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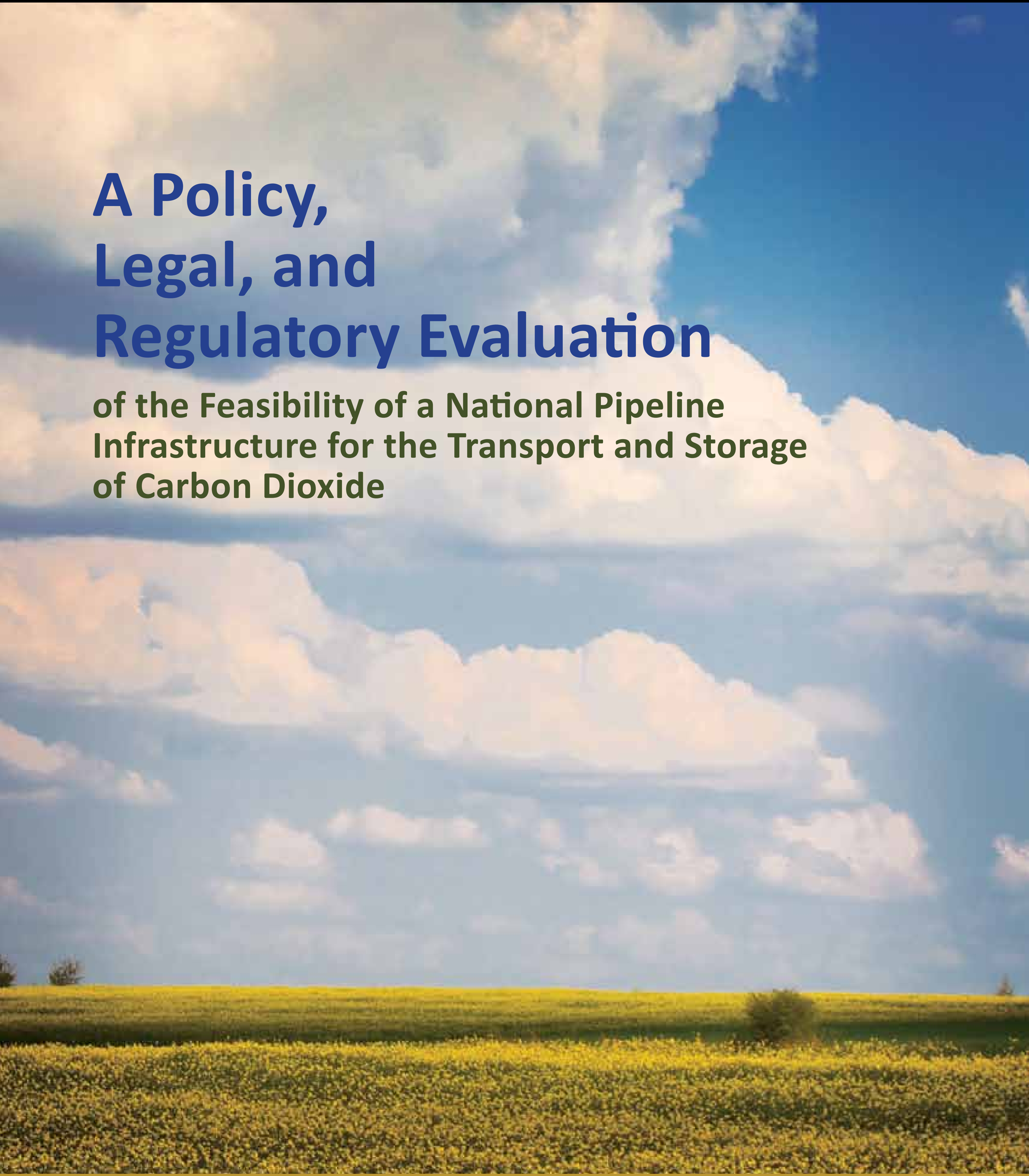

A Policy, Legal, and Regulatory Evaluation

of the Feasibility of a National Pipeline Infrastructure for the Transport and Storage of Carbon Dioxide

Interstate Oil & Gas Compact Commission

Southern States Energy Board

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ABSTRACT

The report focuses on the transportation of carbon dioxide (CO_2) through pipelines from a “source” to a geologic ”sink,” the possibility of a federal mandate requiring capture and storage of CO_2, and provides an overview of carbon capture drivers, the geologic means of storing $CO_{2.}$ It also describes the nature, size, and location of the significant CO_2 pipeline system currently operating in the United States. It describes the state and federal regulatory regime, under which the current CO_2 pipeline system operates. An analysis is made of the regulation of CO_2 pipeline systems under the Interstate Commerce Act and the Natural Gas Act and potential business models for future CO_2 pipeline build-out. Potential regulatory models are described and there is discussion of economic issues relative to future construction of CO_2 pipelines. Conclusions and recommendations suggest that the market is responding to current CO_2 pipeline construction demand. Conclusions recommend that future market response to those needs occur with limited federal intervention.

A Policy, Legal, and Regulatory Evaluation of the Feasibility of a National Pipeline Infrastructure for the Transport and Storage of Carbon Dioxide

Topical Report

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TABLE OF CONTENTS

Carbon capture and storage (CCS) is receiving considerable attention in government, academia, and the media.

However, the economic reality of the capital commitments necessary to move from research and development to large-scale deployment is a challenge of enormous proportions.

Use of carbon dioxide (CO_2) for enhanced oil recovery (EOR) remains the primary driver for CCS deployment. However, national carbon control policies on the horizon could lead to expanded deployment of CCS in the near future. If CCS continues to evolve, a national CO_2 pipeline infrastructure of sufficient scope and capacity will be needed to handle the expected volumes. Accordingly, the Pipeline Transportation Task Force (PTTF) of the Interstate Oil and Gas Compact Commission-Southern States Energy Board (IOGCC-SSEB) evaluated the regulatory status and current level of development of CO_2 pipelines, as well as the policies that would encourage rational build-out of a future CO_2 pipeline system in the U.S.

The U.S. has developed a model for geologic storage in the Permian Basin area that effectively stores CO_2 while producing additional domestic oil through CO_2-driven EOR. While CO_2-driven EOR is not focused on carbon storage, the result was large volumetric storage of CO_2 at a regionally significant scale (currently up to 35 million tons per year).

The potential for oil recovery from large reservoirs in the southwest drove the industry to find a way to connect sources of CO_2 with sinks or reservoirs that could benefit from CO_2-driven EOR. This was accomplished using a private capital model with relatively small incentives from federal and state governments. Oil revenues provided the cash flow and debt collateral. This private sector response has been replicated throughout much of the U.S. with minimal oversight from the federal government, leaving most of the regulatory responsibility to the states. Natural CO_2 fields were expensive to develop, but less expensive than the investment required for CO_2 captured from coal-fired power plants or industrial sources. if federal carbon reductions are imposed the scale of CO_2 infrastructure in the southwestern United States, although large, will pale in comparison with envisioned U.S. CCS infrastructure.

One problem with deploying many large carbon capture projects is the proximity of storage capacity. Many plants are not located near low-risk, high-volume sinks, and not all capture technologies can be moved to areas with large storage capacities. Thus, a national CO_2 pipeline transportation network is necessary.

This report contains an evaluation of several models showing that the private sector model has responded well to market demands. Approximately 4,000 miles of CO_2 pipelines have been constructed in the U.S. These pipelines have been built through a variety of business models (open access, dedicated access, interstate, and intrastate) but each follows a private sector model, with limited government involvement from either a regulatory or financial standpoint. States have dominated the regulatory model, by providing siting, construction, and operating regulations and some economic regulation on a state-by-state basis. The Federal Government regulates safety parameters of

CO_2 pipelines and right of way provisions where the pipelines traverse federal lands. The IOGCC / SSEB Pipeline Transportation Task Force believes the model that will most likely result in a robust CO_2 pipeline system in the U.S. is a private sector model, with a state-based regulatory framework, rather than a federally dominated or expanded regulatory role. While the PTTF believes that the current level of federal regulatory oversight is sufficient, members recommend a federal role that includes incentives to encourage the private construction of CO_2 pipelines.

The economics of CO_2 pipeline construction have been driven by the private sector market demand primarily in response to EOR activities. EOR sinks can serve as significant anchors for future CO_2 pipeline construction to mitigate the costs of transporting CO_2 long distances from sources that would not otherwise have an available sink because of distance and cost of transportation. A federal mandate that requires carbon capture will not change CO_2 pipeline distances, the costs of transportation, location of sinks, CO_2 sources, and the potential adverse reactions from population centers. These factors must be considered when evaluating carbon capture mandates, their efficacy and the significant challenges of capturing and transporting enormous quantities of CO_2 across the U.S.

In the report's final section, the economic factors underpinning CO_2 pipelines are examined. The report outlines the tools used to finance CO_2 pipelines but questions whether the financial markets are interested in or capable of financing a national CO_2 pipeline network.

All aspects of the physical infrastructure costs of developing a CO_2 pipeline network are examined. Categories include capital and material costs, land acquisition costs, and operational and maintenance costs. The PTTF members also examine cost saving options such as cost recovery for pipeline infrastructure in regulated utility markets and various state and federal economic incentives (e.g., income and property tax incentives, grants, loans, etc.) that offset the costs of pipeline infrastructure.

To date, the states have enabled a market-based, robust system to transport CO_2 for use in EOR. Build-out of an extensive pipeline system to accommodate CO_2 transport from several hundred coal plants most likely will occur over an extended period of time. State solutions and interstate compacts are expected to offer the support necessary for those installations. However, there may be scenarios in which federal agencies could play a more significant role in the development of the pipeline infrastructure. An aggressive, short lead-time program that requires CO_2 to be disposed of also could require further federal participation. If a large number of power plants and other sources are required to sequester CO_2, adequate storage sites might require long distance pipelines that cross state lines, which could necessitate a mix of state and federal activity to address those challenges.

The conclusions and recommendations at the end of the report serve to reinforce the finding that the current level of regulatory oversight is appropriate and no additional federal regulation is required. To the degree there is a place for expanded regulation of CO_2 pipelines, such regulation must preserve the contractual basis of CO_2 transport and avoid marginalizing states and their involvement. Specifically, the report finds and recommends the following:

General Recommendations

- The current pipeline infrastructure was sited, constructed, and regulated by the states in which they operate with federal oversight limited to safety regulations or instances where federal lands are traversed. Today, no federal involvement is required to facilitate the development of CO_2 pipelines.
- Growth is occurring in CO_2-driven EOR through the use of anthropogenic, or man-made, CO_2 along with the pipeline infrastructure necessary to meet that demand.
- Non-EOR CO_2 storage and transportation opportunities can be delayed until they are economically or politically mandated. Should such a mandate occur, sufficient public resources must be allocated to build the infrastructure necessary and mitigate the economic disconnects and impacts that are likely to occur.
- Care must be taken to ensure that a pipeline transporting CO_2 for storage only purposes is not viewed less favorably by the public than pipelines transporting CO_2 for EOR.

State Recommendations

- State-based regulatory solutions for CO_2 pipelines should be carefully considered before pursuit of additional federal regulation. Any policy decision should avoid a one-size-fits-all approach and promote flexibility and innovation in response to market conditions.
- States should implement statutes and regulations to approve, site, construct, and manage CO_2 pipelines to meet EOR demands or in response to a federal mandate.
- States should consider creating separate pipeline authorities to foster pipeline build-out. In lieu of additional federal regulation, states should consider multi-state agreements as a way to regulate a national CO_2 pipeline network.
- Because of their existing experience with CO_2-driven EOR, states should quantify and distribute information relating to jobs and public revenue resulting from CO_2 pipelines.

Federal Recommendations

- Federal policy should retain the status quo and allow the private sector to respond to market demands as currently demonstrated.
- If the federal role is expanded (in approval, siting, or economic regulation), the federal model should closely follow the natural gas model.
- Federal policy should encourage private sector build-out for CO_2–driven EOR through incentives and other forms of non-regulatory support.

The PTTF hopes these recommendations will facilitate development of a national pipeline infrastructure with rational regulatory oversight that is responsive to both market forces and national carbon management policies.

Experimental Methods

The data for this study was gathered through informal surveys, letters, personal interviews, site visits, and published reports. Sources include government officials, regulatory agency employees, private oil and gas company owners and employees, oil and gas service-industry owners and employees, academics, trade publications, and government documents. Necessarily, much of the information is anecdotal and somewhat subjective. Statistics cited are identified by source. Estimates are based on published statistical evidence with the methodology and source identified.

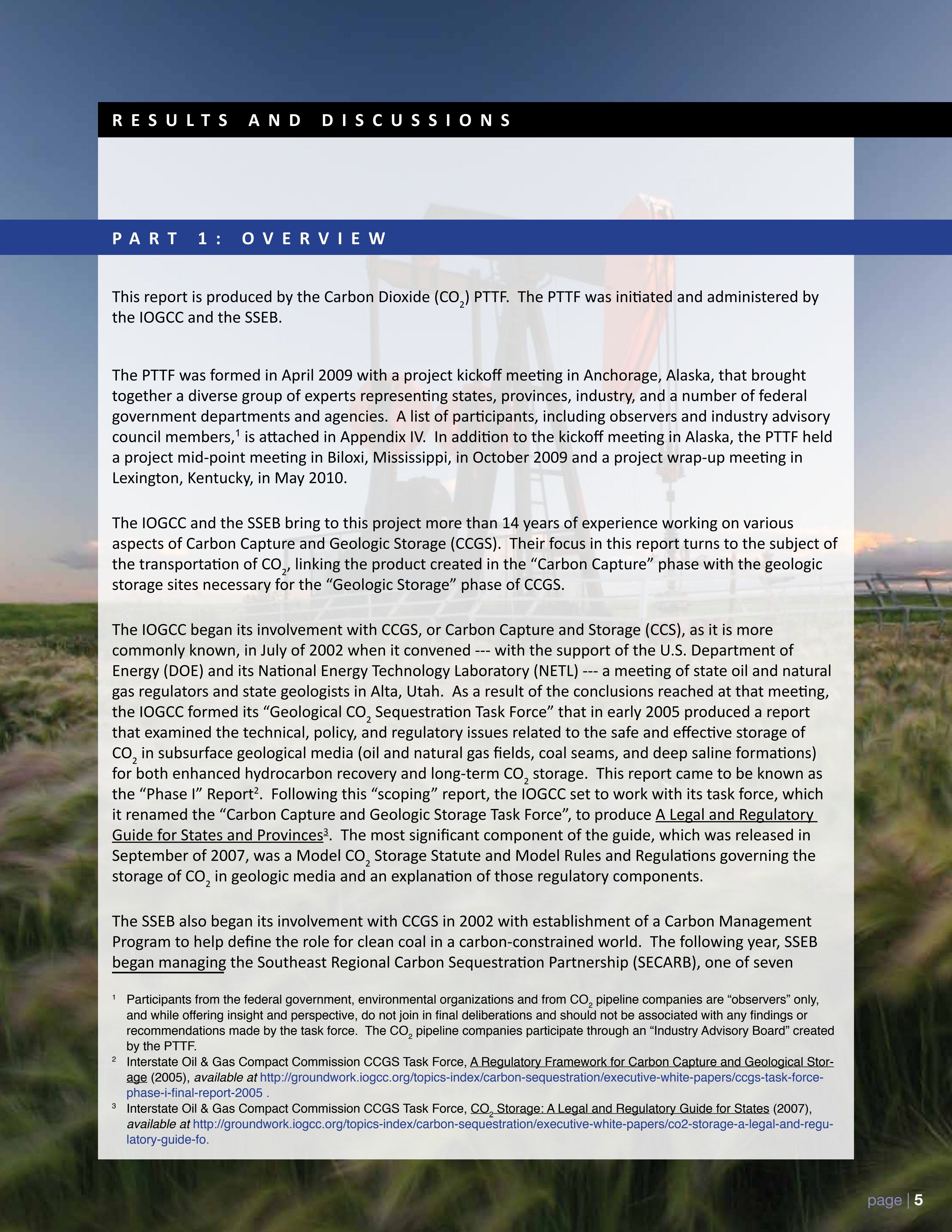
In many instances, the actions of a particular state, or several states, are cited as examples of approaches to challenges faced by oil and gas development. It should be noted that in most of these cases, other oil- and gas-producing states are using similar approaches; the cited examples are deemed to be the most representative or inclusive.

The Interstate Oil and Gas Compact Commission (IOGCC) / Southern States Energy Board (SSEB) Pipeline Transportation Task Force (PTTF) was formed in April 2009 for the purposes of examining the legal and regulatory environment surrounding CO_2 pipelines and transport. This working group led and directed the research, analysis, and conclusions contained in this report utilizing IOGCC's collaborative work group model.

Task force members represent diverse interests and regions --- from state oil and gas lawyers, to regulatory authorities, scientists, and industry representatives --- and are charged with creating comprehensive guidance documents that encompass all management aspects involving the transport of CO_2, including regulatory, legal, economic, environmental, and educational issues. The task force includes the member states of both the IOGCC and the SSEB, thus facilitating broad-based input to the study. A full roster of task force participants can be found in Appendix IV.

IOGCC Collaborative Work Groups

In its 75-year history, the IOGCC has perfected a consensus-building model for development and review of statutory and regulatory guidance documents. Collaborative work groups --- comprised of state oil and gas lawyers, regulatory authorities, content-area experts, industry representatives, and other stakeholders --- are facilitated by the IOGCC project management team and contracted content-area experts. This collaborative process leverages the combined experience and expertise of oil and gas community members to create comprehensive guidance documents that encompass all management aspects, including regulatory, legal, economic, environmental, and educational issues.



RESULTS AND DISCUSSIONS

PART 1: OVERVIEW

This report is produced by the Carbon Dioxide (CO_2) PTTF. The PTTF was initiated and administered by the IOGCC and the SSEB.

The PTTF was formed in April 2009 with a project kickoff meeting in Anchorage, Alaska, that brought together a diverse group of experts representing states, provinces, industry, and a number of federal government departments and agencies. A list of participants, including observers and industry advisory council members,[1] is attached in Appendix IV. In addition to the kickoff meeting in Alaska, the PTTF held a project mid-point meeting in Biloxi, Mississippi, in October 2009 and a project wrap-up meeting in Lexington, Kentucky, in May 2010.

The IOGCC and the SSEB bring to this project more than 14 years of experience working on various aspects of Carbon Capture and Geologic Storage (CCGS). Their focus in this report turns to the subject of the transportation of CO_2, linking the product created in the "Carbon Capture" phase with the geologic storage sites necessary for the "Geologic Storage" phase of CCGS.

The IOGCC began its involvement with CCGS, or Carbon Capture and Storage (CCS), as it is more commonly known, in July of 2002 when it convened --- with the support of the U.S. Department of Energy (DOE) and its National Energy Technology Laboratory (NETL) --- a meeting of state oil and natural gas regulators and state geologists in Alta, Utah. As a result of the conclusions reached at that meeting, the IOGCC formed its "Geological CO_2 Sequestration Task Force" that in early 2005 produced a report that examined the technical, policy, and regulatory issues related to the safe and effective storage of CO_2 in subsurface geological media (oil and natural gas fields, coal seams, and deep saline formations) for both enhanced hydrocarbon recovery and long-term CO_2 storage. This report came to be known as the "Phase I" Report[2]. Following this "scoping" report, the IOGCC set to work with its task force, which it renamed the "Carbon Capture and Geologic Storage Task Force", to produce A Legal and Regulatory Guide for States and Provinces[3]. The most significant component of the guide, which was released in September of 2007, was a Model CO_2 Storage Statute and Model Rules and Regulations governing the storage of CO_2 in geologic media and an explanation of those regulatory components.

The SSEB also began its involvement with CCGS in 2002 with establishment of a Carbon Management Program to help define the role for clean coal in a carbon-constrained world. The following year, SSEB began managing the Southeast Regional Carbon Sequestration Partnership (SECARB), one of seven

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[1] Participants from the federal government, environmental organizations and from CO_2 pipeline companies are "observers" only, and while offering insight and perspective, do not join in final deliberations and should not be associated with any findings or recommendations made by the task force. The CO_2 pipeline companies participate through an "Industry Advisory Board" created by the PTTF.

[2] Interstate Oil & Gas Compact Commission CCGS Task Force, A Regulatory Framework for Carbon Capture and Geological Storage (2005), *available at* http://groundwork.iogcc.org/topics-index/carbon-sequestration/executive-white-papers/ccgs-task-force-phase-i-final-report-2005 .

[3] Interstate Oil & Gas Compact Commission CCGS Task Force, CO_2 Storage: A Legal and Regulatory Guide for States (2007), *available at* http://groundwork.iogcc.org/topics-index/carbon-sequestration/executive-white-papers/co2-storage-a-legal-and-regulatory-guide-fo.

regional partnerships nationwide co-funded by DOE NETL and partners within each region. Since its inception, the SECARB partnership has grown to encompass 13 states and includes a network of more than 100 stakeholders. In three phases, SECARB has focused on 1) identifying and characterizing the most promising options for technology deployment and geologic CO_2 storage in the Southeast; 2) demonstrating, through small-scale field testing, the viability of geologic storage technologies and the options most prominent in the region; and 3) developing large, commercial-scale projects that validate multiple monitoring, verification, and accounting protocols and tools and that integrate CO_2 capture from a coal-fired generating facility with CO_2 transportation via pipeline and geologic storage in a deep saline formation. In conjunction with this activity, SSEB maintains a productive partnership with the U.S. DOE's Office of Coal and Power and the Office of Clean Coal and Energy Collaboration through which SSEB provides leadership in international efforts such as in the 24-member Carbon Sequestration Leadership Forum.

The focus of the this report is on the transportation of CO_2, with an emphasis on the policy, legal, and regulatory aspects of development of the pipeline infrastructure necessary to move CO_2 "captured" from a "source" to a "sink" for storage underground. It is the intention of both organizations and the PTTF that the report serve as a "scoping paper" that informs states and the federal government, as well as CCGS stakeholders, on a broad range of issues likely to be encountered by governments and industry in the building of a transportation infrastructure that enables timely CCGS development. The PTTF considered likely business models for pipeline construction and how they would be affected and influenced by differing potential state and/or federal regulatory frameworks. Included are some tentative conclusions related to which of the various potential scenarios will be most likely to remove barriers and facilitate the timely deployment of CO_2 pipelines.

The work of the IOGCC-SSEB Task Force is funded by DOE and NETL through a cooperative agreement with the SSEB in support of the Southeast Carbon Sequestration Partnership Phase II program. The task force gratefully acknowledges the support of DOE and NETL. It also acknowledges the critical support of the states and provinces and other entities that so generously contribute their employees' time to this project. Deep appreciation is also expressed to task force members. Without their dedicated participation, this effort would not be possible. The assistance of task force Chairman Robert Harms of North Dakota as well as Working/Writing Subgroup Chairs John Harju of North Dakota and Michael Moore of Texas are also gratefully acknowledged.

PART 2: BACKGROUND

Carbon capture and geologic storage is one of the four most commonly discussed and viable means of reducing the emissions of anthropogenic[4] greenhouse gases[5] in the earth's atmosphere on the environment. Carbon capture and geological storage is accomplished by first capturing CO_2 and then pressurizing and transporting it to where the CO_2 can be stored in geologic formations by means of underground injection (instead of being released into the atmosphere). Other means to mitigate carbon emissions include: 1) energy conservation and energy efficiency; 2) the use of technologies involving renewable energy, nuclear power, hydrogen, or fossil fuels containing lower carbon content (e.g., natural gas); and 3) the indirect capture of CO_2 after its release into the atmosphere utilizing subseabed or terrestrial sequestration (e.g., reforestation, agricultural practices, etc.).

The focus of this report is the transportation of CO_2, that essential link between the product created in the "Carbon Capture" phase and the geologic storage sites necessary for the "Geologic Storage" phase of CCS. Arguably the task force should be talking not about CCS but about CCTS (Carbon Capture, Transportation, and Storage), because transportation is so important to the viability of CCS. Therefore, a useful starting point in a discussion of transportation is a brief explanation of both the "Carbon Capture" and "Geologic Storage" bookends.

I. Carbon Capture

One of many challenges of working with anthropogenic CO_2 is its small percentage of the atmosphere and combustion emissions. Total CO_2 is less than 4/100 of one percent of the atmosphere by volume[6]. Of that, naturally occurring CO_2 accounts for about 96.7% and man-made about 3.3%. The total is so small that direct removal from the atmosphere is not practical. Even in power plant flue gas emissions, CO_2 accounts for only 7% to 15% of the flue gas emissions.

Before CO_2 from an anthropogenic source can be transported via pipeline, it must first be captured and compressed.[7] CO_2 capture as an emissions reduction strategy is suitable only for large point sources, (e.g., power generators and large industrial sources).[8] Most attention regarding capture technologies has focused on power plants, but capture technologies are already being extensively used in natural gas plants and can also be applied to large, energy-intensive CO_2 emitting industries, including cement manufacture, oil and natural gas refining, ammonia production, ethanol production and iron and steel manufacture.[9]

CO_2 capture technologies have long been used by industry to remove unwanted CO_2 from gas streams or to separate CO_2 as a product gas. But, for hydrocarbon combustion processes there currently are only three primary methods for capture: post-combustion, pre-combustion and oxy-fuel. Post-combustion

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[4] Anthropogenic is defined in this context as "of, relating to, or influenced by the impact of man on nature." Webster's New Collegiate Dictionary (1st ed. 1975).

[5] The major components of greenhouse gases are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), chlorofluorocarbons (CFCs), and ozone (O_3). These gases account for about 0.04 percent of the atmosphere. They are referred to as "greenhouse gases" because they effectively capture radiation from sunlight in that they prevent radiant heat from reflecting back into space.

[6] Nat'l Oceanic & Atmospheric Admin., Trends in Atmospheric Carbon Dioxide, *available at*: http://www.esrl.noaa.gov/gmd/ccgg/trends/.

[7] Intergovernmental Panel on Climate Change, Special Report on Carbon Dioxide Capture and Storage, (Bert Metz et al. eds., 2005).

[8] *Id.*.

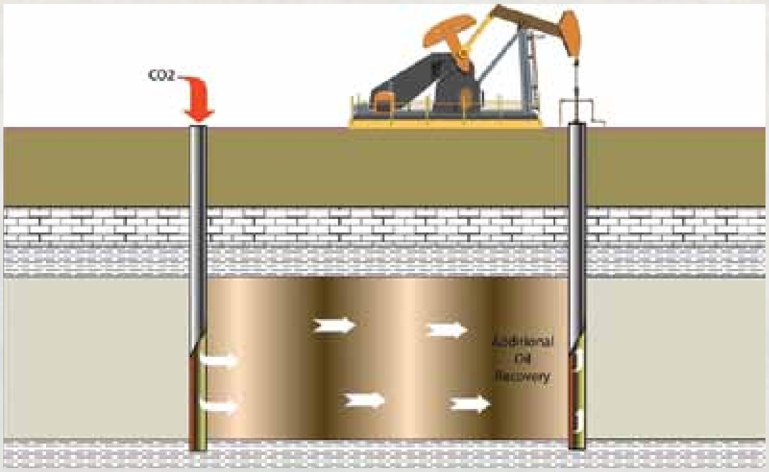
[9] Global Climate Change and U.S. Law 708 (Michael B. Gerrard ed., 2007).

involves scrubbing the CO_2 out of flue gases or natural gas streams. Oxy-fuel involves combusting fuel in recycled flue gas enriched with oxygen to produce a CO_2-rich gas. Pre-combustion uses a gasification process followed by CO_2 separation to yield a hydrogen fuel gas. Of these methods, post-combustion CO_2 capture using solvent scrubbing is one of the more established. There are several facilities at which amine solvents are used to capture significant flows of CO_2 from flue gas streams.[10]

Both pre- and post-combustion systems are capable of capturing 80% to 90% of CO_2 emissions from power plants. In addition to the capital and operating costs of scrubbing, a power plant equipped with CCS would need roughly 10% to 40% more energy and is therefore more costly than a plant of equivalent output without CCS.[11]

II. Geologic Storage

Once captured, CO_2 can be injected into deep underground formations below the earth's surface. Rather than being released into the atmosphere, CO_2 can be stored [12] permanently in underground geological formations. Natural CO_2 traps exist in many places around the globe. It is important to realize that geologic storage is not a new technology but merely an application of technologies developed over decades in the injection and storage of both natural gas and acid gas,[13] and the injection of natural CO_2 for purposes of enhanced oil recovery (EOR). Similarly, the regulation of CO_2 geological storage by the states builds upon the extensive experience of the states in regulating the injection and storage of natural gas and CO_2-driven EOR. Although the scale of CO_2 geological storage projects will be much larger than the analogues set forth above, the technology is fundamentally the same.[14] Ultimately, this technology holds promise of storing between 1.2 trillion to 3.6 trillion metric tons, the equivalent of hundreds of years, of CO_2 captured from industrial sources.[15]



The introduction of an artificial drive and displacement mechanism, such as steam, water, or CO_2, into a reservoir to produce oil unrecoverable by primary and secondary recovery methods.

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[10] Tom Kerr & Brendan Beck, Technology Roadmaps: Carbon Capture and Storage (October 2009).

[11] *Supra* note 7 at 4.

[12] The term "storage" rather than sequestration will be used in this report, however the terms in this context are largely synonymous.

[13] Acid gas is a combination of hydrogen sulfide (H2S) and CO_2.

[14] This is discussed in much greater detail in previous IOGCC publications. *See* Interstate Oil and Gas Compact Commission, Task Force on CO_2 Geologic Sequestration, A Regulatory Framework for Carbon Capture and Geological Storage (2005), [hereinafter IOGCC Phase I Report], and Interstate Oil and Gas Compact Commission, Task Force on Carbon Capture and Geological Storage, Storage of Carbon Dioxide in Geologic Structures: A Legal and Regulatory Guide for States and Provinces (2007), [hereinafter IOGCC Phase II Report].

[15] Congressional Budget Office, The Potential for Carbon Sequestration in the United States (September 2007), *available at* http://www.cbo.gov/ftpdocs/86xx/doc8624/09-12-CarbonSequestration.pdf.

There are three primary options for the geologic storage of CO_2:

1) Storage in depleted oil and natural gas reservoirs;

2) Storage in deep saline formations;

3) Adsorption within coal-beds that are un-minable because of depth, thickness, or other economic factors.[16]

Additionally, there is the possibility of storage in organic shales, fractured basalts, and hydrates, although those will not be addressed here.[17]

The primary geological storage involve injection of CO_2 through wells into the receiving formations or coal layers. Figure 1 illustrates the geologic options for underground injection of CO_2. There are advantages to injecting into deeper formations (deeper than 2,500 feet), because the CO_2 can be emplaced in a supercritical state under pressures exceeding 1,200 pounds per square inch (psi). Supercritical CO_2 occupies less pore space for a given quantity of CO_2 thereby maximizing the reservoir capacity for storage.

Many regions of the United States offer one or more of these geologic options, the most common of which are discussed below.

