Development of a Policy Framework For CO_2 Carbon Capture and Storage in the States

Prepared for
The Pew Center on Global Climate Change

L. Stephen Melzer

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Executive Summary

This paper presents the background and policy issues surrounding development of a commercial market for captured carbon dioxide (CO_2), and seeks to foster among policymakers a deeper understanding of 1) both the generation and carbon capture and storage (CCS) technologies involved, as well as their costs; 2) the technical and regulatory barriers to deployment of those technologies, and 3) the opportunities CCS may offer for increased employment and income. Enhanced oil recovery (EOR) offers one potential pathway to large-scale, widespread use of captured CO_2, and Ohio seems particularly well-positioned to take advantage of these emerging opportunities.

There are a number of state-specific actions that Ohio and other states might initiate to facilitate the deployment of next-generation coal technologies. States can compensate for, or even remove, many of the barriers facing first movers by recognizing CCS, and CO_2 stored through EOR, as clean energy options. States can provide various incentives for CO_2 capture, transportation, and storage, and, since public acceptance of storage of CO_2 in deep saline formations (DSFs) may be years away, adoption of CO_2 EOR as a recognized CCS activity could facilitate new projects today and set the stage for deeper, more permanent injection and storage in the future.

Federal policies to move the United States to a low-carbon energy future are almost certain to be enacted within the next two to four years. To be at the forefront of states in a favorable position under future federal legislation, Ohio, and other states, should encourage first movers and address policies to remove current impediments to the implementation of projects that could create a source of CO_2 for CCS field demonstrations and solutions.

Overview

The approval of additional power plants to meet expected growth in electricity demand is becoming increasingly difficult. Coal-fueled plants are meeting resistance due to concerns over NO_x, SO_x, ozone, particulates, and mercury emissions. Recent concerns over climate change and carbon dioxide (CO_2) emissions have further exacerbated permitting difficulties. The short-term solution has been to shift toward natural gas as a fuel source. Natural gas plants are less expensive to build and generally meet with less environmental opposition, since gas is a cleanerburning fuel with fewer harmful emissions. However, long-term natural gas supply and price volatility concerns lead most experts to conclude that replacing coal with natural gas is not a long-term solution to America's power needs.

Despite the concerns noted above, coal remains a mainstay of power generation in both the United States and other countries. Abandonment of coal as an energy source is not a feasible option in the short to medium term. This is particularly true in the United States, where coal accounts for over half of all power generation and reserves are plentiful. The challenge lies in discovering how to extract its energy in an environmentally responsible manner. As such, encouraging the next generation of coal power plant technologies, which are expected to have much smaller environmental footprints, might be considered a policy strategy worthy of public support. In general, however, both policy makers and the public lack understanding of the technologies involved, particularly the relatively new concept of capturing carbon dioxide emissions from coal power generation and storing them in underground geologic formations (carbon capture and storage, or CCS). Furthermore, installation and operation of a plant with CCS increases costs and "rate-base" approval of these extra costs by regulatory agencies is often difficult to obtain. Where utilities operate in unregulated markets, these higher costs make it hard for coal with CCS to compete for sales against other competitors.

Carbon dioxide is a by-product of combustion of fossil fuels and, because of the large volumes emitted, is the greenhouse gas that contributes most to human-induced climate change. However, CO_2 also has productive applications, such as its use in enhanced oil recovery (EOR). As oil has become increasingly scarce in recent years, many have come to recognize that a sizeable fraction of the CO_2 that could be captured from U.S. coal-fueled power plants has value as a commodity that can be used to recover oil and gas from mature oil reservoirs. Thus, rather than immediately treating it as a pollutant or waste, a commercial application for CO_2 is available and well worth consideration as a path forward.

This paper presents the background and policy issues surrounding development of a commercial market for captured CO_2.[1] ,Attaching a commercial value to CO_2 for its role in producing oil can greatly reduce the additional costs of CCS to the public. However, few states have meaningfully considered the issues involved, owing largely to a lack of background in the use and storage of CO_2. If coal is to continue serving as a widespread power source, its future seems inextricably linked to CCS, and policymakers at all levels need to begin to understand 1) both the generation and CCS technologies involved, as well as their costs; 2) the technical and regulatory barriers to deployment of those technologies,, and 3) the opportunities CCS may offer for increased employment and income.

