existing power plants burning coal, natural gas, and oil will remain in operation for years to come.[10] The EIA projects that the continued use of these plants, in addition to the planned construction of new coal-fired power plants, will cause domestic coal production to increase at 0.3% per year through 2015, with an even greater increase between 2015 and 2030 if CO_2 emissions remain unrestricted.[11]

The large number of fossil fuel–fired power plants in operation, combined with the large reserves of domestic coal and concerns about energy security, suggest that efforts to reduce GHG emissions must focus not only on carbon-free energy resources such as wind, solar, and nuclear power, but also on addressing emissions from existing and new fossil fuel–fired power plants. For this reason, a set of emerging technologies that could allow power plants and manufacturing facilities to capture their CO_2 emissions before they are released into the atmosphere and store them in geologic formations—collectively referred to as carbon capture and storage (CCS)—are receiving significant attention from policymakers and the private sector.[12] The 2007 Energy Bill, for example, provides hundreds of millions of dollars a year for CCS studies and demonstration projects.[13] In 2008, the U.S. Senate debated the Lieberman-Warner Climate Security Act ("the Lieberman-Warner bill"), a bill that would have created a mandatory economy-wide cap-and-trade program for CO_2 and other greenhouse gas (GHG) emissions. If enacted, the legislation would have provided billions of dollars in incentives for large CO_2 emitters to incorporate CCS technologies into power plants and industrial facilities.[14] Following the rejection of the Lieberman-Warner bill, three new bills have been introduced that would provide tax incentives or direct funding for early CCS projects.[15]

Economic and energy models predict that CCS technology could become commercially available as early as 2020 and could be a central element in energy infrastructure by 2050, assuming that lawmakers enact a policy that imposes a cost for GHG emissions that is high enough to make the technology cost effective.[16] Large-scale adoption of CCS to mitigate CO_2 emissions will depend on the construction of a CO_2 pipeline network capable of transporting the captured emissions to sequestration sites.[17]

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[9] The U.S. emitted a total of 7,075.6 MMT of CO_2 in 2006. U.S. EIA, U.S. Carbon Dioxide Emissions from Energy Sources: 2007 Flash Estimate, May 2008, at 3, Hhttp://www.eia.doe.gov/oiaf/1605/flash/pdf/flash.pdfH; U.S. EIA, Emissions of Greenhouse Gases Report, Nov. 28, 2007, Hhttp://www.eia.doe.gov/oiaf/1605/ggrpt/index.htmlH.
[10] Mark C. Bohm, *et al.,* Capture-Ready Coal Plants – Options, Technologies, and Economics, INT'L JOURNAL OF GREENHOUSE GAS CONTROL, 2007, at 113–4.
[11] U.S. EIA, Annual Energy Outlook 2008, (2008), at 84.
[12] For a brief description of CCS technologies, *see* U.S. Dept. of Energy, Carbon Sequestration, Hhttp://fossil.energy.gov/sequestration/H (last updated Apr. 3, 2008).
[13] Public Law No: 110–140.
[14] S. 3036, 110th Congress (2008).
[15] S. 3132 110th Congress (2008); S. 3208, 110th Congress (2008); H.R. 6258, 110th Congress (2008).
[16] *See, e.g.,* J.J. Dooley, *et al.,* Modeling Carbon Capture and Storage Technologies in Energy and Economic Models, An Invited Paper for the Intergovernmental Panel on Climate Change's Expert Meeting on CO_2 Removal and Storage, Joint Global Change Research Institute, College Park, MD, at 1. A recent study from the Massachusetts Institute of Technology estimates that a CO_2

Pipelines generally provide the safest, most efficient methods of transporting large volumes of hazardous liquids and gases and are expected to be a major element in a CCS system.[18] Today, there are only 3,600 miles of CO_2 pipelines in the U.S., [19] compared to 302,000 miles of natural gas pipelines.[20] This current CO_2 network is aimed at providing CO_2 to oil fields for "enhanced oil recovery" (EOR) and does not transport CO_2 for the purpose of permanently storing GHG emissions.[21] Financing, permitting, and constructing the necessary pipelines will require years of lead time before CO_2 is actually transported to sequestration sites. As Congress considers legislation to encourage early adoption of CCS, it should also consider the regulatory changes that may be necessary to facilitate the rapid expansion of the pipeline network.

This paper provides an overview of the federal pipeline regulatory structure and the challenges associated with expanding the network to accommodate large-scale deployment of CCS technologies. It then examines the authority of the federal agencies responsible for pipeline regulation and recommends certain changes to the regulatory structure to facilitate the construction and operation of a safe nationwide CO_2 pipeline network. Finally, the paper discusses an issue that is unique to pipelines carrying CO_2 from facilities subject to a GHG emissions limit—how to account for fugitive emissions caused by pipeline leaks.[22]

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price of $30/ton would make CCS cost effective for new power plants. MIT, The Future of Coal, 2007, at xi, Hhttp://web.mit.edu/coal/The_Future_of_Coal.pdfH.

[17] Geologic formations capable of storing CO_2 include oil and gas reservoirs, deep saline formations, unmineable coal seams, oil- and gas-rich organic shales, and basalts. For more information on geologic sequestration of CO_2, *see* National Energy Tech. Lab., Carbon Sequestration: FAQ Information Portal, http://www.netl.doe.gov/technologies/carbon_seq/faqs.html.

[18] According to the Pipeline and Hazardous Materials Safety Administration: To move the volume of even a modest pipeline, it would take a constant line of tanker trucks, about 750 per day, loading up and moving out every two minutes, 24 hours a day, seven days a week. The railroad-equivalent of this single pipeline would be a train of seventy-five 2,000-barrel tank rail cars every day. These alternatives would require many times the people, clog the air with engine pollutants, be prohibitively expensive and—with many more vehicles on roads and rails carrying hazardous materials—unacceptably dangerous. U.S. Dept. of Transp. Pipeline & Hazardous Materials Safety Admin., Safe Pipelines FAQ, Hhttp://www.phmsa.dot.gov/pipelineH.

[19] Adam Vann & Paul W. Parfomak, *Regulation of Carbon Dioxide (CO_2) Sequestration Pipelines: Jurisdictional Issues*, Congressional Research Service, Report RL343070 (April 15, 2008), at 2.

[20] U.S. EIA, Office of Official Energy Statistics from the U.S. Gov't, About Natural Gas Pipelines, Hhttp://www.eia.doe.gov/pub/oil_gas/natural_gas/analysis_publications/ngpipeline/H (last visited July 12, 2008).

[21] Oil producers use a variety of techniques, collectively referred to as "Enhanced Oil Recovery" or EOR, to recover a higher percentage of crude oil from reservoirs. "CO_2 flooding"—injecting CO_2 into reservoirs to "push additional oil out to the wellbore"—is the fastest growing EOR technique in the U.S. U.S. Dept. of Energy, Enhanced Oil Recovery/CO_2 Injection, Hhttp://www.fossil.energy.gov/programs/oilgas/eor/index.htmlH; U.S. Nat'l Renewable Tech. Lab., CO_2 EOR Technology: Technologies for Tomorrow's E&P Paradigms, Mar. 2006, at 2.

[22] *See, e.g.,* Gunnar Birgisson & William Lavarco, "An Effective Regulatory Regime for Transportation of Hydrogen," INTERNATIONAL JOURNAL OF HYDROGEN ENERGY 29, pp. 771–780 at (2004).

