Energy Policy 39 (2011) 2974–2981

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

Regulating hydraulic fracturing in shale gas plays: The case of Texas

Dianne Rahm *

Department of Political Science, Texas State University, 601 University Drive, San Marcos, TX 78666, USA

ARTICLE INFO

Article history:
Received 8 January 2011
Accepted 2 March 2011
Available online 22 March 2011

Keywords:
Hydraulic fracturing
Shale gas
Regulation

ABSTRACT

The ability to economically produce natural gas from unconventional shale gas reservoirs has been made possible recently through the application of horizontal drilling and hydraulic fracturing. This new technique has radically changed the energy future of the United States. The U.S. has shifted from a waning producer of natural gas to a growing producer. The Energy Information Administration forecasts that by 2035 nearly half of U.S. natural gas will come from shale gas. Texas is a major player in these developments. Of the eight states and coastal areas that account for the bulk of U.S. gas, Texas has the largest proved reserves. Texas' Barnett Shale already produces six percent of the continental U.S.' gas and exploration of Texas' other shale gas regions is just beginning. Shale gas production is highly controversial, in part because of environmental concerns. Some U.S. states have put hydraulic fracturing moratoriums in place because of fear of drinking water contamination. The federal government has gotten involved and some states, like Texas, have accused it of overreaching. The contention over shale gas drilling in the U.S. may be a bellwether for other parts of the world that are now moving forward with their own shale gas production.

1. Introduction

In its 2011 *Annual Energy Outlook*, the U.S. Energy Information Administration (EIA) estimates that the recoverable gas resources from U.S. shale gas plays have more than doubled in the past year, in large part due to the successful use of advanced drilling techniques. Indeed, the report forecasts that by 2035, almost half (45%) of the natural gas produced in the U.S. will come from shale gas, up from 14% in 2009 (Energy Information Administration, 2011). Over the last few years new drilling techniques are remapping the energy future of the U.S. These new drilling techniques have opened vast quantities of natural gas. Estimates suggest these new reserves will amount to 616 trillion cubic feet (17,248 billion cubic meters)—about the same as Kuwait's proven reserves (Cox, 2010).

Almost all of the natural gas used in the United States is domestically produced. Natural gas consumption accounts for about one quarter of total U.S. energy use. While conventional sources of natural gas are declining, unconventional sources like shale gas are rapidly increasing. Instead of facing dwindling reserves of conventional natural gas, the application of new drilling techniques in shale gas reservoirs has turned the U.S. from a nation of waning gas production to one of increasing production. Texas is a major player in these developments and is forecast to be the key state contributing to U.S. natural gas supplies in the future. Of the eight U.S. states or coastal areas that contain the bulk of U.S. proved gas reserves, Texas is the largest accounting for nearly one third of the current U.S. total (Energy Information Administration, 2010a). Texas' Barnett Shale already provides 6% of all natural gas produced in the continental U.S. (Vaughan and Pursell, 2010). Texas' proved reserves are just beginning to be tapped.

Shale gas extraction using horizontal drilling and hydraulic fracturing (fracking, fracing, or HF), a gas drilling technique recently introduced, has revolutionized gas production in the United States. Vertical HF is not new. A relatively recent innovation in HF, however, incorporates horizontal drilling and multi-stage fractures to get at what otherwise would be uneconomical sources of gas that lie in unconventional reservoirs.

The U.S. may be a bellwether for other parts of the world. Germany, Hungary, Romania, and Poland are participating in discussions regarding the application of hydraulic fracturing to get at their shale gas reserves. Exxon Mobil, ConocoPhillips, Marathon Oil, and Chevron have already entered into negotiations with Poland. The U.S. government is encouraging this effort by establishing partnerships with other countries. In November of 2010 the U.S. entered into an agreement with China called the U.S.–China Shale Gas Resource Initiative, and a similar partnership was been created with Poland (Galbraith, 2010a).

The use of this technique and the gas drilling boom that has resulted from its use has, however, led to some controversy and environmental worries. Concern centers not only around air

* Tel.: +1 512 245 1565; fax: +1 512 2457815.
E-mail address: dianne.rahm@txstate.edu

0301-4215/$ - see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.enpol.2011.03.009

emissions and potential water contamination associated with fracking chemicals used, but also around the substantial amount of water necessary to make the wells productive. Additionally, apprehension extends to chemical waste management practices, the large land footprint of drilling operations, and the necessary infrastructure required to support these large drilling operations. An anti-fracking film by Josh Fox called *Gasland* that received a 2010 special jury prize for documentary at the Sundance Film Festival has aired on Home Box Office (HBO) television and has provided fodder for much of the debate. Depicted in the film are some of the environmental impacts including dramatic instances of explosively contaminated tap water being lit a fire. Concern over HF drilling in shale gas plays has led to grassroots movements, political opposition, and calls for regulatory action at the local, state, and national levels.

The U.S. contains a number of natural gas shale basins and plays. The term "play" is used by the oil and gas industry to denote a specific geographical area that is targeted for exploration because of the belief that there is an economic quantity of natural gas to be found there. The Marcellus play of the Appalachian Basin extends from upstate New York, through Pennsylvania, and into West Virginia. Other shale gas plays are located in the states of Alabama, Illinois, Michigan, North Dakota, Colorado, Oklahoma, Arkansas, Louisiana, and Texas.

The state of Texas contains five major shale gas plays and has assumed a critical role in demonstrating the new HF drilling technology. The largest of the Texas' plays, the Barnett play, is located in north central Texas. Nationally, this was the first play to be exploited. Between 2005 and 2007, almost all completed horizontal HF wells were successful in the Barnett Shale play. Texas is also site of the Haynesville Shale play in the eastern part of the state along the Texas–Louisiana border. This site is expected to be the largest national producer over the coming decade. The Eagle Ford Shale play, located just south of San Antonio, is the newest site to begin production and is also expected to be a significant producer. Texas also is home to the Barnett–Woodford Shale in the west and the Bend Shale play in the Panhandle.