Enhanced oil recovery (EOR) offers one potential pathway to large-scale, widespread use of captured CO_2.[2] This paper attempts to dissect this opportunity in a level of detail lacking in most

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[1] Such a market is distinct from the market for emissions allowances created by a cap-and-trade or similar mechanism. Some countries, including the U.S., are considering the development of a cap-and-trade market for CO_2 and other greenhouse gases; such an emissions trading program already exists in Europe. The difference between the two can be stated as a whether the market is commercially derived (from the value of oil) or from the establishment of a price on carbon through an emissions trading market or other market mechanism.

[2] Depending on the efficiency of the CO_2 EOR process, the net storage during CO_2 EOR operation can be 50-150% carbon neutral with respect to produced oil. The use of advanced technologies could further enable CO_2 EOR to

current dialogues on this topic in the United States and around the world. This paucity of rigorous discussion is understandable, as the growth of CO_2 EOR over the last two decades has gone relatively unnoticed by most of the international and domestic policy communities. This can be attributed in part to the proprietary nature of the technologies involved, as well as the fact that experience with CO_2 EOR has been confined primarily to the southwestern United States. Today, however, interest is beginning to grow due to broad recognition of the need to deploy CCS at power plants and to expand the sites for CO_2 EOR beyond now very mature oilfields.[3] A unique window of opportunity currently exists to develop a large market for CO_2 while also extending the life of, and increasing yields from, oil and gas fields. Ohio may be well-positioned to take advantage of these emerging opportunities, and this paper aims to contribute to a robust discussion among relevant stakeholders within the state.

Many involved in these policy discussions to date tend to minimize or dismiss altogether the potential role of and sequestration opportunities afforded by CO_2 EOR, focusing instead on waste injection of captured CO_2[4] streams. This report does not seek to discredit the need for deep saline formation injection, but rather seeks to outline the more immediate and commercially attractive alternative present in CO_2 EOR. Adequately addressing climate change will likely require that mid- to long-term deep saline injection be employed in most regions including the Midwest.

Policies advancing the commercial use (for EOR) of CO_2 from industrial processes are already being pioneered in several states (e.g., Texas, North Dakota, Kansas, Wyoming) where both coal and EOR play significant roles. A potential regulatory framework for CCS is also being developed at the state and regional level. The Interstate Oil and Gas Compact Commission has published a model regulatory framework which states have been using to help design the legislation and regulations necessary to support use and storage of CO_2 from power plants within their borders.[5] As of the time of this writing, Kansas and Wyoming have adopted their rules and North Dakota has released an early draft of its proposed regulations The draft rules released to date differ in that North Dakota plans to allow on-going CO_2 EOR projects to apply for Carbon

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store much more CO_2 than is released. A recent DOE study (ARI, 2/08) finds a 70% carbon benefit as compared to imported oil. See "Storing CO_2 with Enhanced Oil Recovery," DOE/NETL-402/1312/02-07-08 Available on-line at http://www.netl.doe.gov/energy-analyses/pubs/Storing%20CO2%20w%20EOR_FINAL.pdf

[3] Oil reservoirs pass through a phase called primary production wherein the natural pressure within the reservoir fluids provide the drive to the producing wells. This phase is most often followed by a repressuring stage called secondary production wherein an injectant, such as water, is introduced under pressure to "push" oil from injector wells to producing wells. Eventually, the produced injectant volumes overwhelm the oil volumes and the reservoir falls into a stage of advanced maturity. Today, most fields are abandoned prior to waterflooding or at this stage. A tertiary phase of production, often using CO_2, can alter the properties of the oil left within the reservoir and allow yet more production.

[4] The Environental Protection Agency is developing rules for sequestration, and the Carbon Sequestration Partnership is conducting research on deep saline formation injection.