II. The Evolution of Federal Pipeline Regulatory Authority

Federal regulation of fuel pipelines began in 1906 with the Hepburn Act, granting the Interstate Commerce Commission (ICC) the authority to implement tariff controls for operators of oil pipelines.[23] The law required the operators "to charge only just and reasonable rates, and to avoid unjust discrimination and undue preferences, including any deviation from the published tariff rates."[24] In 1938, Congress expanded federal jurisdiction over energy pipelines with the Natural Gas Act (NGA), granting the Federal Power Commission (FPC) regulatory authority over interstate natural gas pipelines.[25]

There are currently three approaches to pipeline regulation on the federal level.[26] The most limited regulatory approach grants to the Surface Transportation Board (STB) jurisdiction over interstate pipelines carrying "a commodity other than water, gas, or oil."[27] Under this scheme, states retain authority to site the pipelines and the STB regulates the rates that pipeline operators charge for transportation. Notably, the STB does not have authority to challenge a pipeline operator's rates on its own accord and can only exercise its rate-making authority if a complaint is filed with the Board.[28]

The second regulatory model applies to natural gas pipelines. Under this model, the Federal Energy Regulatory Commission (FERC) has responsibility for siting interstate pipelines, controlling aspects of pipeline operations, and regulating rates charged to customers.[29] Federal courts have found that FERC regulations regarding interstate natural gas pipelines preempt state regulations.[30]

The final federal pipeline regulatory model covers oil pipelines. Similar to the STB approach described above, the FERC's authority over oil pipelines is limited to rate regulation, with states retaining siting authority.[31] Unlike the STB, however, the FERC can initiate rate cases on its own accord.[32]

In each circumstance, post construction pipeline safety is governed by the Department of Transportation's Office of Pipeline Safety (OPS).[33]

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[23] Hepburn Act, ch. 3591, 34 Stat. 584 (1906).
[24] Steven Reed & Pantelis Michalopoulos, Oil Pipeline Regulatory Reform; Still in the Labyrinth?, 16 Energy L.J. 65, 68 (1995).
[25] 15 USC § 701 *et. seq.*
[26] *See* Joseph T. Kelliher , Testimony before the Senate Committee on Energy and Natural Resources, Jan. 31, 2008 at 3, Hhttp://www.ferc.gov/EventCalendar/Files/2008013114275-8Kelliher%20testimony%20Senate%20ENR%20January%2031%202008.pdfH.
[27] 49 USC § 15301 (2000).
[28] 49 USC § 15901(a).
[29] 42 USC § 7172(a)(1)(C).
[30] *See, e.g.,* James B. Slaughter & James M. Auslander, Preemption Litigation Strategies Under Environmental Law, 22-SPG Nat. Resources & Env't 18, 20 (Spring 2008). The Natural Gas Act originally granted siting authority to the states, but Congress amended the law to preempt state's siting authority in 1947 after determining that state siting for natural gas pipelines was ineffective. *See* Kelliher, *supra* note 26, at 3.
[31] 49 USC § 60502; Christopher J. Barr, "Growing Pains: FERC's Responses to Challenges of the Development of Oil Pipeline Infrastructure," 28 ENERGY L. J. 43, 49–50 (2007).
[32] Pub. L. 102–486, title XVIII, § 1801 (1992); 18 CFR Subchapter P.
[33] 49 USC § 60102(a)(1) & (i).

The Pipeline Safety Act specifically grants OPS jurisdiction over the safety of CO_2 pipelines.[34] While it is generally assumed that rate regulation for CO_2 pipelines currently falls under the jurisdiction of the STB, the issue remains unresolved.[35] As is discussed below in more detail, both the FERC and the ICC, the predecessor to the STB, rejected arguments that they have jurisdiction over CO_2 and the STB has yet to hear a rate case involving a CO_2 pipeline.

Even if the STB currently has jurisdiction over CO_2 pipelines, that authority occurred by default and not as a result of a deliberate congressional or administrative decision. Instead, the legal framework that granted jurisdiction over oil and natural gas pipelines to the FERC and jurisdiction over other pipelines carrying commodities to the STB was established long before the concept of CCS was considered. Given the rapid expansion of CO_2 pipelines expected in the coming years as industry begins deploying CCS technologies to reduce GHG emissions, it is prudent for regulators to take a fresh look at the appropriate regulatory structure(s) to govern CO_2 pipelines.

III. The Challenges Associated With an Expanded CO_2 Pipeline Network

A. Pipeline Construction

Siting pipelines through populated areas is difficult, especially on an interstate scale.[36] There are a number of difficulties that must be addressed, regardless of whether siting of CO_2 pipelines falls under federal or state jurisdiction. Residents may object to pipeline siting ("not in my backyard") because of real or perceived risk of harm from leaks or explosion.[37] Private siting without eminent domain also runs the risk of a having a "hold-out" problem, where one land owner is able to engage in rent seeking by holding out on the sale of a right-of-way in order to receive an exorbitant price.[38] This problem is often seen when the acquisition of a large, contiguous parcel or right-of-way is necessary but is impeded by exceedingly strong property right interests of individual owners.[39] Eminent domain authority may be necessary to avoid these gross inefficiencies in construction.

[34] 49 USC § 60102(i).
[35] *See, e.g.,* Office of Senator Ken Salazar, Press Release: Sen. Salazar: 'Carbon Capture is Central to Our Nation's Energy Policy and Environmental Security' (Jan. 31, 2008) (stating that the U.S. Surface Transportation Board has "regulatory jurisdiction for transporting carbon dioxide"); GAO Report: Surface Transportation: Issues Associated with Pipeline Regulation by the Surface Transportation Board, April 1998 at 3 (stating that stated that CO_2 pipelines are subject to STB oversight).
[36] *See, e.g.,* Birgisson & Lavarco, *supra* note 36, at 772 (2004) ("The main barrier to constructing pipelines is the acquisition of the right-of-way needed to site the pipelines.").
[37] *See, e.g.,* The Interstate Oil and Gas Compact Commission Task Force on Carbon Capture and Geologic Storage, *Storage of Carbon Dioxide in Geologic Structures: A Legal and Regulatory Guide for the States,* (2007) at 4.
[38] *See, e.g.,* Birgisson & Lavarco, *supra* note 36, at 772 ("If a pipeline had to rely solely upon the market to acquire these easements, pipeline developers would have little leverage against individual landowners who could demand exorbitant payments for the easements," making it "economically infeasible to construct a pipeline.").
[39] For a discussion of property rights rules and the use of liability rules for government appropriation projects, *see* Guido Calabresi & Douglas Malamed, "Property Rules, Liability Rules and Inalienability: One View of the Cathedral," 85 Harvard Law Rev. 1089 (1972); *see* generally Richard Epstein, *Takings: Private Property and the Power of Eminent Domain* (1985).