This paper explores issues associated with the production of shale gas in the U.S. in general and Texas in particular. It begins with a description of the new horizontal hydraulic fracturing drilling techniques. An overview of where HF is being used in the U.S. and some of the associated problems reported is provided. A brief overview of U.S. national policy regarding HF is given. A brief overview of what the other U.S. states are doing in terms of new regulation is provided. A discussion of why the state of Texas is critically important to this issue follows. The paper concludes with an analysis of the regulatory structure and administration of Texas, which enables an aggressive pro-drilling policy.

2. The evolution of techniques for economic access to shale gas

Conventional reservoirs of natural resources are those that typically hold small amounts of high-quality resources and are easy to develop. Unconventional reservoirs, including shale gas reserves, contain large volumes of resources but they are more difficult to develop (Kohl, 2007). In shale gas formations the reservoir rock does not permit the natural gas to flow into a conventional vertical well at an economical rate. The goal of horizontal drilling and hydraulic fracturing is to enable such a flow. The technology itself has existed for about 60 years but until relatively recently it has been applied mainly to vertical wells in a far more limited way.

A conventional natural gas well typically goes down between 5900 and 6600 ft (from 1798 to 2011 m) and is vertical only. To get at shale gas, a vertical well is first drilled and then, using directional drilling equipment, the well is drilled horizontally. The vertical drilling typically goes down between 5000 and 12,000 ft (from 1524 to 3657.6 m). At that point the horizontal drilling begins. The horizontal drilling extends the well several thousand more feet (approximately 600 m). During the drilling of the vertical portion of the well, a series of steel casings are cemented into place to protect fresh water aquifers from potential contamination. These fresh water aquifers typically lie far above the shale gas formations. Hydraulic fractures are created by pumping fracturing fluids down the well. The fracking fluids are forced into the well in great volume and at high pressure that exceed the breaking point of the rock. The fracking fluid contains sand or ceramic "propping" agents that hold the fractures open after pumping of the fracturing fluid ceases. The fractures are made in the horizontal part of the well. Once the rock is fractured, the gas can flow through the horizontal part of the well, up the vertical part, for collection. Shale gas wells are typically fractured in stages and multiple times (ten or more). Each stage fracture is designed to fracture rock a few hundred of feet (perhaps 60 m) from the well (Vaughan and Pursell, 2010).

The volume of fracking fluids can be large. The Environmental Protection Agency (EPA) estimates that the water needed to drill a horizontal hydraulically fractured shale gas well is typically between 2 and 5 million gallons per well (from 7.6 to 19 million liters) depending on the depth, horizontal distance, and number of times a well is fractured (Environmental Protection Agency, 2010b). Some amount of the fracking fluid is returned to the surface after the fracturing procedure. The amount varies based upon the well that is being fractured. This wastewater, called flowback, must be handled appropriately as it contains contaminants that consist either of chemicals deliberately added to the fluid prior to drilling to assist with some aspect of the drilling operation or contaminants that have been absorbed from the rock itself. Recovered fracking fluids can range from 15% to 80% of the volume initially injected, depending on the site. This wastewater can be disposed of in several ways. It may be injected back underground if such injection is permitted, it may be discharged to a surface water body after treatment to remove contaminants, or it can be applied to land surfaces (Office of Research and Development, 2010).

3. Environmental concerns and emerging issues

A controversy has arisen as the use of hydraulic fracturing has increased and expanded with its application to horizontal drilling. The major issues that are discussed include groundwater (aquifer) contamination by fracking chemicals, accidental chemical spills, waste disposal, air quality, the land footprint of drilling activities, pipeline placement and safety, and the amount of water used.

Fracking fluids not only contain propping agents to hold the fractures open but often other substances. While the fracking fluid is typically more than 99% water, other components are used. These substances are generally considered proprietary so drilling companies are not required to disclose their content (although a few states do now require or are moving to require such disclosure). It is thought that the substances added to the fracking fluids may include potassium chloride, guar gum, ethylene glycol, sodium carbonate, potassium carbonate, sodium chloride, borate salts, citric acid, glutaraldehyde, acid, petroleum distillate, and isopropanol. These substances are added for a variety of reasons. For instance, acid helps dissolve minerals and assists with the fracturing process by creating fissures in the rock. Borate salts maintain fluid viscosity. Other substances are added to prevent pipe corrosion, minimize friction between the pipe and

fluid, and to prevent scale deposits on the pipe. Proponents of hydraulic fracturing practices largely argue that for the most part these substances are non-toxic (Vaughan and Pursell, 2010).

Critics allege that some of the substances used are hazardous materials and carcinogens, toxic enough to contaminate groundwater resources and create toxic air emissions. These include diesel fuel, kerosene, benzene, toluene, xylene, and formaldehyde. There are a number of cases in the U.S. where local communities claim that their air or drinking water has been polluted by hydraulic fracturing fluids, methane, or petroleum by-products such as benzene. Incidents have been reported in several states.

For instance, in June of 2010, Houston-based EOG Resources had a blowout at a Clearfield County, Pennsylvania well that discharged 35,000 gallons of HF fluid into a state forest. As a result, the state ordered the company to suspend all gas drilling activities until an investigation of the causes of the explosion could be undertaken. In that same month, in Dish, Texas blood and urine samples taken from residents living near Barnett Shale gas wells revealed that 65% of households tested had toluene in their systems and another 53% had detectable levels of xylene. These chemicals have all been identified in Dish air samples on multiple occasions. EPA and the Texas Commission on Environmental Quality (TCEQ) are looking into air emissions from Barnett Shale gas operations (Fowler, 2010).

In Pavillion, Wyoming residents were informed by EPA in 2009 that many drinking water wells were contaminated by toxics often used in hydraulic fracturing fluids. For nearly a decade Pavillion residents had complained about miscarriages, rare cancers, and central nervous system disorders including seizures. EPA confirmed the presence of 2-butoxyethanol, a known constituent in HF fluid, in three wells (Earthworks, 2009).