A. Depleted Oil and Gas Fields

Depleted oil and natural gas fields offer geologic traps that represent a substantial reservoir capacity available for storage of CO_2. Where these reservoirs are below 2,500 feet, they offer tremendous pore volume space for supercritical CO_2 injection and storage. These geologic traps by their very nature, having confined accumulations of oil and natural gas over millions of years, have proven their ability to contain fluids and gas. Additionally, if storage pressures of CO_2 stay below original reservoir pressures, fluid containment is assured if leakage from wellbore penetrations can be avoided.

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[16] IOGCC Phase I Report, *supra* note 14.

[17] Nat'l Energy Tech. Laboratory, Carbon Sequestration FAQ Information Portal, *available at*: http://www.netl.doe.gov/technologies/carbon_seq/FAQs/carbon-seq.html

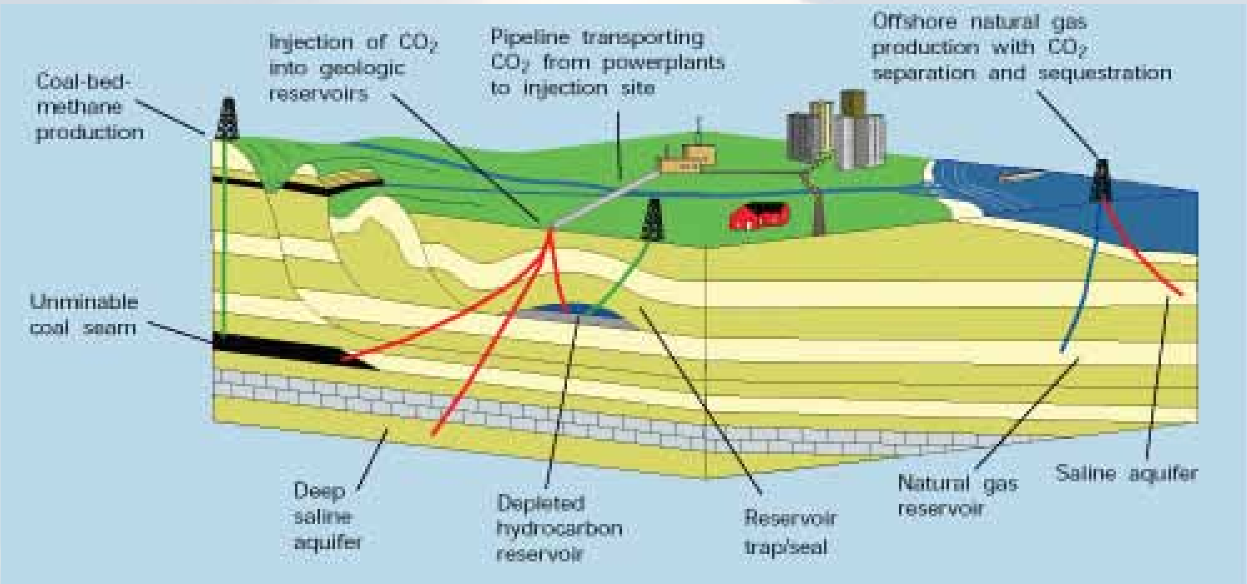

Figure 1. Potential CO_2 Sequestration Reservoirs and Products.

Red lines indicate CO_2 being pumped into the reservoirs for sequestration, green lines indicate enhanced recovery of fossil fuels caused by CO_2 sequestration, and the blue line indicates conventional recovery of fossil fuels. The offshore natural gas production (blue line) and CO_2 sequestration scenario is currently occurring off the coast of Norway at the Sleipner complex operated by Statoil. There, the gas produced is a mixture of CO_2 and methane. The CO_2 is removed and injected into a nearby saline aquifer.[18]

With many depleted oil and natural gas fields there is also huge potential for EOR at the same time that CO_2 is stored in these formations using anthropogenic sources of CO_2.[19] Injection of CO_2 for EOR has been in practice for the past three decades, most widely in the Permian Basin of west Texas and southeast New Mexico. It is important to note that during EOR operations, CO_2 produced with the oil is not released into the atmosphere but is captured, separated and recycled back into the reservoir to recover additional oil. While the majority of CO_2 currently utilized for EOR in the U.S. comes from naturally occurring CO_2 source fields, as anthropogenic sources of CO_2 become more available, there is a significant opportunity for storage at the same time that additional oil resources are produced.

B. Deep Saline Formations

The option offering the greatest potential storage volume among the geologic possibilities nationwide is the injection of CO_2 into saline formations significantly below underground sources of drinking water. Access to saline aquifers often occurs close to existing CO_2 emission sources, such as coal-fired power plants. The water in some of these formations, for example in the depth range of 4,000 to 5,000 feet in the Illinois Basin, has many times the salinity of sea water and hence is not usable as a potable resource. Research shows that injection of CO_2 into these deeper saline formations could be contained through solubility trapping (CO_2 dissolution in formation waters), structural trapping (formation of a secondary gas cap within formation boundaries), or through mineral trapping (carbonate precipitation).[20]

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[18] U.S. Geological Survey Fact Sheet 26-03, March 2003 - Online Version 1.0, *available at*: http://pubs.usgs.gov/fs/fs026-03/fs026-03.html.

[19] U.S. Department of Energy, Enhanced Oil Recovery/ CO_2 Injection, *available at* http://www.fossil.energy.gov/programs/oilgas/eor/index.html.

[20] Thomas, David C. and Sally M. Benson, editors, *Carbon Dioxide Capture for Storage in Deep Geologic Formations Results from the CO_2 Capture Project: Capture and Separation of Carbon Dioxide from Combustion Sources*, Vol. 1 (2005) pg. 793-795; *see also* Sally M. Benson "Multi-Phase Flow and Trapping of CO_2 in Saline Aquifers". (Paper No. OTC 19244). Published in the Proceedings of 2008 Offshore Technology Conference held in Houston, Texas, USA, May 5–8, 2008.

C. Coal-beds

Coal-beds or unmineable coal seams provide a potential geologic storage option for CO_2 through adsorption. Methane is chemically adsorbed on coal-beds to varying extents depending on coal character (maceral type, ash content, etc.), depth, basin burial history, and other factors and has been produced to an ever greater extent over the last decade to add to the nation's natural gas supply. The expectation is that the adsorption sites on the coal matrix surface have stronger affinity for the CO_2 than the methane and would retain CO_2 and liberate producible methane. This is frequently referred to as enhanced coal-bed methane (ECBM). Coals deemed economically unmineable due to depth, limited thickness, or other factors would be the only coals potentially suitable for storage.

Commercial storing of CO_2 in geologic formations as an incident of oil production has occurred for nearly 40 years. CO_2 supplies to this industry have been separated and captured from natural gas processing plants, produced from high-quality naturally-occurring underground formations, captured from a coal-to-gas manufacturing facility, and captured from a few other industrial facilities. Estimates of the injected quantities over the last four decades are in the hundreds of millions of metric tons. There have been only limited amounts of CO_2 injected into other types of geologic formations, however. Accordingly, since 2003 the U.S. Department of Energy through its Regional Carbon Sequestration Partnership (RCSP) Program has been actively engaged in CCS research and development in different locations around the country.[21] The most recent phase of the partnership program will involve "the injection of 1 million tons or more of CO_2 by each RCSP into regionally significant geologic formations of different depositional environments" so as to "demonstrate that CO_2 storage sites have the potential to store regional CO_2 emissions safely, permanently, and economically for hundreds of years."[22] This program will lay the foundation for the deployment of commercial scale CCS projects as early as 2020.[23]

Regional Carbon Sequestration Partnerships (RCSPs)

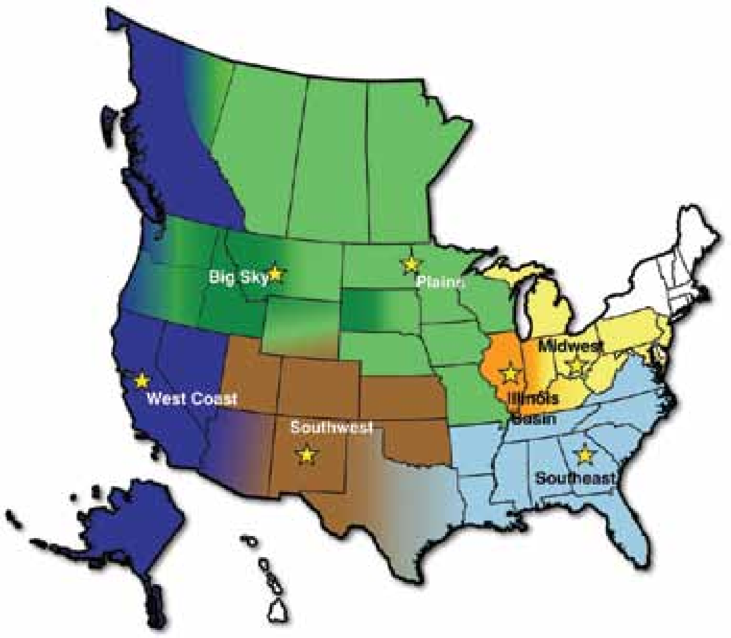

Figure 2. US DOE NETL's Regional Carbon Sequestration Partnerships

The U.S. DOE NETL has formed a nationwide network of regional partnerships to help determine the best approaches for capturing and permanently storing gases that can contribute to global climate change. The Regional Carbon Sequestration Partnerships (RCSPs) are a government/ industry effort tasked with determining the most suitable technologies, regulations, and infrastructure needs for carbon capture, storage, and sequestration in different areas of the country. The seven partnerships that comprise the RCSPs represent more than 500 organizations in 40 states, three Indian nations, and four Canadian provinces.[24]

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[21] U.S. Department of Energy, NETL, Carbon Sequestration: Regional Carbon Sequestration Partnerships, available at http://www.netl.doe.gov/technologies/carbon_seq/partnerships/partnerships.html.

[22] U.S. Department of Energy, NETL, Carbon Sequestration: Regional Carbon Sequestration Partnerships – Development Phase, available at http://www.netl.doe.gov/technologies/carbon_seq/partnerships/development-phase.html.

[23] U.S. Department of Energy, NETL, Technologies-Carbon Sequestration, available at http://www.netl.doe.gov/technologies/carbon_seq/index.html.

[24] NETL: Regional Carbon Sequestration Partnerships. (n.d.) *DOE - National Energy Technology Laboratory: Home Page*. Retrieved July 28, 2010, from http:/www.netl.doe.gov/thecnologoes/carbon_seq/partnerships/partnerships.html.

Big Sky Regional Carbon Sequestration Partnership (Big Sky)
Montana State University
http://www.bigskyCO2.org/

Midwest Geological Sequestration Consortium (MGSC)
University of Illinois,
Illinois State Geological Survey
http://www.sequestration.org/

Midwest Regional Carbon Sequestration Partnership (MRCSP)
Battelle Memorial Institute
http://www.mrcsp.org

Plains CO_2 Reduction Partnership (PCOR)
University of North Dakota,
Energy & Environmental Research Center
http://www.undeerc.org/pcor/

Southeast Regional Carbon Sequestration Partnership (SECARB)
Southern States Energy Board
http://www.secarbon.org/

Southwest Regional Partnership on Carbon Sequestration (SWP)
New Mexico Institute of Mining and Technology
http://www.southwestcarbonpartnership.org/

West Coast Regional Carbon Sequestration Partnership (WESTCARB)
California Energy Commission
http://www.westcarb.org/

A number of states are actively moving forward to develop laws and regulations that will govern the geologic storage of $CO_{2,}$ using as a base the model statute and rules created by the IOGCC in 2007.[25] Wyoming, North Dakota, Louisiana, Texas, and Montana already have passed CO_2 geologic storage statutes and have developed or are developing comprehensive rules. Numerous other states and provinces are moving forward to do the same.[26] The U.S. Environmental Protection Agency (EPA) is also developing regulations under the Underground Injection Control (UIC) Program of the Safe Drinking Water Act (SDWA) covering the geological storage of CO_2.[27] The EPA rule development process is expected to be completed by 2011. The rule is also expected to authorize states to apply for and obtain primary enforcement responsibility, or primacy. State agencies that are granted primacy will oversee the injection activities under rules adopted in their states.[28]

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[25] IOGCC Phase II Report, supra note 14.

[26] See Carbon Sequestration, http://groundwork.iogcc.org/topics-index/carbon-sequestration. This website contains up-to-date information on the status of state and provincial efforts to develop legal and regulatory frameworks for the geologic storage of CO_2.

[27] U.S. Environmental Protection Agency, Regulatory Development: Proposed rule for Federal Requirements under the UIC Program for Carbon Dioxide (CO_2) Geologic Sequestration (GS) Wells, http://www.epa.gov//safewater/uic/wells_sequestration.html#regdevelopment.

[28] Underground Injection Control Program, UIC Program Primacy, http://www.epa.gov/safewater/uic/primacy.html.

III. Transportation

The focus of this report is on the policy, legal, and regulatory aspects of the transportation of CO_2 -- that necessary connector of the capture and storage phases of CCS. The following analysis addresses the broad range of issues likely to be encountered by government and industry in the planning, financing, and construction of a transportation infrastructure that not only enables but encourages timely CCS development.

PART 3: ANALYSIS

The analysis that follows has four principal components.

The first component contains a snapshot of the existing physical and regulatory structure for CO_2 pipelines in the U.S. as well as a discussion of certain other pertinent foundational issues such as CO_2 commodity/pollutant discussion and potential CO_2 pipeline build-out scenarios.

The second component examines: (1) the potential business models for pipeline construction and operation likely to emerge in the U.S.; (2) the state and federal regulatory systems that could conceivably develop to govern those business models; and (3) the impact that the prospective federal and state regulatory systems might have on the various business plans and development of the pipeline infrastructure -- intrastate, interstate and, international.

The third component addresses the economic aspects of the prospective regulatory frameworks.

The final section contains conclusions and recommendations of the task force to state and federal policy-makers as they contemplate development of laws and regulations governing CO_2 pipelines.

I. Existing Physical and Regulatory Infrastructure in the U.S.

A. Existing CO_2 Pipeline Infrastructure in the U.S.

1. CO_2 Pipeline Basics

The existing CO_2 pipeline infrastructure in the U.S. has evolved over the last 40 years to support the injection of large quantities of CO_2 for purposes of producing oil through EOR. There are more than 4,000 miles (see Table 3) of CO_2 pipeline that connect a handful of major CO_2 sources. The CO_2 sources include naturally occurring geological formations, a few large natural gas processing plants, and one large coal-to-gas manufacturing facility, as shown on Figure 3.

According to a Massachusetts Institute of Technology (MIT) report,[29] about 1.5 billion tons of CO_2 are produced annually in the United States from coal-fired power plants. If all of this CO_2 were to be transported for sequestration, the quantity would be equivalent to three times the weight and, under

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[29] Stephen Ansolabhere et al., The Future of Coal, (2007) [hereinafter "MIT Report"].

typical operating conditions, one-third the volume of natural gas transported annually by the U.S. natural gas pipeline system.[30]

A study prepared for the Interstate Natural Gas Association of America Foundation found that, depending upon the quantity of CO_2 that must be stored and the degree to which EOR will be involved, the length of pipeline needed to transport CO_2 will be in the range of 15,000 miles to 66,000 miles by 2030.[31] These statistics highlight the scale-up challenge that faces the widespread deployment of carbon capture and storage.

CO_2 pipelines are similar in many respects in design and operation to natural gas pipelines; however, because the CO_2 is normally transported as a supercritical fluid,[32] there are a number of significant differences. To maintain the product in its supercritical state, it is transported at pressures that range from 1,200 to 2,700 psi.[33] These pressures are higher than the operating pressures used in most natural gas pipelines, which typically range from 200 to 1,500 psi.[34] Booster stations along the pipeline route maintain the necessary pipeline pressure for CO_2 pipelines.[35] Because the supercritical CO_2 behaves as a liquid in the pipeline, pumps, rather than compressors, are used at CO_2 pipeline booster stations.[36] The increased pressure in CO_2 pipelines is typically accommodated with thicker-walled pipe than that used for natural gas transportation.[37]

Table 1. Estimated CO_2 Pipeline Design Capacity

Pipeline Diameter, in.	CO_2 Flow Rate			
	Lower Bound		Upper Bound	
	Mt/yr	MMscfd	Mt/yr	MMscfd
4			0.19	10
6	0.19	10	0.54	28
8	0.54	28	1.13	59
12	1.13	59	3.25	169
16	3.25	169	6.86	357
20	6.86	357	12.26	639
24	12.26	639	19.69	1025
30	19.69	1025	35.16	1831
36	35.16	1831	56.46	2945

Pipeline diameters are calculated using rigorous iterative calculations[38] but estimations correlating pipeline diameter and CO_2 flow rates can be made. Table 1 shows such an estimation made by MIT.[39]

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[30] *Id.*

[31] ICF International, Developing a Pipeline Infrastructure for CO_2 Capture and Storage: Issues and Challenges. (2009) [hereinafter ICF Report], available at: www.ingaa.org/File.aspx?id=8288.

[32] CO_2 becomes a supercritical fluid when it is compressed to approximately 1,200 psig at temperatures greater than 31.1 degrees Celsius. At this point, it assumes certain characteristics of both a gas and a liquid. Supercritical CO_2 can be handled like a liquid but is more compressible than a typical liquid and retains the ability to diffuse through pores like a gas. The greater density and the ability to handle the product as a liquid, rather than as a gas, make the supercritical state more desirable for pipeline transmission.

[33] The pipeline to the Weyburn site in Canada operates somewhat above these pressures, up to 2,964 psig. Myria Perry & Daren Eliason, CO_2 Recovery and Sequestration at Dakota Gasification Company, Presented at the 19th Western Fuels Symposium in Billings, MT, Oct. 12-14, 2004 [hereinafter Perry and Eliason].

[34] Naturalgas.org, Transportation of Natural Gas, www.naturalgas.org/naturalgas/transport.asp (last visited Dec. 2009).

[35] Naturalgas.org, Transportation of Natural Gas, www.naturalgas.org/naturalgas/transport.asp (last visited Dec. 2009).

[36] ICF Report Supra Note 31.

[37] *Id.*

[38] Rubin, E.S., Berkenpas, M.B., Frey, H.C., Chen, C., McCoy, S., and Zaremsky, C.J., 2007, Development and application of optimal design capability for coal gasification systems: Technical documentation for integrated gasification combined cycle systems (IGCC) with carbon capture and storage (CCS). Final Report of work performed for the U.S. Department of Energy under contract DE-AC21-92MC29094, Pittsburgh, Pennsylvania, Carnegie Mellon University, May 2007.

[39] Carbon Capture and Sequestration Technologies Program, 2009, Carbon management GIS: CO_2 pipeline transport cost estima-

2. Costs of CO_2 Pipeline Construction

The cost components of CO_2 pipeline construction are analogous to those of natural gas pipelines with carbon steel being a major cost component. Because it can account for 15% to 35% of the total pipeline cost, the dramatic increase in carbon steel price over the last decade has resulted in higher pipeline costs, as shown in Table 2.

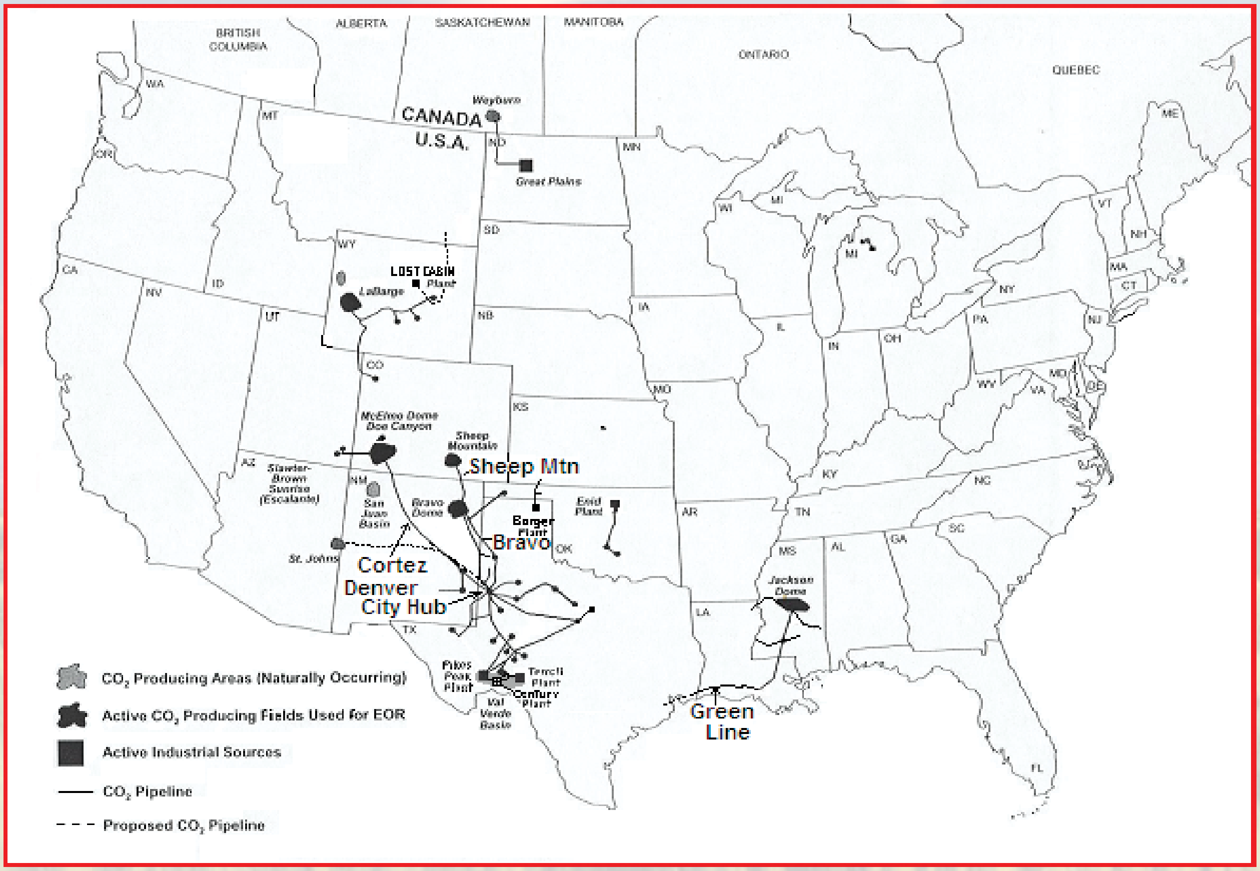

Figure 3. Existing or Planned CO_2 Pipelines in the United States.[40]

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tion, Massachusetts Institute of Technology, Report for U.S. Department of Energy National Energy Technology Laboratory under contract DE-FC26-02NT41622.

[40] Source: Steve Melzer, Melzer Consulting (2010)

Table 2. CO$_2$ Pipeline Capital Costs for Various Pipelines [41]

Project	Year	Cost, $/in. diameter-mile	Inflation adjusted 2009 dollars
Dakota Gasification[42]	2000	37,300	46,500
Hall-Gurney (KS)[43]	2001	22,000	26,650
Regression Analysis of FERC Data[44]	2003	33,800	39,400
Coffeyville Resources[45]	2007, 2009	52,100–83,300	54,000-83,000
Oil and Gas Journal Average of Natural Gas Pipelines[46]	2008	65,100	64,900
Green Pipeline[47]	2009	93,750	

3. CO$_2$ Quality Specifications for Pipeline Transportation

Requirements for CO$_2$ pipeline quality specifications are subjects of debate. To date, most existing compositional specifications appear only within private contracts between buyers and sellers. As a result, there is little publicly available information on the quality specifications of CO$_2$ pipelines. However, uniform CO$_2$ quality specifications may be useful to promote development of a national CO$_2$ pipeline network. While imposing a national uniform quality specification on CO$_2$ composition in pipelines can be expensive to a given plant in terms of both capital investments and operating costs, such uniform quality specifications may be necessary to promote a national CO$_2$ pipeline infrastructure. Recognition today of what might be an appropriate national compositional specification would prove invaluable in the early stages of source and pipeline design.

Some early work[48] attempted to group compositional specifications into three potential categories. The first type (Type I) would be for CO$_2$ transport by point-to-point, single-use pipelines with a case-by-case compositional specification. This type of specification could be envisioned similar to most disposal pipelines in use today and could compositionally vary in dramatic fashion from pipeline to pipeline. Each permit would require a study of safety and operating procedures based upon the specific CO$_2$ composition being transported. None of the existing CO$_2$ pipelines fit this model.

The second type (Type II) could be referred to as the Uniform North American CO$_2$ Pipeline Network Compositional Standard which would have restrictions designed to meet specified CO$_2$ compositional requirements allowing compatibility with existing contracts between sources and sinks and, more importantly, allowing interconnections with future pipelines. The concept of multiple sources and sinks networked by interconnecting pipelines would provide pipeline "buffer" storage, increased reliability of source volumes, and injection capacity through the interconnection of multiple sources and sinks. Existing and future contracts between sources and sinks would need to reflect the "uniform" compositional standards. What may, at first glance, seem like an unachievable goal is, in fact, generally reflects prevailing industry practice. All but a handful of the current pipelines fall within this category.

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[41] These costs were calculated using the information presented in the documents referenced in notes 15-32.

[42] J.E. Sinor and Associates, Financial Future Brightens for Dakota Gasification, http://edj.net/sinor/sfr7-00art6.html (last visited Dec 2009).

[43] G. Paul Willhite, Carbon Dioxide Flooding in Kansas Reservoirs, Presentation at the 14th Oil Recovery Conference, Wichita, Kansas, March 14–15, 2001.

[44] Gemma Heddle, Howard Herzog, & Michael Klett, The Economics of CO$_2$ Storage (2003).

[45] Nat'l Energy Tech. Lab., NETL Carbon Sequestration Newsletter: Annual Index, September 2007 – August 2008 (2008); *see also* ICF Report, *Supra* note 31.

[46] Oil and Gas Journal, Construction, Other Cost Increases Hit Home, Oil and Gas Journal v. 106, No. 33 (2008).

[47] Gary Perilloux, Enhanced Oil Recovery Key to $720 million Deal, *available at*: www.2theadvocate,com/news/business/3875982.html.

[48] Guidelines for Carbon Dioxide Capture, Transport, and Storage, Forbes, S., Verma, P.; Curry, Thomas, E., Friedmann, S. J., Wade, S.M., World Resources Institute Report , Oct 08, available at http://www.wri.org/publication/ccs-guidelines.

One of the most important factors in avoidance of nitrogen and methane concentrations that preclude dense phase operations. The most common specification is 5% of esch, or, aggregate, 10%. Higher concentrations of either nitrous oxide (N_2O) or methane (CH_4) raise minimum miscibility pressures to a level ofter unacceptable for EOR end use. Sulfur compounds, especially h_2S, for example, are hazardous to humans and wildlife, and those concerns require robust source, sink, and pipeline safety regimes.

Oxgen content also affects the quality of CO_2 pipeline streams. High oxygen concentrations lead to microbial related corrosion of forged iron and steel. Oxygen also leads to chemical reactions and aerobic bacterial growth downhole either within the injection tubulars or in the geologic formation. As a result, the evolved specification has become an accepted concentration of less than 10 or 20 parts per million (ppm).

Water is another substance requiring critical control in CO_2 streams. Corrosion is the key concern. Maximum specifications are often expressed in pounds (lbs) /million cubic feet (MMcf) or in ppm and are most commonly specified in the range of 20-30 lbs/ MMcf.

Type III composition standard would allow one or more quality specifications to vary. Varying specifications could be appropriate for small proprietary networks. Existing examples of this Type III standard are evident in the Dakota Gasification, Val Verde, Canyon Reef Carriers, and Zama pipelines. All four of these pipelines allow a higher level of hydrogen sulfide (H_2S), and therefore cannot deliver the CO_2 stream into a pipeline with more standard specifications without treating the CO_2 stream to remove the excess H_2S. These Type III pipelines serve a dual purpose -- transporting CO_2 for EOR and economical disposal of H_2S. Another example where a Type III compositional standard would be appropriate could be where higher nitrogen content is required to assist with injection into coal beds.

It is notable that both Type II and Type III pipeline operators have chosen to seek a dense phase state of CO_2 (operating above 1,200 psi) for efficiency and end use purposes. Type I lines might not necessarily require dense state CO_2 for transportation.

Table 3 lists the 47 major North American CO_2 pipelines. There are others, however, these pipelines are high-pressure (exceeding 1,000 psi maximum allowable internal pressure) and of sufficient length (10 miles or greater) to warrant inclusion. It is worth noting that most of the pipelines included in Table 3 fall into the Type II category and allow interconnection. No example of a Type I pipeline exists at this time. Table 4 compares CO_2 stream compositions for several different streams.