In addition to siting problems common to pipeline systems in general, expanding the CO_2 pipeline network presents some special challenges. Current CO_2 pipelines exist primarily in rural, unpopulated areas.[40] Their operators have thus avoided many of the problems associated with siting large energy infrastructure projects.[41]

As CCS technologies become commercially viable, the CO_2 pipeline system is expected to expand beyond these rural areas, although there is some disagreement as to the scope of the expansion of the pipeline system. Some studies suggest that most captured CO_2 will be stored at or very near its source,[42] while others indicate that CO_2 storage will be more centralized, with a number of feeder lines from each power plant into a few large storage sites.[43] In either case, the CO_2 pipeline network will expand first around existing CO_2 point sources, many of which are located close to densely populated areas. The high costs of electricity transmission will likely lead power producers to continue locating plants near highly-populated areas.[44]

B. Rate Regulation

Some form of rate regulation for CO_2 transport will likely be necessary. As with any capital-intensive project, there will be high barriers to entry into the CO_2 transport market. Because of these high costs, there will likely be monopoly power associated with pipeline ownership, creating the possibility of rate manipulation and overcharging users. Rather than rely on an ad hoc state-by-state system to deter these issues, a federally-regulated rate structure may be desirable, similar to that used for interstate electricity transmission lines or natural gas pipelines.

Federal rate regulation may also be necessary to avoid the emergence of multiple state-based rate structures for interstate pipelines.[45] In addition, cost recovery for capital investments in pipeline

[40] Paul W. Parfomak and Peter Folger, *Carbon Dioxide (CO_2) Pipelines for Carbon Sequestration: Emerging Policy Issues*, Congressional Research Service, Report RL33971 (Apr. 19, 2007), at 16.

[41] *See, e.g.,* Shalini P. Vajjhala and Paul S. Fischbeck, "Quantifying Siting Difficulty A Case Study of U.S. Transmission Line Siting," Resources For the Future DP 06-03 (February, 2006).

[42] *See* Parfomak & Folger, *Carbon Dioxide (CO_2) Pipelines for Carbon Sequestration: Emerging Policy Issues*, *supra* note 40, at 6 (citing R.T. Dahowski, et al "A North American CO_2 Storage Supply Curve: Key Findings and Implications for the Cost of CCS Deployment," *Proceedings of the Fourth Annual Conference on Carbon Capture and Sequestration* (Alexandria, VA: May 2–5, 2005); and John Deutch, Ernest J. Moniz, et al., *The Future of Coal* [Cambridge, MA: Massachusetts Institute of Technology: 2007] at 58).

[43] *See* M.A. de Figueiredo, *et al.*, Regulating Carbon Dioxide Capture and Storage, MIT, April 2007, at 2 ("In a regime where many power plants are capturing CO_2, a more likely configuration will involve a networked [pipeline] system that is used by multiple power plants at different locations which are transporting CO_2 to one or more large storage sites."); Eric Williams, *et al.,* "Carbon Capture, Pipeline and Storage: A Viable Option for North Carolina Utilities?" Working paper prepared by the Nicholas Institute for Environmental Policy Solutions and The Center on Global Change, Duke University (Durham, NC; March 8, 2007), at 4.

[44] *See* Adam Newcomer & Jay Apt, "Implications of Generator Siting for CO_2 Pipeline Infrastructure," 36 ENERGY POLICY 1776, 1781–1782 (2008). *See also* Paul W. Parfomak and Peter Folger, *Pipelines for Carbon Dioxide (CO_2) Control: Network Needs and Cost Uncertainties*, Congressional Research Service, Report RL34316 (Jan. 10, 2008) at 10 (citing Jeffrey M. Bielicki and Daniel P. Schrag, "On the Influence of Carbon Capture and Storage on the Location of Electric Power Generation," Harvard University, Belfer Center for Science and International Affairs, Working paper [2006]).

[45] Parfomak & Folger, *Carbon Dioxide (CO_2) Pipelines for Carbon Sequestration: Emerging Policy Issues*, *supra* note 40, at 13.

networks may be an issue for utilities operating in regulated markets where prices are controlled by public utility commissions.[46]

C. CO_2 Safety Concerns

Direct exposure to low levels of CO_2 poses a relatively low risk to human health and the environment. The gas is not flammable and does not carry the risk of fire or explosion that accompanies natural gas pipelines.[47] Nonetheless, a CO_2 pipeline network does pose some unique safety concerns, as exposure to high levels of CO_2 can be detrimental to ecology and human health, possibly resulting in death.[48] Because CO_2 is heavier than air, it does not disperse like natural gas. Instead, it will accumulate in low-lying areas, like basements, tunnels, and valleys.[49] Furthermore, CO_2 is odorless and colorless, making detection difficult.[50]

Normal outdoor air concentration for CO_2 is 300 parts per million (ppm). The Occupational Safety and Health Administration (OSHA) and National Institute for Occupational Safety and Health (NIOSH) limit workplace exposure to CO_2 at 5,000 ppm (0.5% by volume) over an 8-hour workday, although OSHA recommends 1,000 ppm as an upper limit.[51] Exposure to concentrations between 2,000–5,000 ppm may cause headaches, drowsiness, poor concentration, increased heart rate, and nausea.[52] CO_2 concentration levels of 10% or more by volume (100,000 ppm) may result in unconsciousness or death.[53] CO_2 pipeline leaks that do not present a danger to human health may still cause environmental harm. "Persistent low-level leakage of CO_2 can affect aquatic ecosystems by lowering the pH, especially in stagnant or stably stratified waters."[54]

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[46] *Id.*
[47] *Id.* at 4; *See* Airco, Inc., "Carbon Dioxide Gas," *Material Safety Data Sheet* (Aug. 4, 1989) [Hhttp://www2.siri.org/msds/f2/byd/bydjl.htmlH]; *Cf.* Mobile Oil Corp., "Natural Gas," *Material Safety Data Sheet* (March 28, 1994) [Hhttp://www2.siri.org/msds/f2/ckr/ckrjr.htmlH].
[48] Andrew C. Byers, "Success of Carbon Sequestration Hinges on Legal and Regulatory Risks," 24 NATURAL GAS & ELECTRICITY 10, p. 3 (May 2008).
[49] J. Barrie, K. Brown, P.R. Hatcher, and H.U. Schellhase, "Carbon Dioxide Pipelines: A Preliminary Review of Design and Risks," Proceedings of the 7th International Conference on Greenhouse Gas Control Technologies (Vancouver, Canada: Sept. 5–9, 2004): 4.
[50] *Id.*
[51] 29 CFR 1910.1000 Table Z-1; OSHA, OSHA Technical Manual, Section III, Chapter 2, at IV.C.3., Hhttp://www.osha.gov/dts/osta/otm/otm_iii/otm_iii_2.htmlH ; NIOSH, NIOSH Pocket Guide to Chemical Hazards, Hhttp://www.cdc.gov/NIOSH/npg/npgd0103.htmlH.
[52] Wisconsin Dept. of Health Services, Carbon Dioxide, Hhttp://dhs.wisconsin.gov/eh/chemfs/fs/CarbonDioxide.htmH.
[53] Stephen Mallinger, OSHA Hazard Bulletin: Potential Carbon Dioxide (CO_2) Asphyxiation Hazard When Filling Stationary Low Pressure CO_2 Supply Systems, U.S. Dept. of Labor, Occupational Safety and Health Admin., June 5, 1996, Hhttp://www.osha.gov/dts/hib/hib_data/hib19960605.htmlH; CRS, at 15.
[54] Andrew C. Byers, "Success of Carbon Sequestration Hinges on Legal and Regulatory Risks," 24 NATURAL GAS & ELECTRICITY 10, at 3 & n.2 (May 2008) (citing the "persistent leaks of CO_2 in concentrations up to 50 percent from a stratovolcano in Inyo National Forest that has created a 170-acre tree kill area on the southern flank of Mammoth Mountain in California").