Surface handling of materials have been a problem in a number of cases. In Caddo Parish, Louisiana in 2009 seventeen cattle were found dead near a drilling site. Louisiana regulators concluded that HF fluid leaked from the well pad and ran into an adjacent pasture. The private companies involved were fined $22,000. At Dunkard Creek, Pennsylvania in 2009 a 43 mile fish kill resulted from an overgrowth of algae that live in salty water. Pennsylvania officials say they have not ruled out that the cause was brine wastewater associated with HF drilling discharge to surface water bodies. In 2008 in southwest Pennsylvania, parts of the lower Monogahala River were found by the Army Corps of Engineers to have too high a salt content. The Army Corps cited drilling in the Marcellus Shale as a possible cause. Pennsylvania regulators drew on the Corps findings to call for more stringent regulation. In Hopewell Township, Pennsylvania in 2009, a spill of fracking fluid into a water body resulted in a fish and amphibian kill. Pennsylvania regulators fined the responsible company $141,175. In 2009, Dimock, Pennsylvania experienced three spills of fracking fluid totaling more than 8000 gallons (30,284 l). The spills entered a nearby creek and the operators were fined $56,650 by Pennsylvania regulators (Vaughan and Pursell, 2010).

Health threats and fear of environmental contamination are critical issues in the debate over the new hydraulic fracturing techniques but land and water use issues also abound. The surface land use for conventional gas and oil wells was typically much smaller than the land space needed for a hydraulic fracturing operation. Older drilling techniques used less equipment, less water, and produced less waste. Use of the large quantities of water necessary, especially in arid locations, may be an issue for local water providers. For instance, to break the Haynesville Shale of Louisiana, companies had to drill down more than 2 miles (3.2 km). The scale of these new HF drilling operations are huge in terms of the amount of rock that needs to be drilled, the trucks and other needed equipment, the miles of pipe necessary, the volume of casing cement needed, the amounts of water and energy used, and the resultant amount of wastewater produced. The intensity of shale gas production is magnified by the fact that it is a 24 h, 7 day a week operation. While many shale gas plays are relatively rural, many are not. This poses a new wrinkle in gas production. Many of the new shale gas discoveries are in highly populated regions, making the protection of the water supply and the drilling intensity a high-profile and critical issue (Vaughan and Pursell, 2010).

The disposal of wastewater from the hydraulic fracturing process can be complicated and involve either deep-injection, surface water body disposal after decontamination, or disposal directly to the land. In any event, this wastewater must be dealt with, producing another large surface water body, land, or underground hydrological impact (Office of Research and Development, 2010). Wastewater handling was the key problem prompting environmental opposition in Caddo Parish, Louisiana; Clearfield County, Pennsylvania; Dunkard Creek, Pennsylvania; Monongahala River, Pennsylvania; Hopewell Township, Pennsylvania; and Dimock, Pennsylvania (Vaughan and Pursell, 2010).

Finally, another consideration is the pipeline infrastructure used to gather the gas and then to move the gas from its collection point, through refining, to end-use locations. The intricate transport network for natural gas consists of gathering systems, processing plants, pipelines, and storage fields. Gathering systems are made up of small-diameter, low-pressure pipelines that move natural gas from the well to either a processing plant or to an interconnection with a larger main pipeline. Processing plants are necessary if the gas contains impurities that need to be collected before the gas can enter an interconnection to a main pipeline. The main pipeline system consists of wide-diameter, high-pressure lines for intra- and inter-state transport. The U.S. has more than 300,000 miles (about 483,000 km) of main pipeline. Compressor (pumping) stations are required along the routes to keep the gas flowing. In the U.S. these lines and stations are operated by over 200 private companies. Since gas use is seasonal, with greater use for home heating in the winter, underground storage facilities are used to store excess gas produced until it is needed. The U.S. has about 400 of these storage facilities (which consist largely of depleted oil, gas, or aquifer reservoirs or salt caverns) that are operated by over 100 private companies. Finally, there are more than 1300 local distribution companies that take the gas from the main pipelines and move it into hundreds of thousands of miles of small-diameter, low-pressure service lines that deliver to local customers (Energy Information Administration, 2010b).

Erection of new pipelines to accommodate the newly produced natural gas from shale gas plays can be an issue especially in heavily populated areas. For instance, in the Barnett Shale of Texas many high-pressure gas lines are being built near homes. More than 14,000 wells have been drilled in the Barnett Shale (as of 2010) and about 1200 of them are in the city of Fort Worth. By the time the Barnett Shale gas play is fully established there will be about 6000 wells in the city of Fort Worth. Fort Worth is rapidly becoming the first urban gas field in the country. These pipelines provoke fear and controversy. In 2009, an older pipeline blew up in a suburb of Amarillo, Texas with the force of a magnitude 4 earthquake. It sent a column of flames hundreds of feet (more than 60 m) into the air and burned at temperatures in excess of 7000 degrees Fahrenheit (3871 °C). Pipelines are now being built within feet of residential housing, causing considerable concern (Wilder, 2010).

4. U.S. regulatory policy actions—an overview

As these issues suggest the use of horizontal drilling and hydraulic fracturing methods are controversial. What has been

the governmental response to the introduction of this new drilling technique?

In 1997, following a coalbed methane (CBM) fracturing operation in Alabama that contaminated a residential drinking water well, the U.S. Court of Appeals for the 11th Circuit ordered EPA to regulate HF fluids under its authority associated with the Safe Drinking Water Act (Sumi, 2005). In response to the court order, EPA undertook a study to assess potential damage to drinking water resources. The study, completed in 2004, gave the technique a clean bill of health. It should be noted that EPA examined only applications of HF to CBM drilling. The report indicated, however, that no further study of the technique was warranted (Environmental Protection Agency, 2004). Subsequently, the report has been called into question based upon what critics suggest was unfair influence of the Bush administration in the study results.