Table 3. The Major North American CO_2 Pipelines[49]

PIPELINE	Owner/Operator	Length (mi)	Length (km)	Diameter (in)	Estimated Max Flow Capacity (MMcfpd)	Estimated Max Flow Capacity (million tons/yr)	Location
Adair	Apache	15	24	4	47	1.0	TX
Anton Irish	Oxy	40	64	8	77	1.6	TX
Beaver Creek	Devon	85	137				WY
Borger, TX to Camrick, OK	Chaparral Energy	86	138	4	47	1.0	TX, OK
Bravo	Oxy Permian	218	351	20	331	7.0	NM, TX
Centerline	Kinder Morgan	113	182	16	204	4.3	TX
Central Basin	Kinder Morgan	143	230	16	204	4.3	TX
Chaparral	Chaparral Energy	23	37	6	60	1.3	OK
Choctaw (aka NEJD)	Denbury Onshore, LLC	183	294	20	331	7.0	MS, LA
Comanche Creek *(currently inactive)*	PetroSource	120	193	6	60	1.3	TX
Cordona Lake	XTO	7	11	6	60	1.3	TX
Cortez	Kinder Morgan	502	808	30	1117	23.6	TX
Delta	Denbury Onshore, LLC	108	174	24	538	11.4	MS, LA
Dollarhide	Chevron	23	37	8	77	1.6	TX
El Mar	Kinder Morgan	35	56	6	60	1.3	TX
Enid-Purdy *(Central Oklahoma)*	Merit	117	188	8	77	1.6	OK
Este I to Welch, TX	ExxonMobil, et al	40	64	14	160	3.4	TX
Este II to Salt Creek Field	ExxonMobil	45	72	12	125	2.6	TX
Ford	Kinder Morgan	12	19	4	47	1.0	TX
Free State	Denbury Onshore, LLC	86	138	20	331	7.0	MS
Green Line I	Denbury Green Pipeline LLC	274	441	24	850	18.0	LA
Joffre Viking	Penn West Petroleum, Ltd	8	13	6	60	1.3	Alberta
Llaro	Trinity CO2	53	85	12-8	77	1.6	NM
Lost Soldier/Werrz	Merit	29	47				WY
Mabee Lateral	Chevron	18	29	10	98	2.1	TX
McElmo Creek	Kinder Morgan	40	64	8	77	1.6	CO, UT
Means	ExxonMobil	35	56	12	125	2.6	TX
Monell	Anadarko			8	77	1.6	WY
North Ward Estes	Whiting	26	42	12	125	2.6	TX
North Cowden	Oxy Permian	8	13	8	77	1.6	TX
Pecos County	Kinder Morgan	26	42	8	77	1.6	TX
Powder River Basin CO_2 PL	Anadarko	125	201	16	204	4.3	WY
Raven Ridge	Chevron	160	257	16	204	4.3	WY, CO
Rosebud	Hess						NM
Sheep Mountain	Oxy Permian	408	656	24	538	11.4	TX
Shute Creek	ExxonMobil	30	48	30	1117	23.6	WY
Slaughter	Oxy Permian	35	56	12	125	2.6	TX
Sonat (reconditioned natural gas)	Denbury Onshore, LLC	50	80	18	150	3.2	MS
TransPetco	TransPetco	110	177	8	77	1.6	TX, OK
W. Texas	Trinity CO2	60	97	12-8	77	1.6	TX, NM
Wellman	PetroSource	26	42	6	60	1.3	TX
White Frost	Core Energy, LLC	11	18	6	60	1.3	MI
Wyoming CO_2	ExxonMobil	112	180	20-16	204	4.3	WY
Canyon Reef Carriers	Kinder Morgan	139	224	16	204	4.3	TX
Dakota Gasification (Souris Valley)	Dakota Gasification	204	328	14-12	125	2.6	ND, Sask
Pikes Peak	SandRidge	40	64	8	77	1.6	TX
Val Verde	SandRidge	83	134	10	98	2.1	TX
	Totals:	4,111	6,611				

**Tabulation does not include many shorter high pressure truck lines to individual fields*

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[49] Melzer Consulting, Hattenbach, BlueSource (2010)

Table 4. CO_2 Stream Compositions from Various Processes

Component	Kinder Morgan CO_2 Pipeline Specs[50]	Ethanol Plant[51]	Great Plains Synfuels Plant[52]	Gas Processing Plant[53]	Coffeyville Resources Ammonia-UAN Fertilizer Plant[54]	Food-Grade CO_2 Specs[55]
CO_2	≥ 95 vol%	> 98 vol%	96.8 vol%	≥ 96 vol%	99.32 vol%	≥ 99.9 vol%
Water	≤ 30 lb/MMcf	Dry	< 25 ppm	≤ 12 lb/MMcf	0.68 vol%	≤ 20 ppmw
H_2S	≤ 20 ppmw		< 2 vol%	≤ 10 ppmw		≤ 0.1 ppmv
Total Sulfur	≤ 35 ppmw	40 ppmv	< 3 vol%	≤ 10 ppmw		≤ 0.1 ppmv
N_2	≤ 4 vol%	0.9 vol%	0 ppm			None
Hydrocarbons	≤ 5 vol%	2300 ppmv	1.3 vol%	≤ 4 vol%		CH4: ≤ 50 ppmw; others: ≤ 20 ppmw
Hydrocarbons	≤ 5 vol%	2300 ppmv	1.3 vol%	≤ 4 vol%		CH4: ≤ 50 ppmw; others: ≤ 20 ppmw
O_2	≤ 10 ppmw	0.3 vol%	0 ppm	≤ 10 ppmw		≤ 30 ppmw
Other	Glycol: ≤ 0.3 gal/MMcf		0.8 vol%			≤ 330 ppmw
Temperature	≤ 120°F	120°F	100°F	≤ 100°F	100°F	

4. Pricing for CO_2

Traditionally, the value for CO_2 is based upon purity, pressure, and location of the CO_2 stream. Markets for CO_2 are primarily limited to food grade applications (e.g., beverages, cooling/freezing, solvent markets) and enhanced oil recovery.

In addition to CO_2 for EOR and food grade applications, markets for commodity CO_2 include the following uses:

1) As a raw material feedstock for some chemical processes, including the manufacture of methanol and nitrogen urea.

2) As a fire retardant agent in hand-held and larger-scale fire extinguishing systems.

3) To make dry ice.

4) For the treatment of alkaline water.[56]

Other uses of CO_2 under development include:

1) To enhance natural gas recovery.

2) To enhance coal-bed methane recovery.

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[50] Kinder Morgan, Quality Specifications of Sales Contract Between Resolute Natural Resources and Kinder Morgan, www.secinfo.com/dsvRu.u4Kg.6.htm#1stPage (last visited Dec 2009).

[51] S.G. Chen, Y. Lu & M. Rostam-Abadi, Assessment of Geological Carbon Sequestration Options in the Illinois Basin: Task 2 – Assess Carbon Capture Options for Illinois Basin Carbon Dioxide Sources (2004).

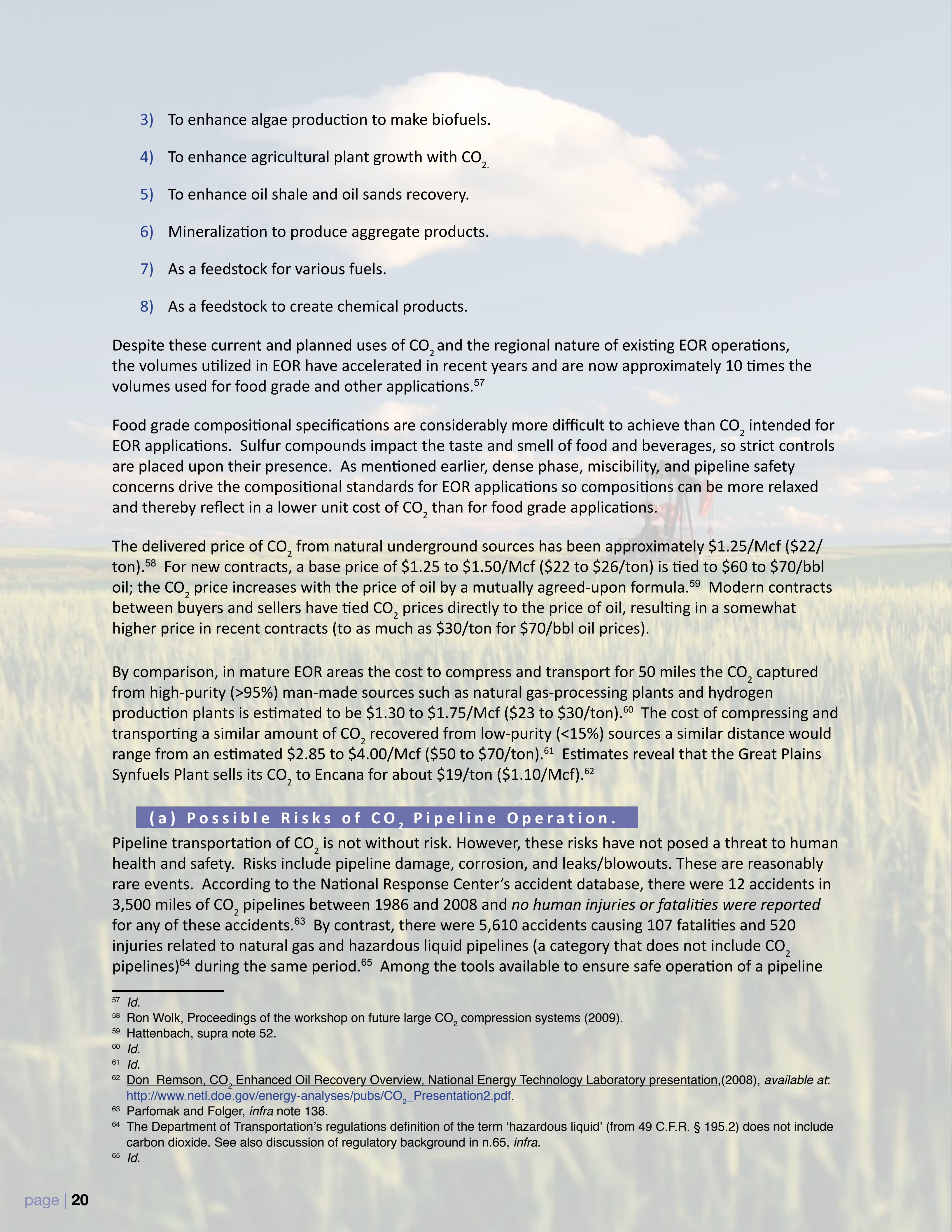
[52] Perry and Eliason, *Supra* note 33; see also Ray Hattenbach, Blue Source LLC, Personal Communication with Melanie Jensen, Energy & Environmental Research Center regarding pipeline specifications, November 2009 [hereinafter Hattenbach].

[53] Keith Tracy, Carbon Pipeline Development: Presented at ACI Carbon Capture and Sequestration Summit, Washington, DC, September 14–15, 2009.

[54] Dan Kubek, Large CO_2 Sources & Capture Systems: Presented at Workshop on Future Large CO_2 Compression Systems, Gaithersburg, Maryland, March 30, 2009, http://www.nist.gov/eeel/high_megawatt/upload/2_3-Kubek-Approved.pdf.

[55] Logichem Process Engineering, http:www.logichemprocess.com/CO2%20Food%20Grade%20Specs.pdf.

[56] Southern States Energy Board (SSEB). (2010). [Internal Report]. Unpublished data.



3) To enhance algae production to make biofuels.
4) To enhance agricultural plant growth with $CO_{2.}$
5) To enhance oil shale and oil sands recovery.
6) Mineralization to produce aggregate products.
7) As a feedstock for various fuels.
8) As a feedstock to create chemical products.

Despite these current and planned uses of CO_2 and the regional nature of existing EOR operations, the volumes utilized in EOR have accelerated in recent years and are now approximately 10 times the volumes used for food grade and other applications.[57]

Food grade compositional specifications are considerably more difficult to achieve than CO_2 intended for EOR applications. Sulfur compounds impact the taste and smell of food and beverages, so strict controls are placed upon their presence. As mentioned earlier, dense phase, miscibility, and pipeline safety concerns drive the compositional standards for EOR applications so compositions can be more relaxed and thereby reflect in a lower unit cost of CO_2 than for food grade applications.

The delivered price of CO_2 from natural underground sources has been approximately $1.25/Mcf ($22/ton).[58] For new contracts, a base price of $1.25 to $1.50/Mcf ($22 to $26/ton) is tied to $60 to $70/bbl oil; the CO_2 price increases with the price of oil by a mutually agreed-upon formula.[59] Modern contracts between buyers and sellers have tied CO_2 prices directly to the price of oil, resulting in a somewhat higher price in recent contracts (to as much as $30/ton for $70/bbl oil prices).

By comparison, in mature EOR areas the cost to compress and transport for 50 miles the CO_2 captured from high-purity (>95%) man-made sources such as natural gas-processing plants and hydrogen production plants is estimated to be $1.30 to $1.75/Mcf ($23 to $30/ton).[60] The cost of compressing and transporting a similar amount of CO_2 recovered from low-purity (<15%) sources a similar distance would range from an estimated $2.85 to $4.00/Mcf ($50 to $70/ton).[61] Estimates reveal that the Great Plains Synfuels Plant sells its CO_2 to Encana for about $19/ton ($1.10/Mcf).[62]

(a) Possible Risks of CO_2 Pipeline Operation.

Pipeline transportation of CO_2 is not without risk. However, these risks have not posed a threat to human health and safety. Risks include pipeline damage, corrosion, and leaks/blowouts. These are reasonably rare events. According to the National Response Center's accident database, there were 12 accidents in 3,500 miles of CO_2 pipelines between 1986 and 2008 and *no human injuries or fatalities were reported* for any of these accidents.[63] By contrast, there were 5,610 accidents causing 107 fatalities and 520 injuries related to natural gas and hazardous liquid pipelines (a category that does not include CO_2 pipelines)[64] during the same period.[65] Among the tools available to ensure safe operation of a pipeline

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[57] *Id.*

[58] Ron Wolk, Proceedings of the workshop on future large CO_2 compression systems (2009).

[59] Hattenbach, supra note 52.

[60] *Id.*

[61] *Id.*

[62] Don Remson, CO_2 Enhanced Oil Recovery Overview, National Energy Technology Laboratory presentation,(2008), *available at*: http://www.netl.doe.gov/energy-analyses/pubs/CO_2_Presentation2.pdf.

[63] Parfomak and Folger, *infra* note 138.

[64] The Department of Transportation's regulations definition of the term 'hazardous liquid' (from 49 C.F.R. § 195.2) does not include carbon dioxide. See also discussion of regulatory background in n.65, *infra*.

[65] *Id.*

are the inclusions of fracture arrestors approximately every 1,000 feet, block valves to isolate pipe sections that are leaking, the use of high durometer elastomer seals, and automatic control systems that monitor volumetric flow rates and pressure fluctuations.[66] Other methods include aircraft and/or satellite monitoring of pipeline rights of way, implementation of periodic corrosion assessments, and internal cleaning and inspection using pipeline "pigs." The use of specific safety and monitoring tools will vary depending on the location, size, and pressure of the pipeline.

The U.S. Department of Transportation (DOT) Office of Pipeline Safety (OPS) sets and enforces standards for the safe operation of CO_2 pipelines. [67] Its definition of CO_2 is "a fluid consisting of more than 90% carbon dioxide molecules compressed to a supercritical state."[68] CO_2 is not considered a hazardous liquid by the regulation, which covers design, pipe, valves, fittings, flange connections, welding, breakout tanks, leak detection, inspection, pumps, compressors, etc. The siting of new CO_2 pipelines is not regulated by any federal agency, but is subject to regulation by the states.

5. Safety Regulation of Carbon Dioxide Pipelines in the U.S.

The federal Pipeline Safety Reauthorization Act of 1988 included a provision to regulate the safety of CO_2 pipelines.[69] Pipelines that both "start and stop" exist within a state boundary are considered *intrastate* and would be regulated by the state authority if that authority has adopted regulations that are at least as stringent as the applicable federal safety regulations. Pipelines traversing more than one state are *interstate* pipelines and their safety is regulated by the Federal Pipeline and Hazardous Materials Safety Administration (PHMSA) within the DOT. PHMSA also would regulate those intrastate facilities within a state that has not adopted regulations as stringent as federal safety regulations.

In June 1991, the Research and Special Programs Administration of the DOT issued Docket PS-112 establishing safety regulations for transporting CO_2 by pipeline in a supercritical state. The effective date for these safety regulations was July 12, 1992. CO_2 is transported as a supercritical liquid at pressures exceeding 1,275 psig. This is done to transport larger volumes using smaller diameter pipelines.

These pipelines are regulated under 49 CFR Part 195, Transportation of Hazardous Liquids by Pipeline. DOT has not classified CO_2 as a hazardous liquid, but as DOT explained in promulgating the rules, it retained the regulations governing CO_2 pipelines within the section addressing such liquids "for administrative convenience."[70] The federal government chose to regulate the transportation of CO_2 by pipeline under this set of rules due to the characteristics of the pipeline. As mentioned above, when CO_2 is compressed under high pressure for transportation, it becomes a dense phase gas (or supercritical

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[66] John Gale & John Davison, Transmission of CO_2—Safety and Economic Considerations, Energy, v. 29, 1319–1328 (2004).

[67] 49 C.F.R. § 195 (1991).

[68] *Id.*

[69] Pipeline Safety Reauthorization Act of 1988 (P.L. 100-561, Oct. 31, 1988).

[70] Some confusion has arisen from the fact that regulations applicable to CO_2 pipelines are included under the heading entitled "Transportation of Hazardous Liquids by Pipeline." 49 C.F.R. pt. 195. This led some commentators to assume, erroneously, that CO_2 is a "hazardous liquid" under the regulations. This is not accurate. The Department of Transportation proposed safety regulations for CO_2 pipelines in 1989 precisely because the regulations governing transportation of "hazardous liquids" did not apply to CO_2. See Notice of Proposed Rulemaking, "*Transportation of Carbon Dioxide by Pipeline*", 54 Fed. Reg. 41912 (October 12, 1989). The term "hazardous liquid" is defined at 49 C.F.R. § 195.2, and does not include carbon dioxide. Commentators were concerned that including CO_2 pipeline regulations under the section heading for "hazardous liquids" would lead to confusion. In response, the Office of Pipeline Safety said it had "no good reason to dispute" this notion, and indeed it agreed that carbon dioxide "should not be included in the definition of 'hazardous liquids'". *Id.* Nevertheless, the Department said it would not change the title heading "because it would result in an awkward title" *Id.* The distinction between carbon dioxide and hazardous liquids is maintained at 49 C.F.R. § 195.0 which essentially provides that "[t]his part prescribes safety standards and reporting requirements for pipeline facilities used in the transportation of hazardous liquids or carbon dioxide." *Id.* (emphasis added) Although CO_2 is listed as a Class 2.2 (non-flammable gas) hazardous material under DOE regulations (49 C.F.R. § 172.101), the agency applies nearly the same safety requirements to CO_2 pipelines as it does to pipelines carrying hazardous liquids such as crude oil, gasoline, and anhydrous ammonia (49 C.F.R. § 195).

liquid) and flows in a manner analogous to liquids. Therefore, the liquids pipeline safety rules are applied to these pipelines rather than the natural gas safety rules. The regulations cover the large transmission pipelines and the production lines as they enter the field of production and any return lines to a plant for recycling. Once the production lines branch off to individual wells, they do not fall under the scope of the safety regulations.

There are nine states with CO_2 pipelines of varying lengths within their boundaries. From information obtained from PHMSA, the following states report CO_2 pipeline mileage data through annual reports and map data (ranked here in decreasing order in terms of miles of CO_2 pipeline): Texas, New Mexico, Wyoming, Mississippi, Colorado, Oklahoma, North Dakota, Utah, and Louisiana.

There are 21 different companies operating a total of 3,637 miles of CO_2 transmission pipelines (see Appendix I). Almost one-third (1,200) of the federally regulated *interstate* pipeline miles are located in Texas, followed by New Mexico with 966 miles. The lowest mileage is 75 in Louisiana. All of these pipelines are covered under the federal pipeline safety program and regulated under Part 195.

Pipeline safety regulations and operations in Texas reflect the coordination between federal and state authorities. Texas has nearly 1,700 miles of CO_2 pipelines -- including *interstate* transmission, *intrastate* transmission, and production field distribution lines. Most of the CO_2 is brought into Texas from New Mexico and Colorado where several key natural CO_2 sources exist. The CO_2 is primarily used in EOR projects. Tertiary EOR projects typically occur where CO_2 is injected into underground formations to produce additional oil following primary and secondary recovery methods. There are approximately 183 authorized CO_2 EOR projects active in Texas.[71]

All regulated Texas pipelines have a permit (Form T-4), issued by the Railroad Commission of Texas (RRC) that details the pipeline route. Pipeline permits and new construction reports can be viewed online at the RRC's website under the licensing and permit tab.[72] Only those pipelines regulated by the RRC's Pipeline Safety Division are required to file new construction reports.

The RRC has adopted the federal pipeline safety rules under Chapter 117 of the Texas Natural Resources Code. With regard to CO_2, the RRC's rules, for the most part, mirror the federal regulations. However, there are more stringent Texas regulations regarding cathodic protection and integrity management. If the pipeline contains more than 100 ppm of hydrogen sulfide, the permit to construct the pipeline must be approved at the Commission level rather than administratively by RRC staff. Many of the pipelines in west Texas contain large amounts of H_2S and have been approved by the RRC and monitored for compliance with the RRC's Rule 36 governing H_2S safety regulations by the Oil & Gas Division. The Oil & Gas Division has field representatives designated as H_2S experts to assist in the review and permitting of these pipelines and other production-related activities. Other states may have similar requirements for their intrastate pipelines.

There are 40 pipeline permits held by 19 different operators transporting CO_2 in Texas. Of the 40 permits, 15 are listed as interstate and would be regulated by the federal PHMSA office in Houston. These interstate pipelines range in size from 8 to 24 inches. The remaining 25 permits are listed as intrastate and total 483 miles. The RRC regulates 314 of the intrastate miles under its state-specific pipeline safety program. The remaining 169 miles are considered part of the production process and are not included in the regulations set out in Part 195.

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[71] Victor Carrillo, Chairman, Railroad Commission of Texas.

[72] The licensing and permit tab can be found at: www.rrc.state.tx.us/licenses/index.php.

The RRC lists 22 pipeline systems in Texas. The Pipeline Safety Division conducts routine safety evaluations on these systems at least once every three years. The pipelines take CO_2 that is brought into the state and delivers it to the fields that are using CO_2 for EOR. Some of those fields include piping necessary to transport recovered CO_2 within and between fields for further use.

One of the newer projects, the Denbury Green Pipeline Project, is a 24-inch pipeline from Donaldsonville, Louisiana, to the Hastings Field, south of Houston, Texas. The pipeline is being designed to transport both naturally occurring and anthropogenic CO_2. Denbury plans to purchase anthropogenic CO_2 from at least four plants; however, those plants have yet to be built. At this time, Denbury has filed the pipeline permit only for the portion located just inside the Texas border. The Green Pipeline is expected to be completed by late 2010.

The pipeline network feeding the Permian Basin is the most intensely developed CO_2 pipeline network to date. The oldest pipeline is the Canyon Reef pipeline that has been in operation since the early 1970s.

B. Existing Regulatory Infrastructure for CO_2 Pipelines in the U.S.

As stated earlier, CO_2 pipelines are subject to safety regulations at the federal level and economic and other regulation at the state level. Safety regulation is assured by PHMSA within DOT and by state regulators applying standards that are at least as stringent as the federal standards.

As detailed below, economic regulation of the terms and conditions of service (including rates and conditions of access) of CO_2 pipelines is subject to the states. At the federal level, CO_2 pipelines are neither "common carriers" under the Interstate Commerce Act (ICA) administered by the Surface Transportation Board (STB), nor "natural gas companies" under the Natural Gas Act (NGA) administered by the Federal Energy Regulatory Commission (FERC). However, there may be a federal carriage obligation imposed in certain circumstances involving use of federal land. In one case, the federal antitrust laws have been used to modify some terms and conditions of service. These points are explained below.

1. Regulatory Status under the ICA and the NGA.

(a) *Jurisdiction under the Interstate Commerce Act.* When originally adopted in 1906, the Hepburn Act[73] added regulation of oil pipelines as common carriers to the pre-existing regulatory responsibilities of the Interstate Commerce Commission (ICC). The statute originally extended the provisions of the Interstate Commerce Act (ICA) to those "engaged in the transportation of oil or other commodity, except water and except natural or artificial gas, by means of pipe lines".[74] The exact wording of the ICA pipeline provisions changed several times over the years due to the transfer of oil pipeline regulation

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[73] 34 Stat. 584, 59th Cong., 1st. Sess. 1, ch. 3591, enacted June 29, 1906.

[74] *Id.*

to FERC in 1977 under the Department of Energy Organization Act [75] and the re-codification of the U.S. Code in 1978. Those changes deleted the qualifiers "natural or artificial", leaving the exclusion of pipelines transporting "gas". Following the changes, FERC acquired regulatory jurisdiction over oil pipelines, while the ICC retained jurisdiction over the transportation of other commodities except for pipelines transporting “gas” (or water).[76] A question was posed, however, as to whether the exclusion of “gas” (in the 1978 re-codification) or of “natural or artificial gas” (in the originally-adopted statute) included all gases or was intended to exclude only gases used for heating (i.e., methane pipelines subject to regulation by the FERC under the NGA).

Two requests for a declaratory order to resolve this question were filed with the ICC in 1980 on behalf of Cortez Pipeline Company and ARCO Oil & Gas Company in conjunction with the construction of a new interstate CO_2 pipeline. The ICC invited public comment on the requests in light of their precedential character. The agency analyzed the applicable statutory provisions and ultimately concluded that under the “plain meaning” of the statute (referring back to the originally enacted text that excluded the transportation of “natural or artificial gas”), Congress excluded the entire “universe” of gas types. Following public comment on a proposed ruling, the agency issued a final order declaring that the agency lacked jurisdiction under the ICA over the interstate transportation of CO_2 by pipeline.[77]

In 1995, the ICC was abolished pursuant to the Interstate Commerce Commission Termination Act of 1995 (the “Termination Act”), and certain of its authorities and responsibilities were transferred to a newly created STB.[78] There was no change, however, in the applicable substantive law governing the regulation of pipelines.[79] Moreover, the savings provisions of the 1995 ICC Termination Act (Section 204 of the statute)[80] confirmed the validity of prior rulings of the ICC and specifically provided for the continuing legal effectiveness of the prior orders and determinations of the ICC “until changed in accordance with the law.”[81]

(b) *Jurisdiction under the NGA*. The developers of the Cortez Pipeline also presented the jurisdictional question to FERC under the NGA and the Natural Gas Policy Act of 1978, seeking a comparable declaratory order regarding jurisdiction. FERC granted the request, finding that a gas that was 98 percent pure carbon dioxide with traces of methane in the remaining 2 percent (which was not

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[75] Section 402 (b) of the Department of Energy Organization Act, originally codified at 42 U.S.C. 7172 (b), *repealed* by Pub. L. 103-272, 108 Stat. 1379 (1994).

[76] 49 U.S.C. 15301 (a)

[77] Interstate Commerce Commission, *Cortez Pipeline Company*, "Petition for Declaratory Order – Commission Jurisdiction Over Transportation of Carbon Dioxide by Pipeline" and *Arco Oil and Gas Company*, "Petition for Declaratory Order -- Jurisdiction Over Interstate Pipeline Transportation of Carbon Dioxide”, Nos. 37427 and 37529, 45 Fed. Reg. 85177 (December 24, 1980) (“Tentative Declaratory Order”); *Arco Oil and Gas Company* "Petition for Declaratory Order -- Jurisdiction Over Interstate Pipeline Transportation of Carbon Dioxide,” No. 37529, 46 Fed. Reg. 18805 (March 26, 1981) (“Final Declaratory Order”).

[78] Interstate Commerce Commission Termination Act of 1995 (ICCTA), Pub. L. No. 104-88, 109 Stat. 803 (1995).

[79] As amended by the Termination Act, section 15301 of the Interstate Commerce Act, 49 U.S.C. 15301(a) provides in material part that the Surface Transportation Board has jurisdiction over “transportation by pipeline, or by pipeline and railroad or water, when transporting a commodity other than water, gas, or oil.”

[80] Section 204 (a) of the ICCTA. The saving provision was not included in the codification of the Termination Act, but may be found in the notes to the codification of the sections establishing the Surface Transportation Board *available at*:(http://www.law.cornell.edu/uscode/html/uscode49/usc_sec_49_00000701----000-notes.html). As recognized by the STB itself, the saving provision of ICCTA “provides that ICC precedent applies to the Board”. GWI Switching Services, L.P., et al, (August 12, 2001), at n. 12, http://www.stb.dot.gov/decisions/readingroom.nsf/389e96bb615974918525653f005497a0/9cc76279022bab0085256a8e006bfb45?OpenDocument (last visited June 29, 2008). See also “Class Exemption For Motor Passenger Intra-Corporate Family Transactions”, STB Finance Docket No. 33685, (February 18, 2000), http://www.stb.dot.gov/decisions/readingroom.nsf/UNID/4B9598F2477DF0828525688900662DA5/$file/30325.pdf, *mimeo*, at 10 (under section 204(a) of ICCTA, ICC precedent in effect on the date of enactment of the ICCTA continues in effect until modified or revoked in accordance with law).

[81] For a discussion of the jurisdictional issue, see Vann and Parfomak, “Regulation of Carbon Dioxide (CO_2) Sequestration Pipelines: Jurisdictional Issues” (January 7, 2008 and April 15, 2008) (Congressional Research Service, Order Code RL34307) (hereafter “CRS 2008 CO_2 Pipeline Jurisdictional Analysis”) (discussing Cortez rulings by ICC and FERC) available at: http://assets.opencrs.com/rpts/RL34307_20080415.pdf.

separated from the main production) was not "natural gas" within the meaning of the NGA.[82] As a result, the CO$_2$ pipeline operator would not become a "natural-gas company" under the NGA by constructing or operating the proposed CO$_2$ pipeline. The 1979 jurisdictional ruling was reiterated in a 2006 order granting abandonment of a natural gas pipeline for conversion to CO$_2$ transportation.[83]

2. Jurisdiction under Mineral Leasing Act of 1920.

Federal regulatory jurisdiction may occur if a CO$_2$ pipeline crosses federal land and receives a right of way authorization issued by the Bureau of Land Management (BLM) under the Mineral Leasing Act of 1920 (the MLA).[84] Section 28 of the MLA imposes a “common carrier” obligation on pipeline and related facilities that are authorized under that act. The statute thus requires the owner or operator to transport “without discrimination” all “oil or gas” delivered to the pipeline “without regard to whether such oil or gas was produced on Federal or non-Federal lands.”[85] The BLM’s decision to issue the right of way authorization under section 28 of the MLA rather than under another federal land statute[86] was challenged in court, but affirmed in 1992.[87]

Philip M. Marston and Patricia A. Moore provided a useful summary of the federal regulatory landscape in a 2008 article in the Energy Law Journal.[88]

> ***It seems fair to say that CO$_2$ pipelines are neither “common carriers” under the Interstate Commerce Act nor “natural gas companies” under the Natural Gas Act. They may however be “common carriers” under the [Mineral Leasing Act] if: (a) they cross federal land that is subject to that act, and (b) if the [Bureau of Land Management] issues right of way authorization under the [Mineral Leasing Act] rather than the [Federal Land Policy and Management Act]. The operation of CO$_2$ pipelines remains subject of course to other generally applicable federal law.***

3. CO$_2$ Pipeline Regulation under State Law.

State governments began to address CO$_2$ pipeline regulation several decades ago, when new facilities were being built or expanded. Several states have enacted laws or promulgated regulations[89] specifically designed to address and encourage CO$_2$-based oil production, which may include mechanisms for obtaining a right of eminent domain to acquire rights of way for CO$_2$ pipelines. The following discussion of state regulation is intended only to provide a general overview of regulation in selected states. A thorough inventory of state statutory and regulatory law is included in Appendix II.

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[82] *Cortez Pipeline Company*, 7 FERC 61,024 (1979).

[83] Southern Natural Gas, 115 FERC 62,266 (2006), at P.3.

[84] Mineral Leasing Act of 1920 (MLA), as amended, 30 U.S.C. § 185.

[85] Section 28 of the MLA, provides in relevant part as follows:

> (a) Rights-of-way through any Federal lands may be granted by the Secretary of the Interior or appropriate agency head for pipeline purposes for the transportation of oil, natural gas, synthetic liquid or gaseous fuels, or any refined product produced there from to any applicant possessing the qualifications provided in section 181 of this title in accordance with the provisions of this section.
>
> (r)(1) Pipelines and related facilities authorized under this section shall be constructed, operated, and maintained as common carriers.
>
> (2)(A) The owners or operators of pipelines subject to this section shall accept, convey, transport, or purchase without discrimination all oil or gas delivered to the pipeline without regard to whether such oil or gas was produced on Federal or non-Federal lands.