The frequently-cited example of Lake Nyos in Cameroon illustrates the potential dangers of a large-scale, undetected CO_2 pipeline failure. [55] In 1986, a cloud of CO_2 produced by volcanic eruptions was released from Lake Nyos. The cloud billowed slowly downhill until it settled over a 23km valley, where 1,700 villagers and hundreds of livestock asphyxiated.[56]

CO_2 pipeline transport also poses some unique technical safety issues. CO_2 as an isolated chemical is inert and poses minimal corrosion hazards for the carbon-manganese steels commonly used for pipelines.[57] But as CO_2 is combined with impurities, its chemical properties can change dramatically. CO_2 combined with water, for example, will form carbonic acid, which eats away at carbonic steel pipes.[58] CO_2 combined with hydrocarbons also has potential to clog pipelines.[59] CO_2 also must be transported at a high pressure (about 100 atm, or 1,400 psi) to maintain a single-phase liquid state for handling and pumping. This necessitates a pipe and pumping system capable of withstanding this high pressure, and may pose a potential risk of leakage. All of these risks increase the chance of an accidental leak of CO_2.

IV. Federal Regulation of Pipeline Construction and Operation

The FERC and the STB are responsible for pipeline regulation on the federal level for issues other than pipeline safety. The STB has authority over all interstate pipelines transporting "a commodity other than water, gas, or oil."[60] The FERC has authority over interstate pipelines carrying natural gas or oil,[61] as well as electricity transmission lines.[62] Currently, regulation of CO_2 pipelines—especially CO_2 piped as a waste product destined for storage—falls into a gray area on the federal level.

A. Overview of the Surface Transportation Board

The STB is a "decisionally-independent adjudicatory body" that is housed within the U.S. Department of Transportation (DOT).[63] The STB's regulatory authority is limited, with jurisdiction to resolve rate discrimination disputes for a narrow scope of interstate pipelines.[64] The STB has no authority to initiate a rate-case on its own, however, and pipeline operators are under no obligation to inform the STB of

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[55] *See id.*, at 7, n.1 (May 2008). *See also* Parfomak & Folger, *Carbon Dioxide (CO_2) Pipelines for Carbon Sequestration: Emerging Policy Issues*, *supra* note 40; Soren Anderson & Richard Newell, Prospects for Capture and Storage Technology, Resources for the Future, RFF DP 02-68 (Jan. 2003) at 23, n.25.
[56] Byers, *supra* note 48, at 7, n.2.
[57] IPCC, Report on CCS, Chapter 4, at 181–2, Hhttp://www.mnp.nl/ipcc/pages_media/SRCCS-final/SRCCS_Chapter4.pdfH; J. Barrie, *et al.,* "Carbon Dioxide Pipelines: A Preliminary Review of Design and Risks," Proceedings of the 7th International Conference on Greenhouse Gas Control Technologies (Vancouver, Canada: Sept. 5–9, 2004): 2
[58] J. Barrie et al, *supra* note 25, p.2.
[59] *Id.*
[60] 49 USC § 15301.
[61] 15 USC § 717 *et seq*., 49 USC § 60502; 49 App. USC § 1 *et seq*.
[62] 16 USC § 792.
[63] 49 USC § 701, 703(c); Surface Transportation Board, FY 2002–2004 Report (2005), at 1 Hhttp://www.stb.dot.gov/stb/docs/ActivityReport2002-2004.pdfH.
[64] 49 USC §§ 1530, 15501-15506, 15901.

planned rate changes, new pipeline construction, or pipeline acquisitions.[65] The Board also has no eminent domain or siting authority,[66] and has no authority over completely intrastate pipelines.[67]

The STB's role regarding pipeline regulation is further limited due to the small number of pipelines that fall under its jurisdiction. According to a Government Accountability Office report, the STB had authority over only 21 pipelines as of 1998, amounting to 6,000 miles of pipeline.[68] In contrast, the FERC had jurisdiction over 400,000 pipeline miles during the same period.[69]

A successor agency to the Interstate Commerce Commission (ICC)—first established in 1887 to regulate railroad rates—the STB's primary mission remains focused on railroad regulation rather than pipelines.[70] In fiscal years 2002–2004, for example, the STB handed down 776 rail-related decisions.[71] Over the same period, the STB issued only five pipeline-related decisions.[72] According to the Congressional Research Service: "Presiding over a large number of CO_2 rate cases of varying complexity in a relatively short time frame might … be administratively overwhelming for the Board, which today has limited resources available for pipeline regulatory activities."[73]

B. Overview of the Federal Energy Regulatory Commission

Unlike the STB, the FERC plays a significant role in regulating the major elements of the nation's interstate energy infrastructure. The Commission regulates oil pipeline rates under the Interstate Commerce Act (ICA)[74] and natural gas pipeline siting and rates under the Natural Gas Act (NGA).[75]

The FERC's oil vs. natural gas regulatory models

The FERC's jurisdiction over oil and natural gas pipelines is based on different regulatory approaches. Oil pipeline regulation is based on a common carrier model, requiring pipeline operators to charge "just and reasonable" rates and provide "reasonable access" to customers.[76] According to *Williston on Contracts*, "The common carrier of goods or passengers is bound, in the absence of legal excuse, to receive and transport all goods or passengers presented at proper times and places and in proper condition."[77] The

[65] 49 USC § 15901(a).
[66] Parfomak & Folger, *Carbon Dioxide (CO_2) Pipelines for Carbon Sequestration: Emerging Policy Issues*, *supra* note 40, at 8.
[67] 49 USC § 15301(b).
[68] GAO, *Surface Transportation: Issues Associated with Pipeline Regulation by the Surface Transportation Board* (March 1998) at 1, 3–4 (*hereinafter* GAO Report).
[69] *Id.* at 4.
[70] 49 USC § 702;
[71] STB Activity Report, 2002–2004, Appendix C (2005).
[72] *Id.*
[73] Parfomak & Folger, *Carbon Dioxide (CO_2) Pipelines for Carbon Sequestration: Emerging Policy Issues*, *supra* note 40, at 8
[74] 49 USC § 60502; 49 App. USC § 1 et seq.
[75] 15 USC § 717 et seq.
[76] Pub.L. 102-486, Title XVIII, §§ 1803(a); *Phillips Pipe Line Co. v. Diamond Shamrock Refining and Marketing Co.*, 50 F.3d 864, 867 (10th Cir. 1995).
[77] 22 Williston on Contracts § 58:3 (4th ed.)

FERC does not control the construction or abandonment of oil pipelines, nor does it approve tariff rates in advance.