During the George W. Bush administration a great deal of controversy arose over then Vise President Dick Cheney's Energy Task Force, which recommended energy policy goals for the Bush administration. The oil and gas industry was very influential on the task force. Despite the fact that the courts ruled in favor of White House secrecy demands, documents show that executives from both ConocoPhillips and Exxon Mobil participated on the task force (Rahm, 2010). One recommendation of the Energy Task Force was that Congress exempt hydraulic fracturing from regulation under the Safe Drinking Water Act. The National Energy Policy Act of 2005 did just that.

By 2009, concern from many quarters resulted in the introduction of proposed legislation in both the House (H.R. 2766) and Senate (S. 1215). Two identical bills were introduced. The Fractured Responsibility and Awareness of Chemicals (FRAC) Act sought to amend the Safe Drinking Water Act to allow EPA power to regulate hydraulic fracturing and to require disclosure of fracking chemicals (Library of Congress, 2009). Opponents argued that enough detail of chemicals is already disclosed in the Material Safety Data Sheets (MSDS) required by the Occupational Safety and Health Administration (OSHA). The matter was rendered mute, however, when the congressional session expired without action on the bills.

The issue did not end with the close of the 111th Congress. The Fiscal Year 2010 Budget Report of the House Appropriation Conference Committee called upon EPA to study the relationship between hydraulic fracturing and drinking water contamination. The Obama administration EPA, reversing the stand taken by EPA during the Bush administration, agreed to undertake the study. The proposed study timeline is to provide study guidelines to the Science Advisory Board for peer review in early 2011, to initiate the study in 2011, and to release findings in 2012. On September 9, 2010, the EPA issued voluntary information requests to nine leading hydraulic fracturing companies. The information requests are for data on the chemical composition of fracking fluids used, data on the impacts of fracking fluids on human health or the environment, and the sites where the chemicals have been used (Environmental Protection Agency, 2010a).

On December 7, 2010 EPA issued an endangerment order against a Barnett Shale gas company in Fort Worth, Texas. EPA ordered the company to take immediate action to protect homeowners who have complained repeatedly about flammable and bubbling drinking tap water. EPA testing confirmed that high levels of methane gas in the water posed an immediate risk of explosion or fire. In August of 2010, EPA received the initial citizens' complaints. When an EPA inspector followed up on the complaints, EPA learned that the homeowners had previously complained to the Railroad Commission of Texas (RRC), the state regulatory authority for the gas and oil industry, but that the RRC had taken inadequate action. EPA confirmed that the water contained both methane and benzene, a known carcinogen (Environmental Protection Agency, 2010a).

While the EPA is actively investigating hydraulic fracturing and its impacts on drinking water resources, there currently is little federal regulatory oversight of HF drilling practices. Aside from EPA issuing immediate endangerment orders, regulation that does exist rests primarily with the states. However, because of the many concerns associated with hydraulic fracturing, EPA indicated in December of 2010 that energy extraction sector compliance with the nation's environmental laws will be one of the EPA's National Enforcement Initiatives from 2011 to 2013 (Environmental Protection Agency, 2010a).

However, some alternative signals are coming for the federal government. In 2010, the Department of Interior held a forum in November on the use of hydraulic fracturing on federal lands. The stated position of Interior is that they encourage the safe and environmentally sustainable extraction of natural gas on federal lands (Department of Interior, 2010). In addition, the Obama administration is entering into partnerships, one with China and another with Poland, to encourage those nations to develop their shale gas reserves.

5. Regulatory steps at the state level

In the absence of cohesive federal regulatory policy, it falls to the states to exercise authority. Many of the states involved with the gas boom have taken some action to regulate some aspects of hydraulic fracturing and horizontal drilling.

On May 25, 2010 representatives of more than 20 local and regional organizations called on the New York state legislators to put in place a moratorium on HF over the Marcellus Shale. The concerns expressed by the local and regional groups included the danger posed to human health and the environment associated with fracking fluid chemicals, toxic waste, and wastewater generated (Earthworks, 2010). Particular concern has resulted because the drinking water supply for New York City is in upstate New York and opponents fear its vulnerability to contamination from HF operations in the Marcellus Shale. The New York State Assembly in November of 2010 passed a law that would have placed a moratorium on issuing new permits for HF drilling. The outgoing governor, David Paterson, vetoed the law, however. He instead issued an executive order instituting a moratorium on HF and horizontal drilling that extends until July 1, 2011 but that allows vertical drilling to continue (Zeller, 2010). With this action, the future of drilling in New York remains undecided. The incoming governor, Andrew Cuomo, will certainly have a pivotal role to play in coming to a resolution.

Other states have taken action as well. The state of Colorado requires partial revelation of chemicals added to fracking fluids in the event of an emergency. This disclosure, however, is only to physicians and regulators and not to the general public, thereby preserving private drillers' trade secrets. Colorado does require companies to maintain a chemical inventory for each well and to provide it to the Colorado Oil and Gas Conservation Commission if asked. Wyoming's Oil and Gas Conservation Commission initially required drillers to report chemicals used in HF operations to the Commission, but like the Colorado regulation, disclosure was shielded from the public (Soraghan, 2010a). But effective September 15, 2010 the state requires full disclosure to the public of each ingredient used in hydraulic fracturing operations (Soraghan, 2010b). The Pennsylvania Department of Environmental Protection requires MSDS be attached to every drilling plan, which would then be available to land owners, local governments, and emergency response personnel (Soraghan, 2010a).

6. Why Texas matters in the shale gas boom

Texas is the second largest state in the United States, both by land area and population. The 2010 Census reports that Texas has a population of 25,145,561 (the total 2010 U.S. population is 308,745,538 and the largest state, California, has a population of 37,253,956) (U.S. Census Bureau, 2010). While Alaska is physically larger, Texas is the largest state in the "lower 48" and consists of 268,601 square miles (695,676 square kilometers). At its widest points, Texas is 790 miles (1271 km) in length and 660 miles (1062 km) wide (Carpenter and Provorse, 1998). This vast space is rich in oil and gas reserves and is home to the industries that can exploit them.