30 U.S.C. §§ 185(a), (r)(1), (r)(2)(A).

[86] Previously, the BLM had acted under the Federal Land Policy and Management Act (FLPMA) which does not impose a comparable carriage obligation.

[87] *Exxon Corp*. v. Lujan , 970 F.2d 757 (10th Cir. 1992) (hereafter *Lujan*).

[88] Philip M. Marston and Patricia A. Moore, From EOR to CCS: *The Evolving Legal and Regulatory Framework for Carbon Capture and Storage,* Energy Law Journal, V.29,No.2, P.421 at P.455 (2008).

[89] See IOGCC Groundwork (www.groundwork.iogcc.org) for state-by-state regulatory information

Texas

In 1991, the Texas Legislature enacted laws that brought CO_2 and hydrogen pipelines under regulation by the Texas Railroad Commission under certain defined circumstances.[90] The statute gives the CO_2 pipeline operator a choice of operating as either a private carrier (without a right of eminent domain) or a common carrier (in which case the operator may exercise a state-granted power of eminent domain). The statute includes within the definition of common carrier a person who owns, operates, or manages, wholly or partially, pipelines for the transportation of carbon dioxide or hydrogen in whatever form to or for the public for hire, "but only if such person files with the commission a written acceptance of the provisions of this chapter expressly agreeing that, in consideration of the rights acquired, it becomes a common carrier subject to the duties and obligations" of that statute. The statute provides that "common carriers have the right and power of eminent domain."

In short, Texas offers the option of remaining a private contract carrier or of becoming a common carrier by filing with the regulatory commission, while reserving the power of eminent domain to those that elect the common carrier option.

It may be noted that under the Texas statute, the grant of eminent domain power to a CO_2 pipeline is not limited to those transporting for EOR purposes, but applies to any pipeline transporting CO_2 without imposing any limitation of purpose. A pipeline carrier that accepted the common carrier option could use the pipeline either for EOR or for transportation to a free-standing geologic storage location.

Mississippi

The Mississippi CO_2 legislation dates from 1984.[91] It does not impose common carriage duties on CO_2 pipelines but grants a more limited power of eminent domain than under the Texas law, as the availability of eminent domain is limited to the construction of CO_2 pipelines "for use in connection with secondary or tertiary recovery projects located within the state of Mississippi for the enhanced recovery of liquid or gaseous hydrocarbons."[92] Hence, a pipeline developer under the Mississippi statute is unable to exercise eminent domain if the pipeline is used solely for purposes of reducing CO_2 emissions via geologic storage.

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[90] Tex. Nat. Res. Code Ann.§ 111.019(a). For a review of Texas law governing exercise of eminent domain powers by common carrier pipelines generally, see Comment, *"Judicial Battles Between Pipeline Companies And Landowners: It's Not Necessarily Who Wins, But By How Much"*, 37 Houston L. Rev. 125 (2000), http://www.houstonlawreview.org/archive/downloads/37-1_pdf/hlr37p125.PDF (last visited May 11, 2008).

[91] Miss. Code Ann. § 11-27-47 (2009)

[92] Miss. Code Ann Sec. 11-27-47(1972), http://www.mscode.com/free/statutes/11/027/0047.htm (last visited June 30, 2008). The rules of the Mississippi Oil and Gas Board in its Rulebook (at §53-1-3) define the term "gas" as including carbon dioxide. See § 53-3-159.

Louisiana

Louisiana allows the exercise of “expropriation” (which is to say condemnation) of property for piping or marketing of carbon dioxide for use in connection with a secondary or tertiary recovery project for the enhanced recovery of liquid or gaseous hydrocarbons approved by the Commissioner of Conservation.[93] The exercise of that power is conditioned on approval of the enhanced recovery project by the Commissioner of Conservation and issuance of a certificate of public convenience and necessity for the pipeline.[94] Unlike Mississippi, Louisiana law applies even if the CO_2 transportation is entirely in connection with projects in other states.[95] In that case, the commissioner’s approval “shall consist of confirmation that the applicable regulatory authority of that state or jurisdiction has approved or authorized the injection of carbon dioxide in association with such project.”[96] Similar to Mississippi, and in contrast to the Texas statute, Louisiana law limits the expropriation power to pipelines to supporting secondary or tertiary recovery of hydrocarbons.

Other states with significant CO_2 operations also have provisions for pipeline right of way acquisition or address other aspects of a regulatory regime needed for transport, injection, or storage of CO_2. Examples include Wyoming, New Mexico, Colorado, and North Dakota.[97]

This area of the law is dynamic. States are in a constant process of developing their particular regulatory frameworks. As noted above, a thorough inventory of the current status of state statutory and regulatory law is included in Appendix II.[98]

In addition to state statutory law, CO_2 pipelines may in certain cases be subject to carrier obligations of common law. The traditional view holds that a carrier ceases to be a "private" or "contract" carrier and becomes a *common* carrier when it "holds itself out" to the public as a common carrier by posting rates and offering to carry for all.[99]

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[93] Louisiana R.S. Sec. 19:2(10)(2007).

[94] Louisiana R.S. 30:4 (c)(17)(b). The Commissioner is also tasked to regulate the construction design and operation of pipelines transmitting carbon dioxide to serve secondary and tertiary recovery projects for increasing the ultimate recovery of oil or gas, “including the issuance of certificates of public convenience and necessity for pipelines serving such projects approved hereunder.”

[95] *Id.*

[96] *Id.*

[97] For a review of state legislative action governing CCS as of early 2008, see D. Eugene, “State CCS Progress”, 24 Natural Gas & Electricity 8 (May 2008)(discussing in particular Wyoming, New Mexico, California, North Dakota, Texas and Kansas). *See also* Robert R. Nordhaus and Emily Pitlick, "*Carbon Dioxide Pipeline Regulation*", 30 Energy L. J. 85 (2009).

[98] A number of resources are available that endeavor to track changes in state law governing CO2 pipelin regulation. The University College London’s Carbon Capture Legal Programme (CCLP) has created one such site with links to recently passed legislation at both the U.S. and state levels (*available at*: http://www.ucl.ac.uk/cclp/ccsdedlegnat-US.php#state), as well as around the world (http://www.ucl.ac.uk/cclp/ccsdata.php).

[99] Marston and Moore, From EOR to CCS, *supra* 88

C. CO$_2$: Commodity or Pollutant – Resource Management – A New Paradigm

The evolution of CO$_2$ as either a commodity or a pollutant has significant implications for how CO$_2$ will be handled and transported. The traditional conversation regarding the status of CO$_2$ has centered on whether CO$_2$ is a commodity or a pollutant. In this discussion, the PTTF hopes to move beyond that limited focus toward a more constructive paradigm of "Resource Management."

Resource Management -- Regulation that seeks to manage, maintain, and advance the beneficial uses of a commodity while regulating and controlling any harmful or deleterious effects of the commodity.

Classification of CO$_2$ as both a commodity and as a pollutant creates an immediate conflict which needs to be addressed for the sake of future CCS implementation and to ensure the consistency of future CCS with current CO$_2$ pipeline operations.[100] The Government Accountability Office identified regulatory uncertainty of how injection, capture, and storage of CO$_2$ will be handled as one of the chief hurdles to the development of a CO$_2$ pipeline network.[101]

Classification of CO$_2$ as a pollutant would lead to greater regulatory oversight, permitting requirements, safety inspections, etc. Classification of CO$_2$ as a commodity would require some federal oversight but not to the extent required by a pollutant classification. There is another regulatory option that looks beyond the "pollutant v. commodity" dichotomy. Perhaps a more practical way of looking at CO$_2$ transportation, capture, storage, and injection is through the lens of "resource management." Resource management changes the scope of the "either/or" classification inherent in the pollutant v. commodity discussion, to a "both/and" mode of looking at CO$_2$. The resource management regulatory paradigm focuses on managing and maintaining the beneficial uses of a commodity, while regulating and controlling any harmful or deleterious effects of the commodity.

With either model there are issues that need to be addressed in terms of CO$_2$. A key issue affecting the implementation of a regulatory framework is the quality of the CO$_2$. High quality CO$_2$ (almost pure) presents little challenge to capture, storage, and transportation. Less compression is needed to move the CO$_2$ through the pipeline because the CO$_2$ stream is close to pure. CO$_2$ quality also might have an effect on the storage and injection requirements. Pure CO$_2$ is more likely to be injected because environmental concerns are diminished. For example, injection of CO$_2$ with high H$_2$S content is more likely to raise public safety concerns because of the issues associated with acid gas. That being said, acid gas injection is an oilfield activity that has been in safe practice since the early 1990's. A CO$_2$ stream with high levels of impurities is less likely to be transported via pipeline because of the greater compression requirements and expense of moving such "impure" CO$_2$.

Adding to the regulatory uncertainty of development of a CO$_2$ infrastructure are legal challenges to government action concerning the handling of CO$_2$ emissions. In 2003, the EPA disclaimed jurisdiction under the Clean Air Act (CAA) to regulate CO$_2$ and concluded that even if the EPA had authority to regulate CO$_2$, it would not do so.[102] In 2007, 30 complainants petitioned the U.S. Supreme Court to

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[100] *See* CRS Report for Congress: Carbon Dioxide (CO$_2$) Pipelines for Carbon Sequestration: Emerging Policy Issues, updated January 17, 2008.

[101] U.S. Government Accountability Office. (September 2008). *Climate Change: Federal Actions Will Greatly Affect the Viability of Carbon Capture and Storage as a Key Mitigation Option* (Vol. GAO-08-1080, p. 4) (U.S. Government Accountability Office). Retrieved from http://www.gao.gov/new.items/d081080.pdf

[102] Mass v. EPA, 549 U.S. 497 (2007)

challenge the EPA's conclusion disclaiming jurisdiction to regulate CO_2.[103] The Supreme Court, in a 5-4 decision, held that the CAA gave the EPA authority to regulate CO_2 emitted from automobile exhaust.[104] The Court concluded that "greenhouse gases fit well within the Clean Air Act's capacious definition of air pollutant.[105]" The Supreme Court concluded that the Administrator of the EPA may regulate CO_2 under the CAA based upon the results of an endangerment finding. . In December 2009, the EPA issued an endangerment finding declaring that "elevated concentrations of greenhouse gases in the atmosphere may reasonably be anticipated to endanger the public health and to endanger the public welfare of current and future generations.[106] Under the endangerment finding, the EPA concluded that CO_2 emissions from automobiles posed a threat to human health and the environment.[107] Since the EPA made a finding of endangerment under Section 202 of the CAA, it is reasonable to assume that the EPA will issue a similar finding for fossil fuel electric generation projects, because the same endangerment finding language is found in Section 108 of the CAA, which sets the national ambient air quality standards (NAAQS). Every pollutant regulated under Section 202 is also regulated under Section 108.

In addition to the purity issue and the EPA actions on CO_2, there also are political issues associated with the development of the CO_2 infrastructure. Whether CO_2 is treated as a commodity, pollutant, or transport resource to be managed, the likelihood of public opposition to pipeline transport is high, just as with other resource infrastructure.

"Federal models for "commodity v. pollutant" and "resource management" can be applied to the states. It seems reasonable to conclude that where states have oil and gas production, the development of a CO_2 infrastructure is more likely to occur because of the usefulness of CO_2 for enhanced oil recovery. State oil and gas regulatory agencies will most likely regulate CO_2 as a commodity. However, if CO_2 regulation is left to the state's environmental quality department, then CO_2 will most likely be regulated as a pollutant. The spirit of the "resource management" paradigm is based upon the hybrid regulatory framework envisioned by cooperation between commercial and environmental regulators. Some states have opted to regulate CO_2 under both commerce regulatory agencies and environmental management agencies. For instance, some states may recognize that CO_2 is valuable as a commodity for EOR thereby granting the state oil and gas agency regulatory authority for these activities, while granting the environmental agency the authority to regulate CO_2 for storage only purposes.

Classification of CO_2 as either a pollutant or commodity is necessarily narrow. By looking at CO_2 regulation through the "resource management" paradigm, the discussion of CO_2 and its potential will be broadened by bringing multiple stakeholders to the discussion of how to regulate CO_2. The resource management paradigm opens a dialogue among multiple agencies ensuring that CO_2 use is regulated appropriately, thereby encouraging the development of a viable CO_2 infrastructure.

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[103] *Id.*

[104] Mass. v. EPA, 549 U.S. 497, 528-529 (2007).

[105] *Id.*

[106] U.S. EPA. (2009, December 07). *Greenhouse Gases Threaten Public Health and the Environment / Science overwhelmingly shows greenhouse gas concentrations at unprecedented levels due to human activity* [Press release]. Retrieved July 30, 2010, from http://yosemite.epa.gov/opa/admpress.nsf/7ebdf4d0b217978b852573590040443a/08d11a451131bca585257685005bf252!OpenDocument.

[107] U.S. EPA, Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act (2009), http://www.epa.gov/climatechange/endangerment.html.

D. Future Pipeline Build-out Scenarios

Any discussion of the barriers and opportunities related to CO_2 pipeline infrastructure to support CCS (including CO_2-EOR) necessarily relies on assumptions about the timing, scope, and configuration of the anticipated growth in the current pipeline network.

Except for pipelines associated with business-as-usual CO_2-EOR and other commercial uses, pipelines for CCS will be associated with enactment of legal restrictions on industrial emissions of carbon dioxide. Legal restrictions on industrial emissions of carbon dioxide could result either from enactment of carbon regulation by Congress or by particular state governments[108], and/or imposition of CO_2 emissions standards by the EPA under the federal Clean Air Act as a result of EPA's recent endangerment finding.[109]

There are substantial uncertainties under both scenarios regarding whether they will occur, and if so, when; and the timing, stringency, and manner of imposition of CO_2 controls on industrial facilities. Regardless of how CO_2 emissions controls are implemented, it is reasonable to assume that they will be phased in over a substantial number of years, and perhaps a decade or more. This suggests that it is unlikely that a nationwide infrastructure of CO_2 pipelines will need to be built in the near future over a short period of time. The more likely result is a gradual build-out of infrastructure over time as CO_2 emission controls or carbon caps tighten.

Another uncertainty that impacts future CO_2 pipeline networks is whether future geologic storage sites will be sited throughout the United States or concentrated in a handful of major locations in regions of the country that are deemed to have particularly favorable geology for storage. The pipeline networks supporting these models would be quite different. And the costs of pipeline construction and operation would be expected to influence the future growth of geologic storage sites.

Experts have put forth several models of what a future CO_2 pipeline network to support CCS might look like. One assumes a nationwide network, similar to that for natural gas, which would transport CO_2 from geographically dispersed industrial sources to a handful of large-scale storage sites. A variant of that model assumes the gradual build-out of regional networks that integrate new supply sources into the existing pipeline infrastructure serving EOR operations with local storage. Under a third model, CO_2 injection sites might be located close to many large CO_2 power plant sources, requiring much shorter "stub" type pipelines linked directly to the storage location.

Analogies to the natural gas network must not be overstated, because under either of the first two models, a CO_2 pipeline network required to accommodate wide-spread deployment of carbon capture is likely to look quite different from the nation's natural gas pipeline network. The natural gas pipeline network is essentially a "many-to-many" network. It links hundreds of thousands of individual gas sources (producing wells and processing plants) with millions of individual delivery points, comprised of both large and small end users. Because of historical and seasonal requirements, the network includes extensive gas storage facilities of varied types, including underground formations (e.g., former producing fields, aquifers, and salt domes) as well as above-ground facilities (typically holding the gas cryogenically converted to liquefied natural gas or "LNG").

While it is unclear how existing business models for CO_2 pipelines may evolve if CCS becomes widespread, all such models will be dealing with a different mix of supply sources and delivery locations

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[108] A number of northeastern states have already enacted legislation imposing constraints on carbon dioxide emissions. *See* http://www.rggi.org.

[109] Endangerment and Cause or Contribute Findings for Greenhouse Gases under the Clean Air Act, available at: http://www.epa.gov/climatechange/endangerment/downloads/FinalFindings.pdf.

than is the case for natural gas. This results because CO_2 pipelines for CCS purposes will almost certainly be built to link a relatively small number of large output sources of CO_2 (power plants and other large stationery sources) with a relatively small number of injection sites, which are likely to begin with EOR fields and gradually expand to include free-standing geological storage facilities. Movement in this direction has been underway for the last several years with regard to current pipeline construction and feasibility planning.

The phenomenon can be illustrated by a simple example. Take the case of a 500 megawatt (MW) power plant that produced 3 million metric tons per year and captured 80% of the $CO_{2.}$ This would produce approximately 2.4 million metric tons available for off-take.[110] If this amount were delivered ratably on a daily basis, it would amount to about 6,575 metric tons per day, or, in volumetric terms, approximately 125,000 Mcf of dense-phase gas available for transport.[111] The output of just eight such plants would fill the largest existing 30-inch CO_2 pipeline, which has a capacity of approximately 1 billion cubic feet per day (Bcf/d).[112]

Even under the very aggressive schedule for CCS deployment developed by the International Energy Agency (IEA), Blue Map scenario, the number of power plant source locations in North America is projected to be roughly 17 plants by 2020 and reach only 250 point sources over approximately 40 years.[113] While the addition of carbon capture from industrial sources would increase the number of individual supply sources, the overall number of supply sources at the end of 40 years projected by IEA still would be more than three orders of magnitude – more than 3,000 times -- fewer than the 478,000 natural gas wells that currently feed into the natural gas pipeline system.[114] And it is by no means certain that CCS will be deployed as quickly as projected under the IEA Blue Map scenario.

Accordingly, rather than the “many-to-many” set of network receipt and delivery points that characterizes the natural gas industry, the CO_2 pipeline network is unlikely over the next half-century to develop beyond a “few-to-few” type network. Under that scenario, a handful of large CO_2 sources feed pipelines whose capacity is specifically dedicated to those sources and that carry the gas to a select number of large EOR injection sites that have contracted for long-term supply. The remainder would be delivered to free-standing geologic storage facilities that receive surplus CO_2 that cannot be marketed for use in EOR operations. The rate at which CO_2 supply captured from anthropogenic sources may come to exceed EOR demand is a major uncertainty in evaluating potential pipeline network development.

It would appear extremely unlikely that the CO_2 pipeline network would ever resemble the natural gas pipeline network, with millions of retail delivery points for CO_2 deliveries or with networks of small CO_2 “gathering lines” to receive small amounts of anthropogenic CO_2 captured from small point sources. The cost of compressing small amounts of CO_2 for dense-phase transportation would by itself render such a system cost-prohibitive. As a result, any future pipeline network for CCS purposes is likely to be a “wholesale-oriented” business from end to end, quite unlike the natural gas network.

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[110] MIT Report, *supra* note 29.

[111] There are 19.01 thousand cubic feet (Mcf) of CO_2 in one metric ton (i.e., 1,000 kilograms) at 60°F and 1 atmosphere. Therefore, 6,575 metric tons of CO_2 at the same conditions × 19.01 Mcf/metric ton equals 124,991 Mcf. To convert U.S. short tons of 1,000 pounds each to Mcf of CO_2, a conversion factor of 17.24 is applied instead.

[112] The largest capacity existing CO_2 pipeline, the 30-inch, 803 kilometer “Cortez” pipeline operated by Kinder Morgan, LLP, has an estimated annual capacity of 19.3 million tons. See Table 4.1 of Intergovernmental Panel On Climate Change, Special Report On Carbon Dioxide Capture An Storage, (Bert Metz, ed., Cambridge University Press 2005) (hereafter “IPCC Special Report on CCS”), at 183 ((19.3 million tons per year/365 days) *multiplied times* a conversion factor of 19.1 equals 1.001 billion cubic feet/day of dense phase gas).

[113] International Energy Agency, “Technology Roadmap: Carbon capture and storage” (2009), at 17 (projections under the “BLUE Map” scenario).

[114] U.S. Energy Information Administration, Natural Gas Annual (2008), at 1 (Table 1) (showing over 478,000 natural gas producing wells in 2008).

These underlying realities may have major implications for potential legal and regulatory structures. New capture sources will require pipeline off-take capacity that is specifically dedicated to receive the plant's CO_2 output. Failure to accommodate the requirement to ensure the availability of designated amounts of capacity for very lengthy periods could pose a significant regulatory barrier to wide-scale commercial deployment of CCS technologies.

II. Prospective Business Models and State and Federal Regulatory Options

In this section the PTTF examines:

1) the potential business models for pipeline construction and operation likely to emerge in the U.S;

2) the state and federal regulatory systems that could conceivably develop to govern those business models; and

3) the impact that the prospective federal and state regulatory systems might have on the various business plans and the development of the intrastate, interstate, and international pipeline infrastructure.

A. Leading Potential Business Models for CO_2 Pipeline Build-out in the U.S.

With a view towards possible storage of anthropogenic CO_2, it seems reasonable to survey the present development of CO_2 infrastructure and the policy frameworks that have developed around this successful business. The analysis will help to gain insights that may facilitate future development should CO_2 capture and storage be required by federal or state carbon regulation.

There are 36 CO_2 pipelines operating in the U.S. today. Of these, six cross state boundaries and one pipeline crosses the international border between the U.S. and Canada. This indicates that the overwhelming number of CO_2 pipelines operating in the U.S. do so in a single state (intrastate) with the majority of them in Texas. Below, various operating models are defined, discussed, and compared to actual pipelines currently operating in the U.S.

Model Definitions

***Intrastate Dedicated Pipeline Model**: a model where parties enter into a contract to develop a pipeline to carry CO_2 under specific terms and conditions. Under this model, the carrier does not require state assistance, i.e., eminent domain authority or an exclusive franchise, and the business arrangement is a contractual agreement between private parties and does not involve economic regulation. Because all of the transport capacity is committed to receiving the output of a particular set of CO_2 sources there is limited access for subsequently developed capture projects. In certain states, such as Mississippi and North Dakota, the carrier may have eminent domain authority; however, such authority does not concomitantly subject the carrier to economic regulation.*

***Intrastate Open Access Model*: a model where a pipeline is developed with significant government involvement and includes defined rights of access. In return for certain benefits such as eminent domain authority or an exclusive franchise, the developer is subject to government regulation. This regulation could take the form of defined rights of access (open access or common carrier), economic regulation (rate-setting) or other forms of government oversight.**

***Interstate Dedicated Pipeline Model*: a model similar to the intrastate dedicated model except that the pipeline crosses state boundaries.**

***Interstate Open Access Model*: a model similar to the Intrastate Open Access Model except that some form of federal action [oversight/approval/involvement/regulation] is necessitated.**

***Government/Public Option Model*: a model that involves government financing and/or ownership of facilities. Under a government/public option model, a local, state, or federal entity would finance or build pipeline facilities or charter a corporation to do so.**

1. Intrastate Dedicated Pipeline Model Description and Examples

Most of the intrastate pipelines in this model have been built by a single operator and in some instances by multiple owners, each having a dedicated proprietary portion of the pipeline's capacity. These lines were built, for the most part, without the need or use of eminent domain to acquire the pipeline right of way. The lines typically are not subject to federal siting, regulatory, or legal framework unless they cross federal lands. If federal lands are not involved, they may have to obtain siting approval from state and local agencies. The pipelines have been built either to deliver the owners' CO_2 to their oil fields (considered to be a private carrier) or to deliver CO_2 to third party customers under long-term CO_2 supply contracts (considered to be contract carriers). Many of the existing intrastate lines operate in both of these modes, but with the contract carriage being limited to surplus capacity that is not required by the owner for its own use. With only limited access available, normally under long-term contracts, transportation rates are negotiated, are not subject to regulation, and may differ among customers.

Table 5. Examples of Intrastate Dedicated Pipelines

Pipeline Name CO_2 Source	Operators End Use	From (St) To (St)	Length (Miles)	Diameter (in)	Capacity (10^6 t/yr)
Adair	Apache	TX – TX	15	4	1.0
Bravo Dome	EOR				
Anadarko P River	Anadarko	WY – WY	125	16	4.3
NatGas plant	EOR				
Anton Irish	Oxy	TX – TX	40	8	1.6
Bravo Dome	EOR				
Choctaw (NEJD)	Denbury	MS – MS	183	20	7.0
Jackson Dome	EOR				
Val Verde	Petro Source	TX – TX	83	10	2.1
NatGas plant	EOR				

2. Intrastate Open Access Model

Intrastate Open Access pipelines are those that are built primarily to provide transportation to multiple users. In some instances the owner of the pipeline not only provides transportation of the CO_2 but also sells the CO_2 to the end user. These lines can take advantage of eminent domain statutes provided by most states to acquire the necessary right of way for the pipeline but most owners and operators prefer to acquire the pipeline right of way without using eminent domain. The exercise of eminent domain often subjects the pipeline operators to economic regulation and/or third party access.

The ExxonMobil Wyoming CO_2 line right of way was granted by the BLM under the Mineral Leasing Act and was therefore designated as a common carrier. Current CO_2 pipelines for EOR do not create or publish rate tariffs and are not required to do so by federal or state agencies.

Table 6. Examples of Intrastate Open Access CO_2 Pipelines

Pipeline Name CO_2 Source	Operators End Use	From (St) To (St)	Length (Miles)	Diameter (in)	Capacity (10^6 t/yr)
Canyon Reef Denver City Hub	Kinder Morgan EOR	TX – TX	139	16	4.3
Center Basin Cortez, Bravo, Sheep Mountain	Kinder Morgan EOR	TX – TX	143	16	4.3
Centerline Denver City Hub	Kinder Morgan EOR	TX – TX	120	6	4.3
Comanche Ck Central Basin	ExxonMobil EOR	TX – TX	100	14	1.3
Este I Denver City Hub	ExxonMobil EOR	TX – TX	40	14	3.4
Este II Denver City Hub	ExxonMobil EOR	TX – TX	45	12	2.6
Shute Creek NatGas plant	ExxonMobil EOR	WY – WY	30	30	23.6
Wyoming CO2 NatGas plant	ExxonMobil EOR	WY – WY	112	20, 16	4.3

3. Interstate Dedicated Pipeline Model

Interstate Dedicated Pipelines would be those built without the need to obtain rights of way from the BLM or other federal regulatory agencies. Siting approval would be obtained from state or local authorities and if possible such pipelines would be constructed without exercising the right of eminent domain. Two of the existing Interstate Dedicated Pipelines were built without having to acquire rights of way from the BLM; they also did not have to utilize the right of eminent domain. These pipelines are not required to provide access to third party shippers, but may do so under contract if transport capacity is available. As in the Intrastate Dedicated Pipeline Model, transportation rates are negotiated with the shipper and there are no published tariff rates.

4. Interstate Open Access Model

Interstate Open Access Pipelines are built requiring some form of federal regulatory action. If federal approval is required, the pipeline owners have to acquire rights of way, for example, from the BLM either under the provisions of the Federal Land Policy and Management Act (FLPMA) or the MLA. If the right of way was granted under the MLA, then these pipelines are considered ”common carriers” and must provide ratable access to all shippers. While the BLM involvement causes the pipelines to fall into the open access category, the BLM does not exercise any regulatory authority over the rates that would be charged the third party transporters. The BLM, and its enforcement of the MLA, is aimed at protecting consumers and insuring the right of transport. If state public utility commissions are involved in siting, not only will ”common carrier” status be imposed, but the rates charged to third parties for transporting CO_2 will be regulated.

Four of the six interstate pipelines operating today fall under this category. Three of these pipelines transport CO_2 primarily for the owner’s end use. Two of the three lines are at capacity and as a result, are not required to transport CO_2 for third parties at this time. The other line is not at capacity so it would be required to transport CO_2 for third party shippers if requested. The fourth line transports CO_2 for its own use, but the majority of CO_2 shipped is sold to third party customers. The line is at capacity, so while it is classified as a “common carrier” it would not be required to transport an additional third party’s CO_2 at this time. If in the future it had available capacity and another party petitioned for access, it would have to offer the available capacity at just and reasonable rates. Table 7 identifies the six interstate pipelines and one international pipeline operating today.

Table 7. Interstate Pipelines and One International Pipeline Operating Today

Pipeline Name CO_2 Source	Operators End Use	From (St) To (St)	Length (Miles)	Diameter (in)	Capacity (10^6 t/yr)
Bravo Bravo Dome	Oxy Permian EOR	NM – TX	218	20	7.0
Chaparral Anadarko PB	Chaparral E. EOR	TX – OK	23	6	1.3
Cortez McElmo Dome	Kinder Morgan EOR	CO-NM-TX	502	30	23.6
Raven Ridge LaBarge	Chevron EOR	WY-UT-CO	160	16	4.3
Sheep Mountain Sheep Mountain	BP-Exxon EOR	CO-NM-TX	408	24	11.4
TransPetco Denver City Hub	TransPetco EOR	TX-NM-OK	120	12	2.6
DGC Great Plains Syn	DGC/S Valley EOR	ND-SK	205	14/12	4.6

5. Government/Public Option Model

This development business model involves government financing and/or ownership of facilities. Under a government/public option model, a local, state, or federal entity would finance or build pipeline facilities or charter a corporation to do so. Three states, Alaska, North Dakota, and Wyoming, have established "governmental corporations" or "pipeline authorities" that have the right to own and operate pipelines. Each state has taken a slightly different path in the rights that have been granted to these entities. However, to date, no government entity has built or financed a CO_2 pipeline.

Case Study: Big Inch, Little Inch Pipelines

While the uncertainty over climate change raises questions regarding the need for federal policies for greenhouse gas management, federal policy in response to a public need has previously driven construction of pipeline infrastructure in the U.S. During World War II, German U-boats had effectively cut off crucial supplies of crude oil coming from the oil fields in the southeast United States for use in the northeast United States. To circumvent the U-boat threat, the federal government commissioned construction of the Big Inch (approximately 24 inches in diameter) and Little Inch (approximately 20 inches in diameter) pipelines that would travel overland from the oil fields in Texas and the southeast, connecting to markets in the northeast.[115] ***Eleven private oil companies pooled their resources and personnel to create War Emergency Pipelines, Inc. in 1942.***[116] ***Construction and operational supervision was conducted by the federal government.***[117]

There are three key lessons to learn from the development, planning, and construction of the Big Inch and Little Inch Pipelines. First, the development of the pipelines flowed from coherent and effective federal government policy. Second, with clear direction from the government, industry was quick to start on the construction and operation of the pipelines. And third, a national emergency fueled a public/private partnership that was effective in meeting a crisis.

The construction and operation of the Big Inch and Little Inch pipelines is a case study in federal government response to a national need. While the historical backdrop for the development of CO_2 ***pipelines is not as dire as that of the wartime pipelines, the efforts that developed the Big Inch and Little Inch pipelines may be instructive. The lessons learned from this example could serve as a guide to the development of a national*** CO_2 ***pipeline network if there is a determination to regulate carbon in the public interest.***

B. Examples of the Government/Public Option Business Models

Alaska

Alaska established the Alaska Natural Gas Development Authority (ANGDA) with the purpose to develop its natural gas resources. [118] The ANGDA can purchase gas; design, construct, and operate pipelines; and design, construct, and operate other facilities necessary to deliver gas to market.