[5] The Task Force commissioned by the IOGCC spent two years studying the technical aspects of CCS and published what they refer to as their Phase I report. The contributors were state regulators and other state and federal government agencies. The study was followed by another two-year effort to develop a regulatory framework for the states drawing on the expertise of state regulatory agencies and their experience with regulation of oil and gas activity within their borders. *See* Interstate Oil and Gas Commission Compact, "Carbon Capture and Storage: A Regulatory Framework for the States." (2005). Available online at http://www.iogcc.state.ok.us/PDFS/CarbonCaptureandStorageReportandSummary.pdf . Accessed 12/11/07.

Capture and Geologic Storage permits [status?], while Wyoming's provisions indirectly deny that option until after EOR operations cease.[6]

To a certain extent, the technological, regulatory, and funding challenges facing deployment of CCS at coal plants are distinct from the challenges facing CO_2 EOR; the former requires an increased level of confidence in both the feasibility and economics of storage before widespread commercial deployment can become a reality. Developing markets for CO_2 and regulations governing both its use for EOR and its long-term storage in a number of diverse states can enhance and accelerate deployment of next-generation coal technologies. Ohio has an opportunity to become one of the leaders in this field, particularly among non-western states. Ohio may possess significant EOR opportunities in addition to its vast coal resources, and current high petroleum prices and new advances in recovery techniques have created an environment favorable to EOR and in which the state is well-positioned to exploit these opportunities.

Background on CO_2 EOR

Oil is generally discovered trapped in subsurface porous rock formations.[7] Oil is lighter than water so it tends to migrate toward the surface until trapped by what are termed "seals." Fluids within these geologic traps can be recovered because the traps are at depth and under pressure; the fluids move through the rock's pore spaces to lower-pressure areas created by wellbores that penetrate into the porous formations. Eventually, however, pressures in the reservoirs decline to a point where the oil no longer flows readily and fluid extraction at the wellbore is no longer commercially viable. Considerable oil is left behind so many operators inject a substance to re-pressurize the reservoir. The first injectant of choice is commonly water (because it produces the oil at lower costs than other options) and the operation called a waterflood. This procedure requires converting some of the producer wells to injection wells, and setting up what the industry terms well "patterns," wherein a central injector well is surrounded by producing wells. Some reservoirs yield more oil than others through waterflooding, but a typical reservoir still retains 50-60 percent of the original oil in place prior to production.[8]

Following the waterflood, many reservoirs are evaluated for a third phase of production. One of these methods involves the use of CO_2 as the injectant. CO_2 can be very effective under certain circumstances due to characteristic properties that allow it to mix with and swell the remaining oil,. Other methods involve the use of specialized polymers, surfactants, or heat.[9] The choice of the injectant is usually made based on the depth of the reservoir, the properties of the oil, and the availability and cost of the injectant. High petroleum prices have created unprecedented demand

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[6] Although EOR projects store CO_2 through normal operations, they may not qualify as storage under some regulatory regimes since they lead to oil production, which has an emissions burden due to the products (i.e. gasoline or diesel) produced from the oil. As written today, the Wyoming rules seem to preclude qualifying EOR as storage regardless of the net balance of CO_2 storage vs. emitted volumes.

[7] These subsurface formations lie within sedimentary basin settings and are most commonly sandstones (SiO_2), limestones ($CaCO_3$) or dolomites ($CaMgCO_3$).

[8] The reason for this is that the water simply "sweeps" portions of the formation and the water does not react with the oil to swell it or thin it as CO_2 or other solvents would do.

[9] Polymers or surfactants are chemical additives intended to ease the attractive forces of the oil to the rock. Heat is used to thin the oil allowing it to flow more freely within the rock system.

for CO_2 in order to expand existing CO_2 EOR projects or implement new ones. Accessing sufficient volumes of CO_2 presents a challenge wherever EOR is practiced, even where naturally occurring CO_2 has historically been plentiful. New demand for CO_2 has developed to such a point that further EOR growth has stalled owing to a lack of supply.