Texas has a long history of oil and gas production. While the first successful drilling of an oil well dates back to the 1860s, Texas did not enter into the true boom of oil and gas production until 1901 when the Spindletop gusher in came in. Since that discovery, Texas has maintained its position as one of the world's largest producers of oil and gas (Railroad Commission of Texas, 1991).

Overall U.S. production of natural gas amounted to just over 26,013 billion cubic feet in 2009 (728.36 billion cubic meters) (Energy Information Administration, 2010c), of which 7682 billion cubic feet (215 billion cubic meters) were produced in Texas (Railroad Commission of Texas, 2010a). This amounts to about 30% of current U.S. total natural gas production.

Where that natural gas is coming from is changing rapidly. Across the U.S. withdrawals from conventional gas and oil wells are declining while withdrawals from shale gas wells and coalbed wells are increasing. Coalbed well production is going up modestly but shale gas production is rising precipitously. The Energy Information Administration in the last few years has increased its forecast of shale gas reserves extensively. The EIA's 2011 projections are double what they forecast in 2010. The expectation that such increases will continue into the future are underscored by EIA's prediction that by 2035, 45% of U.S. natural gas will be produced from shale gas plays, up from 14% in 2009 (Energy Information Administration, 2011). The increases in production are due, EIA says, to "more efficient, cost-effective drilling techniques, notably in the production of natural gas from shale formations" (Energy Information Administration, 2010a).

Production of shale gas in Texas is increasing rapidly. In 2007, Texas produced 988 billion cubic feet (27.66 billion cubic meters) of shale gas. In 2009, production had risen to 1789 billion cubic feet (50 billion cubic meters). That production accounted for 57% of the 3110 billion cubic feet (87 billion cubic meters) of shale gas produced in the United States that year (Energy Information Administration, 2010d). And estimates of proved shale gas reserves within Texas continue to rise at the same steep rate. Texas is the key player in domestic U.S. shale gas production.

7. The regulatory tangle of Texas

While other states have moved legislatively or administratively to control shale gas drilling within their jurisdictions, the regulatory climate of Texas has thus far prevented any similar action in the Lone Star State. Where some efforts have been attempted, they have not gone far. The reasons are interrelated and primarily due to the fragmentation of the regulatory bureaucracy, a fundamental anti-regulatory disposition, and a well entrenched legal and administrative structure that promotes oil and gas extraction above other concerns.

Texas, like some other states, does not have a centralized administrative structure for managing environmental regulation. Multiple commissions and authorities have a role to play in jurisdiction over mineral, water, air, and land regulation. But unlike states like California, that also have a fragmented structure, Texas does not have a strong ethos of environmental protectionism. Moreover, under the leadership of Governor Rick Perry, Texas has taken a decidedly anti-EPA and anti-federal regulation position.

Within Texas, environmental pollution issues typically fall under the jurisdiction of the Texas Commission on Environmental Quality. TCEQ is the agency that deals with air and water quality issues as the state agency given primacy for implementing federal clean water and air environmental laws. TCEQ, however, has recently found itself in conflict with the EPA over what EPA considers lax enforcement of the federal Clean Air Act. In a most unusual step, in March of 2010 EPA disapproved Texas' air permitting exemption program (Environmental Protection Agency, 2010c). The Qualified Facilities exemption rule was submitted by TCEQ to EPA as part of the required State Implementation Plan (SIP). The rule allows certain facilities that have Texas permits to avoid following federal Clean Air Act requirements. EPA rejected the permitting plan and told Texas to change the SIP to bring it into compliance with Clean Air Act requirements (Galbraith, 2010b). Texas refused and the standoff began. The Governor and the TCEQ argue that the federal government is meddling in Texas' business and is involved in an unconstitutional overreach.

Tension between the TCEQ and the EPA escalated later in 2010 when Texas became the only state to refuse to implement EPA's greenhouse gas regulations. While several other U.S. states have joined with Texas in suing the EPA over its efforts to regulate greenhouse gases, Texas is the only state that has refused to create a state program to implement the federal rules. In December, EPA announced that it would seize authority and issue Clean Air Act greenhouse gas permits in Texas because of Texas' unwillingness to do so (Micheals, 2010). Texas has appealed to the courts and continues to fight the EPA. It is important to note that Texas is the leader in greenhouse gas production in the United States and that the EPA does not seem ready to negotiate a deal with the state.

EPA has pushed TCEQ to consider carefully air emissions in the Barnett Shale. Responding to complaints from citizens of Dish, Texas EPA began an investigation of toxic air emissions in 2010. The Texas Commission on Environmental Quality also conducted a study of air quality in the Barnett Shale. They found elevated levels of benzene and other chemicals. TCEQ recommended long-term monitoring (Vaughan and Pursell, 2010). Subsequently, the TCEQ put in place a two-phase monitoring study to examine air emissions in the Barnett Shale (Texas Commission on Environmental Quality, 2010). But drilling continues.

Conflict with the EPA has spilled over to another Texas agency, the Texas Railroad Commission. Under Texas law, the Railroad Commission regulates the oil and gas industry including pipeline transporters. It is responsible for community safety and stewardship of natural resources, while at the same time one of its missions is to promote "enhanced development and economic vitality" (Railroad Commission of Texas, 2011a). Given its dual purposes, some would suggest that the missions of community safety and of stewardship of natural resources fall victim to that of promoting the oil and gas industry.