Regulation of natural gas pipelines, on the other hand, is based on the public utility model. The FERC must approve construction and abandonment of pipelines, and authorizes rates in advance.[78] Pipeline operators must notify the FERC at least 30 days before any proposed rate change will take effect.[79] The FERC has the authority to hear cases brought on its own initiative as well as cases brought by complaint.[80] The FERC may direct pipeline operators to build connecting pipelines and may issue "public certificates of public convenience and necessity."[81] A certificate of public convenience and necessity not only allows a pipeline owner to build a pipeline, it also gives the owner eminent domain authority after approval by a federal circuit court.[82] The FERC's regulations over natural gas pipelines preempt state laws, although states do retain the authority to determine whether a proposed pipeline project "is consistent with" state law.[83]

The different approaches for siting and regulating access to pipelines represent perhaps the most significant issues for policymakers to consider when designing new regulations for CO_2 pipelines. The lack of federal eminent domain authority for oil pipelines has presented significant barriers to constructing interstate routes, with some states granting eminent domain authority, others only granting it in special circumstances, and others not at all.[84] If Congress determines that CCS is an important element in a strategy to reduce GHG emissions, it should give particular consideration to the questions of eminent domain and preemption of state pipeline regulations.

C. The Current State of CO_2 Pipeline Regulation

It is generally assumed that STB has jurisdiction over the current interstate CO_2 pipeline network.[85] Nonetheless, the issue remains unresolved. The FERC rejected jurisdiction over CO_2 pipelines in 1979, finding that CO_2 is not a "natural gas" under the Natural Gas Act. The FERC has not revisited the issue since that ruling.[86] Subsequently, the ICC ruled in 1980 that Congress intended to exclude any "gas"

[78] 15 USC § 717c(c) & (d).
[79] 15 USC § 717c(d).
[80] 15 USC §§ 717l, 717m.
[81] 15 USC § 717f(c)
[82] *Id.*
[83] *See, e.g.,* Paul Frisman, State Permits Required for Gas Pipeline, Conn. OLR Research Report 2002-R-0657, July 19, 2002, Hhttp://www.cga.ct.gov/2002/olrdata/env/rpt/2002-R-0657.htmH.
[84] *See, e.g.,* Barr, *supra* note 31, at 49–50 (citing examples of where eminent domain authority was denied to oil pipeline builders).
[85] For example, a 1998 report by the Government Accountability Office (GAO) states that CO_2 is subject to oversight by the STB. GAO Report, *supra* note 35, at 3. In a more recent example, U.S. Senator Ken Salazar stated the STB has "regulatory jurisdiction for transporting carbon dioxide" during a speech on the floor of the Senate. Office of Senator Ken Salazar, Press Release: Sen. Salazar: 'Carbon Capture is Central to Our Nation's Energy Policy and Environmental Security' (Jan. 31, 2008).
[86] Vann & Parfomak, *supra* note 19, at 4 (citing Cortez Pipeline Company, 7 FERC ¶ 61,024 [1979]).

from its jurisdiction and therefore it did not have authority over CO_2.[87] The ICC acknowledged the regulatory gap for CO_2 and "institute[d] a proceeding and accept[ed] comments on the petition and our view on it."[88] After the comment period, the ICC affirmed that CO_2 was not within its jurisdiction.[89] Currently, "there is no federal role in siting carbon dioxide pipelines,"[90] and the STB has not heard any CO_2 pipeline cases. This may be a result of the fact that many of the current CO_2 pipelines are also owned by CO_2 producers, so no rate regulation cases have been brought to date.[91] Further complicating the jurisdiction question, the STB has authority over "*commodit[ies]* other than water, gas, or oil," suggesting that CO_2 being treated as a pollutant to be stored in a sequestration site may not fall within the Board's jurisdiction.[92]

This pollutant versus commodity issue could become significant for CO_2 pipeline operators and could interfere with the construction of an integrated CO_2 pipeline network carrying gas destined for sequestration sites (and thus having a negative economic value) and to active oil fields for use in EOR where it would have a positive economic value. "Without a coherent system of regulation for CO_2 as a pollutant, commodity, or some other classification, developers of interstate pipelines may face numerous litigation or negotiation challenges concerning such issues as siting, pipelines access, and terms of service."[93]

The issue becomes more complicated by the U.S. Supreme Court's ruling that CO_2 is an "air pollutant" under the Clean Air Act.[94] The ruling potentially creates different regulatory structures for CO_2—the EPA governing CO_2 as a pollutant and the STB or FERC governing CO_2 as a commodity—with the distinction based solely on the end use of the gas. This distinction should be irrelevant for the purpose of regulating the delivery system.[95] The physical qualities of the CO_2 in the pipeline will be the same, whether it is destined for use in EOR projects or simply for sequestration, as are concerns regarding siting, eminent

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[87] Cortez Pipeline Company – Petition for Declaratory Order – Commission Jurisdiction over Transportation of Carbon Dioxide by Pipeline, 45 Fed. Reg. 85177 (December 24, 1980). For a more complete discussion of the ICC decision, *see* Vann & Parfomak, *supra* note 19.
[88] Cortez Pipeline Company – Petition for Declaratory Order, *supra* note 87; *see also* Vann & Parfomak, *supra* note 19.
[89] Cortez Pipeline Company – Petition for Declaratory Order, *supra* note 87.
[90] Kelliher, *supra* note 26, at 2.
[91] According to one estimate published in 2004, Kinder Morgan owned "roughly half of the [CO_2] pipeline miles," which were located "in and around the Permian Basin in Texas." Elizabeth J. Wilson & David Gerard, eds., Carbon Capture and Sequestration: Integrating Technology, Monitoring and Regulation, Blackwell Publishing, (2007), at 190 (citing Tim Bradley, CO_2 Flooding: What Kinder Morgan Is Doing," paper presented at SPE/DOE Fourteenth Symposium on Improved Oil Recovery, Apr. 17–21, 2004, Tulsa OK. *See also* Kinder Morgan, KM CO_2 Company, Hhttp://www.kindermorgan.com/business/co2/transport.cfmH (last visited July 13, 2008); Kinder Morgan, KM CO_2 Company: CO_2 supply, Hhttp://www.kindermorgan.com/business/co2/supply.cfmH (last visited July 13, 2008).
[92] 49 U.S.C §15301 (emphasis added).
[93] Hiranya Fernando, "Capturing King Coal: Deploying Carbon Capture and Storage Systems in the U.S. at Scale," World Resources Institute (2008), at 23.
[94] *Mass. v. EPA,* 127 S.Ct. 1438 (2007).
[95] *Id. See also* Hiranya Fernando, "Capturing King Coal: Deploying Carbon Capture and Storage Systems in the U.S. at Scale," World Resources Institute (2008), at 23.

domain, and safety. The actual distinction should exist only in economic terms, as pipeline operators may charge different rates depending on the end use.[96]

D. Updating the Federal Regulatory Structure for Construction and Operation of CO_2 Pipelines

Given the central role that CCS is expected to play in a national effort to reduce GHG emissions, the regulatory system for the CO_2 pipeline network should enable rapid, efficient, and safe construction and operation. Following these principles, a comprehensive regulatory regime with primary authority resting with the federal government will likely be necessary.

> Without a coherent system of economic regulation for CO_2 pipelines, whether as a commodity, pollutant, or some other classification, developers of pipelines may need to repeatedly negotiate or litigate issues such as interstate CO_2 siting, pipeline access, terms of service, and rate "pancaking" (the accumulation of transportation charges assessed by contiguous pipeline operators along a particular transportation route). It is just these kinds of issues which have complicated and impeded the integration of individual utility electric transmission systems into larger regional transmission networks.[97]

Given the STB's limited authority and staff resources and the obstacles that some oil pipeline owners have faced with state approval to build pipelines, the FERC natural gas model provides a more effective regulatory model for CO_2 pipelines.[98] This approach would grant to the FERC eminent domain authority, the power to ensure that transportation costs are fair and reasonable, and regulatory control over the opening and decommissioning of CO_2 pipelines. This approach will help reduce barriers and costs for pipeline construction and will provide large-scale emitters of CO_2 with long-term certainty regarding rates and pipeline access, ultimately reducing the overall costs of a federal climate policy.