The first two large-scale CO_2 EOR projects in West Texas were implemented in 1972 and used CO_2 that had been separated from natural gas.[10] Later projects utilized underground sources of pure CO_2 that had been located, developed, and pipelined to West Texas sites. These first projects were precipitated by the promise of increased oil production and strategic incentives provided by the relevant regulatory authority in Texas, the Railroad Commission. Following a period of observation, the oil industry in other areas of West Texas, Wyoming, and Mississippi began to emulate these first-movers. By 1990, there were 40 CO_2 EOR projects in the U.S. and another 20 around the world.

In spite of two oil price crashes in the last twenty years, the CO_2 EOR industry has continued to grow. Today, the U.S. CO_2 EOR industry uses a total of 2.16 billion cubic feet of new CO_2 every day (45 million tons per year) and produces almost 90 million barrels of oil per annum.[11] The U.S. industry logged in its billionth barrel of CO_2 EOR production in 2002.

Recently, the Hess Corporation announced a huge program to recover oil from the "lower interval" – a zone beneath the areas developed during the initial and waterflood phases of production – in the giant Seminole field in west Texas. This lower interval lies beneath the zone referred to as the main pay interval. During the first two phases of production, only a skim of oil (with water comprising the rest of the produced fluid) could have been extracted from this lower zone. During these phases, wells were drilled only to the top of this lower level, i.e., to the top of what is termed the residual oil zone (ROZ). Ongoing studies indicate the ROZs are formed through geologic changes during the history of an oil basin after initial oil accumulation. As Hess has shown with two recent demonstration projects, the injection of CO_2 into the ROZ mobilizes 20-30% of the oil contained within it. The engineers at Hess estimate that the Seminole field's ROZ interval contains up to a billion barrels of oil. This would imply approximately 100-300 million barrels of incremental production from an interval that has heretofore been excluded from reserve estimates. Modeling work shows the ROZ project may extend the life of the field another 25 years, and studies of the Permian Basin underway at the University of Texas show similar zones exist beneath several other fields in the geologic trend that encompasses the Seminole field.

To date, screening analyses for CO_2 EOR potential have failed to include ROZs. Recent informal reviews are confirming the presence of significant ROZ intervals in Mississippi, Wyoming, Montana, and North and South Dakota, and it is likely that Ohio also has the potential to recover oil from ROZs. However, much work remains to develop estimates of potential recoverable oil from such intervals.

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[10] One source of naturally occurring CO_2 is the CO_2 co-produced with natural gas (methane). This CO_2 "contaminates" the gas and is separated in order to render the methane pipeline quality.
[11] CO_2 EOR production has grown steadily over the last two decades and now accounts for over 15% of the Permian Basin volumes of oil produced and approximately 4% of the U.S. total.

Reevaluation of the Role of CO_2 EOR

New circumstances are leading to the need to reevaluate the potential of CO_2 EOR. First, higher cost barrels from CO_2 EOR have traditionally competed against ample sources of primary and waterflood barrels. Today, however, concerns over 'peak oil' and rising oil prices have created accelerated interest in advanced recovery, especially in the use of CO_2 for EOR. Secondly, screening methods used to evaluate CO_2 EOR potential do not incorporate any value for stored CO_2. While stored CO_2 does not yet have a commercial market value in the United States, emerging legislation at the regional and federal levels is likely to generate one.[12] Third, CO_2 EOR has not yet been evaluated in many regions of the country. Where adequate supplies of CO_2 have not been present or envisioned, there has been no need to perform an expensive CO_2 EOR pilot study. Once a value for CO_2 storage emerges, particularly in conjunction with greenhouse gas legislation that provides incentives for utilities to reduce emissions, a CO_2 CCS/EOR industry will emerge. CO_2 EOR should become a mainstream activity in Ohio if the state acts preemptively by establishing the needed regulations, undertaking appropriate studies, and providing incentives for use and storage of CO_2 and projects that capture CO_2 from industrial and utility sources.