The Railroad Commission has come into conflict with the EPA for its lax enforcement of the Safe Drinking Water Act. In December of 2010, EPA issued an Imminent and Substantial Endangerment Order to protect drinking water in Southern Parker County. By this order the EPA ordered a natural gas company operating in the Barnett Shale in Fort Worth to take immediate action to protect the water wells of local residents. EPA testing confirmed the presence of flammable substances in the drinking

water. By issuing this order of endangerment, the EPA trumped the RRC which had done nothing in response to complaints from homeowners (Environmental Protection Agency, 2010d).

Air and water quality issues are not the only regulatory concerns in Texas. In an arid state like Texas, water quantity is a key issue. When it comes to determining adequacy of water supplies, multiple authorities exercise overlapping jurisdiction in Texas. These include the more than three dozen river authorities and special law districts, multiple aquifer authorities, nearly 100 Groundwater Conservation Districts, sixteen Groundwater Management Areas, and seven Priority Groundwater Management Areas, myriad water utilities, municipalities, and counties. In addition, the Texas Water Development Board and its regional planning committees are responsible for producing a 50 year plan for water resources, updated every 5 years. However, when it comes to use of groundwater use for drilling gas or oil wells, in Texas, these regulatory bodies have no authority.

The Railroad Commission allows a company to use as much groundwater as it needs to complete a well (Railroad Commission of Texas, 2011b). Drillers that wish to use surface water do need to apply to TCEQ for a permit. The first such application was filed in 2010 for use of San Antonio River water for a fracking operation in the Eagle Ford Shale. The permit seeks 65 million gallons a year for ten years (Harman, 2010). The use of such vast amounts of water raises some concerns especially in dryer parts of the state but there is no attempt to control the water use. Groundwater is specifically exempted from control under the state's water code. It appears that use of water will not be a barrier to continued shale gas hydraulic fracking operations.

In Texas, surface land property right can be separated from mineral rights and mineral rights supersede property rights. Natural gas is classified as a mineral. The separation of surface rights from mineral rights can happen in several ways. Either the land owner sells the minerals but retains the surface or the land owner retains the minerals but sells the surface. In Texas the latter is more common. The language regarding the terms of the sale is recorded in the deed. If the seller fails to reserve the minerals when selling the surface, the mineral ownership goes automatically to the buyer and the transaction is considered a fee simple estate. Whether the surface and mineral estates are separated on a tract of land or not, in Texas mineral rights are dominant. This is because to benefit from the ownership of minerals, access to the surface of the land is essential. If mineral ownership did not have priority over surface rights in law, then mineral rights would be worthless for the mineral owner could not enter the land to explore and extract the minerals (Fambrough, 2009).

Because the surface of the land must be disturbed so that minerals may be accessed, this can create a tension between surface land property owners and mineral rights owners. It is important to note that often the same individual owns both the surface and mineral rights, in which case no conflict would ensue unless the damage done to the property was greater than the owner initially anticipated and later regretted. Mineral rights owners are permitted by Texas law to lease the rights to explore for oil and gas to a company which in turn must provide the surface land owner a notification of intent to explore and drill. In Texas, though, the surface land owner cannot block the mineral rights owner from access to the minerals. Mineral rights owners can use as much surface land as is reasonably necessary to explore, drill, and extract minerals. The mineral rights owner is allowed by Texas law to clear trees and remove fences so that drilling rigs can be brought to the property. Once gas is discovered, the mineral owner can bring in extraction equipment on a dedicated pad that can be an acre or more in size. The mineral rights owner or lessee may also erect pipelines for the removal of minerals. Texas law does not require the mineral owner or lessee to pay for damages to the land or to pay reparations for the loss of use of the land while the drilling operation is in place (Woods, 2010).

In Texas, private gas pipeline companies have been given the right of eminent domain by state statute which in practicality allows them to lay lines where ever they choose. That interstate pipeline companies have the power of eminent domain is established in federal law. Interstate natural gas transmission pipeline companies were given the power of eminent domain by the federal Natural Gas Act of 1938. An interstate pipeline company may use the power of eminent domain if the Federal Energy Regulatory Commission (FERC) has issued a certificate of public convenience and necessity for a pipeline project and the company has not been able to successfully negotiate a purchase price with the property owner (Arntsen and Simmons, 2009). Intrastate pipelines are generally regulated by state Public Utility Commissions. States vary on the authority given to intrastate pipeline operators. In most states, intrastate pipelines and gathering pipelines – lines that take the gas from the wells to a larger transmission line – do not have eminent domain authority (Killion, 2010). In Texas, however, pipeline companies have considerable sway.

In Texas, pipeline operators and gas utilities have the power of eminent domain. The Railroad Commission does not have any right to regulate any pipeline with respect to the exercise of eminent domain (Railroad Commission of Texas, 2010b). So if a company wants to cross private property to lay a pipeline, they are allowed to do so. If they take the entire property through condemnation, they were required under the 1936 case *State v. Carpenter* to provide fair market value for the land (Brennan and Peacock, 2010). However, in 2004, the Texas Supreme Court ruled in *Hubenak v. San Jacinto Gas Transmission Co.* that the dollar amount of the condemning agent's offer does not have to align with fair market value for the land. Further, even if the party whose land is being taken wins in a court appeal, the attorney fees and appraiser fees cannot be recovered as part of the judgment (Fambrough, 2010). These aspects of Texas policy make opposing mineral development difficult and costly.

Taken together these provisions and actions constitute a very friendly environment for oil and gas producers in the state of Texas. Unlike actions in other states and at the federal level to control horizontal drilling and hydraulic fracturing, Texas remains pretty much "the wild West". The fragmentation of the Texas regulatory bureaucracy, a fundamental anti-regulatory disposition of the TCEQ and the Governor, and the well entrenched legal and administrative structures that promote oil and gas extraction above other concerns make Texas a strong pro-drilling state. While land owners who lease their mineral rights to oil and gas companies stand to gain significant income from such leases, once the lease is negotiated land owners have few protections. How much water will be used, the disposal of wastewater, and the footprint of drilling operations are not under their control. What will remain of the rural land that passes to future generations is unclear. And urban dwellers who find themselves unexpectedly living in a gas field will have to deal with the development and production.