Congress has two options for accomplishing this transition: (1) defining CO_2 as a "natural gas" under the Natural Gas Act; or (2) following the OPS model and specifically granting FERC jurisdiction over CO_2, along with the same eminent domain and rate regulation authorities for CO_2 pipelines as it currently has for natural gas pipelines.[99] Either of these approaches could also avoid the pollutant-versus-commodity issue. In the absence of congressional action, it has been suggested that FERC could simply reconsider its

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[96] The Interstate Oil and Gas Compact Commission recommends classifying CO_2 as a commodity in order to avoid local concerns about pipelines carrying wastes or pollutants. Interstate Oil and Gas Compact Comm'n, Task Force on Carbon Capture and Geologic Storage, *Storage of Carbon Dioxide in Geologic Structures: A Legal and Regulatory Guide for States and Provinces*, September 2007.
[97] Parfomak & Folger, *Carbon Dioxide (CO_2) Pipelines for Carbon Sequestration: Emerging Policy Issues*, *supra* note 40, at 13.
[98] There have been suggestions that FERC would also be a more effective regulatory body to oversee other "hazardous liquid" pipelines such as anhydrous ammonia and hydrogen pipelines that are unquestionably under STB's jurisdiction today. *See* GAO Report, *supra* note 35 (addressing transportation of anhydrous ammonia); Birgisson & Lavarco, *supra* note 36, at 771 – 780, (2004) (addressing regulation of hydrogen pipelines).
[99] Following the OPS model, Congress could insert "and carbon dioxide" after the term "natural gas" in appropriate clauses.

1979 determination that it does not have jurisdiction over CO_2 pipelines, although this approach raises the possibility of extensive litigation before the issue is settled.[100]

V. Federal Regulation of Pipeline Safety

Pipelines historically provide the safest method of transporting hazardous materials. The U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA), the agency that collects safety data for interstate transportation of hazardous materials, reports that "compared to the pipeline record, there are 87 times more oil transport truck–related deaths, 35 times more oil transport truck–related fires/explosions, and twice as many oil transport truck–related injuries."[101]

Currently, CO_2 pipelines are among the safest pipelines regulated by OPS.[102] Pipeline safety data may not provide an accurate picture of the relative safety of CO_2 pipelines compared to other types of pipelines, however, because current CO_2 pipelines exist primarily in rural areas and the CO_2 pipeline network is miniscule compared to more than 2.3 million miles of natural gas and hazardous liquid pipelines in the U.S. as of 2003.[103] The low number of incidents and the lack of human injury do suggest, however, that CO_2 pipelines are currently providing reliable, safe transportation, leading the Congressional Research Service to predict that expansion of the CO_2 pipeline network near populated areas will result in a safety record similar to that of LNG pipelines.[104]

A. Overview of the Office of Pipeline Safety

The OPS promulgates minimum safety standards for the "design, installation, inspection, emergency plans and procedures, testing, construction, extension, operation, replacement, and maintenance of pipeline facilities."[105] Per the Pipeline Safety Act, the OPS is specifically required to "regulate carbon dioxide transported by a hazardous liquid pipeline facility." [106]

The OPS has authority to set minimum safety standards to meet needs of practicability, safety, and environmental protection.[107] Furthermore, the OPS is obligated to consider a number of "reasonableness" criteria when making safety rules, including a detailed cost-benefit risk analysis, which

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[100] Vann & Parfomak, *supra* note 19, at 6.
[101] U.S. DOT, Pipeline and Hazardous Materials Safety Administration, Safe Pipelines FAQ, Hhttp://www.phmsa.dot.govH.
[102] Parfomak & Folger, *Carbon Dioxide (CO_2) Pipelines for Carbon Sequestration: Emerging Policy Issues*, *supra* note 40, at 16.
[103] U.S. Dept. of Transp. Pipeline and Hazardous Materials Safety Administration, General Pipeline FAQs,
[104] Parfomak & Folger, *Carbon Dioxide (CO_2) Pipelines for Carbon Sequestration: Emerging Policy Issues*, *supra* note 40, at 16. *See also* Elizabeth J. Wilson & David Gerard, eds., Carbon Capture and Sequestration: Integrating Technology, Monitoring and Regulation, Blackwell Publishing, (2007), at 190 ("[L]arge volumes of CO_2 are already safely transported in pipelines and successfully regulated, indicating that no significant program modifications would be necessary.").
[105] 49 USC § 60102(a)(2)(B).
[106] 49 USC § 60101 *et seq.* (containing the recodification of the Natural Gas Pipeline Safety Act of 1968 (NGPSA) and the Hazardous Liquids Pipeline Safety Act of 1979 [HLPSA]); 49 USC § 60102(i) ("The Secretary shall prescribe standards related to hazardous liquid to ensure the safe transportation of carbon dioxide by such a facility.").
[107] 49 U.S.C § 60102(b)(1)-(4).

must be submitted to a technical standards committee whose express purpose is OPS rule review.[108] The Pipeline Safety Act explicitly states that the OPS does not have siting authority.[109]

The OPS is authorized to incorporate industry standards into its safety regulations, provided it "receives no significant adverse comment within 60 days of notice in the Federal Register."[110] By statute, adopting industry standards allows the OPS to avoid risk assessments in the rulemaking process.[111] In addition, relying on industry standards allows the OPS to adapt quickly to new pipeline design challenges. For example, OPS regulations regarding pipeline integrity in "high consequence areas" (HCAs)—e.g., commercially navigable waterway, urban areas and other areas with concentrated populations—state that pipeline operators must "follow industry practices unless otherwise indicated or the operator can demonstrate that an alternative practice is equally effective at protecting public safety and the environment."[112] By providing the OPS with the flexibility to rely on industry standards rather than conducting its own involved rulemaking with every change in pipeline design, the agency can arguably respond to changing technologies, industry needs, etc., without engaging in a formal rulemaking process. This flexibility could prove useful as CO_2 pipelines grow into populated areas with new safety risks.

Under federal regulations, CO_2 pipeline owners and operators must: (1) comply with prescribed safety standards; (2) prepare, inspect, and carry out a plan for inspection and maintenance; (3) provide the OPS with access to their records; and (4) conduct appropriate risk analyses and implement an integrity management plan.[113] Operators must inspect rights-of-way on average every two weeks and crossings of navigable waterways at least once every five years.[114] Similarly, operators must inspect mainline valves at least twice a year and are responsible for maintaining valves "in good working order at all times."[115]

Pipeline operators face additional requirements for pipelines that may affect HCAs or "unusually sensitive areas," including drinking water supplies or ecological resources.[116] These pipeline operators are required to develop a written plan that specifies how the operator will assess the integrity of the pipe and provide a schedule for completing the integrity assessment.[117] The operator may conduct the assessments using pressure tests, external corrosion direct assessments, internal inspections (using tools to detect corrosion and deformation such as dents), and other methods approved by the OPS.