State Policy Initiatives for Carbon Capture and Storage (CCS)

Regulations

Oil-producing states can pursue several initiatives to lay the legal and regulatory foundation for CO_2 storage. The most expeditious path would be to adapt existing rules governing natural gas storage and the use of CO_2 for oil recovery. A model for this is now available from the Interstate Oil and Gas Compact Commission's Task Force on CCS.[13] Such an approach depends on the existence of a value for the emissions avoided through stored CO_2, as would be created under greenhouse gas 'cap-and-trade' or other programs. Adapting existing regulations, such as those for natural gas storage and oil recovery, has the advantage of treating CO_2 storage as a commercial activity rather than waste disposal. While future injection involving deep saline formations (DSFs) will likely require new regulations, commercial activities associated with CO_2 EOR can sequester large volumes of CO_2. The demonstration of long-term monitoring and verification of storage in concert with CO_2 EOR will also help develop the confidence needed to spur the industry to explore options for storage in deep saline formations (DSFs).

Adoption of a 'DSF first' strategy that allows no transitional role for CO_2 EOR has two significant flaws. First, CO_2 capture projects are very expensive. Revenues generated by the sale of exhaust-stream CO_2 (to the EOR industry) can significantly reduce the net costs, thereby improving the financial feasibility of carbon capture projects. In addition, categorizing CO_2 injection into DSFs as waste injection offers a promising though as-yet unproven regulatory

[12] The cost of separation and transportation of CO_2 has, to date, been covered only by the oil revenues from the EOR projects. When value is added for CO_2 storage, the costs of CO_2 capture and transportation may be assumed by others. The preferred approach has been to incentivize the capture and transportation of CO_2,making the cost of CO_2 less to the producer and opening up more reservoirs for application of CO_2 EOR and CCS.

[13] *See* Interstate Oil and Gas Commission Compact, "Carbon Capture and Storage: A Regulatory Framework for the States." (2005). Available online at http://www.iogcc.state.ok.us/PDFS/CarbonCaptureandStorageReportandSummary.pdf . Accessed 12/11/07

option, and would further increase the risks facing first movers seeking to implement these next-generation coal projects. Treating CO_2 as a commodity and recognizing the incidental storage that occurs when CO_2 is used for EOR removes some of the risks associated with unproven technologies. Drawing on the thirty-five years of successful experience in CO_2 EOR and storage in proven geological traps creates a friendlier financial and regulatory environment than that offered by less familiar circumstances and regulatory frameworks.

State-Based and Early Actions

States with experience in oil and gas recovery have recognized that moving EOR/CCS operations forward requires aggregating mineral rights of many landowners, a process called unitization. Oil and gas producing states all have statutes addressing unitization. Nearly all of these states have recognized the reality that the parties aggregating the rights ("aggregators") are faced with the extremely difficult task of dealing with hundreds or even thousands of owners. Requiring unanimous consent is virtually impossible so states have adopted forced pooling (also called statutory unitization) provisions to assist aggregators. Use of geologic reservoirs for storage may complicate this matter significantly. Depending on individual state laws, storage rights may be controlled by the surface estate instead of the mineral estate. Existing unitization provisions may be applicable to only the mineral estate, requiring new state action to allow more efficient aggregation of the surface (storage rights) ownership. A model based upon eminent domain may prevail for storage rights. If opportunities to store CO_2 in geologic formations within Ohio look promising, the state will need to review its laws to see whether amendments may be required. Depending on potential volumes of CO_2 to be used or stored, aggregation may be needed on a much larger scale than currently practiced.

Long-term liability for CO_2 is another issue that may need to be addressed through state or federal action. The IOGCC model rules suggest a state-based system that assumes liability after a post-closure period during which the commercial injecting entity would be held liable. However, it is possible that liability can be adequately addressed by the private insurance sector. Having a system in place that allows for the designation of some entity that will take long-term responsibility for stored carbon following a successful injection project will be necessary. Under programs in place in some states for "orphaned wells,"[14] the qualification and permitting of a site is a fundamental requirement for assumption of such liability. Development of qualification standards and designation and training of the permitting agency personnel is a key early step to take.