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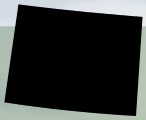
[115] The Handbook of Texas, The Big Inch and Little Inch Pipelines, available at: http://www.tshaonline.org/handbook/online/articles/BB/dob8.html.

[116] *Id.*

[117] *Id.*

[118] Ak. Stat. 41.41 (2009).



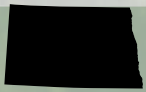
Wyoming

Wyoming has been the most aggressive of the states in establishing an entity to assist in the development of pipelines. The Wyoming Pipeline Authority was created in 1973[119] and is neither a regulatory body nor a state agency, but is a corporation of the state.

The following paragraph sets forth the rights granted to the corporation:

> ***Our mission is to plan, finance, construct, develop, acquire, maintain, and operate a pipeline system or systems within or without the state of Wyoming to facilitate the production, transportation, distribution, and delivery of natural resources produced in the state, including natural resources received as royalties "in kind" pursuant to mineral leases by the state, its agencies and political subdivisions, which authorize the lessor to receive royalties, or received as royalties from the federal government. In order to provide for the financing, construction, development, maintenance and operation of the pipeline system, the authority may lease or rent facilities constructed pursuant to the authority conferred, and all facilities, structures and properties incidental and necessary thereto, to facilitate the production, transportation, distribution, and delivery of natural gas and associated natural resources to point of consumption or to the point of distribution for consumption.***

The authority is actively engaged in promoting the development of intrastate and interstate pipeline infrastructure necessary to enhance natural resource development within Wyoming. It works with producers, gatherers, processors, pipeline companies, end use markets, and local distribution companies interested in tapping into Wyoming's natural resource base. The Wyoming Legislature authorized the authority to issue up to $3 billion in bonds to promote development and financing of pipelines and infrastructure necessary to develop the state's natural resource base, which includes the utilization of CO_2 for enhanced oil recovery.



North Dakota

North Dakota established the North Dakota Pipeline Authority in 2007. It granted rights similar to those granted by Alaska and Wyoming as outlined above, but did not provide any initial funding.

The agency may participate in a pipeline facility through financing, planning, development, acquisition, leasing, rental, joint ownership, or other arrangements.

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[119] Although the Wyoming Pipeline Authority was created in 1973 it did not have professional staff until 2005.

Other states could pass similar statutes that would establish government corporations or pipeline authorities that could own and operate CO_2 pipelines. These state entities will be subject to the same rules and guidelines set forth by each state's regulatory body that has authority over pipelines. Since the premise of establishing these state entities is to foster development of a state's natural resources, one would expect them to be subject to some third party access requirements and economic regulation.

The referenced existing pipeline operating models and the state pipeline authority examples are the result of more than 30 years of private sector for-profit business development. If national policy dictates anthropogenic CO_2 capture and storage, these models may have direct application when considering EOR-related projects. If the geologic storage business model develops, there probably will be the need to develop additional model elements. These may adopt some elements from the established models as well as developing new ideas to address unique aspects of geologic sequestration.

C. The Potential Regulatory Systems State and Federal

1. Status Quo

(a) Federal Lands Not Traversed.

When federal lands are not implicated, CO_2 pipelines are subject only to safety regulations at the federal level and economic and other regulations at the state level. Safety regulation is assured under the Hazardous Liquid Pipeline Act of 1979 by the PHMSA within DOT. This responsibility is carried out within PHMSA by the (OPS).[120] As stated earlier, both STB and FERC have declared that they have no jurisdiction over CO_2 pipelines.

(b) Federal Lands Traversed.

How CO_2 pipelines crossing federal lands are treated depends on whether the FLPMA or the MLA is implicated. The MLA requires pipelines to operate as common carriers. Therefore, if a pipeline crosses federal land that is subject to the act and if the BLM issues right of way authorization under the MLA rather than FLPMA, then it may be required to operate as a common carrier.[121] [122]

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[120] *Supra* note 87.

[121] The U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA) has authority over safety on both interstate and intrastate although states may assume regulatory and enforcement responsibility for all or part of intrastate lines. On interstate lines states can be granted limited authority but PHMSA remains responsible for enforcement. The U.S. Department of Transportation's Surface Transportation Board (STB) has concluded that it has no jurisdiction over CO_2 pipelines. However, were a rate dispute to arise with respect to a CO_2 pipeline, upon petition, the STB could reconsider its previous decision. The authority of the STB is limited in any event to rate disputes. As concerns the Federal Energy Regulatory Commission (FERC), it has concluded that it has no authority to regulate CO_2 pipelines under either the Natural Gas Act or the Natural Gas Policy Act of 1978.

[122] According to an article by Philip M. Marston and Patricia A. Moore, "[summarizing] the applicable federal regulatory landscape as of 2008, it seems fair to say that CO_2 pipelines are neither "common carriers" under the Interstate Commerce Act nor "natural gas companies" under the Natural Gas Act. They may, however, be "common carriers" under the [Mineral Leasing Act] if: (a) they cross federal land that is subject to that act, and (b) if the [Bureau of Land Management] issues right-of-way authorization under the [Mineral Leasing Act] rather than the [Federal Land Policy and Management Act]. The operation of CO_2 pipelines remains subject to other generally applicable federal law." 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, 455 (2008).

2. Possible Future Regulatory Scenarios

The regulatory framework governing the current CO_2 pipeline infrastructure may require adjustment to accommodate a national CO_2 pipeline infrastructure of the magnitude required for full-scale geologic storage based upon federal or state carbon regulation. The existing regulatory framework, developed under unique circumstances to govern delivery of natural and anthropogenic CO_2 to EOR projects, may not be sufficient to meet the demands for geologic storage on such a grand scale.[123] Any future regulatory framework could ultimately be tasked with overseeing as much as 1.8 billion tons per year of CO_2 captured by regulated sources and transported to EOR and geologic sites for storage.[124] That would equal the output of more than 350 600-mw coal-fired power plants. How that regulatory framework could develop and some of the regulatory options to facilitate development will be discussed below.

The principal purpose for non-economic pipeline regulation is to ensure the development of a safe, timely, adequate, and rational pipeline system that meets national policy objectives for increased domestic oil production and possibly carbon management mandates.[125] Regulatory options range from centralized to decentralized regulatory frameworks. Centralized regulatory frameworks involve federal oversight where a federal agency is involved in the majority of the areas of regulation. Decentralized regulatory frameworks mirror the existing regulatory framework for CO_2 pipelines where federal oversight exists only with regard to construction and safety standards and all other areas of regulation (i.e., rates, access, market entry, and siting/eminent domain) are handled by the states. The regulatory frameworks discussed below are presented in Table 8.

A regulatory framework may govern several elements including siting, eminent domain, tariffs, market entry and exit, product quality, and public notice. Each regulatory element and its range of options are discussed below.

Siting

Regulation of pipeline siting involves the notice and/or approval of the regulatory agency prior to construction of the pipelines. The rules for siting regulation primarily establish specific procedure for obtaining the certification of a pipeline corridor. Siting options include federal agency, or the state regulatory agency, or pipeline operator siting discretion.

Eminent Domain

Eminent domain is the sovereign power to seize private property without the owner's consent in exchange for fair consideration. Under the power of eminent domain, the pipeline corporation can be given the right to acquire the property necessary for the construction of the pipeline. Under current state regulations, some states grant such eminent domain power unconditionally or upon certain conditions. For example, Texas grants the right and power of eminent domain to pipelines that elect common carrier status for the transportation of carbon dioxide. Other states grant the power without imposing common carrier status.

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[123] The Interstate Natural Gas Association of America, Developing a Pipeline Infrastructure for CO2 Capture and Storage: Issues and Challenges, 92 (February 2009) *available at*: http://www.ingaa.org/File.aspx?id=8228.

[124] See CCSReg Project, Policy Brief: Regulating Carbon Dioxide Pipelines for the Purpose of Transporting Carbon Dioxide to Geologic Sequestration Sites, 2 (July 13, 2009), available at: http://www.ccsreg.org/pdf/PipelineTransport_07013009.pdf.

[125] INGAA at 93.

Tariffs

Tariffs are the documents filed by the pipeline carriers with the regulatory agencies detailing their terms and conditions of service and associated prices for various classes of customers. Tariffs regulating CO_2 pipelines may require the pipeline carriers to provide terms of their contract and rates. These regulations may also mandate that carriers provide such information in case of any regulatory disputes.

Market Entry and Exit

Market entry/exit regulation describes the methods by which a participant enters or exits a particular market. For instance, owners of natural gas pipelines are required to receive FERC approval before they are allowed to enter or exit a market.

Product Quality

Product quality regulation deals with the content and quality of the product for transportation through the pipelines. Quality specifications may differ from pipeline to pipeline depending upon the varying supply sources, operational constraints, and end user requirements. Product quality regulation can set the standard that CO_2 pipeline operators are required to follow and require them to provide full indemnification in the event of any breach of the quality specification.

Public Notice

Public notice regulations involve making pipeline information publicly available when operators file or change tariffs, routes, or other pipeline characteristics. It may cover all rules and regulations governing the rates and charges for services in a clear, complete, and specific format. Such information should be published in a format that it is readable and under which the terms and conditions are easy to understand and apply. Current CO_2 pipelines are not required by federal regulation to publish tariffs or any other information.

(a) Federal Oversight

Federal CO_2 Pipeline Agency

There are various models for possible federal regulation of CO_2 pipelines. One model would be similar to FERC's existing regulatory authority over natural gas pipelines under the NGA. Another would mirror FERC's regulatory authority over oil pipelines under the Interstate Commerce Act. Other models might be found in the regulation of other network industries (e.g. telephones, railroads, and electric transmissions). The differences among these models are the result of unique historical and market forces that influenced the development of each system. While the development of a national CO_2 regulatory infrastructure may not parallel any of the existing regulatory systems or involve FERC or STB oversight, it is instructive to examine each existing framework. Understanding the current status as well as historical development of existing pipeline regulatory frameworks provides a common reference point for regulators or policy-makers addressing oversight of future CO_2 pipelines.

Oil Pipeline Model

Under the Oil Pipeline Model, pipelines are "common carriers" under the Interstate Commerce Act.[126] As common carriers, oil pipelines cannot refuse space to any shipper that meets their published conditions of service. If shippers nominate more volumes than the line can carry, the pipeline operator allocates space in a non-discriminatory manner, usually on a *pro rata* basis, and is sometimes required to curtail the capacity of existing shippers. This is called "apportionment." Under FERC supervision, oil pipelines are required to provide their services at reasonable non-discriminatory rates. Although FERC has authority over rates and access for oil pipelines, FERC does not have siting authority over such pipelines and by extension there is no federal eminent domain or condemnation authority. For oil pipelines, siting and eminent domain authority (if available) rests with the states.

Under a proposal for a similar federal regulatory framework for CO_2 pipelines, a federal agency would have authority over rates and access, and CO_2 pipelines would have access regulated to require some form of third party access either through common carrier or open access rules. Under this proposal, states would retain authority over siting and eminent domain requirements for CO_2 pipelines.

Table 8. Options for CO_2 Pipeline Regulatory Framework

Option	Siting Authority (eminent domain powers)	Rate Regulation	Access	Entry/Exit	Safety
Current CO_2 Pipeline regulatory framework	States	Contractual agreement	Generally by contractual agreement, except where pipeline crosses federal land	States	OPS State option
Oil Pipeline Model	States	FERC	FERC – common carriage where proration or apportionment is required		OPS State option
Natural Gas Model	FERC - § 717f grants eminent domain authority	FERC	Not common carriers; no apportionment; open season required	FERC	OPS State Option
E.g., Energy Policy Act 2005 "backstop" Option (electric facilities)	States; if state fails to act, FERC may issue permit with associated eminent domain authority				OPS State option
"Opt-in" Model	States or new pipeline developers may access federal siting authority	FERC or other federal regulatory authority	FERC or other federal regulatory authority	FERC or other federal regulatory authority	OPS State option
Multi-State Compact	Intrastate ➡ States Interstate ➡ Compact	Compact	Compact		OPS State option

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[126] 49 U.S.C § 60501.

Natural Gas Pipeline Model

Another federal regulatory option uses the regulation of natural gas pipelines as a model. Natural gas pipelines are regulated by FERC under the NGA.[127] The NGA, enacted in 1938, was the first instance of direct federal regulation of the natural gas industry. Under the NGA and subsequent orders, most aspects of natural gas pipelines are subject to FERC authority. The NGA, enacted in 1938, was the first instance of direct federal regulation of the natural gas industry. Under the NGA and subsequent orders, most aspects of natural gas pipelines are subject to FERC authority. The NGA prohibits the construction or operation of interstate natural gas pipelines or interstate wholesales of natural gas without prior approval by FERC and confers on FERC the authority to issue certificates of "public convenience and necessity" authorizing construction and operation of facilities. The grant of a certificate confers the power of eminent domain under federal law, allowing owners of natural gas pipelines the power to condemn property for beneficial use.[128] be "not unduly discriminatory or preferential" as well as "just and reasonable."[129]

Under NGA reforms adopted by FERC beginning in 1985, natural gas pipelines are required to provide "open-access" transportation services. This means that a transporter must provide service without undue discrimination, or preference of any kind, including access to available capacity, the quality of service provided, duration of service, categories, prices, volumes of natural gas transported, or customer classification. Although natural gas pipelines are not common carriers and therefore not subject to apportionment where all shippers are provided access on a pro rata basis, they are subject to "open season" requirements. During open season, potential shippers can bid for pipeline services, and pipeline operators must employ a non-discriminatory method of allocating available capacity so shippers are treated equally regarding priority in the queue for service. Open season requirements apply only to new capacity made available during greenfield construction or capacity expansions.[130]

The Natural Gas Pipeline Model (NGPM) envisions a larger federal role than the oil pipeline model. Under the NGPM, a federal agency would have authority for siting and the ability to grant eminent domain. Siting authority is likely to become a major issue as the CO_2 network expands beyond short haul pipelines and EOR projects in rural areas, to more urban areas with no prior EOR experience.[131] Under this model, the federal agency would be responsible for transportation rates and open access would be required. The NGPM allows greater ability of pipelines and shippers to structure transactions providing for contractually-defined levels of assured transportation service than under the common carrier rules applicable to oil pipelines.

(b) Federal/State Cooperative Models

In addition to the federally focused regulatory options presented above, there are proposals for cooperative regulatory models that rely on a balance of state and federal involvement. For example, consider the federal "backstop" authority provided for electricity transmission siting in the Energy Policy Act of 2005 (EPACT05).[132] EPACT05 allows developers wishing to construct or modify electric transmission facilities across multiple states to obtain a federal permit for such construction when a state delays or is unable to approve the siting of the facilities, or conditions the approval in a way that is not economically feasible or does not reduce congestion.[133] The law goes further and allows a permit holder to exercise the right of eminent domain to right of way when necessary.

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[127] Natural Gas Act, 15 U.S.C. §717

[128] *Id.* §717f.

[129] *Id.* §717c.

[130] The Interstate Natural Gas Association of America, *America's Natural Gas Pipeline Network: Delivering Clean Energy for the Future*, summer 2009 Ed., p. 116.

[131] *Id.* at 95.

[132] Energy Policy Act of 2005, 16 U.S.C. § 824p.

[133] However, in Piedmont Environmental Council et al. v. FERC, 558 F.3d 304 (4th Cir. 2009) cert. denied (Jan. 19, 2010), the court decided that FERC does not have backstop siting authority to approve a transmission facility in a national interest electric transmission corridor if the relevant state denied that application.

Applying this model to CO_2 pipelines, states would have initial siting authority. However, if a state fails to act and there is a demonstrated need for such development, a federal agency would be authorized to issue a permit to developers to construct or modify a CO_2 pipeline.[134] The permit would extend federal eminent domain authority to permit holders. Other aspects of pipeline regulation --- including rate regulation, access, and market entry/exit --- may be exercised at the state or federal level.

Another hybrid approach promoted by the CCSReg Project and referred to as the "opt-in" approach would continue the current regime of state siting authority, while allowing developers to choose whether to avail themselves of federal siting authority.[135] Under this approach, CO_2 pipeline developers who need federal siting authority in connection with construction of their pipelines could apply for a federal certificate.[136] If granted, the certificate would provide the developer with federal authority to construct and operate the pipeline using federal eminent domain authority. If Congress were to provide pipeline developers with federal eminent domain authority, it is likely that developers would be subject to some form of federal economic regulation. That regulation could entail open access or common carrier requirements or full rate and service regulation.[137]

Under all CO_2 pipeline regulatory options, oversight for construction and operational safety would continue to fall under the jurisdiction of federal and state authorities through PHMSA.

(c) Multi-State Authority[138]

In addition to providing background information on interstate compacts this section will examine the advantages and disadvantages of the multi-state solution. One such option is an interstate advisory compact that might afford a likely avenue for multi-state cooperation to facilitate CO_2 pipeline development on a regional basis. Alternatively, an interstate regulatory compact could facilitate a national CO_2 pipeline infrastructure and could offer eminent domain/condemnation authority in exchange for some form of economic regulation.

Background Information about Interstate Compacts

Interstate compacts represent an opportunity for the kind of multi-state cooperation that could promote the development of a national CO_2 pipeline network. They facilitate multi-state cooperation, reinforce state sovereignty and avoid federal intervention. Because broad public policy issues -- such as developing a national network of CO_2 pipelines that cross jurisdictional boundaries -- present new governing challenges to state authorities a multi-state compact could be useful. Compacts enable states – in their sovereign capacity – to act jointly and collectively, generally outside the confines of the federal legislative or regulatory process.

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[134] See CCSReg Project at 5

[135] *Id.*

[136] *Id.*

[137] Under such an approach, care would be required to craft rules governing the integration of pipelines developed under each option to avoid the development of a bifurcated pipeline system. Otherwise, there is a possibility of encouraging duplicative, parallel pipelines where pipeline developers avoid interconnecting pipelines developed under one or the other option, as was the case with the bifurcated interstate/intrastate markets for natural gas sales and pipeline facilities. In the case of natural gas, intrastate pipeline operators protected themselves from unintentionally becoming subject to Natural Gas Act by including contract clauses that prohibited suppliers or shippers from introducing into the pipeline any gas supply that would subject the otherwise non-jurisdictional pipeline to Natural Gas Act regulation. These clauses were often referred to as "Lo-Vaca clauses", named for the Supreme Court's 1965 decision that led to their creation. California v. Lo-Vaca Gathering Co., 379 U.S. 366 (1965). The widespread adoption of these contractual clauses tended to preclude the integration of intra-state and interstate facilities and lead to the creation of a "bifurcated" natural gas pipeline market with separate interstate and intrastate pipelines.

[138] Most of this information obtained from: Nat'l Ctr. Interstate Compacts, 10 Frequently Asked Questions, http://www.csg.org/knowledgecenter/docs/ncic/CompactFAQ.pdf, (last visited Dec. 2009).

Compacts afford states the opportunity to develop dynamic, self-regulatory systems over which the participating states can maintain control through coordinated legislative and administrative procedures. Compacts enable states to develop adaptive structures that can evolve to meet new and increased challenges that naturally arise over time.

Interstate compacts are contracts between two or more states creating an agreement on a particular policy issue, adopting a certain standard, or cooperating on regional or national matters. Interstate compacts provide a state-developed structure for collaborative and dynamic action to meet new and increased demands over time.

Article I, Section 10, Clause III of the U.S. Constitution provides in part that “no state shall, without the consent of Congress, enter into any agreement or compact with another state.” Historically, this clause meant that all compacts must receive congressional consent. Case law has established that not all compacts or agreements between states require congressional consent.[139] Only those compacts that affect a power delegated to the federal government or alter the political balance within the federal system, require the consent of Congress.[140]

Although there are many types of interstate compacts they generally can be divided into three groups: Border Compacts, Advisory Compacts, and Regulatory Compacts

Types of Interstate Compacts

<u>Border Compacts</u>: agreements between two or more states that establish or alter the boundaries of a state.

<u>Advisory Compacts</u>: agreements between two or more states that create study commissions to examine a problem and report findings to member states.

<u>Regulatory Compacts</u>: broadest and largest category of interstate compacts. Regulatory compacts create ongoing administrative agencies whose rules and regulations may be binding on the states to the extent authorized by the compact.

Advisory Compacts

An interstate advisory compact may be the most likely model for developing an interstate CO_2 pipeline network for a number of reasons. An advisory compact is most likely to develop on a regional basis in response to market demands. Such a compact also facilitates better collaboration among states because the group is smaller and therefore able to tailor its response to the needs of the local area or region, avoiding a one-size-fits-all approach.

The collaborative efforts of a regional advisory compact will foster development of uniform criteria,

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[139] It has been found in a number of instances, notably the 1893 U.S. Supreme Court case of Virginia v. Tennessee 148 U.S. 503 (1893).

[140] Though in most cases congressional consent is satisfied by means of a resolution granting states the authority to create a compact, the Constitution specifies neither the means nor the timing of the required consent. Over the years, the Supreme Court has held that congressional consent may be expressed or implied and may be obtained either before or after a compact is enacted. Compacts are created when an offer is made by one state, usually by statute that adopts the terms of a compact requiring approval by one or more other states to become effective. Other states accept the offer by adopting identical compact language. Once the required number of states has adopted the pact, the “contract” among them is valid and becomes effective as provided. Key steps to developing a regulatory compact include establishing an advisory group, selecting a drafting team, educating policymakers and stakeholders, and finally enactment.

shared timelines, joint hearings, and coordinated response in regulating a CO_2 pipeline network. Further, the advisory compact is more palatable to states and allows states to retain their sovereign authority.

A regional advisory compact may result in a more rapid creation of a regulatory framework than the creation of a federal regulatory framework. A regional advisory compact reduces the regulatory uncertainty resulting from the absence of a regulatory framework needed to address a national CO_2 pipeline infrastructure.

An important advantage of advisory compacts is their potential for quick development and rapid regulatory response. Advisory compacts can sometimes form quickly whereas federal regulation may at times require many years. The speed by which the compact is formed is directly related to the number of participating states. Advisory compacts also allow for a quicker and more efficient regulatory response because of the proximity between the regulated community and the regulators.

Regulatory Compacts

An interstate regulatory compact is another, although potentially less likely, option for developing an interstate CO_2 pipeline network. The factors that would need to be addressed in assessing the advantages or disadvantages of an interstate regulatory compact may include the following:

- Whether to have one national or multiple regional compacts.
- Congressional approval.
- Requiring states to cede some sovereign authority to compact (states might resist this).
- Whether a multi-state compact could respond faster than other solutions.
- Tailor-made to fit the needs of participants rather than a one-size-fits-all.
- Regulatory efficiency through a single point of contact.
- Regulated community closer to the regulator, vis a vis a federal agency.

Even without a formal compact, states could work cooperatively to coordinate regulatory timetables, and facilitate siting approval and interaction among states.

3. The Impact of Possible Regulatory Scenarios on Possible Business Models

The analysis of regulatory frameworks and business models raises certain, often-competing issues for consideration. For instance, one point of analysis centers on promoting competition versus ensuring compliance through dedicated capacity, (i.e., whether the core concern of regulators should be promoting competition among pipeline operators or ensuring that emission sources are able to meet their compliance obligations through firm off-take commitments from dedicated transportation resources). Another point of analysis involves centralized regulatory frameworks versus decentralized frameworks. As networks move from the current decentralized regulatory framework what will be the impact on CO_2 transport costs relative to other costs. Other issues to consider include monopoly franchises versus market-driven, large versus small operators, etc.

While it is unclear how existing business models for CO_2 pipelines may evolve if CCS becomes widespread, all such models will deal with a different mix of supply sources and delivery locations than is the case for current natural gas or oil pipeline systems. Because CCS is best suited to large point sources, any future pipeline network for CCS purposes is likely to be a wholesale-oriented few-to-few business, unlike the many-to-many natural gas network of today.

Elements of the Status Quo, Multi-state Compact Option, or the Natural Gas Pipeline Models (NGPM) may be useful for further study to determine which are most compatible with the various business models discussed earlier. The status quo where CO_2 pipeline regulation is left to the states and handled on a state-by-state basis has resulted in the development of more than 4,000 miles of CO_2 pipeline to date. The current level of oversight provided by the federal government through the Office of Pipeline Safety and its safety regulations is both effective and sufficient as indicated by 40 years of safe operation of CO_2 pipelines. Although this option is best suited to intrastate networks, there is no indication that continued operation under the current regulatory framework would inhibit interstate or intrastate pipeline development.

The multi-state compact option that allows states to act collectively through shared/common regulatory provisions may offer unique advantages over the status quo decentralized system or a future centralized, federal regulatory system. Compacts can be structured uniquely to accommodate any business model. Furthermore, while maintaining state sovereignty, compacts provide a streamlined process for developing interstate infrastructure that encompasses multiple jurisdictions. Pipeline developers would have greater certainty as requirements for operating across multiple jurisdictions would be readily known, thereby saving time in navigating multiple regulatory requirements and expediting and streamlining the permitting process, saving operators both time and money as they seek to permit future CO_2 pipelines. However, a disadvantage to the compact option is the potential for creating geographic windows or competing compacts that would diminish regulatory consistency.

If a more centralized, federal option is considered, the NGPM could also be compatible with the various business models. While not to be overstated, eminent domain/condemnation authority may afford certain advantages that offset the burden of centralized, federal economic regulation. Nevertheless, PTTF sees no fundamental incompatibility when applying the NGPM to the various business models. The NGPM option supports intrastate and interstate development by providing regulatory certainty. It supports open and dedicated networks by providing designated capacity over lengthy periods of time. The NGPM allows greater ability of pipelines and shippers to structure contracts providing for defined levels of assured transportation service than under the common carrier rules applicable to oil pipelines.

With regard to the oil pipeline regulatory framework options, the PTTF believes that option is incompatible with some of the business models. Furthermore, from a network design perspective, it would appear extremely unlikely that the CO_2 pipeline network would closely mimic either the oil pipeline or the natural gas pipeline network. The cost alone of compressing small amounts of CO_2 for dense-phase transportation would render such a system cost-prohibitive. Thus a common regulatory framework overseeing CO_2 pipelines and oil pipelines seems unlikely, given the disparities in the underlying network purpose and design.

Additionally, apportionment under the oil pipeline regulatory framework makes it incompatible with the closed business models contemplated above. Apportionment requires third party access that constrains the pipeline operator's ability to provide firm CO_2 transportation off-take capacity, a function assured under both the intrastate and interstate closed pipeline models. To meet possible future regulatory compliance obligations, new CO_2 capture sources will require pipeline off-take capacity that is specifically dedicated to receive the plant's CO_2 output. Absent the ability to structure transactions that ensure available firm transportation off-take capacity, generation facilities hoping to deploy CO_2 capture technologies will face challenges in financing and development.

These underlying differences between the CO_2 pipeline network and the natural gas and oil pipeline models have major implications for potential legal and regulatory structures. An effective CO_2 pipeline regulatory framework will recognize and accommodate these differences in network purpose and design. The failure to accommodate the requirement to ensure the availability of designated amounts of capacity for very lengthy periods could pose a significant regulatory barrier to wide-scale commercial deployment of CCS technologies. Apportionment creates challenges to assured off-take capacity for a given facility's CO_2 output capacity and therefore makes the oil pipeline model a less desirable regulatory option.

III. Economic Issues

A. Financing

Although pipelines are financed through traditional methods, financing of future CO_2 pipelines to handle geologic storage may require different tools and approaches. The traditional financing methods include project finance, debt financing, and structured or other forms of cash-flow financing. It is generally believed that the pipeline network can be financed through a combination of project and corporate debt, supported by shipper commitments.[141] Additionally, less traditional opportunities exist for government financing through subsidies or public-private partnerships. Other than EOR supported pipelines, some believe that any major construction effort will require some form of government support in the near term.[142]

Project finance is the long-term financing of infrastructure and industrial projects based upon the projected cash flows of the project rather than the balance sheets of the project sponsors. Usually, a project financing structure involves a number of equity investors, known as sponsors, as well as a syndicate of banks that provide loans to the operation. The loans are most commonly non-recourse loans, which are secured by the project assets and paid entirely from project cash flow, rather than from the general assets or creditworthiness of the project sponsors, a decision in part supported by financial modeling. Project lenders are given a lien on all assets, and are able to assume control of a project if the project company has difficulties complying with the loan terms. Denbury's Green pipeline from Louisiana to Texas was financed in this manner.

Corporate debt financing is the payment, in whole or in part, for a capital investment with borrowed funds.

Structured finance and other forms of cash-flow financing rely on cash flow, assets of the company, or revenue from the project being financed.

Each of these forms of finance has its own decision matrix that drives whether and when a certain investment is prudent. In the current CO_2 pipeline industry, where CO_2 is shipped as a commodity, the decision matrix is straightforward -- determined by a specific cash flow generated by the sale and purchase of the CO_2 used for enhanced oil recovery. Because there is an established price formula for commodity CO_2 used for EOR, purchase and sale agreements can be negotiated with certainty. However, a future CO_2 pipeline infrastructure scenario may lack these specific price signals.

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[141] *See* INGAA Foundation, prepared by ICF International, "Carbon Sequestration & Storage: Developing a Transportation Infrastructure" (2009), *available at:* http://www.ingaa.org/cms/31/7306/7626/8230.aspx.

[142] *Id.*

This lack of specific price signals raises a number of questions with regard to the financing of CO_2 pipeline infrastructure.

- Can CO_2 pipelines for geologic storage in a non-EOR environment be financed in a similar manner and what will be the decision points involved in financing such projects?
- Without a specific commodity price to drive decisions, how can projected cash flow (the basis of project-finance) be determined?
- Since the purpose of CO_2 pipelines for geologic storage is different than the current CO_2 -driven EOR environment, the decision-making process will also be different. Will the carbon price be sufficient to cover the cost of CO_2 pipelines for geologic storage?
- If new pipeline infrastructure is needed, will the capital markets be interested in or capable of building such pipelines?
- How will the price of carbon affect the capital markets when it comes to financing CO_2 pipelines for geologic storage?
- What will be the basis of decision-making and go or no-go decisions when banks are considering whether to invest in CO_2 pipelines?
- If private capital is not sufficient to support the build-out of a CO_2 network, will the government be prepared to step in and wholly or partly subsidize projects?
- Since an estimated 95% of sources are near sinks, will there even be a need for long-haul pipelines, if most of the CO_2 injected for storage purposes will be within the fence-line of the source property?

Answers to these questions would only be a matter of speculation now. However, policymakers would be wise to consider these issues in developing a regulatory framework for a future CO_2 pipeline network. Fortunately, the need to answer these questions is not imminent because the foundation of the CO_2 pipeline network infrastructure required for geologic storage is likely to be developed by pipelines used to transport CO_2 for EOR.