8. Conclusion

As this study shows, hydraulic fracturing and horizontal drilling of shale gas plays is fraught with contention. The strife, though, goes in two directions. Pro-drilling states, like Texas, find themselves in conflict with the federal government while anti-drilling forces (individuals or states) find themselves in conflict

with drillers and advocates of drilling. This contention will not be resolved any time soon. Both the pro-drilling and anti-drilling groups will continue to use the courts and the political or administrative powers at their disposal to win their goals.

Baring a smoking gun that undisputedly ties HF techniques to drinking water contamination, hydraulic fracturing and horizontal drilling of shale gas plays will likely not be stopped. There is too much resource to be had, too much need to satisfy, and too much money to be made. The controversy will probably drive drillers toward discovery and use of non-toxic alternatives for fracking chemicals whenever possible. Fear of liability will impel this shift probably as much as the desire to avoid costly and time consuming conflict with opposition parties. Communities near shale gas plays will continue to be transformed by the drilling activities. Rural pastoral land will be littered with drilling rigs, pipeline will be laid, and 24-7 industrial operations will continue until the play is fully exploited. Urban populations that find themselves in the middle of shale gas plays will likewise see their communities transformed to accommodate the industry. The water resources the drillers need will be diverted from other uses to permit shale gas recovery.

The increasing demand from some states for federal oversight seems likely to produce some results. EPA will issue its report on hydraulic fracturing in 2012 and will likely continue to step in when local environmental issues cross the threshold of imminent danger. New York in particular seems poised to take action to slow the use of hydraulic fracturing out of fear for their drinking water. But whether the current horizontal drilling moratorium will be renewed is unclear. Even if the anti-drilling factions succeed in some locations, they will not in others.

Drilling will continue in Texas. Since Texas is such a large part of the future of the industry, it seems pretty clear that the industry will carry on. To what extent the federal government will involve itself in efforts to control the untoward environmental impacts of hydraulic fracturing is questionable. The fact that the Obama administration is engaged in development of international partnerships suggests that the U.S. will continue to vigorously pursue production of shale gas reserves at home and worldwide.

References

Arntsen, A., Simmon, J., 2009. Reviewing eminent domain law. Pipelines and Gas Technology Available at 〈http://www.pipelineandgastechnology.com/article/print/47659〉.

Brennan, R., Peacock, B., 2010. Condemnation Compensation. Texas Public Policy Foundation, Austin.

Carpenter, A., Provorse, C., 1998. The World Almanac of the U.S.A.. St. Martin's Press, New York.

Cox, R., 2010. Shale Gas Success Drives Down Prices. New York Times December 20. Available at 〈http://www.nytimes.com/2010/12/21/business/21views.html〉.

Department of Interior, 2010. Secretary Salazar to Convene Forum on Hydraulic Fracturing on Federal Lands. Department of Interior Available at 〈http://www.doi.gov/news/mediaadvisories/Secretary-Salazar-to-Convene-Forum-on-Hydraulic-Fracturing-on-Public-Lands.cfm〉.

Earthworks, 2009. Pavillion, WY citizens call for fracking moratorium. Press Release. Available at 〈http://earthwroksaction.org/PR_EPApavillionDrinking Water. cfm〉.

Earthworks, 2010. Coalition calls on New York state legislature to enact moratorium on natural gas development. Press Release. Available at 〈http://earthwroksaction.org/PR_NYmoratorium.cfm〉.

Energy Information Administration, 2010a. Natural Gas Explained: How Much Natural Gas is Left. Energy Information Administration. U.S. Department of Energy, Washington, D.C. Available at 〈http://www.eia.gov/energyexplained/index.cfm?page=natural_gas_reserves〉.

Energy Information Administration, 2010b. Natural Gas Pipelines—Basics. U.S. Department of Energy, Washington, D.C. Available at 〈http://www.eia.doe.gov/energyexplained/index.cfm?page=natural_gas_pipelines〉.

Energy Information Administration, 2010c. Natural Gas Gross Withdrawals and Production. U.S. Department of Energy, Washington, D.C. Available at 〈http://www.eia.doe.gov/dnav/ng/ng_prod_sum_dcu_NUS_a.htm〉.

Energy Information Administration, 2010d. Shale Gas Production. U.S. Department of Energy, Washington, D.C. Available at 〈http://www.eia.doe.gov/dnav/ng/ng_prod_shalegas_sl_a.htm〉.

Energy Information Administration, 2011. Annual Energy Outlook 2011 Early Release Overview. Energy Information Administration, U.S. Department of Energy, Washington, D.C. Available at 〈http://www.eia.gov/forecasts/aeo/〉.

Environmental Protection Agency, 2004. Evaluation of Impacts to Underground Sources of Drinking Water by Hydraulic Fracturing of Coalbed Methane Reservoirs. EPA Document 816-R-01-003. Environmental Protection Agency, Washington, D.C.

Environmental Protection Agency, 2010a. Hydraulic Fracturing: EPA's Current Hydraulic Fracturing Study (2010–2012). Environmental Protection Agency, Washington, D.C. Available at 〈http://water.epa.gov/type/groundwater/uic/class2/hydraulic%20fracturing/index.cfm〉.

Environmental Protection Agency, 2010b. Scoping Materials for Initial Design of EPA Research Study on Potential Relationships Between Hydraulic Fracturing and Drinking Water Resources. Environmental Protection Agency, Washington, D.C. Available at 〈http://yosemite.epa.gov/sab/sabproduct.nsf/0/3B745430D624ED3B852576D400514B76/$File/HydraulicFracScopingDocforSAB-3-22-10Final.pdf〉.

Environmental Protection Agency, 2010c. EPA Disapproves Air Permitting Exemption Program in Texas. Environmental Protection Agency, Washington, D.C. Available at 〈http://yosemite.epa.gov/opa/admpress.nsf/0/AE60DE3EF044C1A8852576F70055162F〉.