In order to justify early state initiatives, Ohio should examine the potential economic impacts of inaction versus new policy. Obvious upsides are revenues and employment from future coal production, electricity generation, avoidance of power shortages, incremental oil and gas production, and benefits that accrue to early actors. Downsides include state sharing of the risks of new clean coal technologies, including any costs of incentives/tax breaks. Careful permitting criteria can help limit liability issues associated with storage, but qualifying a competent permitting state agency will be a cost, albeit small compared to revenue upsides.

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[14] Some states have abandoned ("orphaned") wells programs, wherein no commercial entity can be identified as liable, and wells are taken by the state and plugged using an account funded by fees paid in by the industry. Another approach to addressing liability concerns might be an insurance pool funded by an interstate or federal program.

Federal and State Progress

Federal involvement in carbon capture and storage has generally concentrated on U.S. DOE-sponsored research of unproven technologies. Many technologies are now moving to a field demonstration phase. The Midwestern Regional Sequestration Partnership project in Michigan presents one such example.[15]

On the regulatory front, it is expected that the U.S. EPA will establish a new well Class VI (Underground Injection Control) for CO_2 injected for long-term storage. Alternatively, states are utilizing the existing well Class II, focusing on commodity treatment of CO_2 for reasons elucidated in the previous section. This latter approach accelerates early action, as evidenced by examples of state action in 2007 including state tailoring of the IOGCC policy framework (Wyoming, Kansas, and North Dakota); the provision of incentives for CCS and EOR (Texas); and state papers setting the stage for future action (California and New Mexico).

Some salient policy issues that emerged during the IOGCC Task Force's discussions revolved around concurrent or sequential use of CO_2 EOR and long-term CO_2 storage. Keeping in mind the 100 CO_2 EOR projects already operating within the U.S.[16], the discussions centered on whether or not an entity would need to acquire storage rights in order to qualify an injection activity as a storage project while still conducting EOR operations. CO_2 EOR stores large volumes of CO_2 as a necessary result of injection, and within the EOR industry this is commonly referred to as CO_2 'retention.' The possibility of a revenue stream for CO_2 storage raises the question of whether the storage activity would require acquisition of storage rights, or whether it should be disallowed or unrecognized until after EOR activity ceases. Wyoming has apparently adopted the latter approach[17] while North Dakota and Texas appear to favor adoption of a strategy of concurrent storage and EOR activity. This is both a legal question as well as a policy issue in each state.

Incentives

Not all states possess both coal and oil resources, and those that do serve as attractive locations for CCS and CO_2 EOR projects. Ohio already boasts a large coal-delivery infrastructure, and it may also possess significant EOR opportunities. Where coal resources are not proximate to suitable reservoirs, either coal will have to be transported to electric generation plants near CCS opportunities, or CO_2 will need to be transported from desired coal project locations to regions with large CO_2 EOR/CCS sinks. The likely scenario is the construction of a CO_2 pipeline network, suggesting that incentives for pipeline development might represent one policy initiative worthy of evaluation in some states. Some models for this already exist. The Wyoming and North Dakota Pipeline Authorities have recently extended their respective charters

[15] See http://216.109.210.162/MichiganBasin.aspx

[16] Oil & Gas Journal Annual Production Report, Apr 21, 2008

[17] Disallowing concurrent CCS and EOR may not be the actual intent of the Wyoming rules but will likely prove a significant deterrent to a capturer if oil from EOR is the only revenue stream available to pay the entire capture, transportation and storage bill. Put differently, the CO_2 source is disallowed any value for the EOR option for storing CO_2. The issue of sharing of CCS revenue with the storage rights owner is entirely consistent with this issue and should trump the "policy dictate" that storage must follow EOR.

to include CO_2 pipelines. State-backed bonding authority is an important option for such pipeline authorities. Another policy initiative states might consider would be to require partial or fully open access to pipelines.[18]