B. Infrastructure Costs

The factors driving the cost of building and operating CO_2 pipelines are very well understood by pipeline developers. Costs can vary enormously from project to project, depending upon the terrain traversed, international markets for steel, pipe and other facilities and the local market for contractors, to mention just a few variables. In the past couple of years several studies have been conducted to provide some general estimates of the cost of building and operating CO_2 pipelines. One study[143] was issued by the Congressional Research Service (CRS) in January 2008. It reviewed what scenarios for CO_2 pipeline

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[143] Paul W. Parfomak and Peter Folger, "Pipelines for Carbon Dioxide (CO_2) Control: Network Needs and Cost Uncertainties", *CRS Report for Congress* (January 10, 2008).

development should be considered for the future build-out of a system to service the majority of the pulverized coal power plants in the U.S. The study looked at coal-fired power plants because they contribute approximately one-third of the U.S. emissions from fossil fuels. The CRS study concluded that there is a considerable amount of uncertainty as to the length of CO_2 pipelines that will be required to service coal-fired power plants. As a result, they relied on a 2005 study that concluded that 77% of the total annual CO_2 captured from major North American sources could be stored in reservoirs directly underlying the sources and that an additional 11% could be stored within 100 miles of the original sources.[144] The Midwest Regional Carbon Sequestration Partnership (MRCSP) also studied the issue of CO_2 transportation because a large number of coal-fired power plants reside in the MRCSP's region as do a varied mix of potential geologic storage sites.[145] The MRCSP concluded that CO_2 from the power plants could be transported to sites within 32 miles of most of the power plants.

Based on the aforementioned studies, assume that CO_2 from an emission source will have to be transported 50 miles to a storage site. To properly size the pipeline, additional information regarding the CO_2 output of certain coal-fired power plants will be needed. A 2007 Canadian study[146] based on "pulverized coal super critical" (PCSC) power plants having a gross power output of 480 MW found CO_2 output of 4.2 million tons per year. A similar study by NETL[147] was based on a PCSC plant with a gross power output of 580 to 663 MW (which more accurately reflect the typical size of PCSC plants in operation in the U.S.) and results showed larger quantities of captured CO_2 --- up to 5 million tons per year per plant. For the purpose of this analysis we will use the larger quantity of CO_2 captured, 5 million tons per year, to determine the size of a CO_2 pipeline. Five million tons per year of CO_2 results in a daily capture of 266 MMSCF assuming that the plant has an operating rate of 90%. A 16-inch diameter pipeline will be required to transport this volume of CO_2. The CRS study relied on cost models developed at Carnegie Mellon University to determine the capital cost to construct and operate the CO_2 pipelines.[148] The Carnegie study is based on 2004 cost data for natural gas pipelines and looks at four cost components, --- right of way, materials, engineering and overhead, and labor --- to build a model to estimate the capital cost to construct CO_2 pipelines. Figure 4 shows these various cost components for a 16-inch diameter pipeline.

More recent cost data based on actual pipeline cost studies completed in the fall of 2009 indicate that the total cost of construction of a 50-mile, 16-inch diameter pipeline would be $49.6 million. This is about three times the cost indicated in the model developed by Carnegie and shown in Figure 4. This cost difference is directly attributable to the inflation in commodities, energy, and labor that the world has experienced since 2007. Prior to the occurrence of this recent inflationary period, the Carnegie model tracked very well with data from constructed pipelines. If a 30-year life of the pipeline is assumed, then the cost of the line will be approximately $0.55 per ton.

In August 2003, the Massachusetts Institute of Technology (MIT) published "The Economics of CO_2 Storage," a report that investigated the technologies required and the total cost to capture, compress, transport, and store CO_2 for long-term geological sequestration in various geologic strata, including depleted oil and gas reservoirs and saline aquifers. These costs are based on studies done from 2003

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[144] R.T. Dahowski, J.J. Dooley, C.L. Davidson, S. Bachu, N. Gupta, and J. Gale, "A North American CO_2 Storage Supply Curve: Key Findings and Implications for the Cost of CCS Deployment," Proceedings of the Fifth Annual Conference on Carbon Capture and Sequestration (Alexandria, VA: May 2-5, 2005).

[145] MRCSP Phase I Final Report, December 2005.

[146] Future CO_2 Capture Technology Options for the Canadian Market", Report No. Coal R309 BERR/Pub URN 07/125, Department for Business Enterprise and Regulatory Reform, March 2007

[147] Cost and Performance Baseline for Fossil Energy Plants", Final Report DOE/NETL-2007/1281, Volume 1: Bituminous Coal and Natural Gas to Electricity, Issued May 2007, Revision 1, August 2007.

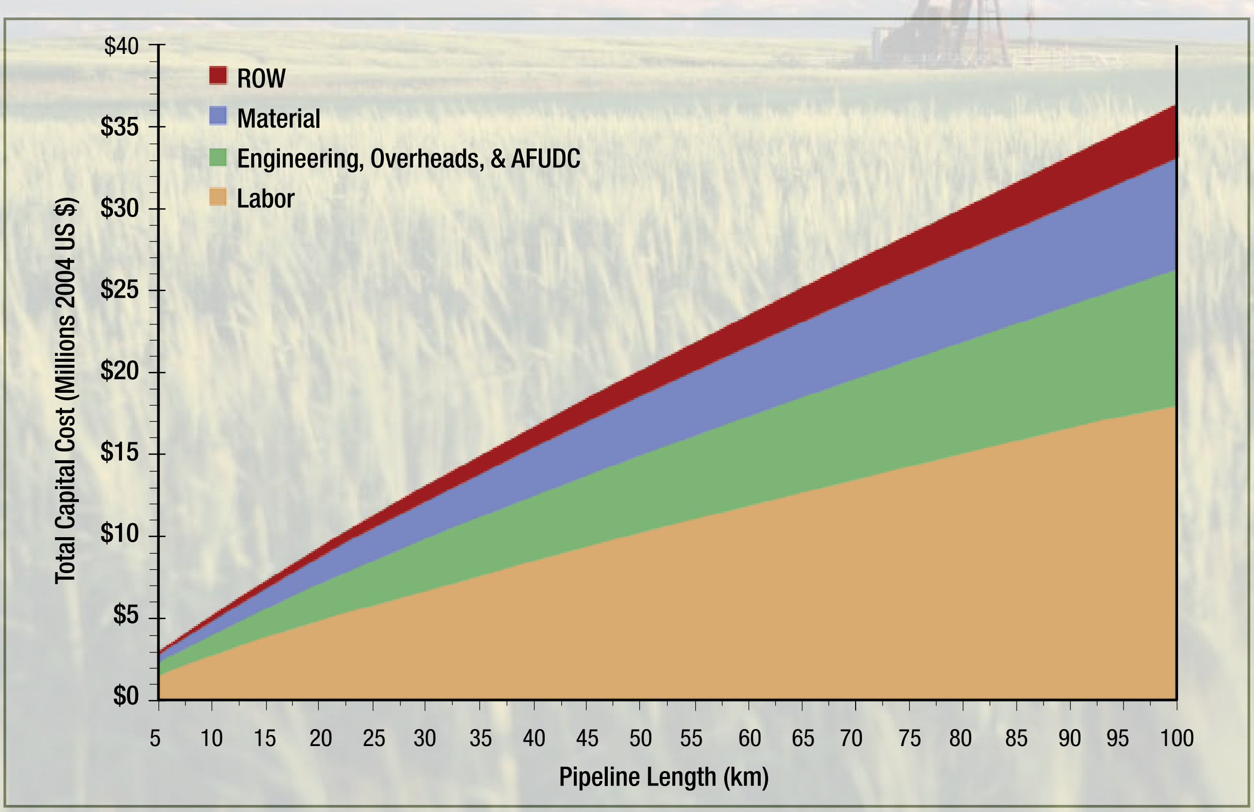
[148] Sean T. McCoy and Edward S. Rubin, "An Engineering-Economic Model of Pipeline Transport of CO_2 with Application to Carbon Capture and Storage," International Journal of Greenhouse Gas Control, (November 19, 2007).

through 2007 and should be considered as initial estimates and for this analysis they provide us with a good approximation of the cost that would be incurred. They do not include any profit that a company entering into the business would expect to obtain to compensate it for the capital employed and provide a reasonable rate of return. With the price escalation that industry experienced in 2008 and 2009, these costs are likely to be 20% to 25% lower than if they would be done today. Table 9 presents the results for three of the cases studied.

In June of 2008, the EPA published the Technical Support Document, "Geologic CO_2 Sequestration Technology and Cost Analysis" that analyzed the various technologies and costs required to store and monitor CO_2 in geologic formations and depleted oil and gas reservoirs. This report provides design parameters and typical costs for each so that one can design geological storage sites and develop capital costs and operating expenses for a specific storage site.

The pipeline cost derived from the Carnegie study, the storage costs from the MIT study, and the Canadian CO_2 capture study were combined to provide a direct comparison with the NETL study. This comparison is displayed in Table 10.

Figure 4. Cost of a 16-inch CO_2 Pipeline of Various Lengths in the Midwest[149]



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[149] Sean T. McCoy and Edward S. Rubin, "An Engineering-Economic Model of Pipeline Transport of CO_2 with Application to Carbon Capture and Storage," *International Journal of Greenhouse Gas Control*, (November 19, 2007).

Table 9. Storage Costs for Depleted Gas Reservoirs: Base, High, and Low Cost Cases [150]

Parameter	Units	Base Case	High Cost Case	Low Cost Case
Depleted Gas Reservoir	$/tonne	$4.87	$19.43	$1.20
Depleted Oil Reservoir	$/tonne	$3.82	$11.16	$1.21
Saline Aquifer	$/tonne	$2.93	$11.71	$1.14

Table 10. Comparison of Costs for CCS for A New PCSC Power Plant: $/ton Basis

Study	CO_2 Capture & Compression	Pipeline	Storage	Total[151]
NETL	$45.00	Incl.	Incl.	$45.00
Canada	$42.45	$0.55	$4.38	$47.38

C. Cost Forecasting of CO_2 Pipelines

Pipeline development and operations as a commercial endeavor will look at a low of 80% utilization rate to as high as 99% to value the opportunity. An assumption will be that the CO_2 leaving a plant fence will go into the pipeline between ~1,800 to ~2,200 psia. Depending on how the CO_2 is sourced, this will mean that “inside the fence” compression may be needed. Additionally, line and booster compression may be needed depending on the length. CO_2 in its supercritical form will be pumped much like a liquid rather than by compression like natural gas. Other factors that should be included in forecasting development costs are current “engineering, procurement, and construction” (EPC) costs, cost of money, material lead time, right-of-way acquisition, siting, and permitting.

Currently $50,000 per inch per mile is used to get a gross estimate of pipeline costs. The variable in this cost will be issues such as: expected volumes and corresponding optimal pipe diameters, the type of terrain including, changes in elevation, river, water way, and wetland crossings, and land, steel, and EPC costs.

As a rule of thumb, multiple sources coupled to multiple sinks allow a degree of more efficient utilization of the transport capacity and facilities. Also, to some degree the pipeline system itself can be utilized for short-term storage to manage system fluctuations in source and sink volumes, much as is done in the natural gas transport systems. This temporary storage is known as line pack.

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[150] Gemma Heddle, Howard Herzog & Michael Klett, “The Economics of CO_2 Storage”, *MIT LFEE 2003 003 RP*, August 2003.

[151] Estimates are based on various studies issued from 2003 to 2007.

Tables 11 and 12 illustrate pipeline cost estimating, volumes to diameter, and compression cost estimation[152].

Table 11. Investment Estimates in CO_2 Pipelines

Criteria	Cost per Inch Mile
Low *(flat. rural, agriculture)*	**$45,000 - $60,000**
High *(mountains, urban, congested)*	**$75,000 - $90,000**
*Example: An 80-mile, 12-inch pipeline in a low cost area will cost $43,200,000 = 80 * 12 * 45,000 = $0.25/Mcf (15 Yrs – 15% IRR)*	

	6 inch	8 inch	10 inch	12 inch	16 inch
MMCFD	**45**	**75**	**120**	**160**	**275**
Tonnes/Yr	**855,000**	**1,426,000**	**2,281,000**	**3,042,000**	**5,228,000**

Table 12. Investment Estimates in CO_2 Compression

HP per MMcf *(This is for very low pressure CO2)*	**360**
$'s Per HP *HP - Horsepower*	**$1,500 - $2,000**
Example: 40,000 Mcf/d at atmosphere compressed to 1,00 psig	*$28,800,000 = 360 * 40 (MMcf/d) * 2,000 = $0.85/Mcf (15 Yrs-15% IRR)*

D. Cost Factors

1. Land Acquisition Costs

A carbon dioxide pipeline requires the purchase of an easement from all landowners along the pipeline right of way to allow construction and installation. Most western states have laws that allow a CO_2 pipeline to use the right of eminent domain to obtain right of way from landowners if necessary. Many Midwest and Eastern states do not have laws that allow a CO_2 pipeline the right of eminent domain.

Right of way is estimated to account for 22% of the total costs of a natural gas pipeline[153], and this figure is useful in estimating the right of way costs for CO_2 pipelines.

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[152] Data from Table 11 and 12 provided by Ray Hattenbach, Vice President, Blue Strategies LLC based on industry experience and research.

[153] Parker, Nathan C. "Using Natural Gas Transmission Pipeline Costs to Estimate Hydrogen Pipeline Costs," UCD-ITS-RR-04-35, Inst. of Transportation Studies, Univ. of California, 1 (Davis, CA 2004) *available at* http://pubs.its.ucdavis.edu/publication_detail.php?id=197.

2. Regulatory Compliance Cost Issues

Investigations of possible costs of compliance with regulation for CO_2 pipelines lead the PTTF to consider interstate natural gas pipelines as an appropriate analog. According to industry representatives, regulatory compliance costs are not separately tracked by owners of natural gas pipelines.

Industry representatives cited a variety of reasons why such costs are not analyzed more carefully:

- Such costs are insignificant when compared to operational and maintenance costs.
- Regulatory compliance costs are not easily distinguishable from other costs including safety, maintenance, and operations.
- No unique tax incentive/credit exists for compliance costs.
- Regulatory requirements vary from state to state, affecting compliance costs. Therefore, a rule of thumb cost/diameter evaluation is not feasible.
- The industry might take note of compliance costs if those costs were to escalate as a result of duplicate reporting requirements or mandates that compliance standards exceed best practice standards.

(a) Cost Recovery

One issue that will significantly affect the economy of CO_2 pipelines concerns whether construction and operational costs can be included in the rate base for regulated electric utilities. Because utility regulations vary from state to state, differences in the economic regulation of utilities could create economic inefficiencies that will affect the attractiveness of CO_2 pipelines for capital investment. Officials from one state public utility commission reported in a Government Accountability Office paper that they considered CCS immature and were unlikely to approve cost recovery for such a project in the foreseeable future.[154]

In an effort to ascertain how regulated utilities are approaching this issue, the PTTF polled several utilities with the following questions:

1. In a utility market that provides a certain rate of return on qualified investments, how are CO_2 pipeline costs being handled by the regulated utility? Are those costs contemplated and included as part of the rate base? If so, was there any opposition? And what arguments were put forth to support including pipeline costs in the rate base?
2. If not included as part of the rate base, who handles the pipeline costs?

While some project developers considered this information proprietary, we received the following response from American Electric Power (AEP) and Duke Energy.

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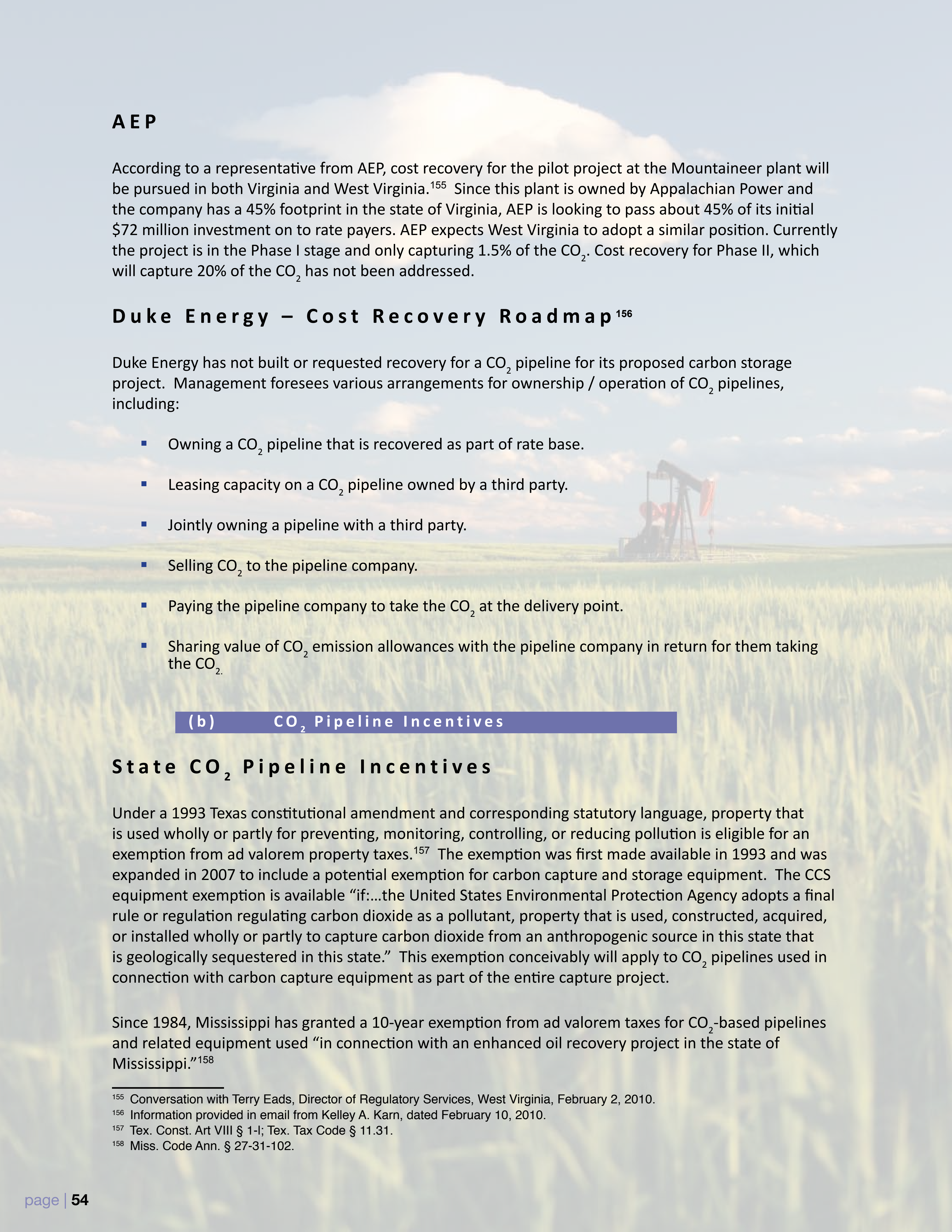
[154] GAO Report, "Coal Power Plants: Opportunities Exist for DOE to Provide Better Information on the Maturity of Key Technologies to Reduce Carbon Dioxide Emission, pg. 10, June 2010.



AEP

According to a representative from AEP, cost recovery for the pilot project at the Mountaineer plant will be pursued in both Virginia and West Virginia.[155] Since this plant is owned by Appalachian Power and the company has a 45% footprint in the state of Virginia, AEP is looking to pass about 45% of its initial $72 million investment on to rate payers. AEP expects West Virginia to adopt a similar position. Currently the project is in the Phase I stage and only capturing 1.5% of the CO_2. Cost recovery for Phase II, which will capture 20% of the CO_2 has not been addressed.

Duke Energy – Cost Recovery Roadmap[156]

Duke Energy has not built or requested recovery for a CO_2 pipeline for its proposed carbon storage project. Management foresees various arrangements for ownership / operation of CO_2 pipelines, including:

- Owning a CO_2 pipeline that is recovered as part of rate base.
- Leasing capacity on a CO_2 pipeline owned by a third party.
- Jointly owning a pipeline with a third party.
- Selling CO_2 to the pipeline company.
- Paying the pipeline company to take the CO_2 at the delivery point.
- Sharing value of CO_2 emission allowances with the pipeline company in return for them taking the CO_2.

(b) CO_2 Pipeline Incentives

State CO_2 Pipeline Incentives

Under a 1993 Texas constitutional amendment and corresponding statutory language, property that is used wholly or partly for preventing, monitoring, controlling, or reducing pollution is eligible for an exemption from ad valorem property taxes.[157] The exemption was first made available in 1993 and was expanded in 2007 to include a potential exemption for carbon capture and storage equipment. The CCS equipment exemption is available "if:...the United States Environmental Protection Agency adopts a final rule or regulation regulating carbon dioxide as a pollutant, property that is used, constructed, acquired, or installed wholly or partly to capture carbon dioxide from an anthropogenic source in this state that is geologically sequestered in this state." This exemption conceivably will apply to CO_2 pipelines used in connection with carbon capture equipment as part of the entire capture project.

Since 1984, Mississippi has granted a 10-year exemption from ad valorem taxes for CO_2-based pipelines and related equipment used "in connection with an enhanced oil recovery project in the state of Mississippi."[158]

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[155] Conversation with Terry Eads, Director of Regulatory Services, West Virginia, February 2, 2010.
[156] Information provided in email from Kelley A. Karn, dated February 10, 2010.
[157] Tex. Const. Art VIII § 1-l; Tex. Tax Code § 11.31.
[158] Miss. Code Ann. § 27-31-102.

Federal Tax Incentives

Master Limited Partnerships (MLPs), special business forms that receive special federal tax status, are widely used in the natural gas and crude oil pipeline industry. Designation as an MLP is desirable because entities able to structure as MLPs obtain certain tax advantages.

MLPs are publicly traded partnerships treated as corporations for federal income tax purposes unless 90% of their gross income consists of certain “qualifying income.”[159] In that case, an MLP is treated as a partnership that provides certain federal income tax advantages. Prior to 2008, a concern was raised over the implications of different tax treatment of naturally occurring CO_2 and industrial source CO_2. The concern centered on whether income from industrial source carbon dioxide would be treated differently than income from naturally occurring CO_2. Under rules governing MLPs, naturally occurring CO_2 is considered a mineral resource subject to depletion and therefore “qualifying income” for purposes of federal tax treatment under MLPs. Anthropogenic CO_2 which is not subject to depletion would not have been “qualifing income”. However, on October 3, 2008, the signing of the Energy Improvement and Extension Act of 2008 (the “Act”) abolished this distinction and removed a potential stumbling block. The Act expands the definition of qualifying income to include among other things, “industrial source carbon dioxide.” The new definition avoids the risk of a bifurcation between CO_2 pipelines carrying naturally occurring CO_2 and those carrying anthropogenic CO_2 captured from stationary sources.

Economic Regulation

Regulatory structure raises questions related to economic regulation of CO_2 pipelines for CCS.

- What economic impact could future regulatory frameworks have on CO_2 transport?

Earlier PTTF examined potential regulatory frameworks for overseeing the development of a national pipeline infrastructure for the geologic storage of CO_2. The task force was reminded that the principal purpose of any kind of CO_2 pipeline regulation should be to ensure the development of a timely, adequate, and rational pipeline system that meets national policy objectives for increased domestic oil production and possibly carbon management mandates. However, at what costs? As regulatory frameworks develop and change what, if any, economic impact will those changes have on CO_2 pipelines?

In response to the question, is the decentralized state-based regulatory system inadequate for CO_2 pipeline infrastructure development, and should it be replaced by a more centralized federal system, the PTTF examines the economic impacts resulting from migrating from a decentralized state-based to a centralized federal regulatory system.

Regulatory centralization runs counter to recent regulatory initiatives stressing deregulation. However, the history of government regulation is rife with past examples of centralizing regulatory efforts and their economic impact. During the early 20th Century, moves toward centralized federal regulation included the regulation of airlines, trucking, railroads, telecommunications, cable television, banking, brokerage, petroleum, and natural gas. Regulation in these instances was a response to “destructive competition” and viewed as improving social economic welfare.[160]

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[159] 26 U.S.C. § 7704(d)(1)(E).

[160] Clifford Winston, Economic Deregulation: Days of Reckoning for Microeconomists, Journal of Eco. Lit. Vol. XXXI (Sept. 1993), pg. 1266.

However, subsequent analysis has revealed economic distortions created by regulation including high rates, barriers to entry, stymied productivity, technological change, and management quality.[161]

In the context of past regulatory frameworks, two efforts are of note –regulating railroads under the Interstate Commerce Act of 1887, and regulating the oil and gas industry in Texas under the RRC. Both initiatives involved the centralization of regulatory control and may provide guidance where options for CO_2 pipelines are concerned.

In the case of railroads and Texas oil fields, the centralized regulatory approach was warranted. During the latter half of the 19th Century and the first part of the 20th Century, the railroad industry and the Texas oil fields faced chaos, fraud, and mismanagement. The railroad industry faced manipulative monopolies, predatory pricing, and rate wars. Piecemeal attacks on these problems from various state legislatures created a patchwork of regulations; however, since the problems were inherently interstate in focus, these efforts failed to bring resolution. By the 1880s many officials of the railroad industry and the federal government were advocating national regulation to bring order to the industry. National regulation came in the form of the ICA and the creation of the ICC in 1887.

In the 1930s, with the discovery of the East Texas Field, the Texas oil industry was plunged into crisis. Unlike many other oil fields, the East Texas Field was taken over by a multitude of small independent operators, each racing to put up a rig. Derricks touched legs with other derricks. Each well was produced wide-open. The price of oil crashed. More critically, it was felt that the natural water drive of the field was being lost. When the Railroad Commission tried to step in and cut production, action began in the courts. In August of 1931, state military forces were called in to regain order. It took several years, but by 1934 the courts and the Texas Legislature were able to settle on the position that the Commission had the right to prorate production--to conserve the state's natural resources, to protect correlative rights, and to prevent pollution.

What can be gained from the review of these regulatory events? In both instances one result of centralizing regulation was price stability and price transparency. With tariffs and production controls, shipping rates and production were regulated and controlled, bringing greater stability to the market. However, other consequences of the more centralized regulation included barriers to entry, production controls, and higher consumer prices.

In both circumstances, market power abuses and “destructive competition” had outstripped the ability of the existing regulatory framework, warranting the imposition of economic regulation. Economic regulation of pipelines or other network industries usually arises in situations where there are abuses of dominant positions (e.g. exercise of monopoly or monopsony power), including unreasonable or unjust prices charged for service, unreasonable denials of service, or unduly discriminatory treatment of some customers or customer classes. That is not the case with regard to CO_2 pipelines. In the current CO_2-driven EOR environment, there is no evidence of market power abuse. Transactions take place regularly and parties do not appear to be unduly litigious, so there has been no basis for broader economic regulation.

However, as the purpose of transporting CO_2 migrates from CO_2-driven EOR to non-EOR geologic storage, potential market power issues could arise. For instance, after expiration of the off-take agreements that initially supported pipeline construction and financing, a given pipeline may be in a position to exercise market power and extract monopoly rents (i.e., to obtain value in excess of costs) from CO_2 sources.

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[161] *Id.* At 1269.

Since CCS is developing, a regulatory framework should guard against increasing costs or hindering technological development. Given the economic distortions that sometimes accompany centralized federal regulation, policymakers contemplating the nature of CO_2 pipeline regulatory frameworks should carefully approach the necessity and timing of regulation. In the absence of market abuses, they must carefully evaluate what impulses drive the call for additional or centralized federal regulation. They must also consider the economic impact hasty regulation would have on the cost and deployment of CCS.

E. Commercial Transactions

The Legal Framework for Commercial Purchase and Sale of CO_2

1. Purchase and Off-take Agreements

(a) Pipeline Contracts – Purchase and Off-take Agreements

Most CO_2 pipeline transactions are controlled by privately negotiated CO_2 sale and purchase agreements or off-take agreements. Sale and purchase agreements govern existing supplies of products or services, in this case CO_2. Off-take agreements govern the sale and purchase of future supplies of a good or service. An off-take agreement is a contract whereby an owner/seller of a good agrees to sell and a buyer/off-taker agrees to purchase a future good in the quantities and on the terms and conditions embodied in the contract. Companies use off-take agreements to ensure that a buyer is willing to purchase future goods produced by the supply company. Off-take agreements are used in transactions governing a number of commodities and are also common among developers and utilities. Companies with off-take agreements can find outside financing to build their facilities, allowing them to retain cash for normal operating uses. The parties to an off-take agreement typically involve an owner/supplier/seller and a buyer/off-taker/user. In the realm of CO_2 transactions, those parties correspond to an industrial source of CO_2 and the pipeline operator or EOR operator, which may or may not be the same entity.

In the CO_2 pipeline arena, off-take agreements associated with producers of anthropogenic CO_2 are usually accompanied by specific language or a separate contract that addresses carbon management. CO_2 pipeline operators have begun to address climate change and carbon management issues in their off-take agreements through specific language or separate Emissions Reduction Credit contracts. These contracts are designed to instruct the parties on how to deal with future carbon reduction requirements. In the event that the industrial CO_2 source is regulated and therefore required to account for the CO_2 produced, these contracts control the duties and obligations of the remaining parties. In the event the parties decide to use the project as a means of offsetting a carbon liability, then the contract controls how the parties will share in any carbon credits or allowances generated by the project. Both mechanisms offer an additional revenue stream to the parties involved, possibly changing the economics of the pipeline transportation function.

(b) Uniform Commercial Code Applicability to CO2 Off-take Agreements

A threshold issue in crafting CO_2 off-take agreements is whether or not the transaction is subject to the Uniform Commercial Code (UCC).[162] The UCC governs commercial transactions and provides a model for uniform state business laws and procedures. Sales of naturally occurring CO_2 are covered under Article 2 of the UCC, which applies to the sale of "goods." The UCC defines the term "goods" in relevant part as

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[162] Marston and Moore, From EOR to CCS, *supra* 87.

"all things... which are movable at the time of identification to the contract for sale." [163] Specifically, the UCC addresses the sale of minerals, including oil and gas, that are "to be removed from realty, providing that a contract for such a sale is a contract for the sale of goods,… if they are to be severed by the seller."[164] Hence, sales of naturally occurring CO_2 produced from geological reservoirs are subject to the UCC as "goods," and a number of court cases have supported this view.[165]

However, anthropogenic CO_2 would not be covered by the mineral provisions of the UCC, but may fall under the general rule for "things" that are "movable at the time of identification to the contract" or "specially manufactured" goods made to conform to a special order. [166] Additionally, an off-take agreement for anthropogenic CO_2 might be viewed by courts as a providing a continuous "service" that would not be subject to Article 2 of the UCC.

Coverage under the UCC is important because it minimizes risks of uncertainty regarding applicable law and promotes transparency in transactions between buyers and sellers. Transactions governed by the UCC are generally subject to both express and implied warranty, merchantability, and fitness standards. Without UCC rules, disputes are resolved subject to general state contract law.