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[108] *Id.*
[109] 49 USC § 60104(e)
[110] 49 USC § 60102(6)(A); 49 CFR § 195.3(b)&(c).
[111] 49 USC § 60102(6)(A).
[112] 49 C.F.R. § 195.452
[113] 49 CFR 195.10; 49 USC § 60118(a).
[114] 49 CFR § 412. Acceptable methods of inspection for rights-of-way include "walking, driving, flying, or other appropriate means of traversing the right-of-way." *Id.*
[115] 49 CFR § 195.420(a)&(b).
[116] 49 CFR § 195.450 & 195.6.
[117] 49 CFR § 195.452.

Unlike pipelines outside of HCAs, the focus of the regulations is on leak prevention as opposed to leak detection.[118] The OPS has mapped HCAs to assist pipeline operators in identifying these areas.

Pipeline operators must submit an annual report to the DOT, as well as a written plan for inspection and maintenance to the OPS.[119] Plans must indicate the methods that the operator will use to discover safety issues that cause a significant change in operation and hazard "to life, property, or the environment."[120] Pipeline operators must develop manuals dictating procedures for regular operation and emergency situations.[121] When an unsafe condition is identified, the operator must correct the problem within a reasonable time.[122] In addition, operators must report any accidental release that results in any of the following:

1) unintentional fire or explosion;
2) the release of 5 gallons or more, if
    a) 1, 3, 4 or 5 in this list also occurs,
    b) wetland is also contaminated,
    c) it is not confined to company property, or
    d) it is not cleaned up promptly;
3) death;
4) injury leading to hospitalization; or
5) estimated property damage, including costs of cleanup, that exceeds $50,000.[123]

B. Legal Liability for Pipeline Operators

Hazardous liquids statutes and regulations, which include CO_2,[124] place liability on pipeline owners and operators.[125] The OPS can issue compliance orders to enforce pipeline safety rules.[126] Additionally, the OPS may bring civil actions to enforce compliance orders, which may result in a temporary or permanent injunction, punitive damages, or other civil penalties.[127] The OPS may also request that criminal charges be brought for situations where there is a continued violation of a compliance order, where a pipeline owner has not complied with marking and notice requirements, or where there has been trash dumping on a pipeline right-of-way.[128]

[118] "An operator must have a means to detect leaks on its pipeline system. An operator must evaluate the capability of its leak detection means and modify, as necessary, to protect the high consequence area." 49 CFR § 195.452(i)(3).
[119] 49 CFR § 195.49.
[120] *See* 49 USC §§ 60108 & 60102.
[121] 49 CFR § 195.402.
[122] 49 CFR § 195.401(b).
[123] 49 CFR § 195.50.
[124] 49 CFR § 195.0.
[125] 49 USC § 60118(a).
[126] 49 USC § 60118(b).
[127] 49 USC § 60120(a).
[128] 49 USC § 60123.

The Pipeline Safety Act includes a private right of action for safety violations against "another person, (including the federal government and other government authorities, to the extent allowed under the 11th Amendment)," including an order issued under the enforcement provisions of the Act. [129] This right only accrues after first notifying the OPS and giving the OPS the first opportunity to react.

At common law, pipeline owners are liable in cases of injury only if they acted negligently in the operation or maintenance of the pipeline.[130] Some states, however, provide that injury liability may be predicated on a theory of nuisance[131] or strict liability.[132] In practice, the OPS enforces most low-risk violations with warning letters.[133] More serious violations involving hazards to life, property, or the environment will receive corrective action orders.[134] Statutory liability for noncompliance with regulations does not affect common-law tort or contract liability.[135]

C. The Role of the States in Pipeline Safety Regulation

The OPS has jurisdiction over both interstate pipelines and intrastate pipelines, and federal regulations preempt state regulation of natural gas and hazardous waste pipelines.[136] State agencies are permitted, however, to participate in the regulation of intrastate pipelines given that they are certified by the OPS and their standards are at least as stringent as, and not inconsistent with, OPS rules.[137] All 50 states currently have received this jurisdiction. This allows OPS to set minimum safety standards for all pipelines under its jurisdiction, regardless of whether the OPS or a state regulator actually oversees the pipeline. Additionally, states can seek regulatory authority over interstate pipelines under an agreement approved by the OPS.[138]

To assist states in their pipeline safety programs, the DOT is authorized to pay for up to 50% of the cost of state pipeline regulatory programs.[139] Currently, 14 state programs are certified to regulate interstate hazardous liquid pipelines.[140] Six of these states also are interstate agents for OPS.[141] Two additional

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[129] 49 USC § 60121(a).
[130] *See* L.M. Johns, *Liability of one maintaining pipeline for transportation of gas or other dangerous substances for injury or property damage sustained by one using surface,* 30 ALR3d 685 (Originally published in 1970) (accessed May 16, 2008).
[131] *See, e.g., Lebanon Light, Heat & P. Co. v Leap*, 39 NE 57 (Ind. 1894); *Indiana Natural & Illuminating Gas Co. v McMath*, 26 Ind. App. 154 (1900); *Carlson v Mid-Continent Development Co.*, 173 P 910 (Kan. 1918).
[132] *See, e.g., Transcontinental Gas Pipe Line Corp. v Myrick*, 51 So. 2d 475 (Miss. 1951); *Texas Pipe Line Co. v Cobb*, 365 P2d 1010 (Okla. 1961).
[133] 49 CFR § 190.205
[134] *Id.*
[135] 49 USC § 60121
[136] 49 USC § 60104(c).
[137] 49 USC § 60105(a).
[138] 49 USC § 60106(b).
[139] 49 USC § 60107(a).
[140] States that are certified to regulate intrastate hazardous liquid pipelines include: Alabama, Minnesota, Texas, Arizona, Mississippi, Virginia, California, New York, Washington, Louisiana, Oklahoma, West Virginia, Maryland, and New Mexico. Office of Pipeline Safety, States Participating in the Federal/State Cooperative, Hhttp://ops.dot.gov/init/partner/LISTING2005.pdfH.
[141] States that are certified to regulate both interstate and intrastate hazardous liquid pipelines include: Arizona, Minnesota, Virginia, California, New York, and Washington. *Id.*

states—Kentucky and South Carolina—operate their programs pursuant to specific agreements with OPS.[142] The OPS directly regulates pipeline safety for interstate pipeline in the remaining states.

D. The Need for Mandatory Leak Detection

Notably, there is no explicit federal requirement for leak detection for pipelines outside of HCAs, nor is there adequate data with which regulators can assess the risk that leaks will occur.[143] Pipeline operators typically have an incentive to protect the product within their pipelines because they are paid for the amount they deliver, an incentive that may not exist for CO_2 piped as a waste product. Currently, many pipelines already have leak detection systems,[144] and in some countries, such as Canada, the systems are mandatory.[145] The OPS regulations do address Computational Pipeline Monitoring (CPM) leak detection system design requirements, but do not mandate a CPM system.[146] Instead, that section of the regulations only applies if a CPM system is voluntarily installed. The Pipeline Inspection, Protection, Enforcement, and Safety (PIPES) Act, adopted in 2006, calls for a study on leak detection technology.[147] Study results are not yet available.