Potential Next Steps for Ohio

State-specific actions that Ohio might initiate to facilitate the deployment of next-generation coal technologies, particularly through facilitating the use and storage of emission-stream CO_2, include:

1) Develop a working group within Ohio to draft the administrative and legislative documents to develop CCS regulations based on the IOGCC model.
2) Work to develop severance and/or property tax incentives for EOR as a bona fide CCS activity (e.g. Texas House Bill 3732).
3) Examine the possibility of providing state assisted bonding (e.g. Wyoming Pipeline Authority) in exchange for open access CO_2 pipelines.
4) Examine the possibility of private/public ownership sharing of key pipelines.
5) Develop a state tax incentive/grant program for first-movers implementing EOR pilot projects. Waiting on large new sources of CO_2 will likely create unacceptable delays, so smaller-scale sources of CO_2 will be needed to accelerate EOR demonstration projects. CO_2 capture and compression from smaller scale ethanol or landfill projects may prove especially useful as targets for capture incentives.
6) Commission an interagency task force within Ohio to prioritize reservoirs for CO_2 EOR and storage for purposes of targeted incentives and pipeline planning. The task force should be charged with developing criteria for secure storage, including site permitting.
7) Continue to work with neighboring states and consider the advisability of joining or forming an interstate CCS Commission.

Summary

The recent work by the IOGCC Task Force on CCS has led to recognition that, while many issues can be addressed by a federally-based model regulatory framework, state-by-state differences in law and regulatory practices require individual states to tailor policies and regulations to their own circumstances. This conclusion, combined with an increasing perception that new conventional fossil fuel plants are no longer desirable, has stimulated state-level policy development for carbon capture and storage. Such policy development has advanced first in states with both coal and oil interests. In those states, policies consistent with encouraging markets for exhaust-stream CO_2 have overridden a waste status classification for injected CO_2. The recently published IOGCC model rules for CCS have described and outlined a feasible regulatory approach while identifying issues that individual states must address. Wyoming and Kansas have passed bills addressing CCS. North Dakota has drafted their rules.

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[18] As mentioned herein, the next generation projects for coal utilization are extremely capital intensive. A large number of states have already recognized this and have positioned themselves to share the financial risk with project developers. The risk sharing comes in various forms: investment tax credits, clean energy preferences, ad valorem (property) tax credits, eminent domain powers, and many others. Since this paper is to address only CCS and state initiatives thereto, no detail is provided on this important facet of state and Federal initiatives.

Federal activity, for the most part, has concentrated on identifying and meeting research needs. Given the growing resistance to permitting of conventional pulverized coal plants within the states, the need to overcome the hurdles to deployment of CCS has become increasingly urgent due to expected growth in demand for electricity and energy. CO_2 market development through CO_2 EOR is the most likely path to early CCS success. Provisions for monitoring and verification of the long-term fate of injected CO_2 are needed and will assist in development of policies appropriate for use of deep saline formations.

State policies are needed to incentivize development of markets for CO_2 and reduce barriers to commercial handling of CO_2. Encouraging growth of CO_2 EOR is a key strategy, although incentives for oil interests are unlikely to be popular given current elevated oil prices and industry profits. As a result, most policies may need to focus on incentives for CO_2 capture, transportation, and storage.

Field-scale demonstrations are now needed to support next-generation coal projects. States can compensate for, or even remove, many of the barriers facing the first movers. Ohio, for example, could recognize CCS, and CO_2 stored through EOR, as clean energy options. It could also provide incentives for CO_2 capture, transportation, and storage. And, since public acceptance of storage of CO_2 in deep saline formations may be years away, adoption of CO_2 EOR as a recognized CCS activity via IOGCC-type rules will facilitate new projects today and set the stage for DSF injection and storage in the future.

Federal policies to move the United States to a low-carbon energy future are almost certain to be enacted within the next two to four years. To be at the forefront of states in a favorable position under future federal legislation, Ohio should encourage first movers and address policies to remove current impediments to the implementation of projects that could create a source of CO_2 for CCS field demonstrations and solutions.