PART 4: CONCLUSIONS AND RECOMMENDATIONS

I. The Market

In response to demand for CO_2 for EOR and other uses, the private sector has successfully constructed and is operating approximately 4,000 miles of CO_2 pipelines in the United States. These pipelines were built over several decades, largely in response to demand for CO_2 to be used in EOR activities. This demand is likely to grow. For example, Oklahoma has produced 12 billion to 15 billion barrels of oil to date.[167] Using EOR activities, the state could double its oil production. Other oil fields across the U.S. are ready candidates for EOR activities, providing a current market for CO_2 and the need for future pipelines. The current pipeline infrastructure was sited, constructed, and regulated by the states in which they operate with federal oversight limited to safety regulations or instances where federal lands are traversed. Neither the FERC, nor the STB exercises jurisdiction over CO_2 pipelines in the U.S.

Today the CO_2 market is driven by demand for EOR and other uses, and is influenced by oil prices and efficiencies in capture technologies. Under the EOR model, CO_2 is put to an economic use. Growth is occurring in this model through the use of anthropogenic CO_2 in EOR activities along with the pipeline infrastructure necessary to meet that demand. For example, Denbury's Green Pipeline is a 314-mile, 24-inch pipeline starting in Louisiana near Baton Rouge and ending near Houston, Texas. It will transport both natural and anthropogenic carbon dioxide. To utilize the pipeline capacity, Denbury has entered into off-take agreements with several coal-to-liquids plants and three gasification projects in the Gulf Coast. A similar project in Wyoming will deliver 55 MMcf/d CO_2 from the Lost Cabin gas processing plant near Lusk, Wyoming, supplying CO_2 for EOR into the Powder River Basin, near Baker, Montana.

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[163] U.C.C. § 2-105

[164] *Id.*

[165] *See* Marston and Moore, From EOR to CCS, supra 88, at 444-448 for discussion of cases.

[166] U.C.C. § 2-105

[167] Okla. Geological Survey, Oil and Gas Commonly Asked Questions, http://www.ogs.ou.edu/oilgasfaq.php#10, Between 1901 and 2002, Oklahoma produced 14.5 billion barrels of oil.

New efficiencies and reduced costs in CO_2 capture technologies contribute to increased profitability for oil and gas companies that will continue to make EOR activities economically attractive and continued use of CO_2 and pipeline build-out likely. The expansion of the CO_2 pipeline system is likely to extend beyond U.S. borders, into neighboring jurisdictions that also have an economic use for CO_2 in EOR activities. Meanwhile, other CO_2 storage and transportation opportunities may be delayed until they are economically feasible, or politically mandated. Should such mandate occur, sufficient public resources must be allocated to build the infrastructure necessary and mitigate the economic disconnects and impacts that are likely to occur.

In today's environment, purity, pressure, and location determine how CO_2 is managed. Because of the value of CO_2 for EOR purposes, a great deal of expertise has been developed in the private sector and within the states for treating CO_2 as a commodity and utilizing it for economic purposes. A departure from that model may result in a skeptical public that could adversely impact future pipeline projects.

II. Climate Change - a Federal Response

Concerns regarding anthropogenic CO_2 contributing to global climate change have fostered an interest among some to federally mandate a carbon management strategy that would require storage of CO_2 for environmental purposes rather than economic reasons. CO_2 makes up a small percentage of the atmosphere (CO_2 represents 4/100 of 1% of the atmosphere; of that 96.7% of CO_2 is natural and 3.3% is man-made). Public policy mandating CO_2 emission reductions and storage should be carefully considered in view of uncertainty regarding global climate change, its causes, costs, and the somewhat limited utility of capturing CO_2 in the U.S., unless other countries follow suit. A federal mandate to reduce CO_2 will promote strategies to capture and store CO_2 and presumes that the infrastructure necessary to transport and store the CO_2 would follow. But, the premise that a mandate will result in infrastructure is unsubstantiated. If a federal mandate requires capture and storage of CO_2, then public resources may be required to build the infrastructure necessary to handle the CO_2 produced in the U.S. Because transport for storage alone is not market driven, there will be economic disconnects that need to be considered and for which compensation may be required. A federal mandate may encourage some sources of CO_2 to off load the cost of transporting and storing CO_2 to third parties through promoting public policies that support/allow for such a cost shift.

Additionally, a pipeline that is moving a non-economic commodity may be viewed less favorably by the public, when compared to CO_2 pipelines moving today's positive value commodity. In the current market-based CO_2 economy and in the absence of a federal mandate, federal intervention into the CO_2 arena may impede further pipeline build-out. It should be noted that in some instances CO_2 can be stored and then extracted at a later date should a beneficial use arise.

Today, no federal role is required in order to develop CO_2 pipeline projects. The assumption that a federal mandate will produce the desired result (capture, transportation, and storage of nationally produced CO_2) may not follow. Other state-based regulatory solutions should be carefully considered before pursuit of an untested federal strategy that could prove harmful to future CO_2 pipeline construction.

III. Recommendations

A. General

- The Status Quo Model (private sector development) has responded to market demands and should be continued for the foreseeable future. Policies should foster competition within the industry while encouraging access to pipeline capacity. Although access and competition may be viewed as counter to the goals of dedicated access, access and competition must be fostered under any pipeline development scenario.
- Public policies should foster flexibility in the market to allow the private sector to respond to growing needs. Any policy decision should avoid one-size-fits-all mentality, but rather promote flexibility and innovation in response to market conditions.
- A mandate to regulate or reduce greenhouse gas emissions should be accompanied by sufficient public resources to assure the infrastructure necessary to accommodate the quantity of CO_2 that is subject to the mandate.
- Policy discussions should be held with members of the legislative and executive branches of government at the state and federal level, and include administrative agencies involved in CO_2 pipeline issues through forums such as the PTTF and the Interagency Task Force on CCS.

B. State Recommendations

- Implement statutes and regulations to approve, site, construct, and manage CO_2 pipelines to meet EOR demands or in response to a federal mandate.
- Consider a pipeline agency (authority) to foster pipeline build-out, through financing, fostering favorable public policies, and serving as a facilitator and catalyst for pipeline projects.
- Initiate discussions with neighboring states to consider multi-state agreements to consider joint time frames, sequential hearings and approvals, and uniform criteria for siting CO_2 pipelines.
- Facilitate developing a single point of contact for this valuable state resource, i.e. CO_2 for EOR and CO_2 pipelines, requiring resource management and prevention of waste.
- Assign responsibility to stay cognizant of other potential beneficial uses of CO_2, such as its use for energized fracturing of oil and gas formations.
- Facilitate the highest and best use of CO_2.
- Quantify and distribute information relating to employment opportunities, average salaries, and public revenue resulting from CO_2 pipelines.

C. Federal Recommendations

- Federal policy should retain the status quo and allow the private sector to respond to market demands as currently demonstrated. Federal intervention beyond safety and siting authority (when federal lands are involved) currently in place may impede future build-out and the private sector's response.

- If the federal role is expanded in approval, siting, or economic regulation, the federal model should more closely follow the natural gas model rather than an oil pipeline model that impedes certainty of access for sources of CO_2. Federal policy, if any, should assume more rapid build-out either in response to a federal mandate or in continued response to EOR requirements.

- The public sector should encourage policies that promote private sector build-out for CO_2-driven EOR through incentives and other forms of non-regulatory support. Such support will benefit eventual storage-only projects for which the economics are not yet present.

- The following are federal policy options that might be considered in the order shown with the most favorable listed first:

OPTION 1: (Status quo)

Continue the federal role in pipeline safety regulations and permits for pipelines that traverse federal lands. In view of the long and successful history of the states to effectively manage the siting, construction and economic regulation of pipelines, continue to leave this authority with the states.

OPTION 2: (Incentives)

Economic incentives may be considered that could enhance future build-out. These incentives might include: direct financial incentives, accelerated depreciation, loan guarantees, tax policy that retains EOR tax credits, which in turn promotes CO_2 pipeline construction, financing to fund overcapacity to supplement the private sector role, and maintenance of Intangible Drillings Costs tax deduction. Some of these policies underpin EOR activity in the U.S. which serves as a foundation for the current build-out of CO_2 pipeline infrastructure. They also allow the federal government a role, in a non-regulatory manner, in encouraging development towards a desired outcome --- a pipeline system that is sufficient and robust enough to transport significant quantities of CO_2 required by EOR market expansion and/or federal mandates.

OPTION 3: (Federal Lands)

Federal resource land management may provide another option for enhancing CO_2 pipeline construction. Permitting across federal lands could be streamlined and simplified by the development of categorical exclusions within certain corridors. Categorical exclusions allow the federal land management agency (e.g. U.S. Forest Service) to make a determination that certain pipelines that fall within pre-determined criteria meet National Environmental Policy Act (NEPA)[168] requirements and can be permitted within the corridor.

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[168] For more information about NEPA and categorical exclusions, *visit* http://ceq.hss.doe.gov/.

OPTION 4: (Sequential)

At present, there is no urgency for an expanded federal role in CO_2 pipeline regulation. Premature federal intervention could harm existing private sector build-out of CO_2 pipelines by increasing regulatory and economic uncertainty in the market. There is sufficient time to design a carefully crafted federal model after a determination is made of "what we need and when do we need it"? In the meantime, the current state-based system addresses needs adequately. If the determination is made that an expanded federal role is necessary, the solution should be tailor-made for the specific needs of the CO_2 industry -- not transplanted from a different commodity such as the federal oil or gas model.

OPTION 5: (Caution)

There is a push for an immediate expansion of federal involvement in the regulation of CO_2 pipelines that could jeopardize the current system. If federal expansion occurs, it should complement the present system, not destroy or supplant it. The NGA could be amended by adding words "CO_2", but such an amendment might have negative consequences by imposing a regulatory regime (similar to the NGA) that grew out of the specific and unique needs of the natural gas industry.

GLOSSARY

Adsorption	The adhesion of a thin layer of molecules of some substance to the surface of a solid or liquid.
Anthropogenic	"…of, relating to, or influenced by the impact of man on nature."
Apportionment (Proration)	A methodology to allocate a commodity such as pipeline capacity or natural gas supply under which the commodity is split among those seeking to obtain it based on a factor, such as quantity requested or numbers of individuals
Sink	Medium represented by biological materials or geologic formations that store carbon dioxide.
Carbon Dioxide (CO_2)	A colorless, naturally occurring gas composed of one atom of carbon and two atoms of oxygen. At temperatures below –78°C (–108°F), CO_2 condenses into a white solid called dry ice. When warmed, dry ice vaporizes directly from a solid to CO_2 gas in a process called sublimation. With enough added pressure, liquid carbon dioxide can be formed.
Climate Change	Refers to a change in the state of the climate that can be identified (e.g. using statistical tests)…by changes that persists for an extended period, usually decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity.
Commodity	Some good or service for which there is demand.
Common carrier	A facility obligated by law to provide service to all potential users without discrimination, with services to be prorated among users in the event capacity is not sufficient to meet all requests. Interstate oil pipelines are common carriers, but interstate natural gas pipelines are not.
Compression	The action on a material which decreases its volume as the pressure to which it is subjected increases. Natural gas is usually compressed for transport.
Corporate debt financing	The payment, in whole or in part, for a capital investment with borrowed funds.
Cost-recovery	Recoupment of the purchase price of a capital or qualified asset through the rate base of a regulated utility.
Eminent domain	The sovereign power to seize private property without the owner's consent in exchange for fair consideration.
Enhanced Oil Recovery (EOR)	The introduction of an artificial drive and displacement mechanism, such as steam, water, or CO_2, into a reservoir to produce oil unrecoverable by primary and secondary recovery methods.
Feedstock	Raw material required for an industrial process.
Gathering lines	Network-like pipeline that transports natural gas from individual wellheads to a compressor station, treating or processing plant, or main trunk transmission line. Gathering lines are generally short in length, operate at a relatively low pressure, and are small in diameter.
Master Limited Partnership (MLP)	Publicly traded partnerships treated as corporations for federal income tax purposes unless 90% of their gross income consists of certain "qualifying income"
Miscibility	The property of liquids to mix in all proportions, forming a homogeneous solution.

Off-take agreement	A contract whereby an owner/seller of a good agrees to sell and a buyer/off-taker agrees to purchase a future good in the quantities and on the terms and conditions embodied in the contract
Open Access	Non-discriminatory, fully equal access to transportation or transmission services offered by a pipeline or electric utility.
Open Season	A period of time in which potential customers can bid for pipeline services, and during which such customers are treated equally regarding priority in the queue for service.
Oxy-fuel	A process of carbon capture that involves combusting fuel in recycled flue gas enriched with oxygen to produce a CO_2-rich gas.
Pig	A device placed into a pipeline for servicing and monitoring the pipeline or segregating fluids being transported in the pipeline.
Pollutant	Generally, any substance introduced into the environment that adversely affects the usefulness of a resource or the health of humans, animals, or ecosystems.
Post-combustion	A process of carbon capture that involves scrubbing the CO_2 out of flue gases or natural gas streams.
Pre-combustion	A process of carbon capture that uses a gasification process followed by CO_2 separation to yield a hydrogen fuel gas.
Project finance	The long term financing of infrastructure and industrial projects based upon the projected cash flows of the project rather than the balance sheets of the project sponsors.
Pumps	Used to move liquid in a pipeline, rather than compressors which move gases.
Resource Management	Regulation that seeks to manage, maintain, and advance the beneficial uses of a commodity while regulating and controlling any harmful or deleterious effects of the commodity.
Right of way	The right of a pipeline or other transmission utility to cross property to go to and from another parcel. The right of way may be a specific grant of land or an “easement,” which is a right to pass across another’s land.
Siting	Involves the notice and/or approval of the pipeline pathway by the regulatory agency prior to construction.
Source	Refers to any process, activity, or mechanism that releases a greenhouse gas, an aerosol, or a precursor of a greenhouse gas or aerosol into the atmosphere.
Supercritical CO_2	CO_2 becomes a supercritical fluid when it is compressed to approximately 1,200 psig at temperatures greater than 31.1 degrees Celsius. At this point, it assumes certain characteristics of both a gas and a liquid.
Tariffs	The documents filed by the pipeline carriers with the regulatory agencies detailing their terms and conditions of service and associated prices for various classes of customers.

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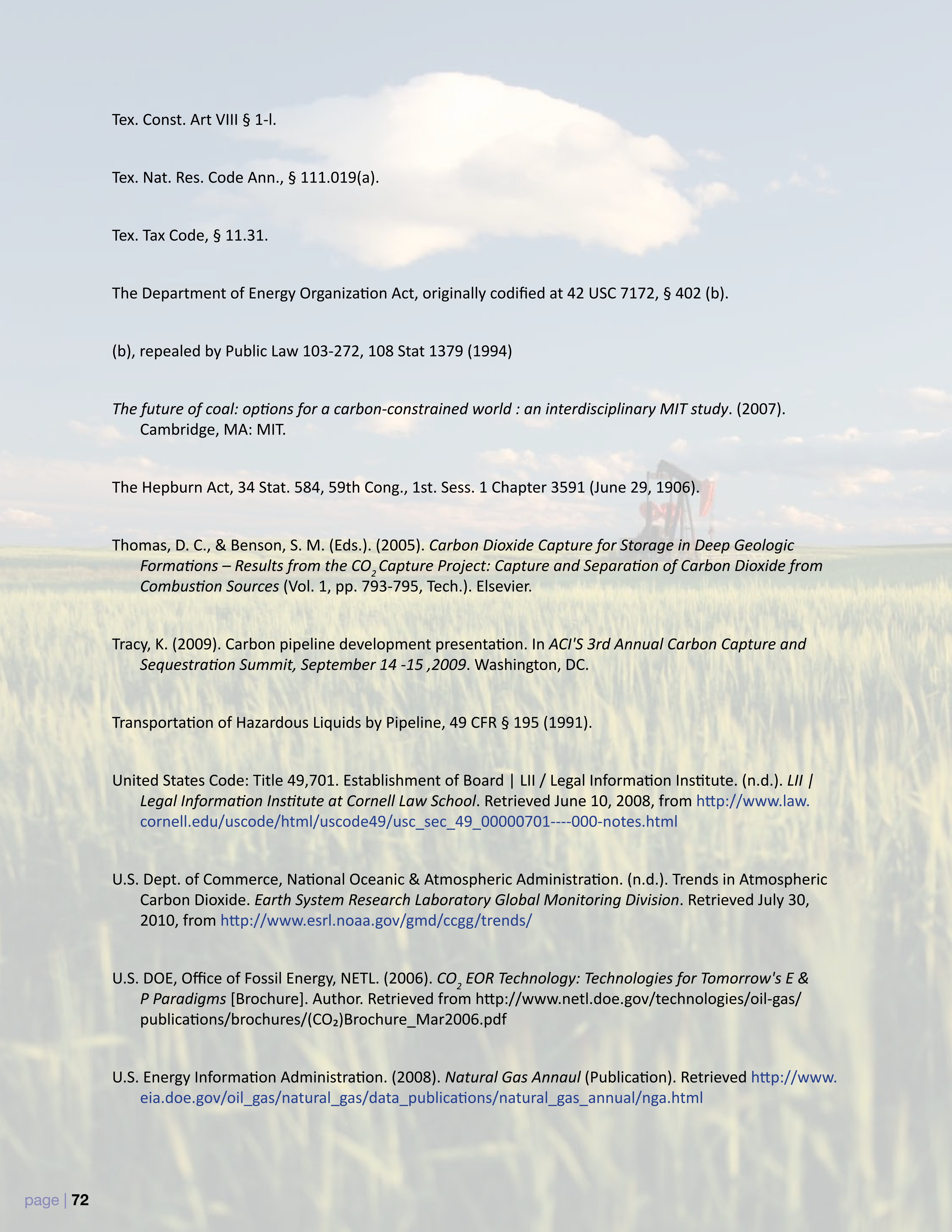

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LIST OF ACRONYMS AND ABBREVIATIONS

AEP	American Electric Power
ANGDA	Alaska Natural Gas Development Authority
bbl	billion barrels
Bcf	Billion cubic feet
BLM	Bureau of Land Management
CAA	Clean Air Act
CCGS	Carbon Capture and Geologic Storage
CCS	Carbon Capture and Storage
CFR	Code of Federal Regulations
CH_4	Methane

CMU	Carnegie Mellon University
CO_2	Carbon Dioxide
CRS	Congressional Research Service
CSA	Canadian Standards Association
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
ECBM	enhanced coal-bed methane
EOR	enhanced oil recovery
EPA	U.S. Environmental Protection Agency
EPACT05	Energy Policy Act of 2005
EPC	“engineering-procurement and construction”
ERCB	Alberta Energy Resources Conservation Board
FERC	Federal Energy Regulatory Commission
FLPMA	Federal Land Policy and Management Act
H_2S	Hydrogen Sulfide
ICA	Interstate Commerce Act
ICC	Interstate Commerce Commission
IEA	International Energy Agency
IOGCC	Interstate Oil and Gas Compact Commission
LNG	liquefied natural gas
Mcf	thousand cubic feet
MIT	Massachusetts Institute of Technology
MLA	Mineral Leasing Act of 1920
MLPs	Master Limited Partnerships
Mcf	thousand cubic feet
MMcf	million cubic feet
MRCSP	Midwest Regional Carbon Sequestration Partnership

MSCO	“multi-state compact option”
MW	megawatt
N_2O	Nitrous Oxide
NEB	National Energy Board (Canada)
NETL	Department of Energy National Energy Technology Laboratory
NGA	Natural Gas Act
NGPM	Natural Gas Pipeline Model
OPR	Onshore Pipeline Regulations (Canada)
OPS	DOT Office of Pipeline Safety
PCSC	“pulverized coal super critical”
PHMSA	Pipeline and Hazardous Materials Safety Administration
ppm	parts per million
psi	pounds per square inch
psia	pounds per square inch absolute
psig	pounds per square inch gauge
PTTF	Pipeline Transportation Task Force
RCSP	DOE NETL Regional Carbon Sequestration Partnerships
ROW	“right of way”
RRC	Railroad Commission of Texas
SDWA	Safe Drinking Water Act
SECARB	Southeast Regional Carbon Sequestration Partnership
SSEB	Southern States Energy Board
STB	Surface Transportation Board
UCC	Uniform Commercial Code
UIC	Underground Injection Control
vol	volume

APPENDICES

Appendix I: Table of United States High Pressure CO_2 Pipelines by State

Appendix II: Inventory of State Statutory and Regulatory Law

Appendix III: Regulatory Infrastructure and Physical Requirements for Canadian CO_2 Pipelines

Appendix IV: Participants in IOGCC/SSEB Pipeline Transportation Task Force

Appendix I: Table of United States High Pressure CO_2 Pipelines by State[169]

ID	Operator Name	Mileage	County	State
19102	ENERGEN RESOURCES CORP.	1.4	Ector	Texas
4908	ExxonMobil Production Company	7.9	Andrews	Texas
4908	ExxonMobil Production Company	17.0	Gaines	Texas
30657	BRAVO PIPELINE SYSTEM	38.2	Bailey	Texas
30657	BRAVO PIPELINE SYSTEM	29.5	Cochran	Texas
30657	BRAVO PIPELINE SYSTEM	0.1	Dawson	Texas
30657	BRAVO PIPELINE SYSTEM	34.9	Gaines	Texas
30657	BRAVO PIPELINE SYSTEM	2.3	Hale	Texas
30657	BRAVO PIPELINE SYSTEM	92.5	Hockley	Texas
30657	BRAVO PIPELINE SYSTEM	1.0	Lamb	Texas
30657	BRAVO PIPELINE SYSTEM	13.6	Parmer	Texas
30657	BRAVO PIPELINE SYSTEM	1.3	Terry	Texas
30657	BRAVO PIPELINE SYSTEM	92.6	Yoakum	Texas
31013	TRANSPETCO TRANSPORT CO.	51.0	Dallam	Texas
31178	XTO ENERGY INC	19.7	Yoakum	Texas
31371	BUCKEYE GULF COAST PIPELINE LP	0.5	Harris	Texas
31471	SANDRIDGE CO2, LLC	3.5	Crockett	Texas
31471	SANDRIDGE CO2, LLC	43.8	Pecos	Texas

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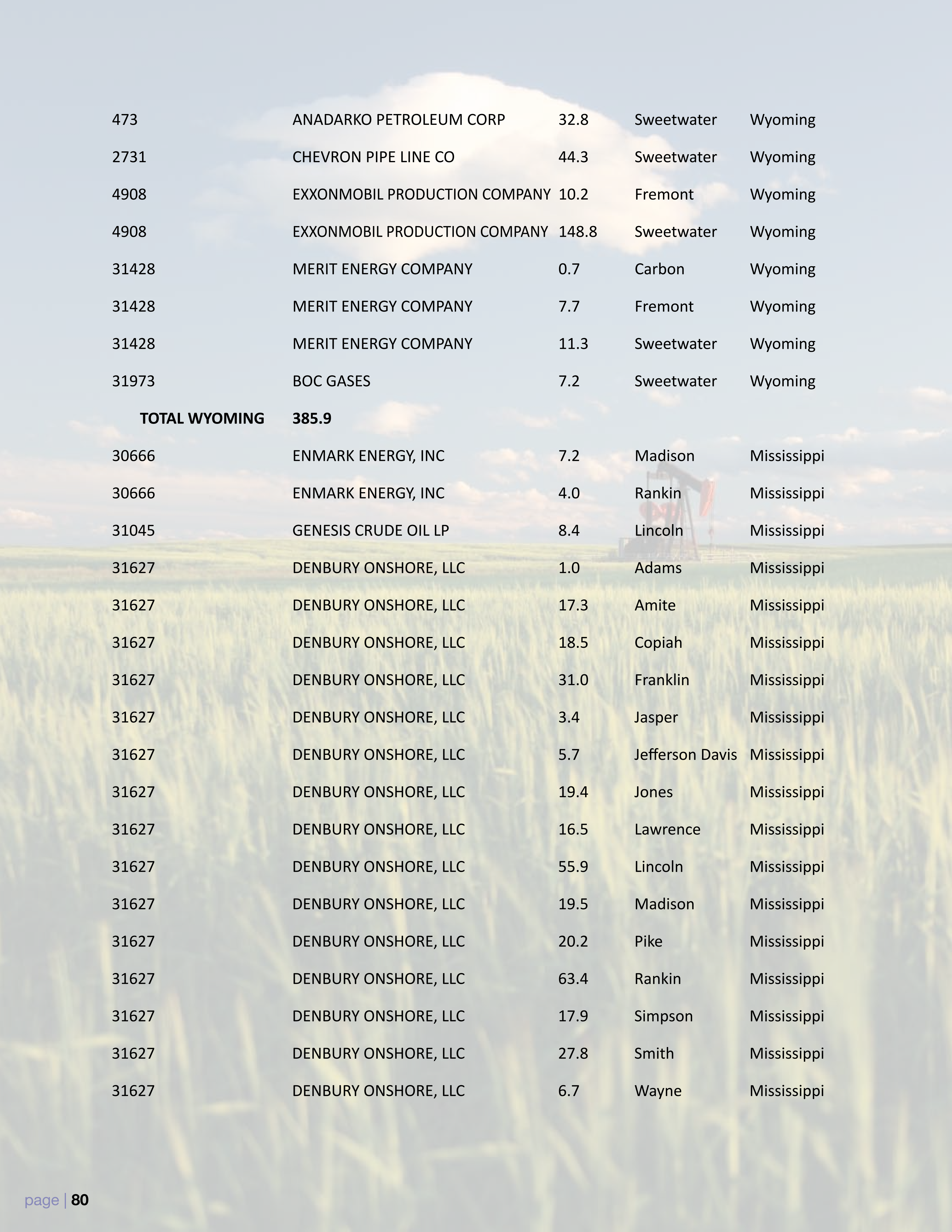
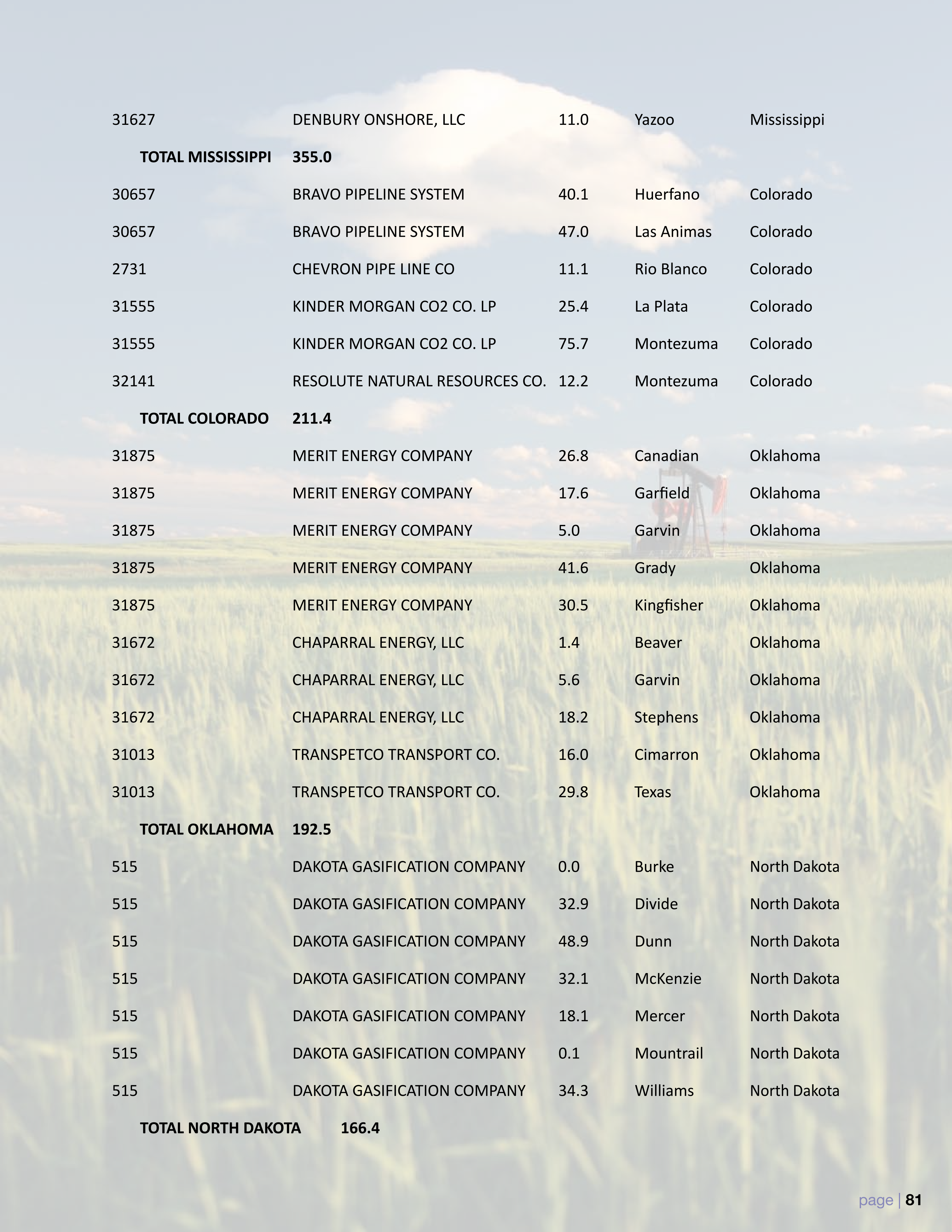
[169] Received from Victor Carrillo, RRC

31471	SANDRIDGE CO2, LLC	33.3	Terrell	Texas
31471	SANDRIDGE CO2, LLC	5.1	Upton	Texas
31475	TRINITY CO2 LLC	6.1	Andrews	Texas
31475	TRINITY CO2 LLC	28.3	Gaines	Texas
31475	TRINITY CO2 LLC	14.0	Loving	Texas
31475	TRINITY CO2 LLC	11.9	Reeves	Texas
31475	TRINITY CO2 LLC	4.0	Ward	Texas
31475	TRINITY CO2 LLC	15.4	Winkler	Texas
31475	TRINITY CO2 LLC	5.6	Yoakum	Texas
31502	OCCIDENTAL PERIMAN LTD	5.8	Scurry	Texas
31555	KINDER MORGAN CO2 CO. LP	68.2	Andrews	Texas
31555	KINDER MORGAN CO2 CO. LP	36.0	Borden	Texas
31555	KINDER MORGAN CO2 CO. LP	58.5	Crane	Texas
31555	KINDER MORGAN CO2 CO. LP	2.7	Crockett	Texas
31555	KINDER MORGAN CO2 CO. LP	33.7	Dawson	Texas
31555	KINDER MORGAN CO2 CO. LP	63.5	Ector	Texas
31555	KINDER MORGAN CO2 CO. LP	65.8	Gaines	Texas
31555	KINDER MORGAN CO2 CO. LP	29.1	Glasscock	Texas
31555	KINDER MORGAN CO2 CO. LP	33.5	Howard	Texas
31555	KINDER MORGAN CO2 CO. LP	0.9	Loving	Texas
31555	KINDER MORGAN CO2 CO. LP	8.4	Midland	Texas
31555	KINDER MORGAN CO2 CO. LP	3.4	Mitchell	Texas
31555	KINDER MORGAN CO2 CO. LP	4.0	Reeves	Texas
31555	KINDER MORGAN CO2 CO. LP	38.2	Scurry	Texas
31555	KINDER MORGAN CO2 CO. LP	48.8	Upton	Texas
31555	KINDER MORGAN CO2 CO. LP	13.1	Ward	Texas
31555	KINDER MORGAN CO2 CO. LP	35.4	Yoakum	Texas