Environmental Protection Agency, 2010d. EPA Issues an Imminent and Substantial Endangerment Order to Protect Drinking Water in Southern Parker County. Environmental Protection Agency, Washington, D.C. Available at 〈http://epa.gov/region6/6xa/120710_endangerment_order.htm〉.

Fambrough, J., 2009. Minerals, surface rights and royalty payments. Real Estate Center, Texas A&M University, Technical Report 840.

Fambrough, J., 2010. Shock Treatment: Negotiating Transmission Line Easements. Tierra Grande. Publication, 1928pp.

Fowler, T., 2010. Just when you thought it was safe to stay out of the water. NewsWatch: Energy Available at 〈http://blogs.chron.com/newswatchenergy/archives/hydraulic_fracturing/〉.

Galbraith, K., 2010a. Dash for Gas Raises Environmental Worries, July 12. New York Times, New York Available at 〈http://www.nytimes.com/2010/07/12/business/energy-environment/12iht-green.html?_r=1&src=tp〉.

Galbraith, K., 2010b. For Rick Perry, EPA is useful villain. The Texas Tribune, December 17. Available at 〈http://www.texastribune.org/texas-environmental-news/environmental-problems-and-policies/texass-governor-epa-useful-villain/〉.

Harman, G., 2010. First water permit filed for SA River water to mine in Karnes, Dewitt. San Antonio Current. Available at 〈http://www.sacurrent.com/blog/gueblog.asp?perm=70449〉.

Killion, M., 2010. The Law of Pipelines. North American Pipelines Available at 〈http://www.napipelines.com/featured/2010/2010-09-feature-3.html〉.

Kohl, K., 2007. Breaking through the Barnett shale: our future in unconventional natural gas. Energy and Capital Available at 〈http://www.energyandcapital.com/articles/barnett+shale-devon+energy-natural+gas/521〉.

Library of Congress, 2009. Thomas: bill summary and status. FRAC Act. 111th Congress. S. 1215. H.R. 2766. Available at 〈http://thomas.loc.gov/cgi-bin/bdquery/z?d111:HR02766:|/home/LegislativeData.php|〉.

Micheals, D., 2010. EPA to issue greenhouse gas permitsin Texas. The Dallas Morning News, December 24. Available at 〈http://www.dallasnews.com/sharedcontent/dws/dn/latestnews/stories/122410dntexepa.41cb7433.html〉.

Office of Research and Development, 2010. Science in Action: Building a Scientific Foundation for Sound Environmental Decisions. Environmental Protection Agency, Washington, D.C.

Railroad Commission of Texas, 1991. An Informal History Compiled for the Centennial. Railroad Commission of Texas, Austin Available at 〈http://www.rrc.state.tx.us/abou/hisoty/centennial/centennial01.php〉.

Railroad Commission of Texas, 2010a. Monthly Oil and Gas Production by Year. Railroad Commission of Texas, Austin.

Railroad Commission of Texas, 2010b. Pipeline Eminent Domain and Condemnation Frequently Asked Questions. Railroad Commission of Texas, Austin Available at 〈http://www.rrc.state.tx.us/about/faqs eminentdomain.php〉.

Railroad Commission of Texas, 2011a. Mission Statement. Railroad Commission of Texas, Austin Available at 〈http://www.rrc.state.tx.us/about/mission.php〉.

Railroad Commission of Texas, 2011b. Water Use in Association with Oil and Gas Activities Regulated by the Railroad Commission. Railroad Commission of Texas, Austin Available at 〈http://www.rrc.state.tx.us/barnettshale/wateruse.php〉.

Rahm, D., 2010. Climate Change Policy in the United States: The Science, the Politics and the Prospects for Change. McFarland and Company, Inc. Publishers, Jefferson, N.C. and London.

Soraghan, M., 2010a. Natural gas company's disclosure decision could change fracking debate. New York Times, July 15. Available at 〈http://www.nytimes.com/gwire/2010/07/15/15greenwire-natural-gas-companys-disclosure-decision-could-5706.html〉.

Soraghan, M., 2010b. Wyoming natural gas fracking rules for point the way for public disclosure of chemicals used. New York Times, December 20. Available at 〈http://www.nytimes.com/gwire/2010/12/20/20greenwire-wyo-natural-gas-fracking-rules-for-point-the-w-18753.html〉.

Sumi, L., 2005. Our Drinking Water at Risk: What EPA and the Oil and Gas Industry Don't Want Us to Know About Hydraulic Fracturing. Oil and Gas Accountability Project, Washington, D.C.

Texas Commission on Environmental Quality, 2010. Point Source Emissions Inventory. Texas Commission on Environmental Quality, Austin Available at 〈http://www.tceq.state.tx.us/implementation/air/industei/psei/psei.html#barnett〉.

U.S. Census Bureau, 2010. U.S. Census Bureau Announces 2010 Census Population Counts—Apportionment Counts Delivered to President. U.S. Census Bureau, U.S. Department of Commerce Available at 〈http://2010.census.gov/new/release/operations/cb10-cn93.html〉.

Vaughan, A.D., Pursell, D., 2010. Frac Attack: Risks, Hype, and Financial Reality of Hydraulic Fracturing in the Shale Plays. Reservoir Research Partners and TudorPickering Holt and Co, Houston.

Wilder, F., 2010. The fire down below. Texas Observer, December 2. Available at 〈http://www.texasobserver.org/cover-story/the-fire-down-below〉.

Woods, G., 2010. Mineral rights vs. property rights in Texas. *e*How. Available at 〈http://www.ehow.com/list_6156127_mineral-vs_-property-rights-texas.html〉.

Zeller, T., 2010. New York governor vetoes fracking bill. New York Times, December 11. Available at 〈http://green.blogs.nytimes.com/2010/12/11/new-york-governor-vetoes-fracking-bill/〉.