Leak detection and reporting are important for CO_2 pipelines because the gas is colorless, odorless, and difficult to detect.[148] As CO_2 pipelines are located closer to populated areas, the risk of injury due to pipeline failure will increase. Mandatory leak detection systems may be preferable for both safety and environmental reasons, and to monitor for fugitive emissions due to pipeline leaks, as discussed below

There is a variety of monitoring and leak-detection approaches that could address these safety concerns, including thermal imaging, computational pipeline monitoring, and smell additives such as mercaptans used in natural gas.[149] Already, regulations require new pipelines, segments, valves, fittings, etc., to be able to accommodate internal inspection devices.[150]

VI. Regulation of Fugitive Pipeline Emissions under a GHG Emissions Cap

Accounting for emissions from pipeline leaks is a unique issue for CO_2 pipelines subject to a GHG emissions cap. Under a cap-and-trade system, for example, covered emitters would be required to

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[142] *Id.*
[143] *See, e.g.,* Kelliher , *supra* note 26, at 3. ("I am not aware of whether any information has been developed regarding the leakage of carbon dioxide from the existing pipeline network or production fields. This might be an area worthy of research and development.")
[144] *See, e.g.,* "Observations on Practical Leak Detection for Transmission Pipelines: An Experienced Perspective," report prepared for the Pipeline Safety Trust, Aug. 30, 2007, at 1.
[145] Onshore Pipeline Regulations SOR/99-294 (1999), *amended by* SOR/2007-50, s. 15(F) (Can).
[146] 49 CFR § 195.134.
[147] Public Law No: 109-468, § 21 (2006).
[148] U.S. PHMSA, Fact Sheet: Products Transported in Pipelines, Hhttp://primis.phmsa.dot.gov/previewOswego/FactSheets/FSProductList.htmH.
[149] *See generally,* Barrie *et al., supra* note 49, at 3–4.
[150] 49 CFR § 195.120.

submit allowances or offset credits for each ton of GHG emissions.[151] Facilities employing CCS would send CO_2 to sequestration sites, thus avoiding the release of GHG emissions into the atmosphere and therefore the obligation to submit allowances or offset credits for those tons.

The entity responsible for fugitive pipeline emissions may depend on how the regulatory structure treats ownership and responsibility for the CO_2 in the pipeline. If the emitter remains legally liable for CO_2 until it is sequestered underground, the emitter (and not the pipeline operator) would be held accountable for pipeline leaks. Emitters would likely address this issue in contractual negotiations with pipeline operators.

This is the approach found in the Lieberman-Warner bill, a GHG cap-and-trade bill debated by the U.S. Senate in June 2008.[152] Had that bill become law, a covered entity would have been required to submit an allowance or offset credit for all GHGs emitted during the previous calendar year. The bill assumed that all CO_2 produced at a facility was emitted for compliance purposes—i.e., the emissions were not captured and sequestered. Emitters would have submitted allowances or offset credits to the EPA for each ton of CO_2 produced, and the EPA would have refunded to the emitter allowances equal to the quantity of metric tons of CO_2 that the entity captured and sequestered.[153]

The bill did not restrict which entities were eligible to receive credit for sequestration, providing an incentive for both covered entities and non-covered entities to earn allowances by sequestering CO_2.[154] This approach also potentially allows CO_2 to be treated as a "commodity," as sequestered CO_2 would have a positive economic value in the form of the sequestration credit refunded to the emitters.

Under this system, pipelines would be required to monitor and report the amount of CO_2 entering the pipeline from each emitter. If multiple emitters transport CO_2 via a single pipeline and some CO_2 is lost during transportation, the EPA would have to determine whom to penalize for the accidental emissions (in the form of a reduced allowance refund) and by how much. Additionally, if the emitters are the entities rewarded for capturing and sequestering carbon, pipeline operators have less of an incentive to ensure that there are no leaks and that all emissions are in fact sequestered. To remedy this, the law could require pipeline operators to purchase the CO_2 transported in the pipeline from the emitters. Pipeline operators would then receive sequestration credits for the number of tons of CO_2 actually sequestered upon the arrival of the CO_2 at the storage site. This altered approach would create an incentive for the pipeline operators to ensure that captured CO_2 reaches the storage sites and would transfer responsibility for accidental emissions to the pipeline operators.

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[151] S. 3036 § 1202 (a) and (b)(1), along with §1103(a)(2) obligate the "affected facility" to ensure capture and sequestration. Under the bill, the CO_2-producing facility would be responsible for any pre-sequestration emission (implicitly, that includes pipeline leaks). S. 3036*, supra* note 14.
[152] *Id.*
[153] *Id.* at § 202(f).
[154] *Id.*

An alternate approach would place liability for fugitive emissions directly on the pipeline operators. This option would create an incentive for pipeline operators to avoid leakage and avoid the problem of distributing responsibility for accidental emissions among the producers of the CO_2. The law could allow emitters to treat the CO_2 as sequestered at the point it enters the CO_2 pipeline network, thus relieving the producers of the obligation to submit allowances or offset credits for that amount of CO_2. Pipeline operators could be required to monitor and report the amount of CO_2 entering the pipeline and the amount delivered to storage sites or EOR facilities. The operators could be required to submit allowances or offset credits to cover any discrepancy between the two amounts. Under this approach, pipeline operators would operate similarly to the other emitters covered by the cap-and-trade system.

Regardless of the approach Congress settles upon to encourage the use of CCS technologies, a system for detecting and reporting leaks will be important, and should be mandated under a cap-and-trade system.

VII. Conclusion

CCS technologies are expected to play a key role in reducing GHG emissions from power plants and industrial facilities. In order to ensure that a safe and efficient pipeline network is available by the time these technologies are commercially available, changes to the pipeline regulatory structure are necessary. These changes fall into three categories: construction and operation, pipeline safety, and assuming a policy is in place that limits GHG emissions, addressing pipeline emissions.

Congress should clarify the agency with primary responsibility for overseeing pipeline construction and operation and provide the appropriate level of regulatory authority to that agency. The FERC's authority over natural gas pipelines (as opposed to its authority over oil pipelines) provides an effective model for facilitating the construction and operation of a national CO_2 pipeline network. Eminent domain authority will likely be necessary to allow pipeline companies to quickly acquire land for rights-of-way. Approval of the construction and decommissioning of pipelines will provide certainty to CO_2 emitters investing in CCS technologies that they will have long-term access to pipelines. Federal authority over transportation rates and preemption of state law will remove the prospect of pipeline operators having to comply with multiple regulatory structures.

Pipelines already provide the safest method of transporting hazardous liquids and gases. While the pipeline safety regulatory structure appears to be effective, Congress should consider mandating leak detection and reporting in order to address both the safety issues presented by piping CO_2 near high population areas and to detect fugitive emissions for environmental purposes. Finally, lawmakers will need to consider how to address liability for fugitive emissions from pipeline leaks in a cap-and-trade system.

the Climate Change Policy Partnership

The Climate Change Policy Partnership (CCPP) researches carbon-mitigating technology, infrastructure, institutions and overall systems in order to inform lawmakers and business leaders as they lay the foundation of a low-carbon economy. Duke University's CCPP is an interdisciplinary research program of the Nicholas Institute for Environmental Policy Solutions, the Nicholas School of the Environment, and the Center on Global Change. Our corporate partners make our research possible and help us bridge the gap between academic research, business expertise, and effective climate change policy application.

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