31672	CHAPARRAL ENERGY, LLC	27.7	Hansford	Texas
31672	CHAPARRAL ENERGY, LLC	29.0	Hutchinson	Texas
31672	CHAPARRAL ENERGY, LLC	15.8	Ochiltree	Texas
TOTAL TEXAS	**1196.0**			
31555	KINDER MORGAN CO2 CO. LP	3.4	Bernalillo	New Mexico
31555	KINDER MORGAN CO2 CO. LP	66.6	Chaves	New Mexico
31555	KINDER MORGAN CO2 CO. LP	20.8	DeBaca	New Mexico
31555	KINDER MORGAN CO2 CO. LP	15.9	Eddy	New Mexico
31555	KINDER MORGAN CO2 CO. LP	15.3	Guadalupe	New Mexico
31555	KINDER MORGAN CO2 CO. LP	83.9	Lea	New Mexico
31555	KINDER MORGAN CO2 CO. LP	15.9	Lincoln	New Mexico
31555	KINDER MORGAN CO2 CO. LP	14.5	McKinley	New Mexico
31555	KINDER MORGAN CO2 CO. LP	85.7	San Juan	New Mexico
31555	KINDER MORGAN CO2 CO. LP	90.4	Sandoval	New Mexico
31555	KINDER MORGAN CO2 CO. LP	12.2	Santa Fe	New Mexico
31555	KINDER MORGAN CO2 CO. LP	60.7	Torrance	New Mexico
31475	TRINITY CO2 LLC	109.1	Lea	New Mexico
30657	BRAVO PIPELINE SYSTEM	36.9	Colfax	New Mexico
30657	BRAVO PIPELINE SYSTEM	80.2	Curry	New Mexico
30657	BRAVO PIPELINE SYSTEM	47.6	Harding	New Mexico
30657	BRAVO PIPELINE SYSTEM	94.7	Quay	New Mexico
30657	BRAVO PIPELINE SYSTEM	37.8	Roosevelt	New Mexico
30657	BRAVO PIPELINE SYSTEM	50.7	Union	New Mexico
31013	TRANSPETCO TRANSPORT CO.	23.3	Union	New Mexico
TOTAL NEW MEXICO	**965.6**			
473	ANADARKO PETROLEUM CORP	17.6	Fremont	Wyoming
473	ANADARKO PETROLEUM CORP	105.4	Natrona	Wyoming



473	ANADARKO PETROLEUM CORP	32.8	Sweetwater	Wyoming
2731	CHEVRON PIPE LINE CO	44.3	Sweetwater	Wyoming
4908	EXXONMOBIL PRODUCTION COMPANY	10.2	Fremont	Wyoming
4908	EXXONMOBIL PRODUCTION COMPANY	148.8	Sweetwater	Wyoming
31428	MERIT ENERGY COMPANY	0.7	Carbon	Wyoming
31428	MERIT ENERGY COMPANY	7.7	Fremont	Wyoming
31428	MERIT ENERGY COMPANY	11.3	Sweetwater	Wyoming
31973	BOC GASES	7.2	Sweetwater	Wyoming
TOTAL WYOMING	**385.9**			
30666	ENMARK ENERGY, INC	7.2	Madison	Mississippi
30666	ENMARK ENERGY, INC	4.0	Rankin	Mississippi
31045	GENESIS CRUDE OIL LP	8.4	Lincoln	Mississippi
31627	DENBURY ONSHORE, LLC	1.0	Adams	Mississippi
31627	DENBURY ONSHORE, LLC	17.3	Amite	Mississippi
31627	DENBURY ONSHORE, LLC	18.5	Copiah	Mississippi
31627	DENBURY ONSHORE, LLC	31.0	Franklin	Mississippi
31627	DENBURY ONSHORE, LLC	3.4	Jasper	Mississippi
31627	DENBURY ONSHORE, LLC	5.7	Jefferson Davis	Mississippi
31627	DENBURY ONSHORE, LLC	19.4	Jones	Mississippi
31627	DENBURY ONSHORE, LLC	16.5	Lawrence	Mississippi
31627	DENBURY ONSHORE, LLC	55.9	Lincoln	Mississippi
31627	DENBURY ONSHORE, LLC	19.5	Madison	Mississippi
31627	DENBURY ONSHORE, LLC	20.2	Pike	Mississippi
31627	DENBURY ONSHORE, LLC	63.4	Rankin	Mississippi
31627	DENBURY ONSHORE, LLC	17.9	Simpson	Mississippi
31627	DENBURY ONSHORE, LLC	27.8	Smith	Mississippi
31627	DENBURY ONSHORE, LLC	6.7	Wayne	Mississippi



31627	DENBURY ONSHORE, LLC	11.0	Yazoo	Mississippi
TOTAL MISSISSIPPI	**355.0**			
30657	BRAVO PIPELINE SYSTEM	40.1	Huerfano	Colorado
30657	BRAVO PIPELINE SYSTEM	47.0	Las Animas	Colorado
2731	CHEVRON PIPE LINE CO	11.1	Rio Blanco	Colorado
31555	KINDER MORGAN CO2 CO. LP	25.4	La Plata	Colorado
31555	KINDER MORGAN CO2 CO. LP	75.7	Montezuma	Colorado
32141	RESOLUTE NATURAL RESOURCES CO.	12.2	Montezuma	Colorado
TOTAL COLORADO	**211.4**			
31875	MERIT ENERGY COMPANY	26.8	Canadian	Oklahoma
31875	MERIT ENERGY COMPANY	17.6	Garfield	Oklahoma
31875	MERIT ENERGY COMPANY	5.0	Garvin	Oklahoma
31875	MERIT ENERGY COMPANY	41.6	Grady	Oklahoma
31875	MERIT ENERGY COMPANY	30.5	Kingfisher	Oklahoma
31672	CHAPARRAL ENERGY, LLC	1.4	Beaver	Oklahoma
31672	CHAPARRAL ENERGY, LLC	5.6	Garvin	Oklahoma
31672	CHAPARRAL ENERGY, LLC	18.2	Stephens	Oklahoma
31013	TRANSPETCO TRANSPORT CO.	16.0	Cimarron	Oklahoma
31013	TRANSPETCO TRANSPORT CO.	29.8	Texas	Oklahoma
TOTAL OKLAHOMA	**192.5**			
515	DAKOTA GASIFICATION COMPANY	0.0	Burke	North Dakota
515	DAKOTA GASIFICATION COMPANY	32.9	Divide	North Dakota
515	DAKOTA GASIFICATION COMPANY	48.9	Dunn	North Dakota
515	DAKOTA GASIFICATION COMPANY	32.1	McKenzie	North Dakota
515	DAKOTA GASIFICATION COMPANY	18.1	Mercer	North Dakota
515	DAKOTA GASIFICATION COMPANY	0.1	Mountrail	North Dakota
515	DAKOTA GASIFICATION COMPANY	34.3	Williams	North Dakota
TOTAL NORTH DAKOTA	**166.4**			

2731	CHEVRON PIPE LINE CO	20.4	Daggett	Utah
2731	CHEVRON PIPE LINE CO	52.9	Uintah	Utah
32141	RESOLUTE NATURAL RESOURCES CO.	15.6	San Juan	Utah
TOTAL UTAH	**88.9**			
31215	PCS NITROGEN FERTILIZER LP	0.0	Ascension	Louisiana
31215	PCS NITROGEN FERTILIZER LP	1.3	Iberville	Louisiana
31627	DENBURY ONSHORE, LLC	12.5	Ascension	Louisiana
31627	DENBURY ONSHORE, LLC	1.1	East Baton Rouge	Louisiana
31627	DENBURY ONSHORE, LLC	6.3	Iberville	Louisiana
31627	DENBURY ONSHORE, LLC	28.8	Livingston	Louisiana
31627	DENBURY ONSHORE, LLC	25.5	St. Helena	Louisiana
TOTAL LOUISIANA	**75.4**			
MASTER TOTAL FED PIPELINE		**3637.2**		

Appendix II: Inventory of State Statutory and Regulatory Laws[170]

TABLE 1: REGULATORY AUTHORITY BY STATE

Regulatory Authority: Authority that has primary regulatory jurisdiction over a state's CO_2 pipeline infrastructure
Statutory Citation: Statutory Provisions that deal with CO_2 pipelines and transportation
Regulatory Citation: Regulations by the regulatory authority to govern CO_2 pipelines and transportation
Form of Regulation: Regulatory regime for CO2 Pipelines: (Private, Contract or Common Carriage)

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[170] Data collected by Pranjal Mehta, University of Texas Law Student through document reviews and telephone conferences. Valid as of April 2010.

STATE	REGULATORY AUTHORITY	STATUTORY CITATION	REGULATORY CITATION	FORM OF REGULATION
AL	Alabama Public Service Commission	The Code of Alabama 1975, Title 37, Chapter 4, Article 3A (Section 37-4-90, Section 37-4-91): Hazardous Liquid Pipeline Facilities	N.A.	N.A.
AK	Regulatory Commission of Alaska	N.A.	N.A.	N.A.
AZ	Arizona Corporation Commission	N.A.	N.A.	N.A.
AR	Arkansas Public Service Commission	Arkansas Code of 1997. Section 15-72-102 (3): Definition of "Gas", Section 15-72-602(2): Definition of "Natural Gas"	N.A.	N.A.
CA	California Public Utilities Commission	N.A.	N.A.	N.A.
CO	Colorado Public Utilities Commission	Colorado Revised Statutes Annotated section 7-43-102: Certificate for Pipeline Companies; Section 38-2-101, Section 38-1-101.5	N.A.	Common carrier
FL	Florida Public Service Commission	Gas Safety Law of 1967 Section 368.021: Applicability of the law for CO2 transmission; 368.03: Legislative Intent for establishment of rules and regulations for gas industry.	N.A.	N.A.
IL	Illinois Commerce Commission	N.A.	N.A.	N.A.
IN	Indiana Utility Regulatory Commission, Division of pipeline safety	Indiana Code Section 8-1-22.5 other standards; compliance; general provisions	170 IAC 5-3-1 Federal and N.A.	
KS	Kansas Corporation Commission	N.A.	N.A.	N.A.
KY	Kentucky Public Service Commission	HB 213 (Ky. Revised Statues Chapter 154, HB 213 Amendments - SCS/LM)	N.A.	N.A.
LA	Conservation commission	Louisiana Code Title 19 Expropriation: Section 19:2(10), Title 30 Minerals, Oil and Gas and Environmental Quality Section 30:4(17)	Title 43 Natural Resources Part XI - Subpart 4: Carbon Dioxide (various rules for CO_2 pipelines)	Common carrier
ME	Maryland Public Service Commission	N.A.	N.A.	N.A.
MI	Michigan Public Service Commission	N.A.	N.A.	N.A.
MS	Mississippi Public Service Commission	Mississippi Code of 1972 Title 53 Chapter 1 Oil, Gas and Other Minerals: Section 53-1-3(d), Title 11 Chapter 27 Eminent Domain: Section 11-27-47	N.A.	N.A.
MT	Montana Public Services Commission	Montana Code Annotated 2009 Title 69 Chapter 13 : Section: 69-13-101, Section 69-13-104.	N.A.	Common Carrier
NE	Nebraska Public Services Commission	N.A.	N.A.	N.A.
NV	Public Services Commission of Nevada	N.A.	N.A.	N.A.
NM	New Mexico Public Regulation Commission, Pipeline Safety Bureau	New Mexico Code, Chapter 70 Oil and Gas: Section 70-3-5 Eminent Domain power, NM STAT. ANN. § 42A-1-22: Condemnation proceedings	N.A.	N.A.
NY	New York Public Service Commission	N.A.	N.A.	N.A.
ND	North Dakota Public Service Commission	North Dakota Century Code - Title 49: Public Utilities, Chapter 49-19: Section 49-19-01; 49-19-12	N.A.	Common Carrier
OH	Ohio Power Siting Board	N.A.	N.A.	N.A.
OK	Oklahoma Corporation Commission	N.A.	N.A.	N.A.
PA	Pennsylvania Public Utility Commission	N.A.	N.A.	N.A.
SD	Public Utilities Commission	N.A.	N.A.	N.A.
TX	Railroad Commission	Texas Natural Resources Code. Section 111.002. (6), (7): Common Carrier Under Chapter, Section 111.013: Control of Pipelines	Texas Administrative Code: Title 16, Part 1, Chapter 3 (Section 8.1, 8.301, 8.305, 8.310, 8.315)	N.A.
UT	Utah Public Service Commission	Title 40 Mines and Mining, Chapter 60 Board and Divisions of Oil, Gas and Mining: Section 40-6-2: "CO2" is defined as "other gas" under this section.	N.A.	N.A.
VA	State Corporation Commission	Chapter 22:1: The Virginia Gas and Oil Act -Section 45.1-361.1 Definition of "Gas" and "Pipeline"	N.A.	N.A.
WV	West Virginia Public Services Commission	N.A.	N.A.	N.A.
WY	Wyoming Public Services Commission	Wyo. Stat. Ann. Section 37-5-201, 37-5-107, 37-1-101 (vi)(G)(II), 1-26-814	N.A.	N.A.

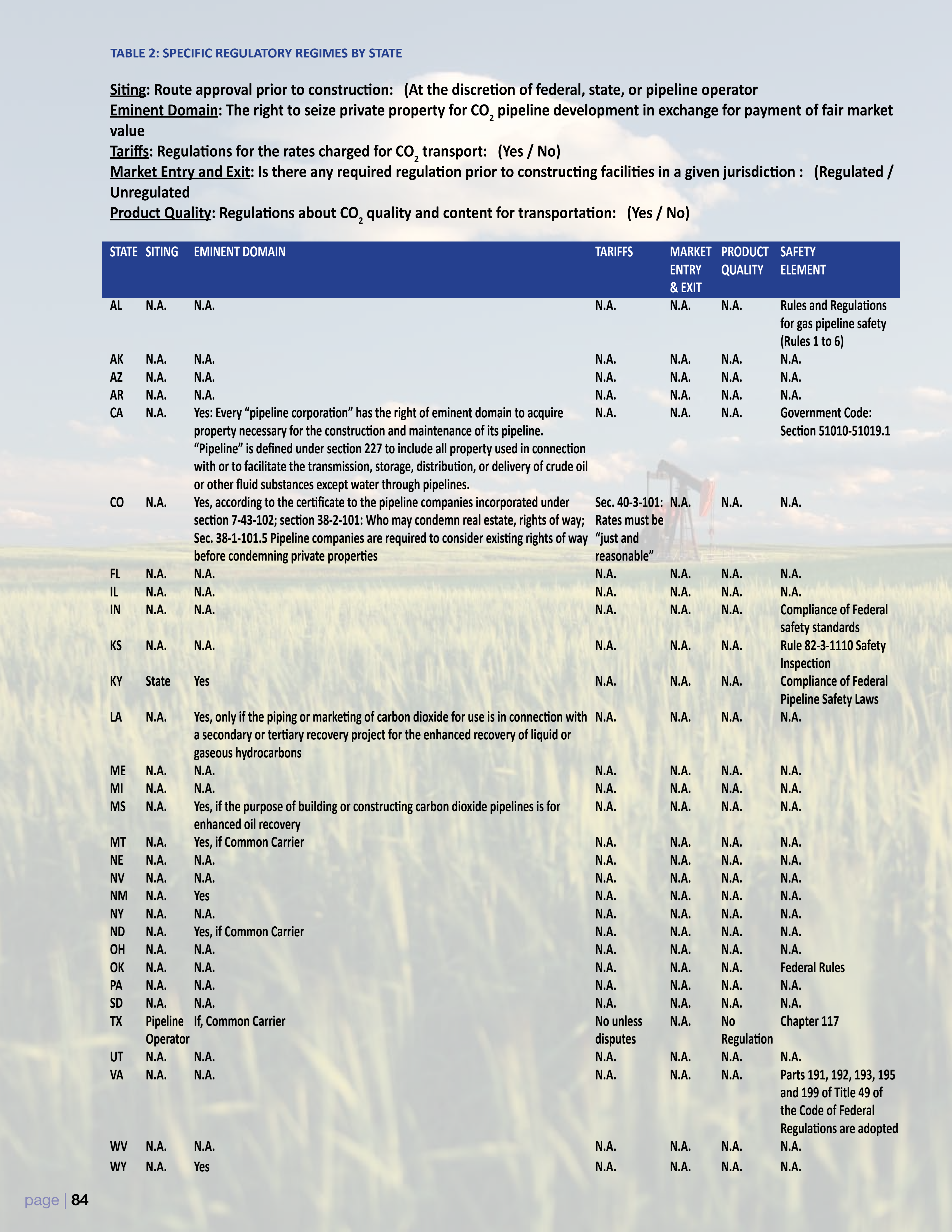

TABLE 2: SPECIFIC REGULATORY REGIMES BY STATE

Siting: Route approval prior to construction: (At the discretion of federal, state, or pipeline operator

Eminent Domain: The right to seize private property for CO_2 pipeline development in exchange for payment of fair market value

Tariffs: Regulations for the rates charged for CO_2 transport: (Yes / No)

Market Entry and Exit: Is there any required regulation prior to constructing facilities in a given jurisdiction : (Regulated / Unregulated

Product Quality: Regulations about CO_2 quality and content for transportation: (Yes / No)

STATE	SITING	EMINENT DOMAIN	TARIFFS	MARKET ENTRY & EXIT	PRODUCT QUALITY	SAFETY ELEMENT
AL	N.A.	N.A.	N.A.	N.A.	N.A.	Rules and Regulations for gas pipeline safety (Rules 1 to 6)
AK	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
AZ	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
AR	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
CA	N.A.	Yes: Every “pipeline corporation” has the right of eminent domain to acquire property necessary for the construction and maintenance of its pipeline. “Pipeline” is defined under section 227 to include all property used in connection with or to facilitate the transmission, storage, distribution, or delivery of crude oil or other fluid substances except water through pipelines.	N.A.	N.A.	N.A.	Government Code: Section 51010-51019.1
CO	N.A.	Yes, according to the certificate to the pipeline companies incorporated under section 7-43-102; section 38-2-101: Who may condemn real estate, rights of way; Sec. 38-1-101.5 Pipeline companies are required to consider existing rights of way before condemning private properties	Sec. 40-3-101: Rates must be “just and reasonable”	N.A.	N.A.	N.A.
FL	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
IL	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
IN	N.A.	N.A.	N.A.	N.A.	N.A.	Compliance of Federal safety standards
KS	N.A.	N.A.	N.A.	N.A.	N.A.	Rule 82-3-1110 Safety Inspection
KY	State	Yes	N.A.	N.A.	N.A.	Compliance of Federal Pipeline Safety Laws
LA	N.A.	Yes, only if the piping or marketing of carbon dioxide for use is in connection with a secondary or tertiary recovery project for the enhanced recovery of liquid or gaseous hydrocarbons	N.A.	N.A.	N.A.	N.A.
ME	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
MI	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
MS	N.A.	Yes, if the purpose of building or constructing carbon dioxide pipelines is for enhanced oil recovery	N.A.	N.A.	N.A.	N.A.
MT	N.A.	Yes, if Common Carrier	N.A.	N.A.	N.A.	N.A.
NE	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
NV	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
NM	N.A.	Yes	N.A.	N.A.	N.A.	N.A.
NY	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
ND	N.A.	Yes, if Common Carrier	N.A.	N.A.	N.A.	N.A.
OH	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
OK	N.A.	N.A.	N.A.	N.A.	N.A.	Federal Rules
PA	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
SD	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
TX	Pipeline Operator	If, Common Carrier	No unless disputes	N.A.	No Regulation	Chapter 117
UT	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
VA	N.A.	N.A.	N.A.	N.A.	N.A.	Parts 191, 192, 193, 195 and 199 of Title 49 of the Code of Federal Regulations are adopted
WV	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
WY	N.A.	Yes	N.A.	N.A.	N.A.	N.A.

Appendix III: Regulatory Infrastructure and Physical Requirements for Canadian CO_2 Pipelines

As a result of the Canada Transportation Act, which took effect July 1, 1996, jurisdiction over interprovincial and international commodity pipelines was transferred from the National Transportation Agency (now the Canadian Transportation Agency) to the National Energy Board (NEB). To assume jurisdiction, the definition of "pipeline" in the NEB Act was broadened to include pipelines transporting commodities other than oil or gas, but excluding municipal sewer and water lines.

Due to the wide variety of fluids transported on commodity pipelines, the NEB determined that it would be more practical to regulate these lines on a case-by-case basis, rather than developing new regulations that would address all potential commodity issues. Therefore, the NEB issued Order MO-CO-3-96, which exempted commodity pipelines from the provisions of the Onshore Pipeline Regulations (OPR).

The first application filed with the NEB for the construction and operation of a commodity pipeline was on October 10, 1997, by Souris Valley Pipeline Limited for the construction and operation of a carbon dioxide transmission pipeline running from a receipt point in North Dakota to an enhanced oil recovery reservoir in southern Saskatchewan. The NEB made the decision that any certificate issued in respect to the proposed facilities would be conditioned to reflect many of the issues addressed by the OPR. The following table identifies some specific characteristics of the Souris Valley Pipeline.

Pipeline	Route	Regulatory Jurisdiction	Length	O/D	Max Capacity	Max Pressure	Gas Purity
Souris	**N. Dakota to Saskatchewan**	**Saskatchewan and Canada**	**61 km**	**324 mm**	**2.7 $10^6 m^3/d$**	**18.6 mPa**	**98% - CO_2 2% - H2S**

Regulation of CO_2 Pipelines in Alberta

Successfully capturing and storing CO_2 is the backbone of Alberta's 2008 Climate Change Strategy, which commits to reducing projected emissions by 200 megatonnes by 2050.[171] As a result, Alberta has promised \$2 billion for CCS projects, using some of the funds to support development of a CO_2 trunk line across the province. The PTTF believes that discussing Alberta is worthwhile because of its focus on CCS.

The Alberta Energy Resources Conservation Board (ERCB) regulates CO_2 pipelines in Alberta under the Pipeline Act (Ch.p-15, RSA 2000) (Updated to January 1, 2010) and AR 91/2005, Pipeline Regulation (consolidated to AR84/2009).

The ERCB undertakes a technical review of CO_2 pipeline applications to ensure that the design and purpose of the project is based on sound engineering practice and is in the overall public interest.

Technical documentation in support of the applications should include, at a minimum, the following information:

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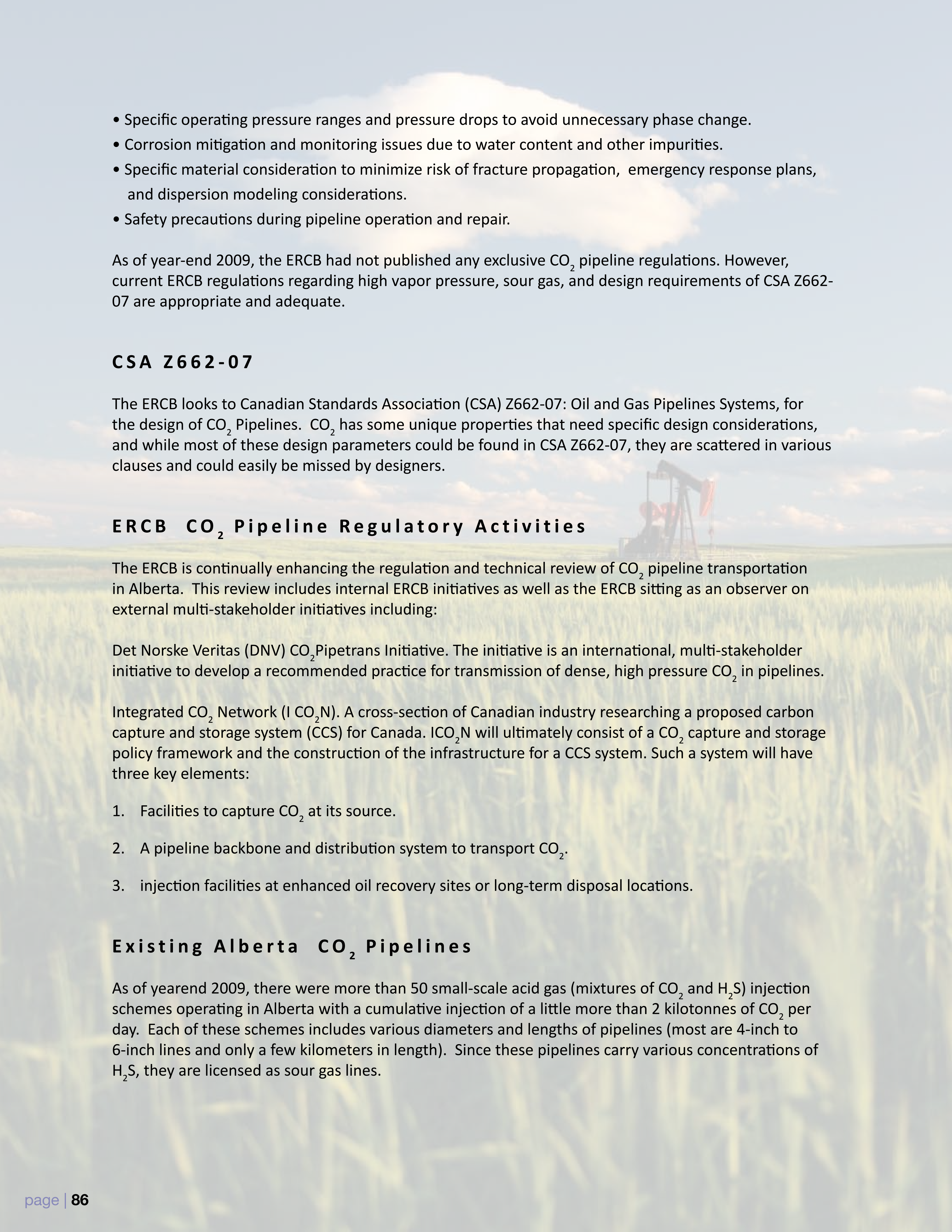
[171] *See* Alberta's 2008 Climate Change Strategy, January 31, 2008 *available at* http://environment.gov.ab.ca/info/library/7894.pdf



- Specific operating pressure ranges and pressure drops to avoid unnecessary phase change.
- Corrosion mitigation and monitoring issues due to water content and other impurities.
- Specific material consideration to minimize risk of fracture propagation, emergency response plans, and dispersion modeling considerations.
- Safety precautions during pipeline operation and repair.

As of year-end 2009, the ERCB had not published any exclusive CO_2 pipeline regulations. However, current ERCB regulations regarding high vapor pressure, sour gas, and design requirements of CSA Z662-07 are appropriate and adequate.

CSA Z662-07

The ERCB looks to Canadian Standards Association (CSA) Z662-07: Oil and Gas Pipelines Systems, for the design of CO_2 Pipelines. CO_2 has some unique properties that need specific design considerations, and while most of these design parameters could be found in CSA Z662-07, they are scattered in various clauses and could easily be missed by designers.

ERCB CO_2 Pipeline Regulatory Activities

The ERCB is continually enhancing the regulation and technical review of CO_2 pipeline transportation in Alberta. This review includes internal ERCB initiatives as well as the ERCB sitting as an observer on external multi-stakeholder initiatives including:

Det Norske Veritas (DNV) CO_2Pipetrans Initiative. The initiative is an international, multi-stakeholder initiative to develop a recommended practice for transmission of dense, high pressure CO_2 in pipelines.

Integrated CO_2 Network (I CO_2N). A cross-section of Canadian industry researching a proposed carbon capture and storage system (CCS) for Canada. ICO_2N will ultimately consist of a CO_2 capture and storage policy framework and the construction of the infrastructure for a CCS system. Such a system will have three key elements:

1. Facilities to capture CO_2 at its source.
2. A pipeline backbone and distribution system to transport CO_2.
3. injection facilities at enhanced oil recovery sites or long-term disposal locations.

Existing Alberta CO_2 Pipelines

As of yearend 2009, there were more than 50 small-scale acid gas (mixtures of CO_2 and H_2S) injection schemes operating in Alberta with a cumulative injection of a little more than 2 kilotonnes of CO_2 per day. Each of these schemes includes various diameters and lengths of pipelines (most are 4-inch to 6-inch lines and only a few kilometers in length). Since these pipelines carry various concentrations of H_2S, they are licensed as sour gas lines.

Major CCS Pipeline Projects in Alberta

The first major Alberta CCS pipeline application was submitted to the ERCB in spring 2009 by Enhance Energy Inc. The Enhance pipeline is a 240-kilometer pipeline that will transport initially 15 kilotonnes of CO_2 per day to be injected for enhanced recovery of oil. However, over the 50- to 100-year life of the project, up to 40 kilotonnes of CO_2 per day could eventually be sent to permanent disposal in deep underground geologic formations.

Pipeline	Route	Regulatory Jurisdiction	Length	O/D	Max Design Capacity	Max Pressure	Gas Purity
Enhance	**Central Alberta**	**Alberta**	**240 km**	**406 mm**	**7.6 $10^6 m^3/d$ (15,000 T/d)**	**17.93 mPa**	**95% CO2 5% other (<4ppm H_2S)**

One other CCS pipeline similar to the Enhance pipeline is being proposed in Alberta for CO_2 disposal. The Shell Quest project is yet to be finalized and a project application to the ERCB is expected in fall of 2010.

Appendix IV: Participants in IOGCC/SSEB Pipeline Transportation Task Force

Anderson, A. Scott *
Senior Policy Advisor
Environmental Defense, Austin

Bengal, Lawrence E.
Director
Oil and Gas Commission of Arkansas

Bliss, Kevin
Task Force Coordinator
IOGCC Washington Representative

Brown, Bruce *
Senior Geologist Project Manager
NETL/DOE

Carrillo, Victor
Chairman
Railroad Commission of Texas

Coddington, Kipp
Attorney
Mowrey Meezan Coddington Cloud LLP

Davidson, Daniel
Energy Development Specialist
West Virginia Division of Energy

Deweese, Wes
Legal and Regulatory Specialist
IOGCC

Dilay, Jim
Board Member
Energy Resources Conservation Board – Alberta

Drechsel, Colby
Associate Director
Wyoming Pipeline Authority

Eugene, Darrick
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Finley, Robert J.
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Illinois State Geological Survey

Freitas, Christopher *
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Garrett, Gary
Sr. Technical Analyst
Southern States Energy Board

Harju, John
Associate Director for Research
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Harms, Robert - *Chairman*
President
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Hattenbach, Ray
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Louis, Doug
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McGehee, Michael *
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McKenzie, Tommy
Oxy

Melzer, Stephen
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Melzer Consulting

Moody, Jack
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Moore, Michael
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Nemeth, Kenneth
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Smith, Mike
Executive Director
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Swartz, Thomas *
Senior Vice President
March USA, Inc.

Whitman, Lon
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**Observer*

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